OPERATING INSTRUCTIONS

MPB10

Multi Physics Box

SICK
Sensor Intelligence.

Described product

MPB10

Manufacturer

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Legal information

Original document

This document is an original document of SICK AG.

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1 Information on the operating instructions

These operating instructions provide important information on how to use sensors from SICK AG.

Prerequisites for safe work are:

- Compliance with all safety notes and handling instructions supplied
- Compliance with local work safety regulations and general safety regulations for sensor fields of application

The operating instructions are intended to be used by qualified personnel and electrical specialists.

NOTE
Read these operating instructions carefully before starting any work on the sensor, in order to familiarize yourself with the sensor and its functions.

The instructions constitute an integral part of the product and are to be stored in the immediate vicinity of the sensor so they remain accessible to staff at all times. If the sensor is passed on to a third party, these operating instructions should be handed over with it.

These operating instructions do not provide information on operating the machine in which the sensor is integrated. For information about this, refer to the operating instructions of the specific machine.

2 About this document

2.1 Further information

You can find the product page with further information under the **SICK Product ID** at: pid.sick.com/{**P/N**}.

P/N corresponds to the part number of the product.

The following information is available depending on the product:

- Data sheets
- These publication in all available languages
- CAD files and dimensional drawings
- Certificates (e.g., declaration of conformity)
- Other publications
- Software
- Accessories

2.2 Symbols and document conventions

Warnings and other notes

DANGER
Indicates a situation presenting imminent danger, which will lead to death or serious injuries if not prevented.

WARNING
Indicates a situation presenting possible danger, which may lead to death or serious injuries if not prevented.

CAUTION
Indicates a situation presenting possible danger, which may lead to moderate or minor injuries if not prevented.

NOTICE
Indicates a situation presenting possible danger, which may lead to property damage if not prevented.

NOTE
Highlights useful tips and recommendations as well as information for efficient and trouble-free operation.

Instructions to action

▶ The arrow denotes instructions to action.

1. The sequence of instructions is numbered.
2. Follow the order in which the numbered instructions are given.

✓ The tick denotes the results of an action.

2.3 Customer service

If you require any technical information, our customer service department will be happy to help. To find your agency, see the final page of this document.

NOTE
Before calling, make a note of all type label data such as type code, serial number, etc., to ensure faster processing.

3 Safety information

3.1 Intended use

The Multi Physics Box MPB10 is a condition monitoring sensor. It is used to detect ambient and/or status conditions of a machine or system, such as vibration, shock and temperature.

The sensor can issue alarms when definable values are exceeded.

The data can be stored, visualized and analyzed via integration in a system controller or a gateway. Through integration with cloud systems and analytics tools, the MPB10 can be used as part of a condition monitoring system.

SICK AG assumes no liability for losses or damage arising from the use of the product, either directly or indirectly. This applies in particular to use of the product that does not conform to its intended purpose and is not described in this documentation.

3.2 Improper use

- The sensor does not constitute a safety-relevant device according to the EC Machinery Directive (2006/42 / EC).
- The sensor must not be used in explosion-hazardous areas.
- Any other use that is not described as intended use is prohibited.
- Any use of accessories not specifically approved by SICK AG is at your own risk.
- The sensor is not suitable for outdoor applications.

! **NOTICE**
Danger due to improper use!

Any improper use can result in dangerous situations.

Therefore, observe the following information:

▶ The sensor should be used only in line with intended use specifications.
▶ All information in these operating instructions must be strictly complied with.

3.3 Limitation of liability

Applicable standards and regulations, the latest technological developments, and our many years of knowledge and experience have all been taken into account when assembling the data and information contained in these operating instructions. The manufacturer accepts no liability for damage caused by:

- Failure to observe the operating instructions
- Improper use
- Use by untrained personnel
- Unauthorized conversions
- Technical modifications
- Use of unauthorized spare parts, wear and tear parts, and accessories

The actual scope of delivery may differ from the features and illustrations shown here where special variants are involved, if optional extras have been ordered, or as a result of the latest technical changes.

3.4 Requirements for skilled persons and operating personnel

WARNING
Risk of injury due to insufficient training!
Improper handling of the sensor may result in considerable personal injury and material damage.

- All work must only ever be carried out by the stipulated persons.

The operating instructions state the following qualification requirements for the various areas of work:

- **Instructed personnel** have been briefed by the operating entity about the tasks assigned to them and about potential dangers arising from improper action.
- **Skilled personnels** have the specialist training, skills, and experience as well as knowledge of the relevant regulations to be able to perform tasks assigned to them and to recognize and avoid any potential dangers independently.
- **Electricians** have the specialist training, skills, and experience, as well as knowledge of the relevant standards and provisions, to be able to carry out work on electrical systems and to recognize and avoid any potential dangers independently. In Germany, electricians must meet the specifications of the DGUV Work Safety Regulations (e.g. Master Electrician). Other relevant regulations applicable in other countries must be observed.

The following qualifications are required for various activities:

Activities	Qualification
Mounting, maintenance	▪ Basic practical technical training ▪ Knowledge of the current safety regulations in the workplace
Electrical installation, device replacement	▪ Practical electrical training ▪ Knowledge of current electrical safety regulations ▪ Knowledge of the operation and control of the devices in their particular application
Commissioning, configuration	▪ Basic knowledge of the design and setup of the described connections and interfaces ▪ Basic knowledge of data transmission ▪ Knowledge of the operation and control of the devices in their particular application
Operation of the device for the specific application	▪ Knowledge of the operation and control of the devices in their particular application ▪ Knowledge of the software and hardware environment in the application

3.5 Hazard warnings and operational safety

Please observe the safety notes and the warnings listed here and in other sections of these operating instructions to reduce the possibility of risks to health and avoid dangerous situations.

4 Product description

4.1 Product ID

4.1.1 Device view

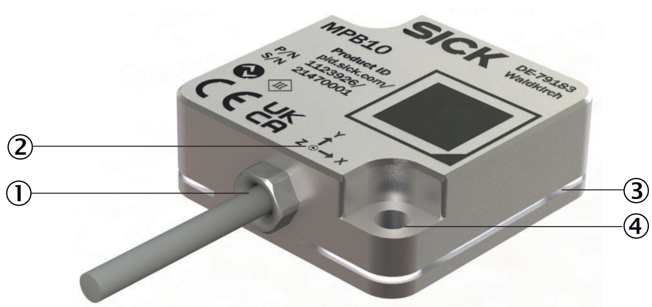


Figure 1: Device view

① Cable connection
② Physical zero position
③ Transparent seal with LED
④ M3 mounting hole

4.2 Product characteristics

4.2.1 Product features

The following parameters are measured at the following positions:

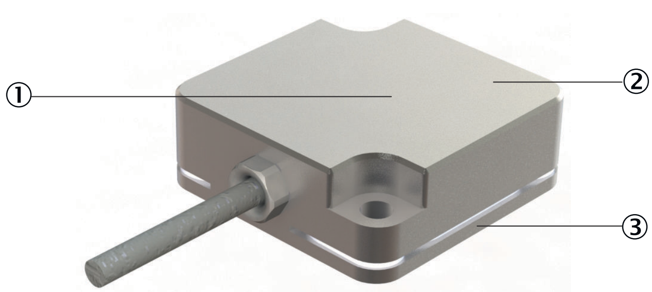


Figure 2: Sensor elements

① Vibration
② Shock
③ Temperature

The measured values can be output via the IO-Link service data as well as via the process data. The structure of the process data and service data can be found in section 10.

Target applications

With the ability to set vibration limit values according to ISO 10816-3 (see "Limit values based on ISO 10816 (Index 4534-4536)", page 33), the Multi Physics Box is ideal for monitoring rotating components such as pumps, fans and motors.

Added to this are vibration, temperature and shock data, which enables condition determination for additional applications. By recording condition indicators and machine states, early maintenance cycles can therefore be carried out before failures and downtime occur with the resulting high costs.

As a result, maintenance intervals can be adapted to the actual maintenance requirements. This results in reduced maintenance costs, higher machine availability, reduced downtime/production loss costs, extended life cycles of machines and plants, and increased production/product quality.

4.2.2 Status indicators

The LEDs indicate the current operational status of the Multi Physics Box. As shown in figure 1, these light up the almost completely transparent seal to the outside at the sides.

The different LED states are shown in table 1.

Table 1: LED states

LED	Operational status
	SIO mode active
(1 Hz)	IO-Link communication
	Alarm active
(2 Hz)	**Find device** mode active[1]

1 With the **Find device** mode, it is possible to clearly identify the Multi Physics Box via the LEDs.

4.2.3 System architecture

The Multi Physics Box provides information for condition monitoring of machines and processes.

For successful interpretation of conditions and incipient failures, ideally the threshold of the condition change should be known or the sensor data should be analyzed. Both on-premise and off-premise systems can be used for data analysis. Possible network structures are listed in figure 3. An off-premise solution can be implemented via a SIM1004 and via a secure SICK cloud connection using SICK LiveConnect. In the cloud, services such as the Monitoring Box (www.sick.com/sick-monitoring-box) can be used. Alternatively, the sensor can also be integrated into a PLC controller via an IO-Link Master (e.g. SIG200) in order to save the data locally on a server.

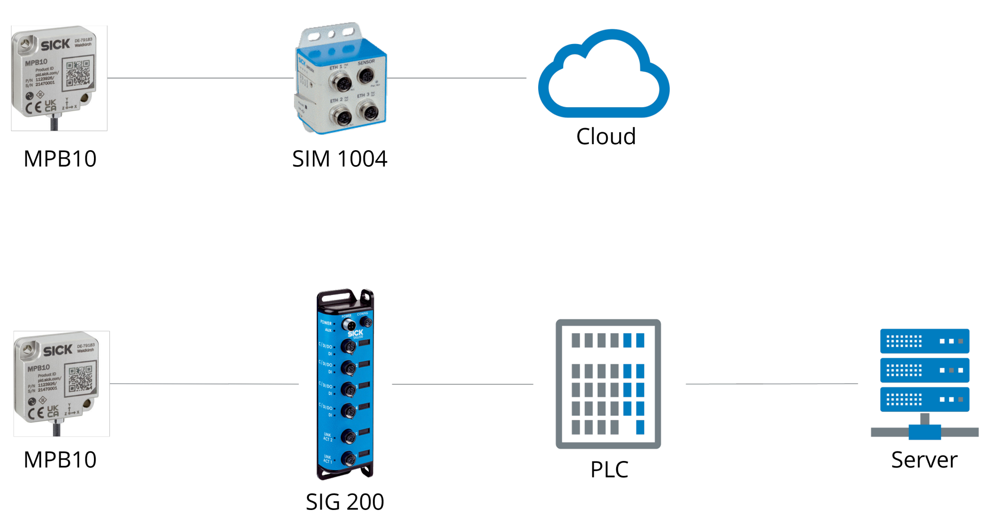


Figure 3: Possible system architecture for data recording

4.3 Vibration analysis (Index 4474-4588)

The Multi Physics Box monitors the vibration of critical components in the time range and in the frequency range.

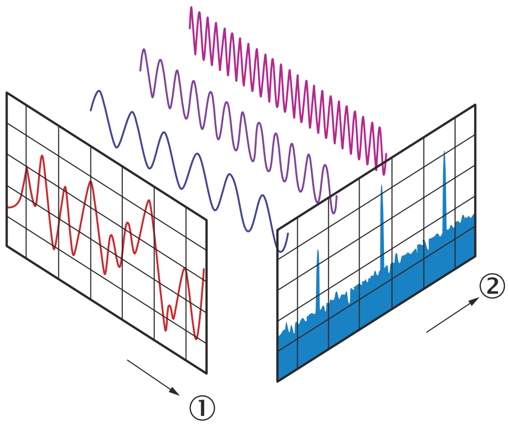


Figure 4: Vibration analysis

① Time

② Frequency

4.3.1 Principle of operation

The sensor detects the acceleration via a MEMS element in the X, Y and Z direction.

For vibration monitoring, the Multi Physics Box does not display raw acceleration values but rather statistical indication values. These values are calculated block by block in an adjustable time window. The sensor needs processing time to calculate values in the frequency range as well as in the time range. No acceleration values are recorded during this time, as the sensor cannot process any other values.

table 2 indicates the typical processing time in relation to the block size. After processing, the indication values are updated and a new block is recorded. This process is shown in figure 5. If a manual trigger (see "Trigger (Index 4474-4475)", page 15) is set, the system waits for the next trigger signal. Likewise, the averaging of blocks (Index 4477, Subindex 5) influences the update rate of the vibration values. Index 4482 can be used to determine whether updated indication values are available.

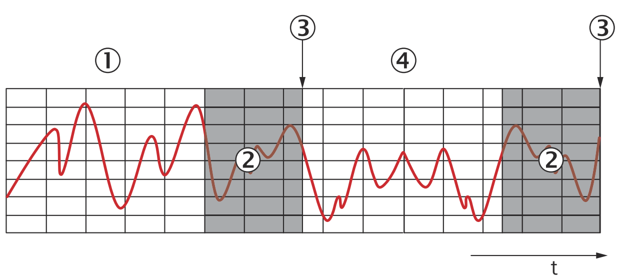


Figure 5: Vibration block and processing

① Block 1

② Process time

③ Available indication values

④ Block 2

4.3.2 Settings for vibration analysis (Index 4477, 4479, 4482, 4531)

The sensor offers the following basic setting options in the vibration analysis:

- Block length
- Alarm axis (see "Vibration monitoring", page 31)
- Signal axis
- Activity detection (see "Activity detection (Index 4479-4480)", page 16)
- Trigger (see "Trigger (Index 4474-4475)", page 15)
- Evaluation zone (see "Limit values based on ISO 10816 (Index 4534-4536)", page 33)

Other adjustments:

- Single-axis mode with a block length of 1,280 ms
- Number of blocks for averaging
- Signal type

NOTICE
Changes in the vibration settings result in all set limit values and alarms being deleted.

Block length (Index 4477, Subindex 2)

The block length represents a compromise between the update rate of the characteristic values and the noise of these values. A shorter block length means more frequent updating, a longer block length means higher averaging and thus lower noise of the indication values. The block length can be set between 20 and 1,280 ms, whereby the maximum duration can only be used in single-axis mode.

Table 2: Block length, processing time and total block length

Block length [ms]	Typical processing time [ms]	Average total block length [ms]
1,280 Only single axis possible	240	1,520
640	320	960
320	160	380
160	80	240
80	40	120
40	20	60
20	10	30

NOTE
Single-axis operation reduces the processing time to approx. 20% of the block length.

Number of blocks for averaging (Index 4477, Subindex 4)

By averaging over several blocks, the noise of the indication values can be reduced even further. However, this reduces the update rate of the frequency and time range parameters.

Table 3: Example values for calculating the update rate

Block length [ms]	Total block length [ms]	Number of blocks for averaging
640	960	3

960 ms (block length) x 3 (number of blocks) = 2,880 ms (update rate)

As shown in the example calculation, the value is updated only after the defined number of recorded blocks with the corresponding processing time. This means that this value is updated every 2.9 seconds. It should also be noted that averaging is only useful if the vibration signal also remains uniform throughout the entire averaging time.

Data update counter (Index 4482)

The data update counter in Index 4482 can be used to see whether the indication values have been updated. This counter is incremented by one each time new vibration data is available in the time and frequency ranges. All influencing factors are taken into account and the counter is only increased if new values are available in the indices. If, for example, 5 blocks are taken into account for averaging, the data update counter is only incremented after 5 blocks and the corresponding processing time.

Signal axis and axis mode (Index 4477, Subindex 1 and 3)

The Multi Physics Box also displays values in the frequency range (see "Vibration in the frequency range", page 18) through a **Fast Fourier** transformation. This is calculated on the vibration data of the signal axis selected via Subindex 3. If information of all 3 axes is required, this can be implemented via the magnitude of the axes.

$$\text{Magnitude} = \sqrt{x^2 + y^2 + z^2}$$

If only one of the three axes is relevant for vibration monitoring, the sensor can be set to single-axis operation via Subindex 1. In this case, all indication values are output only for the axis selected in Subindex 3 (the values on the other axes are ’0’).

NOTE
The maximum block length of 1,280 ms can only be used in single-axis mode.

Signal type (Index 4477, Subindex 4)

The indication values can be calculated based on speed or acceleration values. This selection is valid for the time range and the frequency range.

Indication values calculated based on speed weight low frequencies more heavily.

Indication values based on acceleration, on the other hand, weight higher frequencies more heavily.

Phenomena that primarily cause vibration at frequencies up to 1,000 Hz can be better observed with speed-based indication values. Acceleration-based indication values should be used to detect phenomena that primarily cause higher-frequency vibrations. Some examples are listed in table 4.

Table 4: Vibration speed and acceleration

Signal type	Essential frequency range	Physical influence	Application
Speed	10 ... 1,000 Hz	Kinetic energy and inertia	Unbalance Misalignment Relaxation
Acceleration	Up to 3,200 Hz	Dynamics and shock forces	Mechanical wear, ball bearing damage

It should be noted that the speed-based indication values also heavily weight the low-frequency noise. To obtain stable measured values when using this signal type, the lower limit of the considered frequency range (Index 4478) should therefore be set as high as possible. The minimum value for this limit is 10 Hz with a block length of 640 ms and is set automatically when changing to the Speed signal type. The minimum values for this limit for the other block lengths are shown in table 5.

Table 5: Lower limit of the frequency range for Speed signal type [Hz]

Block length [ms]	Lower limit of the frequency range for Speed signal type [Hz]
20	320
40	160
80	80
160	40
320	20
640	10
1280	10

Bandpass filter (Index 4478)

Which frequency ranges are to be considered can be selected using a bandpass filter. Restricting the frequency range can, depending on the application and the component to be monitored, provide a more precise indication of an error.

If no bandpass filter is applied, the frequency range from 0 to 3,200 Hz is taken into account. When using the “ISO10816 limit values" (see "Limit values based on ISO 10816 (Index 4534-4536)", page 33), the monitored frequency range is limited to 10 ... 1,000 Hz according to the specifications of the standard.

4.3.3 Trigger (Index 4474-4475)

Condition monitoring requires repeatable conditions and corresponding data quality. Only with these two prerequisites can changes in condition over time and deviation over the course of time be detected. In applications with continuous uniform speeds, such as pumps or fans driven by asynchronous motors, this is usually the case. The vibration should always remain the same, no matter at what point in time it is measured during operation. This is not the case with dynamic, non-uniform movements such as punches, presses or motors with changing loads. Here, the data must be recorded at a specific point in time at which a constant vibration pattern is expected (e.g. always the same point in time in the punching process).

NOTE
When using the trigger, the number of blocks for averaging (Index 4477 Subindex 4) should be considered and set to 1 if necessary. With a block number of 4, for example, the trigger must fire 4 times before the values are output.

Trigger settings (Index 4474)

Recording starts with an automatic trigger immediately after the boot process. The data blocks and the evaluations then line up seamlessly and the indication values are updated according to the total block length (see table 2, page 13). This is the factory setting, which is suitable for uniform, permanent movements.

If, on the other hand, recording of data is to be started at an exactly defined time, it can be triggered via an index or via pin 2. The selection of the trigger source (automatic, index or pin 2) is done in Index 4474, Subindex 1. If required, this trigger can be delayed by an adjustable time (Index 4474, Subindex 3).

Trigger via an ISDU

Index 4475 can be used to trigger by writing a 1 if trigger source ISDU is selected in Index 4474, Subindex 1.

Trigger via pin 2 (Index 121)

Alternatively, pin 2 can be triggered by a falling or rising signal edge or both on the hardware side. The setting via which a signal edge is to be triggered takes place in 4474, Subindex 2. At the same time, pin 2 in Index 121 must be configured as a trigger signal (see "Configuration of digital outputs", page 44).

4.3.4 Activity detection (Index 4479-4480)

The sensor updates the indication values even when there is no vibration. In this case, the indication values are calculated from the noise signal of the vibration sensor. Especially the impulse factor (see "Vibration in time range (Index 4483-4539)", page 16) can assume very high values, which can lead to misinterpretations of the machine condition and undesired alarms.

An applied vibration can therefore be registered via activity detection. When the function is used, Index 4480 outputs whether an activity is detected or not.

If no vibration is detected, all current indication values are set to 0, the minimum and maximum values are not updated. This has the advantage that, for example, the limit value of the impulse factor is not exceeded as long as no vibration is present. Activity detection is based on the **a-RMS** magnitude value (or in single-axis mode, on the **a-RMS** value of the selected axis). If the **a-RMS** value exceeds the “activity limit” set in Index 4470 Subindex 2, an activity is recognized as such. If the **a-RMS** value falls below the limit value set in Subindex 3, no activity is detected accordingly.

4.3.5 Vibration in time range (Index 4483-4539)

The Multi Physics Box, as shown in section 4.3.1, provides indication values in the time range calculated block by block. These values provide information about the vibration intensity and the type of vibration signal.

A total of 9 statistical and vibration-specific values are provided for interpretation. The mathematical basis of the indication values is described below. Which error cases and effects can represent changes of the respective characteristic values is described in section 9.3.

a-RMS (Index 4483-4485)

a-RMS stands for **acceleration - Root Mean Square.** The value, given in [g = 9.81 m/s^2], is the effective value of the acceleration signal and a measure of the energy contained in the vibration. It can be used to estimate the strength of the vibration. In general, it can be assumed that the **a-RMS** value is more sensitive to changes in vibration above 1,000 Hz than the **v-RMS** value.

v-RMS (Index 4486-4488)

In line with the **a-RMS**, the **v-RMS** (**velocity - Root Mean Square**) in [mm/s] represents the effective value of the speed signal. This value is also a measure of the energy contained in the vibration. Unlike the **a-RMS**, the **v-RMS** is more sensitive to changes in vibration below 1,000 Hz than the **a-RMS**.

Variance (Index 4489-4491)

The variance is a statistical measure that indicates how widely the signal values are scattered around their mean value. In the context of vibration analysis, this is a measure of the strength of a vibration analogous to the RMS value.

Skewness (Index 4491-4494)

Skewness is a statistical measure that indicates the asymmetry of the signal's scatter around its mean value. A change in **Skewness** indicates a fundamental change in the mode of vibration.

Kurtosis (Index 4495-4497)

Kurtosis is a dimensionless parameter for the distribution of values in the acceleration signal. The value can be used to estimate the type of vibration measured and thus detect a change. For example, a white noise signal has a **Kurtosis** of 3, whereby a sine wave has a **Kurtosis** of 1.5. An example is shown in figure 6, where pulses occurring in the vibration are reflected in higher values of **Kurtosis.**

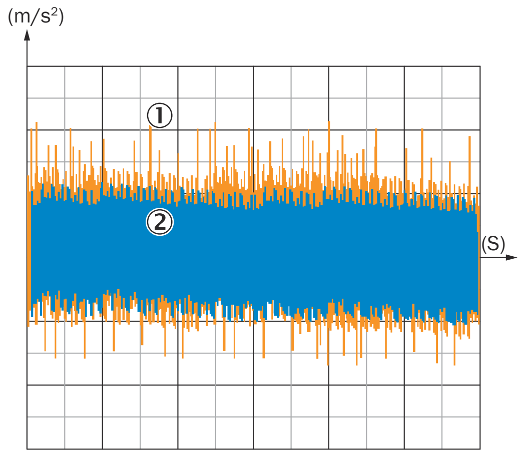


Figure 6: Kurtosis

① Kurtosis = 7

② Kurtosis = 3

Peak to peak (Index 4498-4500)

The **Peak to peak** value indicates the range of raw acceleration and speed values. It is calculated as the difference between the largest and the smallest value.

Shape factor (Index 4501-4503)

The **Shape factor** is defined as the ratio between the effective value of the signal and the mean value of the absolute values of the signal. An increase in the **Shape factor** indicates an increase in the amplitudes of harmonics in the signal.

Crest factor (Index 4504-4506)

The **Crest factor** is defined as the ratio of the **Peak to peak** value to the RMS value of the signal. An increase in the **Crest factor** typically indicates the occurrence of pulsed signal components.

Impulse factor (Index 4507-4509)

The impulse factor is the ratio of the **Peak to peak** raw values to the mean value of the "Absolute raw values." The value can be considered an indication of whether brief pulses occur in the acceleration signal which are significantly stronger than the permanent vibration.

For example, a pure sine wave has a impulse factor of 1.44. If a much stronger impulse factor is measured for an expected sinusoidal vibration, this is an indication of pulsed faults.

Calculation of the impulse factor: IF = maximum value/mean value of the absolute raw values

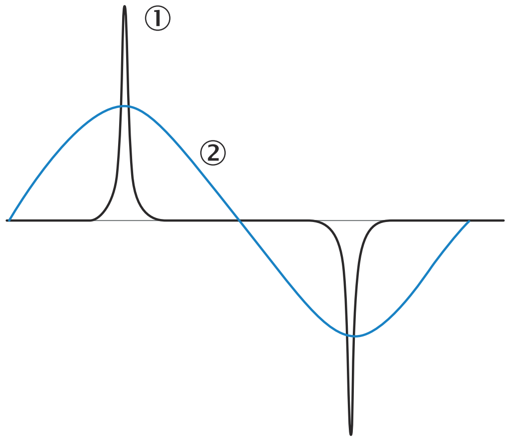


*Figure 7: **Impulse factor** example*

① IF = 4.2

② IF = 1.44

4.3.6 Vibration in the frequency range

Vibration data in the frequency range in many cases allow for a much more precise identification of vibration causes than the previously discussed time range values. For this purpose, the vibration signal is transmitted from the time to the frequency range by means of FFT (**Fast Fourier Transformation**). The information of what are the dominant frequencies in a vibration makes it possible to better understand the cause of the vibration. For example, the vibration of an motor always contains vibrations with frequencies corresponding to the motor speed, but can also contain vibrations caused by the motor bearings or electronic components such as the rectifier, which contain other frequencies.

The acceleration or speed spectrum of the vibration can be observed through the frequency.

The analysis in the frequency range is based on the vibration values of one axis or the sum signal of all 3 axes (magnitude). The selection is made via the settings of the vibration analysis (see "Settings for vibration analysis (Index 4477, 4479, 4482, 4531)", page 12).

The settings for trigger, block length and number of blocks for averaging have the same effect on vibration analysis in the frequency range. The bandpass filter must also be taken into account, which can restrict the frequency range under consideration between 0.78 and 3,200 Hz.

The frequency resolution is calculated with 1 / block length in seconds. It specifies both the smallest measurable frequency and the minimum frequency spacing that two vibration components must have in order to be distinguishable in the frequency analysis.

Table 6: Block length in relation to frequency resolution

Block length [ms]	Resolution [Hz] Smallest measurable frequency
20	50
40	25
80	12.5
160	6.25

Block length [ms]	Resolution [Hz] Smallest measurable frequency
320	3.12
640	1.56
1,280	0.78

As explained in section 4.3.2, the sensor can average the spectra of several data blocks recorded in succession, and continue to process this averaged spectrum (to output the spectrum or to detect the peaks in the spectrum). Averaging improves the signal-to-noise ratio in the spectrum, but the output data is updated correspondingly less frequently.

4.4 Temperature monitoring (Index 4352-4355)

Temperature changes in the application are measured via the back of the sensor housing. The better the thermal diffusivity of the material on which the sensor is mounted, the more accurate the measurement.

If the sensor is non-flush or there is an adapter plate with poor temperature conductivity between the sensor and the machine, the influence of the self-heating of the sensor is stronger and the measured value is less accurate. Observe section 6 here.

4.5 Shock (Index 4434–4448)

In addition to the vibration sensor for vibration, there is another MEMS-based vibration sensor for shock detection in the Multi Physics Box.

With a measuring range of up to 200 g, the maximum accelerations are measured in all three axes, thus monitoring shock events.

5 Transport and storage

5.1 Transport

For your own safety, please read and observe the following notes:

NOTE
Damage to the sensor due to improper transport.

- The device must be packaged for transport with protection against shock and damp.
- Transport should be performed by specialist staff only.
- The utmost care and attention is required at all times during unloading and transportation on company premises.
- Note the symbols on the packaging.
- Do not remove packaging until immediately before you start mounting.

5.2 Transport inspection

Immediately upon receipt at the receiving work station, check the delivery for completeness and for any damage that may have occurred in transit. In the case of transit damage that is visible externally, proceed as follows:

- Do not accept the delivery or only do so conditionally.
- Note the scope of damage on the transport documents or on the transport company's delivery note.
- File a complaint.

NOTE
Complaints regarding defects should be filed as soon as these are detected. Damage claims are only valid before the applicable complaint deadlines.

5.3 Storage

Store the device under the following conditions:

- Recommendation: Use the original packaging.
- Do not store outdoors.
- Store in a dry area that is protected from dust.
- To allow any residual dampness to evaporate, do not package in airtight containers.
- Do not expose to any aggressive substances.
- Protect from sunlight.
- Avoid mechanical shocks.
- Storage temperature: see "Technical data", page 55.
- Relative humidity: see "Technical data", page 55.

6 Mounting

6.1 Mounting requirements

- Comply with technical data such as the permitted ambient conditions for operation of the sensor (e.g., temperature range, EM interference), see "technical data", page 55.
- Protect the sensor from direct sunlight.
- Only mount sensor with the intended accessories.
- Note the signal alignment according to the orientation shown in figure 1.
- A firm connection of sensor and machine without elastic intermediate layers must be ensured. Otherwise, the vibration measurement is falsified.
- For reliable temperature measurement, direct full-surface contact with the measuring object must be ensured.

Mounting location

When selecting the mounting location, the following factors must be considered:

- The mounting location must be as free from (electro)magnetic disturbance fields as possible.
- The area should be at least 28 x 28 mm.
- Attach directly to the component to be monitored or as close as possible (information on measurement on rotating machines such as motors can be found in section 6.3).

6.2 Mounting

Observe the maximum permissible tightening torque of the sensor with M3 fixing screws of 10 Nm.

Recommended mounting screws: M3 x 10 according to EN ISO 4762.

6.3 Mounting methods

NOTICE
It should be noted that when adapter plates and holders are used, the contact temperature is strongly influenced, since the sensor no longer measures directly on the object to be monitored.

Fastening on flat surface

1. Prepare the flat surface with two wells according to the dimensional drawing (see "Dimensional drawing", page 56) with M3 female threads.
2. Clean the mounting surface.
3. Apply thermal paste for optimum contact temperature measurement.
4. Screw the sensor in place accordingly.

Fastening on curved/uneven surface with only one threaded hole

To be able to mount the sensor on an uneven or curved surface, one of the mounting plates listed in section 6.4 should be used. This means the sensor can be fixed with only one screw.

1. Prepare the surface with the well for the M4, M5 or M8 countersunk screw with female thread.
2. Clean the mounting surface.
3. Screw on the adapter plate with the countersunk screw.

4. Screw the sensor in place accordingly.

Figure 8: Mounting on curved/uneven surface by means of adapter plate

Bonding with adhesive

In principle, a screw connection is always recommended. If this is not possible, an epoxy-based adhesive can be used. An adapter plate should always be used to be able to exchange the sensor.

1. Prepare the adhesive according to its application description.
2. Glue on the adapter plate.
3. Allow the adhesive to cure.
4. Screw the sensor in place accordingly.

Temporary mounting with magnets

Before using the accessories, make sure that the mounting surface is flat, not curved and ferromagnetic.

CAUTION
Magnetic forces can cause the material to crush or shatter. Do not let your hands get between the bracket and any ferromagnetic material. Wear gloves and protective goggles when applying.

1. Screw the sensor to the magnetic holder (part number: 2125439) on the side of the magnetic holder shown in figure 9 according to the hole pattern.

Figure 9: Mounting side for mounting bracket

2. Attach the magnetic holder to the mounting surface. Change mounting location if the hold is poor. An additional mounting that prevents a detaching sensor from getting into rotating parts is recommended.

NOTE
When using a magnetic holder, the vibration readings may be affected. Regularly check that the hold and alignment are correct for this mounting method.

Mounting on motors and fans

The best results are obtained when the sensor is placed as close as possible to the motor bearing. If this is not possible, the sensor should be mounted on a surface that is in firm contact with the motor. As with the other mounting methods, mounting the sensor on covers, e.g. the fan cover or other flexible components, is not recommended, as this makes it much more difficult to interpret the vibrations and obtain relevant information about the motor or fan.

The measuring axes should be aligned as shown in figure 10 so that the directions shown are monitored and the vibration changes that occur are detected.

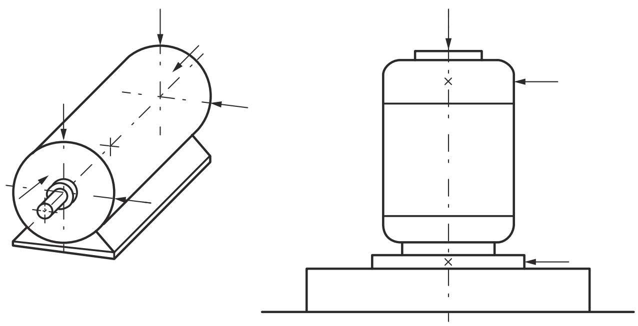
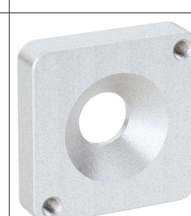


Figure 10: Measuring directions for sensor mounting on motors

6.4 Optional accessories

Table 7: Optional accessories

Part number	Designation	
2129152	M5 adapter plate (also suitable for M4 screws)	
2129153	M8 adapter plate	
2125439	Magnetic holder	

7 Electrical installation

7.1 Safety

7.1.1 Notes on the electrical installation

CAUTION
Danger due to incorrect supply voltage!
An incorrect supply voltage may result in injuries from electric shocks and/or damage to the device.

- Only operate the sensor with safety extra-low voltage (SELV).

NOTICE
Sensor damage or unpredictable operation due to working with live parts.
Working with live parts may result in unpredictable operation.

- Only carry out wiring work when the power is off.
- Only connect and disconnect electrical connections when the power is off.

- **The electrical installation must only be performed by electrically qualified personnel.**
- **Standard safety requirements must be met when working in electrical systems.**
- Only switch on the supply voltage for the device when the connection tasks have been completed and the wiring has been thoroughly checked.
- When using extension cables with open ends, ensure that bare wire ends do not come into contact with each other (risk of short-circuit when supply voltage is switched on!). Wires must be appropriately insulated from each other.
- Wire cross-sections in the supply cable from the customer's power system must be designed in accordance with the applicable standards. When this is being done in Germany, observe the following standards: DIN VDE 0100 (Part 430) and DIN VDE 0298 (Part 4) and/or DIN VDE 0891 (Part 1).
- Circuits connected to the device must be designed as SELV circuits (SELV = Safety Extra Low Voltage).
- Protect the device with a separate fuse at the start of the supply circuit.

A shielded cable is not required in order to adhere to the electromagnetic compatibility guidelines specified by EN 61000-6-2/4. It is recommended, however, especially when working with longer connecting cables.

The IP enclosure rating for the sensor is only achieved if the connected cable is completely screwed in.

7.1.2 Wiring instructions

NOTE
Pre-assembled cables can be found online at:

▶ www.sick.com/mpb10

Please observe the following wiring instructions:

- During installation, pay attention to the different cable groups. The cables are grouped into the following four groups according to their sensitivity to interference or radiated emissions:

- Group 1: Cables very sensitive to interference, such as analog measuring cables
- Group 2: Cables sensitive to interference, such as sensor cables, communication signals, bus signals
- Group 3: Cables which are a source of interference, such as control cables for inductive loads, motor brakes
- Group 4: Cables which are powerful sources of interference, such as output cables from frequency inverters, welding system power supplies, power cables

- ▶ Cables in groups 1, 2 and 3, 4 must be crossed at right angles, see figure 11.
- ▶ Cables in groups 1, 2 and 3, 4 must be routed in different cable ducts or metallic separators must be used, see figure 12 and see figure 13. This applies particularly where cables of devices with a high level of radiated emission, such as frequency converters, are laid parallel to sensor cables.

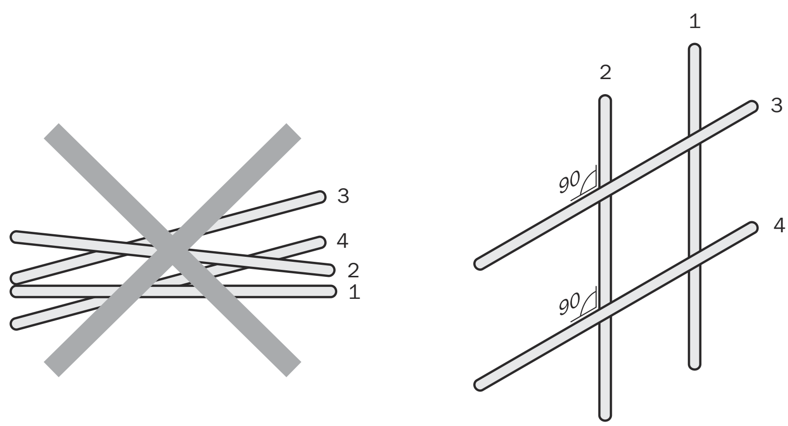


Figure 11: Cross cables at right angles

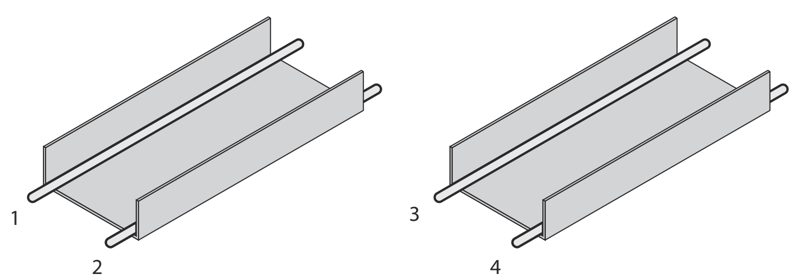


Figure 12: Ideal laying – Place cables in different cable ducts

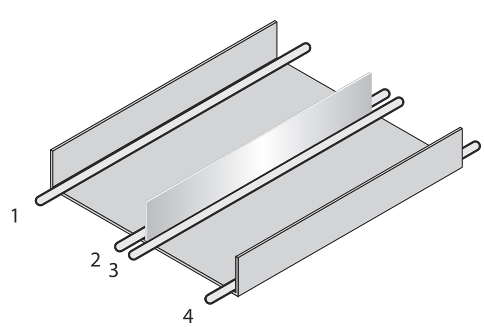


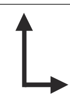
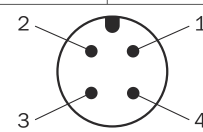
Figure 13: Alternative laying – Separate cables with metallic separators

NOTE
Prevent equipotential bonding currents via the cable shield with a suitable earthing method, see "Safety", page 24.

7.2 Connections

7.2.1 Pin assignment/Connection diagram + wire colors

Table 8: Pin assignment for male connector, M12, A-coded, 4-pin

PIN	Connection	Pin assignment
1	BN	+ (L+)
2	WH	MF
3	BU	- (M)
4	BK	Q/C
	 0.08 mm² AWG 28	

7.3 Connecting the supply voltage

The sensor must be connected to a voltage supply with the following properties:

- Supply voltage DC 10 V ... 30 V (SELV according to currently valid standards)
- Power source with at least 5 W power

Protecting the supply cables

To ensure protection against short-circuits/overload in the customer's supply cables, the wire cross-sections used must be appropriately selected and protected.

8 Commissioning

8.1 Overview of commissioning steps

- Connect the voltage supply.
- Commission the sensor using the factory settings.
- Configure the sensor.

8.2 Put the sensor into operation for the first time

During initial commissioning, the user should first familiarize himself with the various measured values described in see "Product description", page 10. Likewise, the sensor should be configured using the operation described in see "Operation", page 28.

After switching on the supply voltage, the sensor requires approx. 250 ms until recording of the first data block starts. The temperature and shock values are available immediately after this time.

9 Operation

9.1 General notes on operation

The Multi Physics Box can be used in two ways:

On the one hand, for monitoring a machine or plant. The current condition is compared with the recorded condition via the indication values in order to detect possible changes (e.g. due to aging, wear, damage, etc.). For this application, limit values can be defined based on the current measured values.

The machine condition can also be interpreted. Here, the goal is not only to detect a change in condition, but to assign a detected state to specific operational statuses and various fault conditions. This second approach is costly, since initially the recorded data must be correlated with known fault conditions, but it also allows for a significantly more precise interpretation of the machine condition based on the vibration data. The two methods are compared in table 9.

Table 9: Comparison of condition monitoring and condition interpretations

Attribute	Condition monitoring	Condition interpretation
Thresholds	Based on current values	Based on known fault conditions
Sensor support functions	Min, pre-max and max limits Teach-in of the vibration values (see "Teach-in process (Index 4538-4539)", page 34)	Value monitoring based on ISO 10816-3
Necessary infra-structure	Evaluation unit for processing the triggered alarms	Connection, database and visualiza-tion
Initial effort	Low Setting the limits	High Occurrence of errors and correlation of data and errors
Effort during operation	High Each alarm triggered must be checked and, if necessary, the limit values adjusted depending on the result.	Low Errors that have already occurred can be detected at the initial stage

NOTE
The supporting analysis methods are only an aid, but are not applicable in all cases.
It should always be checked whether the monitoring and the resulting alarms correlate with the actual machine condition.

IO-Link

In addition to configuration via the associated SDD and an SI-Link box, the sensor can also be configured via IO-Link commands. A detailed listing of the IO-Link functions, the IODD file and the SDD file can be found under www.sick.com/mpb10.

9.2 Alarm behavior (Index 4842)

Limit values can be defined for all measured values. If these limit values are exceeded or undercut, an alarm is issued. Occurring alarms can be read out via corresponding indices. These are shown in table 10.

Table 10: Alarm indices

Index (hex)	Monitored measurand
4353 (0x1101)	Temperature
4370 (0x1112)	Device diagnostics

Index (hex)	Monitored measurand
4436 (0x1154)	Shock
4533 (0x1185)	Vibration analysis in time range
4574 (0x11DE) - 4577 (0x11E1)	Vibration analysis in frequency range

The alarm flags can also be mapped into the process data of the sensor. Details are described in section 10. The alarms are deactivated by setting the limit values to an invalid value (see IO-Link supplementary sheet, typically -1). All active alarm bits can be reset as a whole using the 229 (i.e. writing value 229 in Index 2). An implicit reset of alarms also occurs when the associated limit values are changed, for vibration alarms also when vibration parameters are changed.

NOTE
By default, alarm bits remain set and must always be actively reset via **Standard Command** 229.

In many applications, it is desirable that short-term outliers and/or one-time events, which may result from accidentally bumping into a piece of equipment, for example, do not directly trigger an alarm. This can be achieved by configuring the alarm behavior (alarm delay time) accordingly. Likewise, the alarms can be reset automatically when the machines are running again in normal condition after a short malfunction (alarm reset time).

Alarm delay time (Subindex 1)

The alarm delay defines the minimum time for which a set limit value must be exceeded before the alarm is triggered. Depending on the moment when the limit value was violated for the first time, the alarm is delayed by this time. In figure 14, this value was set to 2,000 ms. Since the indication value was not high enough above the limit value the first time it was exceeded, no alarm is triggered. The second time the value exceeds the threshold for more than 2,000 ms, the alarm is triggered. A 0 in this subindex deactivates the alarm delay time and the alarms are triggered immediately after the limit value is exceeded.

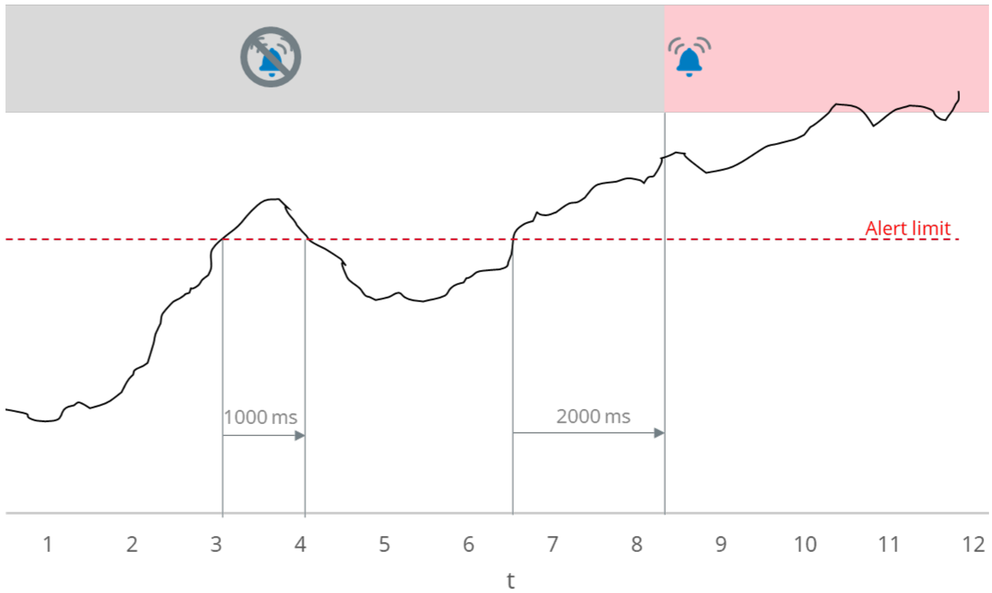


Figure 14: Alarm delay time

Alarm reset time (Subindex 2)

The alarm reset time defines the duration after which the alarm bits are automatically reset again when a machine returns to a normal condition range. The alarm is reset if the indication value was permanently below the limit value for at least the alarm reset time, in figure 15 the reset time of 2,000 ms is selected as an example.

Minimum duration of an alarm

The alarm reset time thus also implicitly defines the minimum time for which alarms are set. If an automatic reset of the alarms is not desired, the function can be deactivated by a -1 in this subindex. This will keep all alarms until they are reset.

NOTE
In order not to lose occurred alarms, the alarm reset time should be set to -1. The alarms must then always be actively reset via **Standard Command** 229.

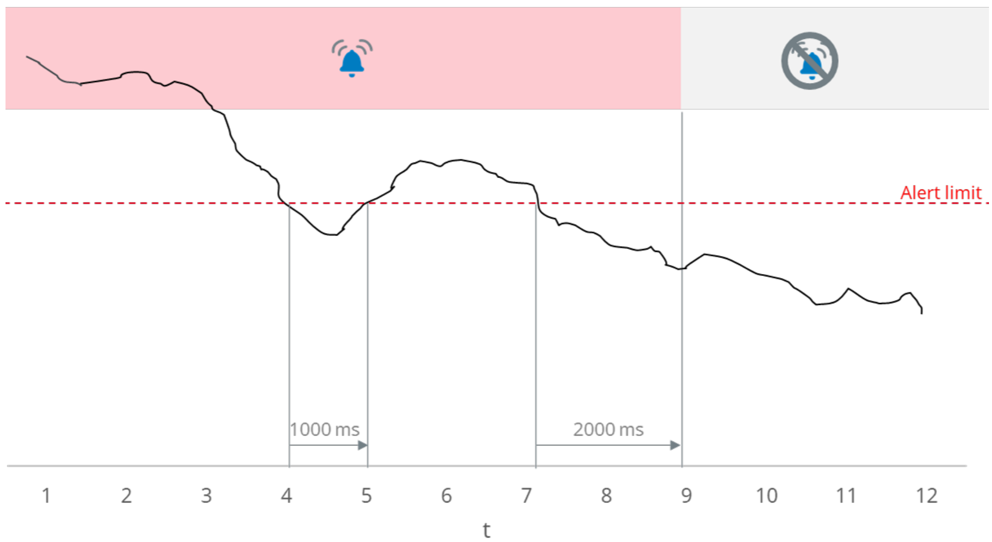


Figure 15: Alarm reset time

NOTE

The alarm reset time applies to all alarms. This also applies to shock events, temperature alarms, the operating hours and the boot cycle counter.

The alarm delay, on the other hand, is not applied to shock events, the operating hours and the boot cycle counter.

9.3 Vibration monitoring

Before starting vibration monitoring, please observe the general settings of the vibration analysis described in section 4.3.2. Maximum and minimum values since the last reset are output for all indication values in addition to the current values. These can be used as a basis for configuring limit values. The minimum and maximum values can be reset via associated indices.

9.3.1 Monitoring in time range

Indication values in the time range provide very good indications of the general condition of machines. A change in the indication values in the time range shows that the strength of the vibration (**a-RMS**, **v-RMS**, **Variance**) and/or the signal shape (**Skewness**, **Kurtosis**, **Peak to peak**, **Shape factor**, **Crest factor**, **Impulse factor**) have changed. For vibration monitoring, the sensor provides not only the current values but also the minimum and maximum values that have occurred since the last reset. These can be used, for example, to derive a range of values in which the plant is in normal operation.
In addition, the indication values can be monitored with definable limit values. The corresponding indices can be found in the IO-Link supplement. In this way, values can be read out for further processing and overshots and undercuts can be transferred to the process data as alarms.

Alarm axis (Index 4531)

Only one axis of the indication values in the time range is monitored at a time; this can be selected in Index 4531. Accordingly, the limit values in the time range are applied to the selected axis, e.g. exceeding the limit value on the Z-axis does not trigger an alarm when alarm axis Y is selected. For **a-RMS** and **v-RMS** values, in addition to monitoring the X-, Y- and Z-axes, the magnitude can also be selected as an alarm axis via Subindex 1.

Setting the limit values (Index 4532)

Minimum and maximum limits can be set for the following indication values:

Variance, **Skewness**, **Kurtosis**, **Peak to peak**, **Shape factor**, **Crest factor**, **Impulse factor**

Additional pre-maximum limits can be set for the following indication values:

a-RMS, **v-RMS**

The additional pre-maximum limit value makes it easy to map the different gravity zones of ISO 10816-3. There is also the advantage that a status between good and bad can also be defined via the pre-alarm, in which the machine should only be operated with restrictions. In figure 16, it can be seen that the good machine condition (green) is demarcated from the condition in restricted operation (yellow) via the pre-maximum limit value. An imminent failure (red) can be delimited via the maximum limit value.

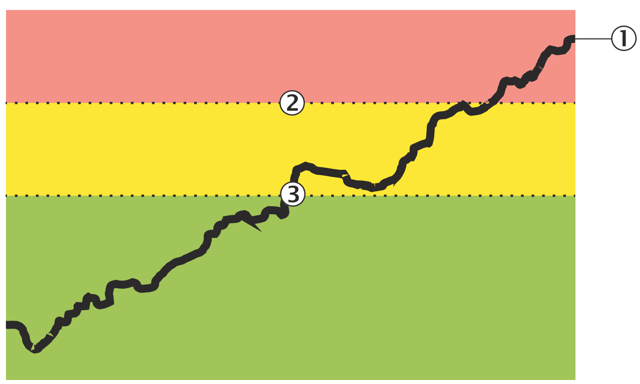


Figure 16: Pre-maximum and maximum limit value

① Current vibration value
② Maximum limit value
③ Pre-maximum limit

All limit values for the time range indication values can be defined via Index 4532, the corresponding alarms are output via Index 4533.

9.3.1.1 a-RMS (Index 4483-4485)

The following mechanical faults have a strong influence on the **a-RMS**:

- Friction
- Touching machine components
- Unbalance
- Wear
- Lubricant complications

In addition to the **a-RMS** value of the individual axes (X/Y and Z), the sensor provides the magnitude, the effective value of the sum vector of all three axes. The magnitude thus represents the energy contained in the vibration without directional separation.

9.3.1.2 v-RMS (Index 4483-4485)

The **v-RMS** changes significantly, especially for the following fault conditions:

- Unbalance
- Misalignment
- Relaxation

As with the **a-RMS**, the sensor for the **v-RMS** also provides the magnitude, the effective value of the sum vector of all three axes, which represents the energy contained in the vibration without directional separation.

9.3.1.3 Limit values based on ISO 10816 (Index 4534-4536)

The ISO10816-3 standard defines limit values that indicate whether **v-RMS** amplitudes are acceptable when operating rotating machines. Here, 4 evaluation zones are defined, which describe the machine condition on the basis of the **v-RMS** vibration values.

The limit values shown in table 11 can be set automatically in the sensor by specifying the machine type and the associated subassembly.

Machine group 1: Nominal power > 300 kW and < 50 MW, axis height ≥ 315 mm

Machine group 2: Nominal power > 15 kW < 300 kW, axis height 160 mm ≤ and < 315 mm

*Table 11: **v-RMS** limit values based on ISO 10816-3*

Machine group	Machine group 1		Machine group 2	
Substructure	**Elastic substructure**	**Rigid substructure**	**Elastic substructure**	**Rigid substructure**
Zone limit C/D [mm/s]	11	7.1	7.1	4.5
Zone limit B/C [mm/s]	7.1	4.5	4.5	2.8
Zone limit A/B [mm/s]	3.5	2.3	2.3	1.4

Zone D Machines that have vibrations in this range can be damaged.

Zone C Machines that have vibrations in this range can run in limited operation. Continuous operation is not considered suitable.

Zone B Machines that have vibrations in this range can run without restrictions.

Zone A Newly commissioned machines exhibit vibrations in this area.

The configuration of the sensor for monitoring based on ISO 10816-3 is done via Index 4535. When writing to this index, the corresponding limit between zone B and C is automatically set as the pre-maximum limit value for **v-RMS**. The limit between zone C and D is set as the maximum limit value. The zone boundaries are also automatically entered in Index 4536. The limits in ISO 10816-3 are defined considering a frequency range of 10-1,000 Hz, therefore this frequency range is also configured in the sensor. In table 12, an example of parameterization for a machine from group 1 with a rigid substructure and a current **v-RMS** of 3.5 mm/s is shown. Index 4534 can be used to read out in which evaluation zone the plant falls with the currently measured **v-RMS** value.

Table 12: Example parameter ISO 10816

Index	Content	Value
4534	Current evaluation zone	2 = Zone B
4535	Preselection	1 = Group 1: elastic
4536 (Subindex 3)	Zone border C/D	7.1 mm/s
4536 (Subindex 2)	Zone border B/C	4.5 mm/s
4536 (Subindex 1)	Zone border A/B	2.3 mm/s

If an application-specific adjustment is necessary, the limit values can also be adjusted manually.

9.3.1.4 Variance (Index 4489-4491)

As with the **v-RMS**, the variance describes the strength of the vibration. It enables the detection of:

- Unbalance
- Relaxation
- Misalignment

9.3.1.5 Skewness (Index 4492-4494)

Skewness indicates abrupt and fundamental vibration changes and can be an indicator of bearing damage.

9.3.1.6 Kurtosis (Index 4495-4497)

Kurtosis can be used to detect changes due to occurring pulses in addition to the RMS values.

9.3.1.7 Peak to peak (Index 4498-4500)

The **Peak to peak value** can be used to detect a pulse-like fault in the vibration signal. One example of possible causes of an increased **Peak to peak value** is bearing damage.

9.3.1.8 Shape factor (Index 4501-4503)

An increase in the **Shape factor** indicates an increase in the amplitudes of harmonics in the signal. Reasons for this may be:

- Loosening of screws
- Unbalance
- Misalignment

9.3.1.9 Crest factor (Index 4504-4506) and Impulse factor (Index 4507-4509)

The **Crest**and **Impulse factors** are very similar and essentially differ in their normalization, which means that depending on the application, one of the indication values may be more sensitive. High values for these indication values indicate that pulse-like faults are present in the vibration signal, caused for example by bearing damage such as cracks in the bearing shells or defective balls. A major advantage of the **Crest** and **Impulse factors** is that these values are, to a first approximation, independent of the speed of a machine and these indication values thus provide meaningful information even for machines with variable speeds.

9.3.1.10 Teach-in process (Index 4538-4539)

The simplest way of condition monitoring in the time range is via teach-in. The limit values are set automatically based on the current measured values. For the **RMS values**, all three limit values (maximum, pre-maximum, minimum) are set, for the other values two limit values (maximum, minimum) are set. The following teach-in operations can be performed:

- **RMS** values (Index 4538, Write value 1): Limit values for **a-RMS** and **v-RMS** are set for the selected alarm axis.
- Non-**RMS** values (Index 4538, Write value 2) limit values for **Variance**, **Skewness**, **Kurtosis**, **Peak to peak**, **Shape factor**, **Crest factor**, **Impulse** factor are set for the selected alarm axis.
- All values (Index 4538, Write value 3): All limit values for time range indication values are set for the selected alarm axis.

Automatic setting of the limit values is done as shown in figure 17:

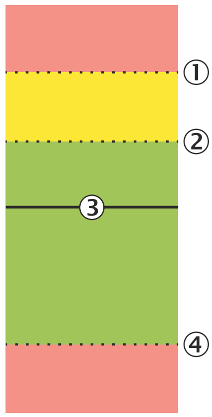


Figure 17: Limit values of teach-in process

① Maximum limit value: approx. 25% above the current value
② Pre-maximum: only for **a-RMS** and **v-RMS**:

Approx.15% above the current value
③ Current value
④ Minimum limit value: approx. 25% below the current value

At the start of the teach-in process, the mean value and standard deviation of the subsequent 10 blocks are considered so that outliers in the limit setting are not as significant.

The progress of the teach-in process can be read out via Index 4539.

9.3.2 Monitoring in frequency range (Index 4549-4582)

In addition to the characteristic values in the time range, the determination of market position also monitors the vibration on a single axis (section 4.3.6) in the frequency range. It is not the complete spectrum that is considered, but rather the maxima (peaks) in the spectrum that reflect the essential frequency components of the vibration. The sensor provides information on the current amplitude [g or mm/s] and frequency [Hz] of the 16 peaks with the highest amplitude. Here, only frequencies whose amplitudes lie above the noise are considered.

The amplitude is output depending on the defined signal type (see "Settings for vibration analysis (Index 4477, 4479, 4482, 4531)", page 12) in acceleration or speed.

9.3.2.1 Reduced analysis

To get a quick overview, the peak with the highest amplitude and the peak with the lowest frequency can be monitored separately in the reduced analysis:

- **Dominant peak** (Index 4549 - 4551)
  - Peak with the highest amplitude
  - This frequency has the highest amplitude in the overall vibration.

- **Fundamental peak** (Index 4553 - 4554)
  - Peak with the lowest frequency
  - Represents e.g. the speed of the monitored system
  - Always corresponds to peak 1 in the standard analysis.

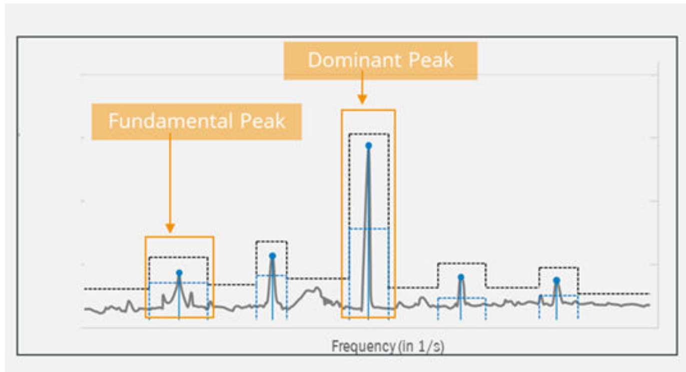


*Figure 18: **Fundamental** and **Dominant peak***

Fundamental peak and **Dominant peak** often represent the same frequency, because e.g. the vibration with the machine speed is both the strongest signal component and the signal component with the lowest frequency. If another signal component with a different frequency occurs, which has a higher amplitude than the vibration at the fundamental frequency, this results in the **Fundamental peak** and **Dominant peak** representing two different peaks. This is a strong indicator of a change in the condition of the machine. For the **Dominant peak** and **Fundamental peak**, the current frequency and amplitude as well as the minimum or maximum values since the last reset are available.

Monitoring in the reduced analysis

To monitor the **Dominant** and **Fundamental peak**, appropriate limit values can be set for the frequency and amplitude of the respective peaks. Thus, as shown in figure 19, the peak is monitored in the X direction (frequency) as well as in the Y direction (amplitude).

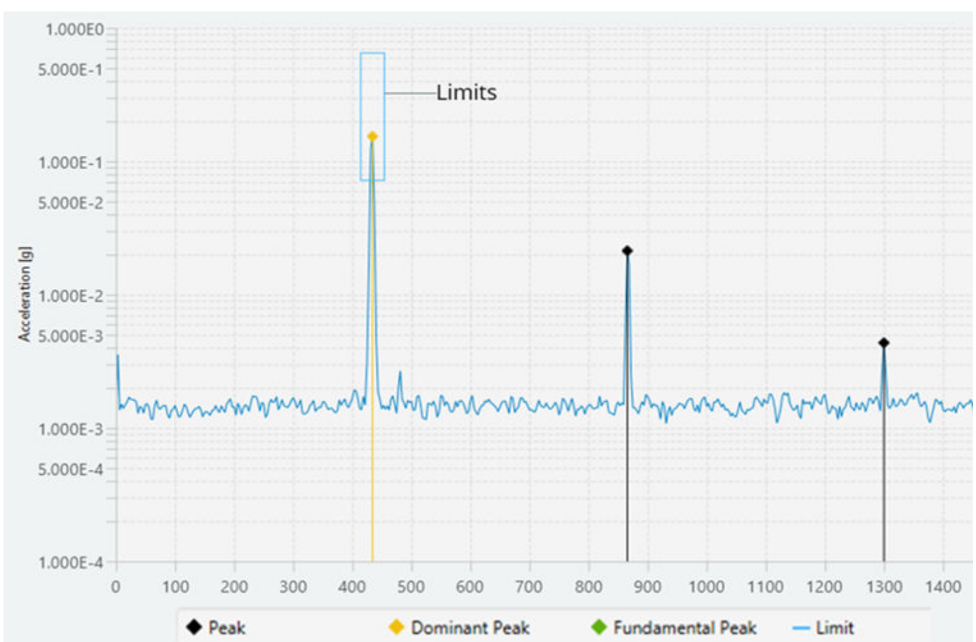


*Figure 19: Limit values of **Dominant peak** frequency analysis*

Manually setting the limits

For monitoring, the limit values for the frequency and amplitude of the respective peaks can be set in Index 4565.

Automatic teach-in of the limits

The teach-in process can be performed separately for **Dominant peak** and **Fundamental peak** via Index 4581. The tolerances defined in Index 4580 are placed around the measured values.

Frequency tolerance (Index 4580, Subindex 1):

Tolerance in the frequency range. A value of 20, for example, sets the limits so that values of 380 to 420 Hz are permitted at a frequency of 400 Hz. When exceeded, the associated alarms are triggered.

Tolerance factor for the amplitude (Index 4580, Subindex 2):

Tolerance in amplitude. The upper amplitude limit (maximum) is calculated by multiplying the current measured value by this factor. The lower amplitude limit (minimum) is calculated by dividing the current measured value by this factor. A factor of, for example, 2 thus sets the upper limit to 1 g and the lower limit to 0.5 g for an amplitude of 0.5 g.

Example of a peak to be monitored:

- Frequency: 400 Hz
- Amplitude: 0.5 g

Selected tolerances:

- Frequency: 20 Hz
- Amplitude factor 2

Resulting limits:

- Frequency: Minimum 380 Hz, maximum 420 Hz
- Amplitude: Minimum 0.25 g, maximum 1 g

If the frequency or amplitude of the peaks change beyond the set limits, corresponding alarms are output. The **Dominant peak** and **Fundamental peak** are monitored independently of each other, and the limit values must be set separately for each. The areas between the peaks and also the remaining detected peaks are not monitored in the reduced analysis. The standard analysis must be used for this purpose.

9.3.2.2 Standard analysis (Index 4555-4582)

In the standard analysis, the sensor outputs up to 16 frequency and associated amplitude values. Only the 16 peaks with the highest amplitude are output. As shown in figure 20, these are output starting with the lowest frequency in ascending order up to the highest frequency via Index 4555 together with the amplitude. A newly appearing peak is sorted according to its frequency and can thus displace peaks with smaller amplitudes from visibility. The **Dominant peak** and **Fundamental peak** always appear in the 16 output peaks, with the **Fundamental peak** always representing peak 1.

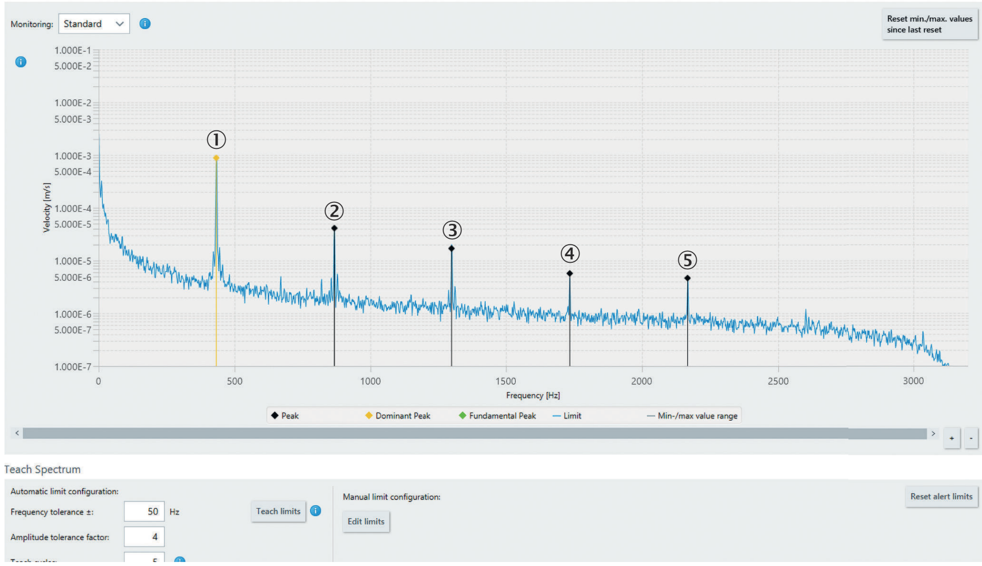


Figure 20: Peak detection frequency analysis

Monitoring in the standard analysis

For monitoring purposes, the relevant ranges in which peaks are expected are defined by their center frequency in Index 4566 and the associated frequency ranges in Index 4567. Once these peak frequency ranges are defined, the associated maximum and minimum values can be read out since the last reset.

NOTE

If no peak frequency ranges are defined, no maximum and minimum values since reset are output in Index 4556-4558.

For each defined peak range, an upper and lower limit value for the amplitude of the peak can be defined. If the amplitude of a monitored peak is greater than the defined upper limit value, this is output via an alarm bit in Index 4575 in the corresponding subindex. If the amplitude of a monitored peak is smaller than the lower limit value or if the peak is no longer detected, this is output via an alarm bit in Index 4576.

A negative amplitude limit value ensures deactivation of the alarm. This means, for example, a peak can fall completely below the noise when the lower limit is deactivated without triggering an alarm.

In addition to the peak frequency ranges, the frequency ranges in between are also monitored. If the frequency of a peak changes beyond the defined peak frequency range or if a new peak occurs in such an intermediate range, a corresponding alarm bit is output in Index 4577. There is one more intermediate range that is monitored than defined peak frequency ranges. Here, the first range extends from 0 Hz to the beginning of the first peak frequency range. The rest lie between the defined peak ranges. The last range covers the frequencies above the last peak range. A newly occurring peak in such an intermediate range is typically an indication of a fault condition on the monitored machine.

Manually setting the limits

Setting the limits manually requires a close look at the frequencies and associated amplitudes that occur. This is usually very time-consuming, but can be bypassed via the automatic teach-in process. The position of the 16 frequency ranges is defined by their center frequencies in Index 4566 and their width by the tolerance of the frequency in Index 4567. The center frequencies are set to the frequencies at which peaks are currently observed. The frequency range without exceeding the limit value is thus defined by the current frequency +/- the tolerance.

Once the peak frequency ranges are defined, the minimum and maximum amplitude values of all defined peaks can be read out. These can be used to get a better impression of the range of values of the amplitudes. Likewise, the maximum amplitude values in the frequency ranges between the defined peak frequency ranges, before the first peak frequency range and after the last peak frequency range can be output.

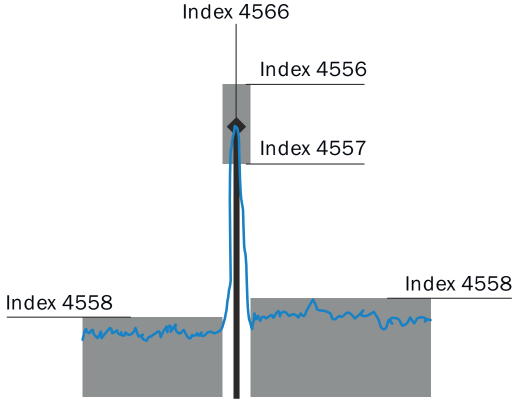


Figure 21: Indices for value output in the standard analysis

An upper and lower limit value for the amplitude can be set for each defined peak frequency range. The special feature of the standard analysis is that upper limit values can also be set for the areas between the peaks via Index 4572.

NOTE
In the case of broadly tapering peaks, it can be difficult to simultaneously define a sufficiently narrow frequency range for the peak and still obtain reasonable maximum amplitude values for the ranges between the peaks.

In the case of broadly tapering peaks, the entire peak is often not within the peak frequency range. This may result in the maximum amplitudes in the intermediate ranges being defined by the offshoots of the peak, as illustrated in figure 22. A frequency range before and after the peak frequency range can therefore be defined in Index 4568 and 4569; this range will be ignored. In this way, it can be ensured that the broadly tapered peak does not affect the amplitudes in the intermediate ranges before and after the peak.

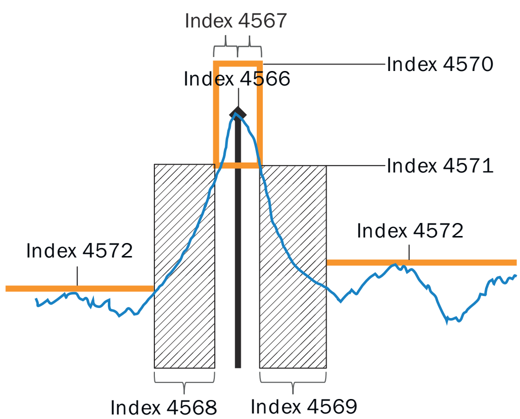


Figure 22: Indices for limit value definition in standard analysis

As soon as a limit value is exceeded, the corresponding alarms can be read out in Index 4575 to 4577.

Automatic teach-in of the limits

The teach-in process can be started via Index 4581 and makes it possible to automatically set the limit values described in figure 22. The teach-in is controlled by the same settings as for the reduced analysis, but in addition the number of teach-in cycles is relevant for the standard analysis.

Frequency tolerance (Index 4580, Subindex 1):

Tolerance in the frequency range. A value of 20, for example, sets the limits so that values of 380 to 420 Hz are permitted at a frequency of 400 Hz. If the value exceeds or falls below the limit, the associated alarms are triggered.

Tolerance factor for the amplitude (Index 4580, Subindex 2):

Tolerance in amplitude. The upper amplitude limit (maximum) is calculated by multiplying the current measured value by this factor. The lower amplitude limit (minimum) is calculated by dividing the current measured value by this factor. A factor of, for example, 2 thus sets the upper limit to 1 g and the lower limit to 0.5 g for an amplitude of 0.25 g.

Example of a peak to be monitored:

- Frequency: 400 Hz
- Amplitude: 0.5 g

Selected tolerances:

- Frequency: 20 Hz
- Amplitude factor 2

Resulting limits:

- Frequency: Minimum 380 Hz, maximum 420 Hz
- Amplitude: Minimum 0.25 g, maximum 1 g

Number of teach-in cycles (Index 4580, Subindex 3):

The number of teach-in cycles indicates how many individual spectra are analyzed by the teach algorithm to derive the limits. A larger number of teach-in cycles allows the fluctuations of the values in the spectrum to be better reflected in the automatically generated tolerance limits, but at the same time, a larger number of teach-in cycles also extends the duration of the teach-in process. The approximate duration of the teach-in process can be estimated as follows:

Teach-in duration = 2 x block length in seconds x number of blocks for averaging x number of teach-in cycles

The progress of the teach-in process can be monitored via Index 4582. It is completed when the value 100 is output at this point. The taught frequency ranges and amplitude limits then appear in Index 4566-4572.

Frequency ranges and amplitude limits that have already been set manually or the values from an earlier teach-in process are overwritten in the process. The manually or automatically set frequency ranges and amplitude limits can be reset to their default values by writing the value 1 in Index 4573.

9.3.3 Readout of raw data

In addition to the reduced vibration information (indication values in the time range and detected peak frequencies and peak amplitudes in the frequency range), it is possible with the Multi Physics Box to read out both the raw acceleration data in the time range and the entire vibration spectrum.

NOTE
The raw data in the frequency and time range are designed for installation and more accurate evaluation only. It is not intended for permanent readout due to the high time required for readout and the large resulting amount of data.

The readout of the vibration spectrum and the time range raw data is done in a **Snapshot** mode. In this **Snapshot** mode, the current spectrum and raw time range data are held in the memory until they are completely read out.

NOTE
As long as **Snapshot** mode is activated, no new data blocks are recorded and accordingly no time or frequency range parameters are updated.

Typically, reading out the entire spectrum and raw time range data can take up to 20 seconds due to the larger amount of data.

If both the raw time range data and the entire spectrum of a block are required, the raw time range data must be read out first before the spectrum is read out.

After a change to the spectrum readout mode, the raw time range data for the recorded block is no longer available. To read out the raw data, **Snapshot** mode is activated by writing the corresponding value in Index 4585. A 1 provides the raw time range data, a 2 the vibration frequency spectrum. If the sensor is in a manual trigger mode, a trigger signal must then be sent to record a block. In automatic trigger mode, the raw data of the next available block is provided.

Table 13: Reading out Index 4586 raw data

Subindex	Name
1	0 = no raw data available 1 = raw time range data available 2 = vibration frequency spectrum available
2	Number of values in the **Snapshot**, corresponds to the number of **samples of** the raw time range data of an axis or the number of amplitude values of the vibration frequency spectrum
3	Number of segments in which the data can be read out
4	Time interval between the individual **Samples** in the raw time range data
5	Frequency spacing between the amplitude values in the vibration frequency spectrum

Since raw data is a large amount of data, it cannot be provided all at once via an index. Instead, they are divided into individual segments and can be read sequentially. By stringing together the individually read segments, the complete data set is obtained. The number of segments to be read out is obtained from Subindex 3. The number of valid data points from Subindex 2.

9.3.3.1 Read out of raw time range data (Index 4585-4588)

The readout of the raw time range data can be especially interesting for applications where you expect changes of the vibration within a block or where you want to set a manual trigger.

Reading the entire block can be done using the following steps:

1. Activate **Snapshot** mode via Index 4585=1. Use this to request raw time range data.
2. Wait until the availability of the data is indicated by a 1 in Index 4586, Subindex 1. Now the readout can be started .
3. Set the axis to be read out via Index 4587, Subindex 2.
4. Select the first segment by writing a 0 in Index 4587, Subindex 1.

5. This allows a 224 byte array containing 112 raw data values to be read in Index 4588. The data format of the individual values is a 16 bit wide signed integer – int16.
6. After that the segment number (Index 4587, Subindex 1) can be increased and then the next segment can be accessed. To reduce the number of write operations and thus the readout time, the segment number is automatically incremented after each read of Index 4588. It is thus sufficient to cyclically read out the data from Index 4588 to obtain the raw time range data of an axis.

By reading out the data segment by segment, a vector of single raw values is obtained whose length is a multiple of 112. This must be trimmed to the length of the valid data points (Index 4586, Subindex 2) at the end.

To scale the raw values to [g], the raw data values must be multiplied by the factor 244/1e6.

To read out the raw values of other axes, the corresponding axis is selected in Index 4587, Subindex 2 and the segment selection is set back to 0 in Subindex 1. The data can then be read out via Index 4588 as described.

9.3.3.2 Readout of the entire frequency spectrum (Index 4585-4590)

The complete frequency spectrum can be used to identify whether other frequencies may be of interest in addition to the 16 peaks displayed, or whether certain ranges can be ignored.

NOTE
The vibration frequency spectrum is only available in a single axis. The desired axis is selected in the settings of the vibration analysis – Index 4477. This setting must take place before activating **Snapshot** mode.

The frequency spectrum can be read out via the following procedure:

1. Activate **Snapshot** mode via Index 4585 = 2. This can be used to request the frequency spectrum.
2. Wait until the availability of the data is indicated by a 2 in Index 4586, Subindex 2. Now the readout can be started.
3. Select the first segment by writing a 0 in Index 4589, Subindex 1.
4. This allows a 224 byte array containing 56 frequency spectrum values to be read in Index 4590. The data format of the individual values is a single measurement accuracy floating point number – float32.
5. After that the segment number (Index 4589, Subindex 1) can be increased and then the next segment can be accessed. To reduce the number of write operations and thus the readout time, the segment number is automatically incremented after each read of Index 4590. It is therefore sufficient to cyclically read out the data from Index 4590 to obtain the frequency spectrum.

By reading out the data segment by segment, a vector of raw spectrum values is obtained whose length is a multiple of 56. This must be trimmed to the length of the valid data points (Index 4586, Subindex 2) at the end.

The raw spectrum values read out are the amplitudes at fixed frequencies. The first value indicates the amplitude at 0 Hz, the following frequency points are equidistant with the distance from Index 4586, Subindex 5. The number of frequency points is equal to half of the block length used plus 1 and is also given in Index 4586, Subindex 2.

9.4 Temperature monitoring (Index 4352-4355)

The temperature is measured via the back of the sensor housing. The better the thermal diffusivity of the connected material, the more accurate the measurement.

If the sensor is non-flush or there is an adapter plate between the sensor and the machine, the temperature line is longer and thus the measured value is delayed. Observe section 6 here.

The Multi Physics Box monitors the contact temperature in the application. It outputs the currently measured temperature as well as the minimum and maximum temperature of all time and since the last reset. The temperature data can be read out via Index 4252.

The temperature values of the sensor can be actively monitored using alarm limits. The minimum and maximum limit values can be set via Index 4354. If the temperature changes beyond the set limits, corresponding alarm bits are output:

Table 14: Index 4355 Alarm bits for temperature monitoring

Subindex	Name
1	Contact temperature: max. limit value exceeded
2	Contact temperature: min. limit value undershot

9.5 Shock detection (Index 4434-4448)

The Multi Physics Box monitors the maximum acceleration of the three axes X, Y and Z in a measuring range of ± 200 g. For active monitoring of shock events, a threshold can be defined from which a shock is recognized as such. The direction of the axes is shown on the sensor with a coordinate system. Accelerations against the direction arrow are negative and with the direction of the arrow positive.

Monitoring of the maximum acceleration is event-driven. Data is only recorded if the acceleration has exceeded an adjustable threshold (i.e. a shock has occurred). For a good function of the shock detection, it is important to set this threshold sensibly for the detection of shocks. As a parameterization aid, a special operating mode is available for this purpose which allows the accelerations occurring during normal operation to be measured. The threshold for detecting shocks should then be set a bit above the accelerations measured in normal operation.

Parameterization help (Index 4434)

As a parameterization aid, the maximum acceleration that has occurred since the last readout can be output in each case. This operating mode is activated by setting the threshold for shock detection in Index 4435 to 0 g. The current maximum acceleration can then be read out via Index 4434 and the limit value set based on this.

Operation in event-driven mode (Index 4435-4448)

If the accelerations occurring during normal operation are known, a threshold value can be defined. The sensor then detects events with higher accelerations. The occurrence of an acceleration above this threshold is considered a shock event.

NOTE
The minimum threshold for a shock event is 10 g. If the set threshold is exceeded, the maximum accelerations that occurred, the time curve of the acceleration and a corresponding alarm are output.

For such a shock event, the maximum acceleration, the associated time stamp and the time curve of the shock event can be output for all three axes.

The current value of the time stamp in milliseconds can be read out via Index 4437. The time stamp always starts at 0 ms when the sensor is reset/restarted. The time stamp can be written after the sensor is started to synchronize it with an absolute time source.

NOTE
The length of the time stamp is 64 bits and cannot be processed by some controllers.

The 5 strongest shock events are stored permanently. Each newly added shock is sorted according to its strength. If a new shock is added, the shock with the lowest acceleration is overwritten accordingly.

For all stored shock events, the maximum acceleration and the time stamp are available, for the strongest shock also the course of time of the shock.

Readout of the history of the shock data (Index 4439 and 4442)

For the shock that occurred last and the shock with the strongest acceleration, the course of the acceleration values in the period from 5 ms before to 21 ms after the shock is available. As shown in figure 23, all 3 axes can be viewed over time.

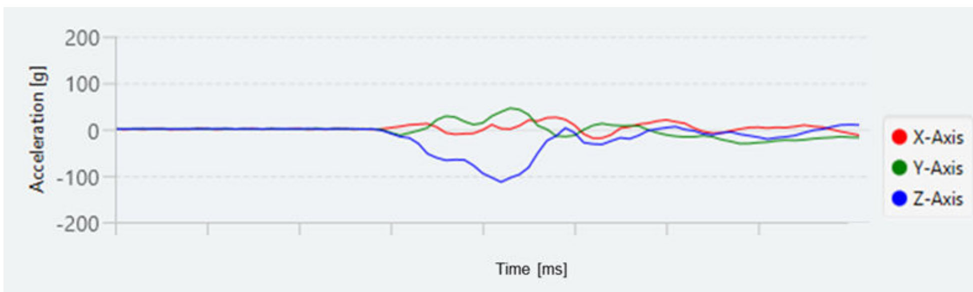


Figure 23: Shock data over time

There are 170 acceleration values available for each axis, which can be read out in two blocks of 85 values each as follows:

1. Set the desired axis via Index 4439 (last shock) or 4442 (strongest shock) using Subindex 2.
2. Select the first data block (block 0) via Subindex 1.
3. Read the first 85 values for the axis via Index 4440 (last shock) or 4443 (strongest shock).
4. After that the second block (block 1) can be selected and read out via the following index.

This procedure can be repeated for the other two axes. The values are sampled at a rate of 6,400 Hz.

Both the permanently stored shock data and the shock data for the last shock that occurred can be reset by writing value 1 to Index 4448.

9.6 Configuration of digital outputs

The sensor has pin 2 and pin 4 as digital inputs/outputs. Pin 2 can be configured as a digital output or external input. When configured as an external input, the input value can either be used as an external trigger or its value can be linked to logic values from the sensor. In applications where IO-Link is not used, pin 4 can also be used as a digital output. Pin 2 of the sensor can be parameterized via Index 121 as external input for the AOO logic, as switching signal and as trigger signal (see "Trigger (Index 4474-4475)", page 15).

Configuration of pin 2 as input

Pin 2 can be configured as an external trigger input by writing value 80 in Index 121 to select this function (in addition, the trigger via pin 2 must be selected by writing value 2 in Index 4474, Subindex 1). As input for the Smart Task functions (see "Smart Task basic logic (A00)", page 45), pin 2 can be configured by writing value 1 to Index 121.

Pin 2 as digital output for a parameter

The Multi Physics Box has no switching points that could be output via the digital outputs. Instead, it is possible to output all alarms from the process data, also via the digital outputs. Specifically, the direct or group alarms can be output that are mapped to bit 6 (diagnostic alarm 1) and bit 7 (diagnostic alarm 2) of the process data (see "Process data structure", page 49). An example output of the maximum temperature alarm via pin 2 can thus be configured as follows:

1. The maximum temperature alarm must be parameterized by writing value 44 in Index 67, Subindex 7. Now the alarm is output via bit 6 (diagnostic alarm 1) of the process data.
2. So that pin 2 issues this alarm, the Diagnostic alarm 1 function must be parameterized in Index 121 for pin 2. This is done by writing the value 44.

The same operation can be performed via bit 7 and the associated diagnostic alarm 2.

Pin 2 as digital output for several parameters

Bit 6 (diagnostic alarm 1) and bit 7 (diagnostic alarm 2) of the process data must first be assigned to the corresponding direct or group alarms via Index 67. Then pin 2 can be parameterized as a switching signal for QL2 via Index 121. The dependency between the alarms defined in bit 6 and 7 must then be configured via the A00 function (see "Smart Task basic logic (A00)", page 45).

As an example, pin 2 is configured so that a switching signal is output when two alarms occur (individually or together):

1. The desired alarms must be parameterized via Index 67, Subindex 7 and 8. Then the alarms are output via bit 6 (diagnostic alarm 1) and bit 7 (diagnostic alarm 2).
2. In order for pin 2 to output this alarm, the Switching signal QL2 function must be parameterized via Index 121. This is done by writing the value 44.
3. The Diagnostic alarm 1 and Diagnostic alarm 2 options must be selected for **Input** 1 and **Input** 2 of the A00 logic via Index 1081 and 1082.
4. By linking both inputs with a logical “or” via Index 1084, pin 2 switches when bit 6 and/or bit 7 issues an alarm.

Other functions can be implemented via the A00 function.

Pin 4 as digital output

If the sensor is not used in IO-Link communication, pin 4 can also be used as a digital output. It then outputs the QL1 output signal of the A00 logic. As shown in figure 24, logic 1 then acts as input function for QL1 and thus pin 4.

9.7 Smart Task basic logic (A00)

The Smart Task basic logic allows logical functions to be applied to the diagnostic alarms (section 10) and external input signals. Signals can be logically linked, delayed and inverted. It is also possible to pass input signals through the logic unchanged, e.g. for output via pin 2 / pin 4.

Logical principle of operation:

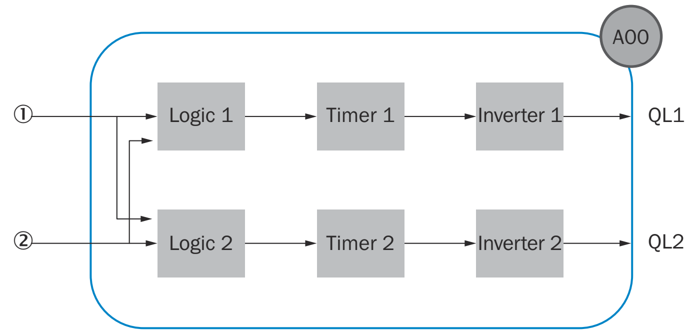


Figure 24: Logical principle of operation A00

① Diagnostic alarm or external input

② Diagnostic alarm or external input

Table 15: Smart Tasks - SLTI Version

ISDU			Name	Data type	Data storage	Length	Access	Default value	Value/Range
Index		Subindex							
DEC	HEX								
1080	438	-	SLTI version	String	-	8 byte	ro	-	-

The **SLTI version** contains the version number for the Smart Task **basic logic.**

The selection of the desired input signals for the Smart Task basic logic is made for the first input via Index 1081 and for the second input via Index 1082, the diagnostic alarms 1 and 2 as well as the external input via pin 2 can be selected. It should be noted that when using the diagnostic alarms, the desired alarms must also be mapped to the diagnostic alarms (section 10) and when using the external input via pin 2, this must be configured accordingly (section 9.6).

Table 16: Smart Tasks – Logic

ISDU			Name	Data type	Data storage	Length	Access	Default value	Value/Range
Index		Subindex							
DEC	HEX								
1083	43B	-	Logic 1	UInt	Yes	1 byte	rw	0	0 = DIRECT 1 = AND 2 = OR 3 = Window Mode 4 = Hysteresis
1084	43C	-	Logic 2			1 byte			

Via the settings at **Logic 1** and **Logic 2**, the two selected input signals can be logically linked.

For this purpose, the **pin 2 configuration** (ISDU 121) must be set to **External input.**

Direct	For **Logic 1:** The first input signal is passed through unchanged without considering the second input signal. For **Logic 2:** The second input signal is passed through unchanged without considering the first input signal.
AND	Logical AND operation of the two input signals.
OR	Logical OR operation of the two input signals.
WINDOW MODE	See the following diagram
HYSTERESIS MODE	See the following diagram

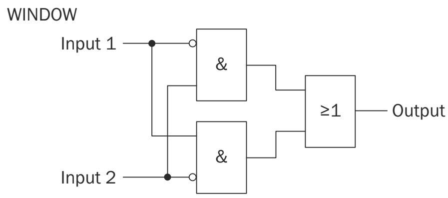


Figure 25: Window Mode

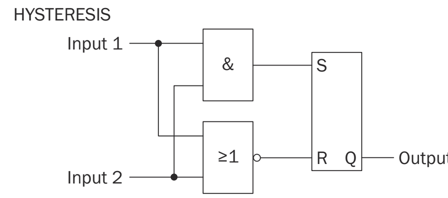


Figure 26: Hysteresis Mode

NOTE
If no physical signal is applied to the external input or if a function other than "**External input**" is selected for pin 2 configuration (ISDU 121), the status of the external input is interpreted as logical 0.

Table 17: Smart Tasks – Timer

ISDU			Name	Data type	Data storage	Length	Access	Default value	Value/Range
Index		Subin-dex							
DEC	HEX								
1085	43D	-	Timer 1 mode	Uint	Yes	1 byte	rw	0	0 = Deactivated 1 = T-on delay 2 = T-off delay 3 = T-on/T-off 4 = Pulses (one shot)
1086	43E	-	Timer 2 mode			1 byte			
1087	43F	-	Time 1 setup			2 bytes		1	1 ... 30,000 ms
1088	440	-	Time 2 setup			2 bytes			

Timer 1/2 mode can be used to select various delay modes.
The relevant delay time is selected under **Time 1/2 setup**.
See the following graphic for details on how the different modes work.

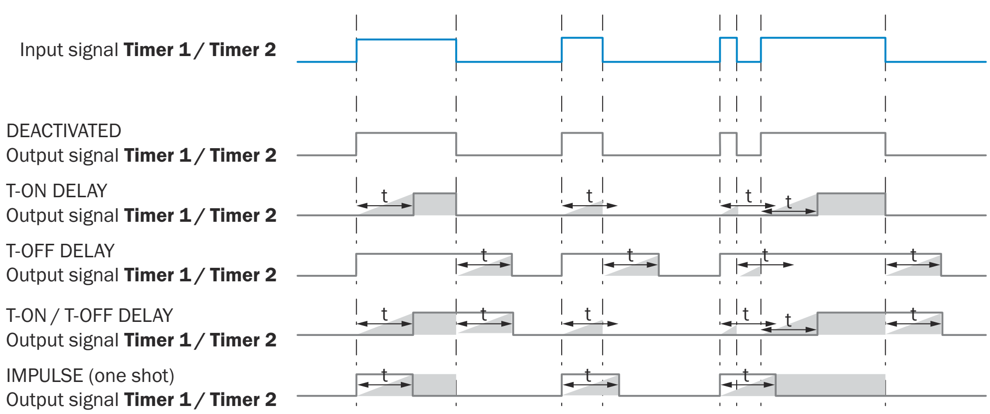


Figure 27: Timer 1 / Timer 2

Table 18: Smart Tasks – Inverter

ISDU			Name	Data type	Data storage	Length	Access	Default value	Value/Range
Index		Subin-dex							
DEC	HEX								
1089	441	-	Inverter 1	Uint	Yes	1 byte	rw	0	0 = Not inverted 1 = Inverted
1090	442	-	Inverter 2			1 byte			

Inverter 1/2 inverts the logical condition of the timer 1/2 output signal.

NOTE
Inverting the **Timer 1/2** output signal does not affect how the delay modes work.
Note that due to the inversion of the **Timer 1/2 output signal**, a set switch-on delay, for example, can act like a switch-off delay.

The outputs of the Smart Task logic are the QL1 and QL2 logic signals. QL1 is output at pin 4 if no IO-Link is used. QL2 is output at pin 2 if the QL2 function is selected in Index 121.

9.8 Device diagnostics (Index 4356-4370)

In addition to vibration, temperature and shock readings, the Multi Physics Box provides device diagnostic data that can be used for self-monitoring.

Operating hours counter (Index 4356)

The operating hours are accumulated internally in hours and output in the following forms:

- Total
- Since the last reset
- Since the boot cycle

Boot cycle counter (Index 4357)

Each power-up cycle is counted internally. Likewise, the values since the last reset can be read out and used for device diagnostics:

- Total
- Since the last reset

9.9 System-wide commands (Index 2)

Index 2 can be used to execute commands across domains.

Restore factory settings (value 130): To use the sensor e.g. in another application, the factory settings can be restored by writing the value 130 in Index 2.

Reset device (value 128): The sensor can also be restarted without disconnecting the connection or the power supply via value 128 in Index 2. This restarts the microcontroller and triggers a boot cycle.

Reset diagnostic parameters (value 228): Via value 228 in Index 2, all minimum and maximum values since the last reset are reset. This command can be helpful during reinstallation and parameterization. The minimum and maximum values can serve as a basis for the limit values.

Reset all existing alarms (value 229): Value 229 can be used to reset all active alarms.

10 Process data structure

General information

IO-Link version 1.1

Process data length 20 byte

Minimum cycle time 5 ms

The process data is 20 bytes long and is divided as follows:

Byte	Content	Description
0	Value 3	Freely configurable current measured value
1	Value 3	
2	Value 3	
3	Value 3	
4	Value 2	Freely configurable current measured value
5	Value 2	
6	Value 2	
7	Value 2	
8	Value 1	Freely configurable current measured value
9	Value 1	
10	Value 1	
11	Value 1	
12	Value 0	Freely configurable current measured value
13	Value 0	
14	Value 0	
15	Value 0	
16	Reserved	Reserved byte for future information
17	Reserved	Reserved byte for future information
18	Alarm bits	8 freely configurable alarm bits (group and direct alarms)
19	Alarm bits	8 freely configurable alarm bits (group and direct alarms)

10.1 Byte 0 to 15

The first 4 values or 16 bytes can be freely assigned with current measured values. The selection which measured value is to appear in the process data is made in Index 67, Subindex 17-20.

Table 19: Configuration of process data values 0-3

Value	Byte	Subindex in Index 67 for configuration	Standard assignment
0	12-15	17	**v-RMS** X-axis
1	8-11	18	**v-RMS** Y-axis
2	4-7	19	**v-RMS** Z-axis
3	0-3	20	Temperature

These can be assigned with the following current measured values:

- **a-RMS** (X-; Y-; Z-axis or magnitude)
- **v-RMS** (X-; Y-; Z-axis or magnitude)
- **Variance** (X-; Y-; or Z-axis)
- **Skewness** (X-; Y-; or Z-axis)

- **Kurtosis** (X-; Y-; or Z-axis)
- **Peak to peak** (X-; Y-; or Z-axis)
- **Shape factor** (X-; Y-; or Z-axis)
- **Crest factor** (X-; Y-; or Z-axis)
- **Impulse factor** (X-; Y-; or Z-axis)
- Temperature

10.2 Byte 18 and 19

The lower 16 bits of the process data can be freely configured to carry alarms to the outside.

NOTE
Only alarms that are taken over into the process data are given as such via the LEDs from the sensor to the outside. Otherwise, only the associated alarm bits are set, but this is not signaled via the LEDs.

Two types of alarms can be distinguished:

Group alarms:

Group alarms are always activated when one or more alarm bits of the corresponding group is active. The following group alarms can be selected:

- Temperature: active if a bit is set in Index 4355
- Vibration in time range: active if a bit is set in Index 4533
- Vibration in frequency range: active if a bit is set in Index 4574
- Shock: active if a bit is set in Index 4436

Direct alarms:

Direct alarms are particularly frequently used alarm bits that can be mapped directly into the process data. Its condition corresponds to the state of a specific alarm or an “OR” operation of a few alarm bits. The available direct alarms are:

- Operating hours
  - Maximum operating hours: active if the bit is set in Index 4370, Subindex 1
- Temperature
  - Maximum temperature: active if the bit is set in Index 4355, Subindex 1
- Boot cycle counter
  - Maximum boot cycles: active if the bit is set in Index 4370, Subindex 2
- Vibration in the time range
  - Maximum **a-RMS**: active if the bit is set in Index 4533, Subindex 2
  - Pre-maximum **a-RMS**: active if the bit is set in Index 4533, Subindex 1
  - Maximum **v-RMS**: active if the bit is set in Index 4533, Subindex 5
  - Pre-maximal **v-RMS**: active if the bit is set in Index 4533, Subindex 4
- Vibration in the frequency range
  - Maximum amplitude **Dominant peak**: active if the bit in is set in Index 4574, Subindex 3
  - Frequency deviation **Dominant peak**: active if at least one bit of Index 4574 Subindex 1 and Subindex 2 is set
  - Maximum amplitude **Fundamental peak**: active if the bit is set in Index 4574, Subindex 7
  - Frequency deviation **Fundamental peak**: active if at least one bit of Index 4574 Subindex 5 and Subindex 6 is set

10.3 Process data profile (Index 120)

Predefined process data profiles can be selected using Index 120. By writing Index 120, the values in Index 67, Subindex 17-20 are automatically set to fill values 0-3 or bytes 0-15 in the process data with the following contents:

Table 20: Process data profile description Index 120

Profile name	Value 0	Value 1	Value 2	Value 3
a-RMS profile	**a-RMS** X-axis	**a-RMS** Y-axis	**a-RMS** Z-axis	Temperature
v-RMS profile	**v-RMS** X-axis	**v-RMS** Y-axis	**v-RMS** Z-axis	Temperature
X-axis profile	**a-RMS** X-axis	**v-RMS** X-axis	**Kurtosis** X-axis	**Impulse factor** X-axis
Y-axis profile	**a-RMS** Y-axis	**v-RMS** Y-axis	**Kurtosis** Y-axis	**Impulse factor** Y-axis
Z-axis profile	**a-RMS** Z-axis	**v-RMS** Z-axis	**Kurtosis** Z-axis	**Impulse factor** Z-axis

11 Troubleshooting

Table 21: Possible faults

LED/fault pattern	Cause	Measures
Green LED does not light up	No voltage or voltage below the limit values	Check the power supply, check all electrical connections (cables and plug connections)
Rapid flashing of the LEDs	Invalid operating mode	Disconnecting and reconnecting the voltage supply
Sensor does not provide values in the vibration range.	Manual trigger selected, but no trigger received	Select automatic trigger or send corresponding signal.
Sensor does not provide updated vibration data.	The sensor is in **Snapshot** mode for reading out the raw data or spectrum.	Set **Snapshot** mode to 0 (normal operation).
Sensor does not provide data in vibration range in 2 axes.	Sensor is configured in the single-axis operating mode	Configuration for multi-axis operation.
Teach-in is not performed.	The sensor is in manual trigger operating mode and is not receiving a trigger. No new data blocks can be supplied.	Select automatic trigger or send trigger signal according to the required number of blocks.
Sensor provides no alarm or only a very brief alarm when limit value is exceeded.	The alarm reset time has been set to 0 or a small value.	To receive all alarms that occur, the alarm reset time should be set to -1.
	The alarm delay time has been set to a very large value.	The alarm delay time should be set to 0 so that limit value overshoots always occur as alarms.
Shock data is not recorded and updated.	Threshold for shock detection has been set to 0 g.	Set threshold for shock detection to ≥ 10 g

12 Maintenance

SICK sensors are maintenance-free.

We do, however, recommend that the following activities are undertaken regularly:

- Clean the sensor surfaces
- Check the fittings and plug connectors

No modifications may be made to devices.

Subject to change without notice. Specified product properties and technical data are not written guarantees.

13 Decommissioning

13.1 Replace device

The IO-Link Data Storage can be used to save previous parameters and transmit them to the exchange device. This prevents complete re-parameterization of the exchange device.

13.2 Disassembly and disposal

Disassembling the device

1. Switch off the supply voltage to the device.
2. Detach all connecting cables from the device.
3. If the device is being replaced, mark its position and alignment on the bracket or surroundings.
4. Detach the device from the bracket.

Disposing of the device

Any device which can no longer be used must be disposed of in an environmentally friendly manner in accordance with the applicable country-specific waste disposal regulations.

NOTE

Disposal of batteries, electrical and electronic devices

- In accordance with international regulations, batteries, rechargeable batteries and electrical and electronic devices must not be disposed of with household waste.
- The owner is required by law to dispose of these devices at the appropriate public collection points at the end of their service life.
-  This symbol on the product, its packaging or in the document indicates that a product is subject to the specified regulations.

13.3 Returning devices

▶ Do not dispatch devices to the SICK Service department without consultation.

NOTE

To enable efficient processing and allow us to determine the cause quickly, please include the following when making a return:

- Details of the contact person
- Description of the application
- Description of the error that occurred

14 Technical data

14.1 Technical data

Mechanics/Electronics

Supply voltage	10 V DC ... 30 V DC
Voltage drop	≤ 1 V
Continuous current I_a	≤ 200 mA
Power consumption	< 350 mW
Enclosure rating	IP68
Protection class	III
Shock and vibration resistance	EN 60068-2-27 shock resistance Ea: 30 g 11 ms; 3 shocks in each direction of the 3 coordinate axes IEC 60068-2-31 drop test: 2 times from 1 m, 100 times from 0.5 m EN 60068-2-6 vibration resistance Fc: 10 Hz ... 150 Hz, 1 mm / 15 g
Reverse polarity protection	Yes
Short-circuit protection	Yes
Ambient temperature, operation	-40 °C ... +80 °C

Vibration

Number of axes	3
Measuring range	± 8 g
Measurement error	± 6%
Measuring range **a-RMS**	0 g ... 5.65 g
Measuring range **v-RMS**	0 mm/s ... 100 mm/s, at 88 Hz
Frequency range	0.78 Hz ... 3,200 Hz
Frequency resolution	≥ 0.78 Hz
Bandpass filter	Freely parameterizable in range 1 ... 3,200 Hz
Block length	0.02 s ... 1.28 s

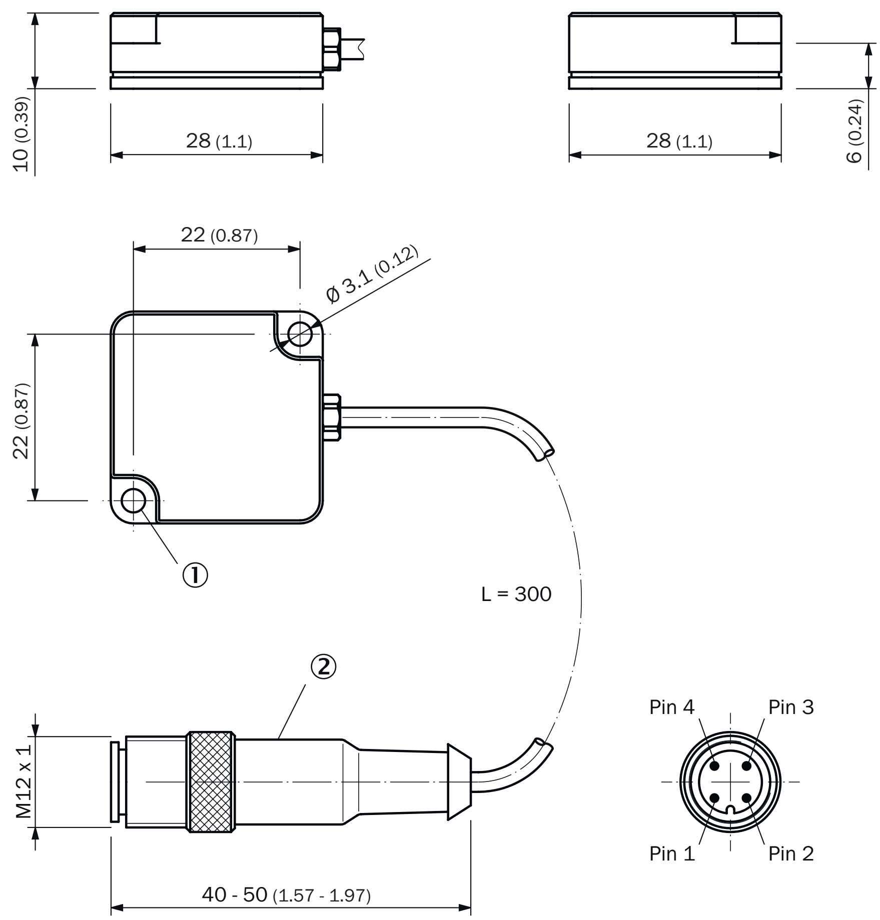
Contact temperature

Measuring range	-40 ... +80 °C
Accuracy	Typ. ± 1 °C
Resolution	1 °C

Shock

Number of axes	3
Measuring range	10 g ... 200 g

14.2 Dimensional drawing



① M3 threaded mounting hole

② Connection

15 Annex

15.1 Conformities and certificates

You can obtain declarations of conformity, certificates, and the current operating instructions for the product at www.sick.com. To do so, enter the product part number in the search field (part number: see the entry in the “P/N” or “Ident. no.” field on the type label).

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