TECHNICAL INFORMATION

TiM51x

2D LIDAR SENSOR

SICK
Sensor Intelligence.

Described product

TiM51x

Manufacturer

SICK AG
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Germany

Legal notes

Original document

This document is an original document from SICK AG.

The TiM51x is certified according to IEC/EN/UL/CSA 61010-1:2007. These operating instructions may contain passages of text in a foreign language.

Contents

1 About this document

This document summarizes additional information on **mounting** and **electrical installation** as well as the **data output format** of the **measured values** of the TiM51x.
The information is intended for sufficiently qualified personnel for installation, commissioning and additional data processing.

Notes on commissioning, configuration and maintenance can be found in the device operating instructions.

You can also find information on the device in the Internet on the product page of the TiM5xx at **www.sick.com/TiM5xx**:

- Detailed technical data in online data sheet (PDF)
- Dimensional drawing and 3D CAD dimension models in various electronic formats
- Scanning range diagram (PDF)
- EU declaration of conformity (PDF)
- Configuration software SOPAS ET (**www.sick.com/SOPAS_ET**)
- Product information with overview of available accessories (PDF)
- TiM51x operating instructions (PDF), in other languages if necessary
- This Technical Information (PDF)

Support is also available from your sales partner at: **www.sick.com/worldwide**.

Symbols used

Some information in this document is emphasized as follows to facilitate quick access to this information.

NOTE

Note!

A note refers to a potential risk of damage or loss of function of the TiM51x or the devices connected to it.

WARNING

Warning!

A warning refers to specific or potential dangers to the physical safety of the user. It is there to protect the user against accidents.

The safety mark next to the warning, on the left, refers to the type of accident risk, e.g., electricity-related. The ascending warning levels (CAUTION, WARNING, DANGER) refer to the severity of the possible danger.

➢ Always read the warnings carefully and make sure you comply with them.

Important This important note is there to advise you on special aspects.

This symbol refers to supplementary technical documentation.

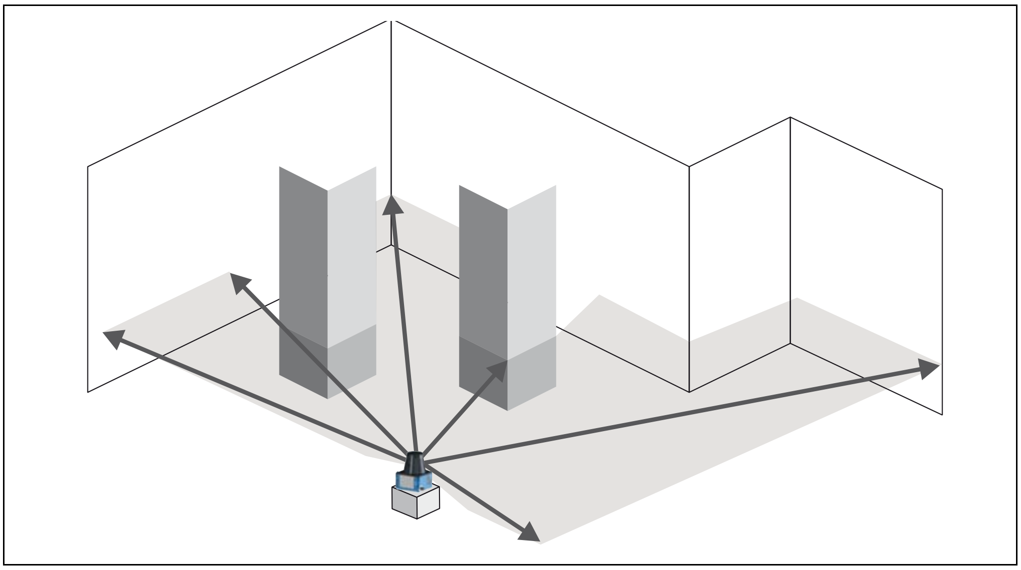
Safety information

- Read the notes on mounting and electrical installation before doing work
- Also read these the operating instructions of the TiM51x 2D LiDAR sensor in order to familiarize yourself with the device and its functions.
- The device complies with laser class 1, see laser information in the operating instructions.
- Use the device only under permitted ambient conditions (e.g. temperature, grounding potential). If applicable, the official and legal regulations for operating must always be complied with.
- Opening the screws of the device housing will invalidate any warranty claims against SICK AG.
- Repair work on the device may only be performed by qualified and authorized service personnel from SICK AG.
- The device does not constitute personal protection equipment in accordance with the respective applicable safety standards for machines.
- The device must not come into contact with moisture and dust when the cover of the USB port is open and/or the USB cable is connected. In this status, the device does not correspond to any specified IP protection class.
- For CE conformity, the maximum length of all connecting cables on the device must not exceed 3 m.

2 Operating principle of the TiM51x

2.1 Measurement principle

The device is an opto-electronic 2D LiDAR sensor (laser scanner) that uses laser beams for non-contact scanning of the outline of its surroundings on a plane. The TiM51x measures its surroundings in two-dimensional polar coordinates relative to its measurement origin. Its measurement origin is marked by a circular indentation in the center of the optics cover. If a laser beam strikes an object, the position of that object is determined in terms of distance and direction.



The scanning sector is 270°. The maximum scanning range is 4 m onto bright, natural surfaces with object remission of > 50% (e.g., a white wall).

2.2 Range finding

The device emits beams pulsed by a laser diode. If a laser pulse hits an object or person, it is reflected on the surface of the object or person in question. The reflection is registered by a photo-diode in the device receiver. The device uses SICK's own HDDM+ technology (**H**igh **D**efinition **D**istance **M**easurement). With this measurement procedure, a measured value is formed by averaging multiple individual pulses. The device calculates the distance from the object based on the elapsed time that the light requires between emitting the beam and receiving the reflection. Radar systems apply this “pulse time-of-flight measurement” principle in a similar way.

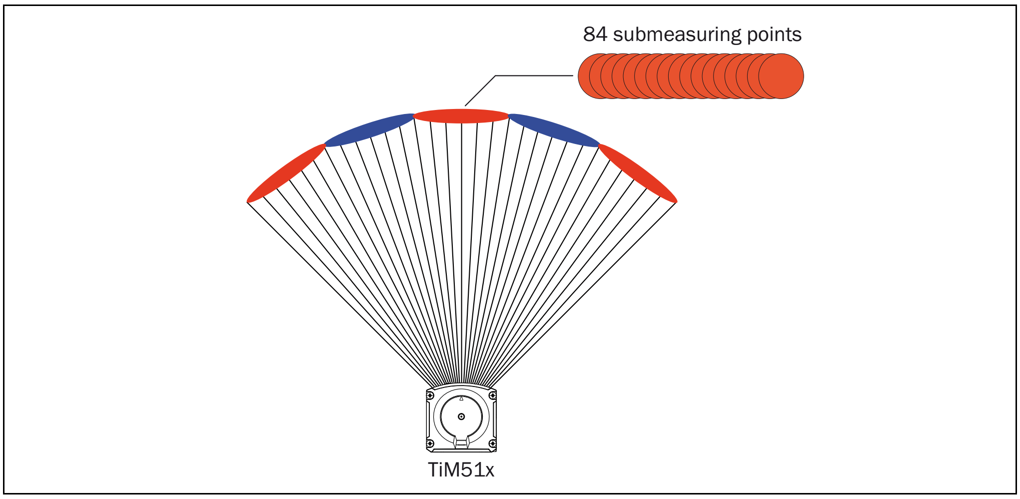
2.3 Direction measurement

The device uses a rotating mirror to deflect the emitted laser beams, thereby scanning its surroundings in a radial pattern. The measurements are triggered internally by an encoder in regular angle increments. One complete rotation represents one measuring process (scan).

The device works at a scanning frequency of 15 Hz, i.e. it performs 15 measuring processes per second and makes the measurement results continuously available in real time via an RS-232 interface.

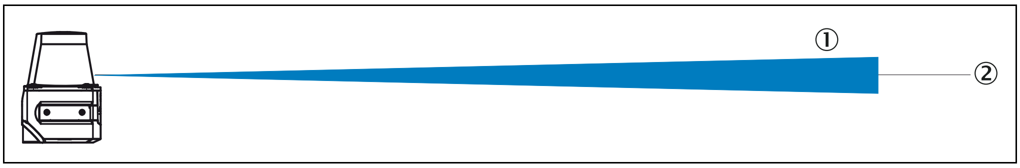
The measurement procedure uses the averaging from multiple pulses to determine individual measured values. A measuring point is the average value of 84 measurements combined.

The measured values are output at 460,800 bit/s with an angular resolution of 1° or at 115,200 bit/s with an angular resolution of 3°.



2.4 Object sizes

As the distance from the device increases, the laser beam expands. As a result, the diameter of the light spot on the surface of the object increases.



① Expanded laser beam

② Optical axis

Required values for calculating the light spot size and minimum object size:

- Light spot size on the device cover: 7 mm (rounded up)
- Light spot divergence per single pulse: 0.49 deg (8.6 mrad)
- HDDM+ supplement (1 measured value comprises several superimposed individual pulses): 17.5 mrad

Formula for calculating the light spot width:

(Light spot divergence [mrad] + supplement [mrad]) * distance [mm] + light spot size on the device cover [mm] = light spot width [mm]

Calculation example of light spot width at a distance of 4 m, with supplement 5.8 mrad:

(8.6 mrad +5.8 mrad) * 4,000 mm +7 mm = 64.6 mm

Formula for calculating the height of the light spot:

Light spot divergence [mrad] * Distance [mm] + Light spot size at the device cover [mm] = Light spot width [mm]

Example calculation of the light spot height at a distance of 4 m:

8.6 mrad * 4,000 mm +7 mm = 41.4 mm

Formula for calculating the minimum object size:

2 * supplement [mrad] * distance [mm] + light spot height [mm] = minimum object size [mm]

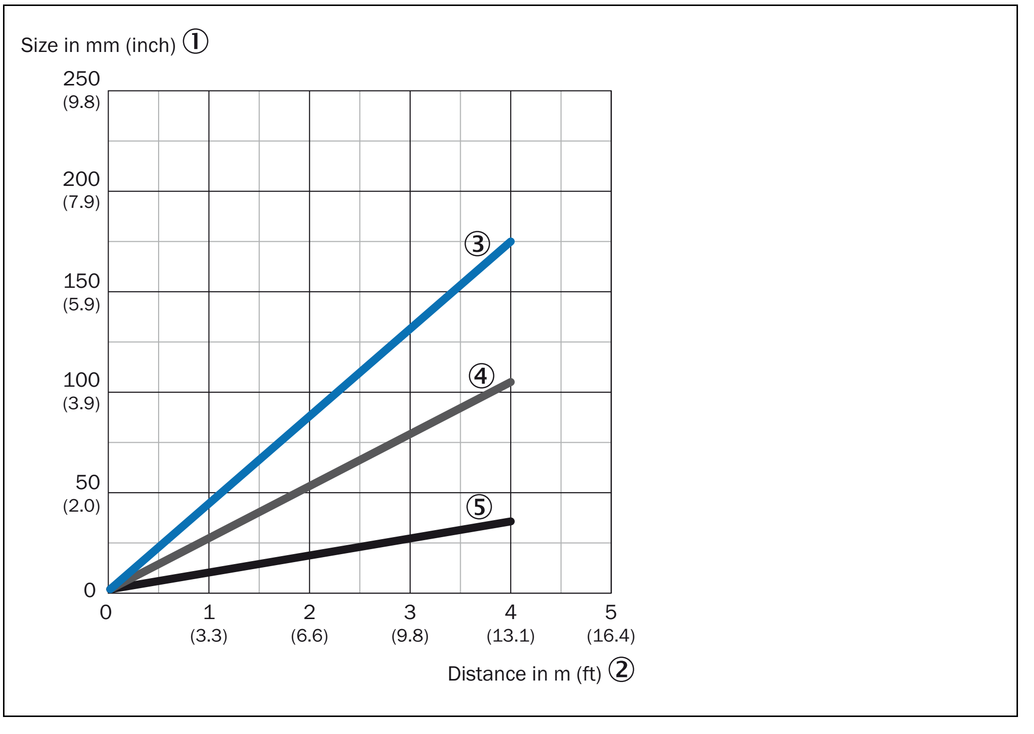
Calculation example of minimum object size at a distance of 4 m, with supplement 5.8 mrad:

2 * 5.8 mrad * 4,000 mm + 41.4 mm = 87.8 mm

NOTE

Note!

For reliable measurement, an object needs to be hit several times. Therefore, the object either needs to be larger than the minimum object size, or both the LiDAR sensor and the object must not be moving.

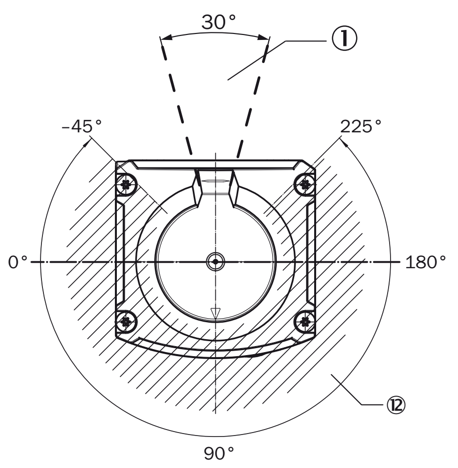


① Size in millimeters (inch)
② Distance in meters (feet)
③ Minimum object size
④ Light spot size
⑤ Light spot height

3 Mounting

3.1 Notes on mounting

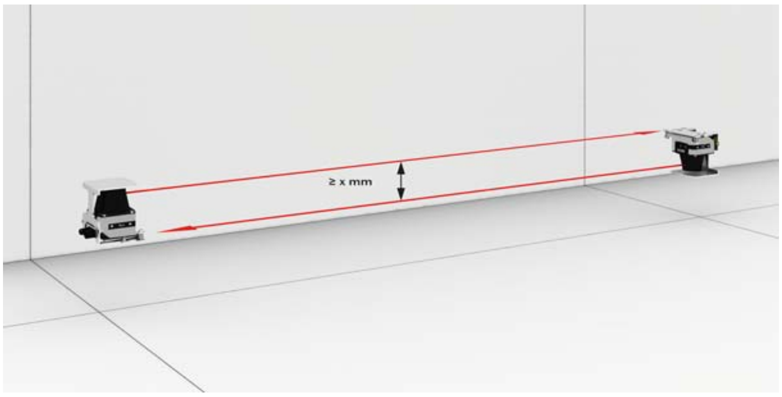
- The device can be mounted in any position depending on the purpose.
- The device should be mounted so that is it as free from shock and vibration as possible.
- Mount the device so that it is not exposed to direct sunlight (window, skylight) or other sources of heat. This causes the temperature in the device to increase improperly.
- During installation, make sure there is no reflective surface behind the reference target (see Figure ①).



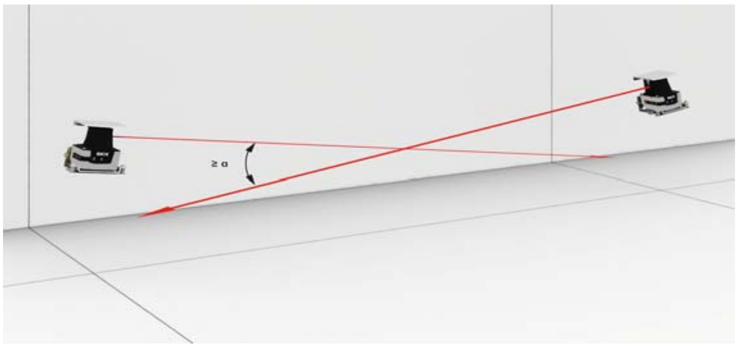
Using multiple devices

The device has been designed to minimize the probability of mutual interference with devices of the same type. To rule out even the slightest effects on the measurement accuracy, the devices should be arranged such the laser beams are not received by another device.

Distance ≥ 200 mm:



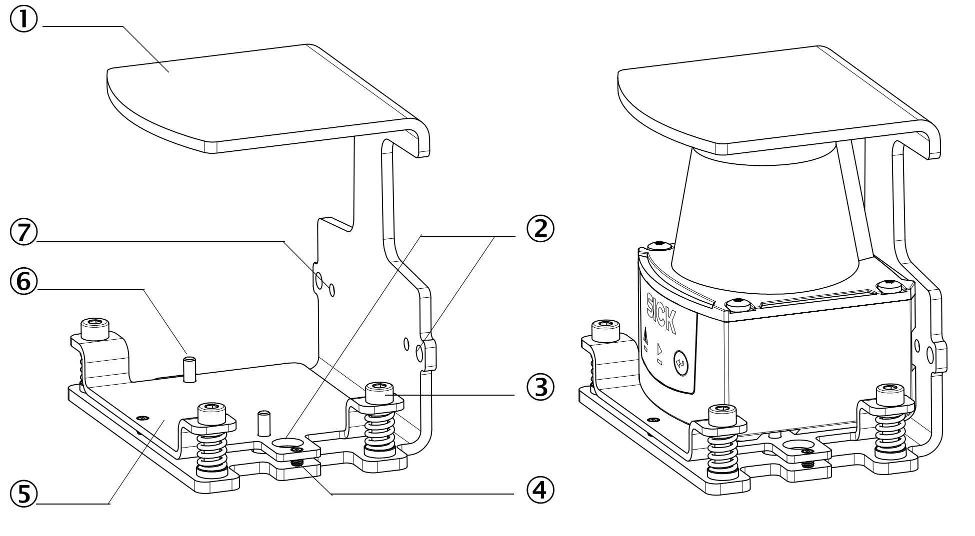
Angle ≥ 6°:



3.2 Optional accessories

3.2.1 Installing mounting kit 2 (part no. 2061776) on the device

The U-shaped mounting kit 2 acts as a bracket with the option of performing fine adjustment of the scan level, and provides impact protection. The device can also be mounted directly on the bracket without the adapter plate (impact protection only).



① Mounting bracket

② Hole ∅ 4.3 mm for horizontal or vertical mounting of the mounting bracket on a base, 2 x 2

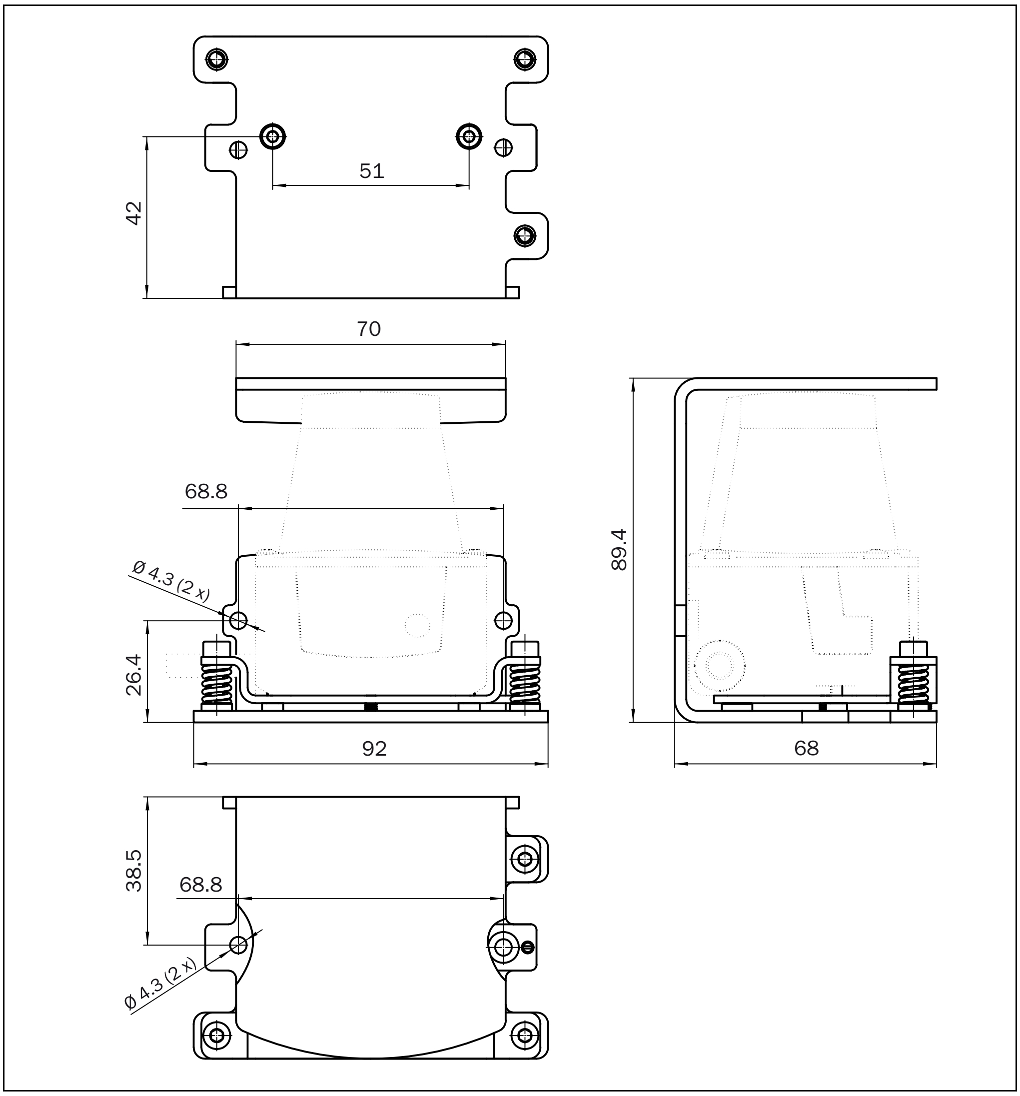
③ M4 x 16 cylinder head screw (hexagon socket) and compression spring for aligning the TiM51x, 3 x

④ Stud for locking the adapter plate after alignment, 2 x

⑤ Adapter plate

⑥ M3 x 8 cylinder head screw with washer in ∅ 3.2 mm hole for mounting the device on the adapter plate, 2 x

⑦ Hole∅ 3.2 mm for mounting the device directly on the mounting bracket, 2 x (alternatively, without the option of adjusting the scan plane)

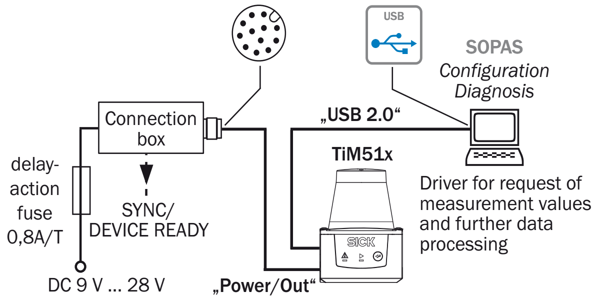


Procedure for mounting the device

1. Mount the device on the adapter plate using the two M3 x 8 screws and washer supplied. To do this, insert the screws with washers from below through the hole in the mounting bracket and the hole in the adapter plate.
2. Align the scan plane of the device using the three cylinder head screws ③.
3. After adjusting the adapter plate using the two studs, lock against the mounting bracket ④.

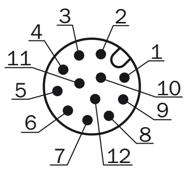
4 Electrical installation

4.1 Overview of all interfaces



4.2 Pin and wire color allocation

“Power/Out” connection (cable with M12 male connector, 12-pin, A-coded)



PIN	Signal	Wire color	Function
1	GND	Black	Ground
2	DC 9 V ... 28 V	Red	Supply voltage
3	N.c.	–	–
4	N.c.	–	–
5	N.c.	–	–
6	N.c.	–	–
7	N.c.	–	–
8	SYNC/DEVICE READY	Red/Black	Synchronization (SYNC/Device Ready)
9	N.c.	–	–
10	N.c.	–	–
11	TxD	Yellow	RS-232 (sender)
12	RxD	Violet	RS-232 (receiver)
–	–	Metal	Screen
Do not wire reserved pins!			

4.3 Notes on electrical installation

- The device must not come into contact with moisture and dust when the cover of the USB port is open or the USB cable is connected. In this condition, the device does not correspond to any specified IP enclosure rating.
  Use the supplied seal for the USB connection to prevent contact with moisture and dirt.
- When operating the USB interface, ESD/EMC interferences can lead to an interruption of the USB connection. To continue with data transmission, disconnect the USB cable from the device and reattach it to establish contact. To re-establish communication between the device and PC, select the COMMUNICATION > GO ONLINE command in the SOPAS configuration software.
- Electrical connections between the device and other devices may only be made or separated in a voltage-free state. Otherwise, the devices may be damaged.
- For CE conformity, the maximum length of all connecting cables on the device must not exceed 3 m.
- Wire cross-sections in the supply cable from the customer's power system must be designed in accordance with the applicable standards.
- Protect the device with an external slow-blow fuse of 0.8 A at the beginning of the supply cable, viewed from the voltage supply.
- All electrical circuits connected to the device must be implemented either as SELV or PELV electrical circuits (SELV = **S**afety **E**xtra **L**ow **V**oltage; PELV = **P**rotective **E**xtra **L**ow **V**oltage).
- When setting up a startup device with a 12-pin M12 male connector, do not wire the reserved pins (e.g., as solder terminal)!
- Only switch on the supply voltage for the device when the connection tasks have been completed and the wiring has been thoroughly checked.

4.4 Prerequisites for safe operation of the device in a system

The device is designed and tested for electrical safety in accordance with EN 61010-1 (ed. 3).

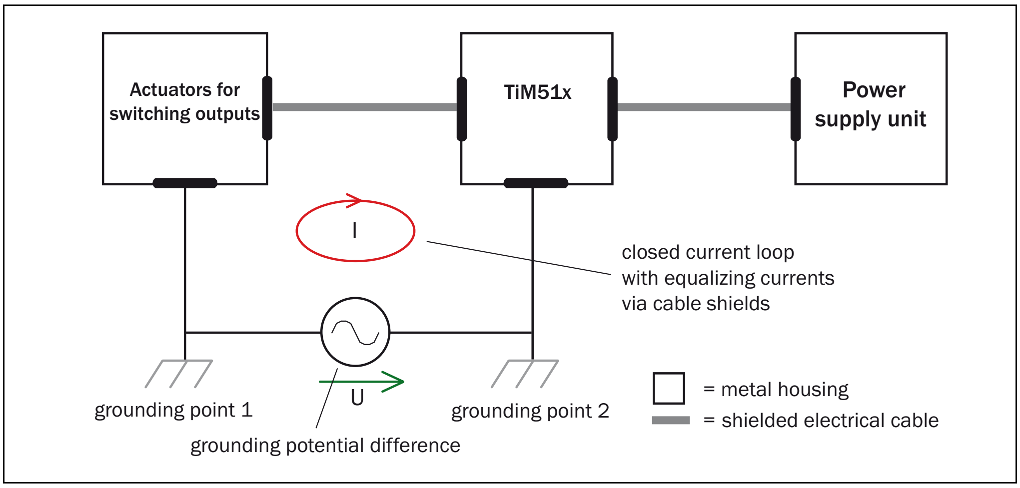
It is connected to the peripheral devices (voltage supply, EDP, actuators) via shielded cables. The cable shield – for the supply cable, for example – rests against the metal housing of the device. The device can either be grounded through the cable shield or through both fastening clips.

If the peripheral devices have metal housings and if the cable shields also lie on their housings, it is assumed that all devices involved in the installation have the **same ground potential**.

This is achieved by complying with the following conditions, among others:

- Mounting the devices on conductive metal surfaces
- Correct grounding of the devices/metal surfaces in the system
- Low-impedance and current-carrying equipotential bonding between areas with different ground potentials, if necessary.

If these conditions are not met, e.g., on devices in a widely distributed system over several buildings, potential equalization currents may, due to different ground potentials, flow along the cable shields between the devices and create hazards.



Due to insufficient ground potential equalization, voltage differences arise between grounding points 1 and 2. The current loop closes via the shielded cables and metal housing.

⚠ DANGER

Risk of injury/risk of damage due to electrical current!

Potential equalization currents between the device and other grounded devices in the system can have the following effects:

- Dangerous voltages on the metal housing
- Incorrect function or irreparable damage to the devices
- Damage/irreparable damage of the cable shield due to heating and cable fires

➢ Where local conditions are unfavorable and thus do not meet conditions for a safe earthing method (same ground potential at all grounding points), take measures in accordance with the following formats.

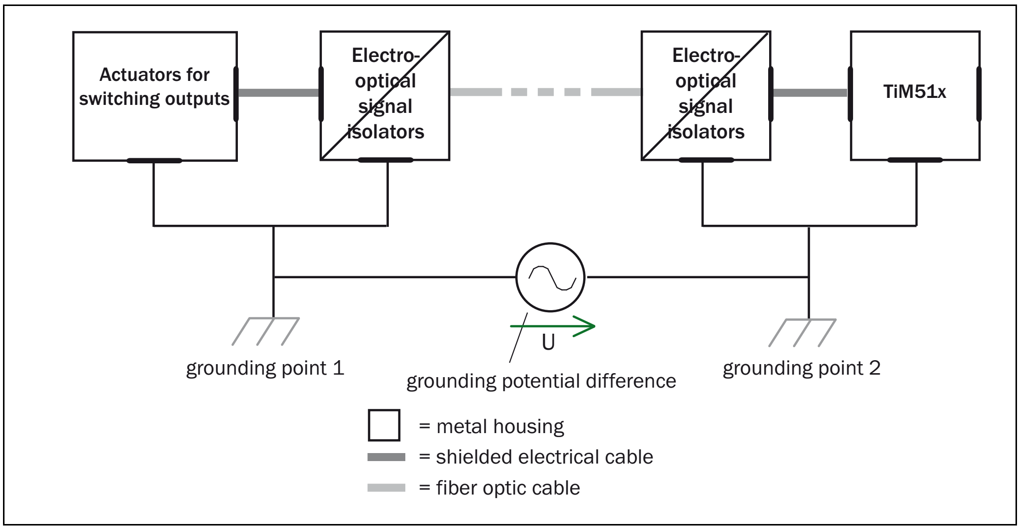
Remedial measures

The most common solution to prevent equipotential bonding currents on cable shields is to ensure low-impedance and current-carrying equipotential bonding. If this is not possible, the following solution approaches serve as a suggestion.

Important We expressly advise against opening up the cable shields. This would mean that the EMC limit values can no longer be guaranteed.

a) Measures for widely distributed system installations

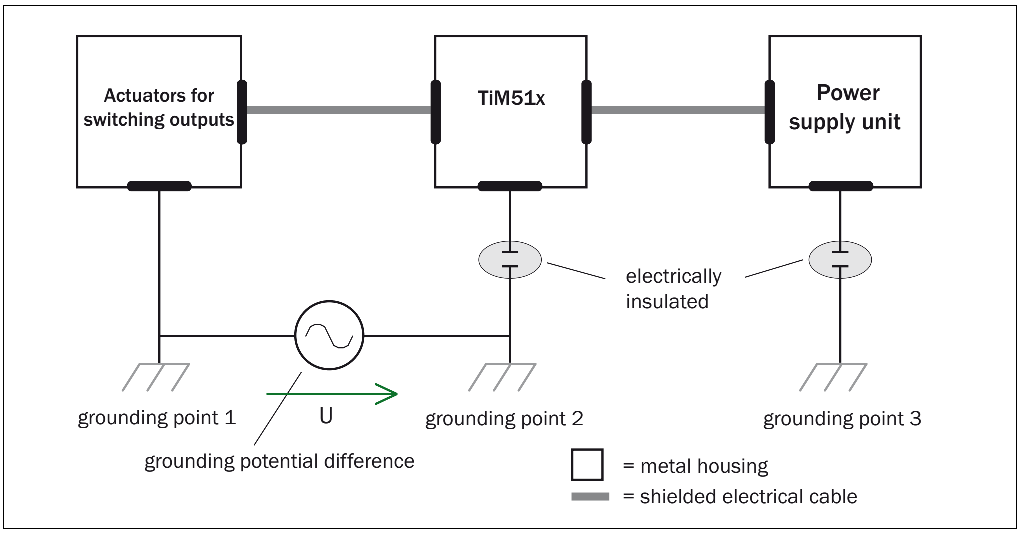
In widely distributed system installations with correspondingly large potential differences, we recommend setting up local islands and connecting them using commercially available **electro-optical signal isolators.** This measure achieves a high degree of resistance to electromagnetic interference while at the same time complying with all the requirements of EN 60950-1.



The ground loop is isolated by using the electro-optical signal isolator between the islands. Within the islands, a stable equipotential bonding prevents equalizing currents on the cable shields.

b) Measures for small system installations

For smaller installations with only slight potential differences, insulated mounting of the device and of peripheral devices may be a sufficient solution.



There is effective suppression of ground loops even at ground potential differentials of up to 60 V RMS / 80 V DC maximum. As a result, equalizing currents can no longer flow via the cable shields and metal housing.

Important The voltage supply for the device and the connected peripheral devices must also guarantee the required level of insulation.

Under certain circumstances, a tangible potential can develop between the insulated metal housings and the local ground potential.

4.5 Installation steps

4.5.1 Supply voltage connection

The device requires a supply voltage of DC 9 V ... 28 V (stabilized protective extra-low voltage [SELV or PELV] in accordance with the IEC 60364-4-41 standard [VDE 0100, part 410]). The source of electricity must be able to supply at least 5 W.

⚠ DANGER

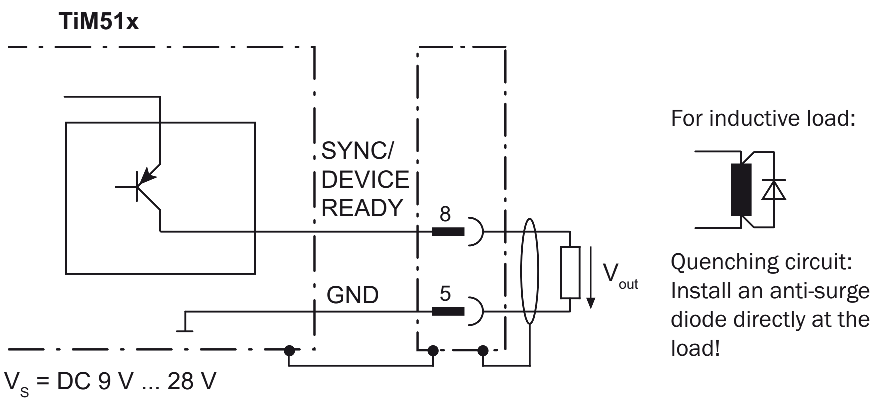
Risk of injury due to electric current!

If the supply voltage is produced by the removal and conversion of electricity from the AC mains power supply with the aid of a stabilized power supply unit, then insufficient electrical separation between input and output current circuit may lead to an electric shock.

➢ Only use a power supply unit whose output circuit has safe electrical separation from the input circuit by means of double insulation and a safety transformer in accordance with IEC 742 (VDE 0551).

4.5.2 Wiring of the SYNC/DEVICE READY output

The SYNC/DEVICE READY output is used to output the “Device Ready” signal, an error, and a periodic index pulse.



Structure and wiring principle of output SYNC/DEVICE

Switching behavior	PNP switching to supply voltage V_S • SYNC/DEVICE READY: Idle level: high (Device Ready), operating level: low (error), low pulse (15 Hz, index, corresponds to measurement at 90°)
Properties	– Short-circuit protected and temperature protected – Not electrically isolated from supply voltage U_V
Electrical values	$0\ V \leq U_a \leq U_V$ $(U_V - 1.5\ V) \leq U_a \leq U_V$ at $I_a \leq 100$ mA

Important Longer connecting cables at the switching outputs of the device should be avoided due to the resulting fall in voltage. This is calculated as follows:

$$\Delta U = \frac{\text{2 x length x current}}{\text{conductance value x cross-section}}$$

Conductance value for copper: 56 m/Ω mm².

5 Output of measured values

5.1 Telegrams

Notation

The individual parts in the syntax of the telegrams of the device are separated in each case by a space (ASCII code 32, 20h), as also required in the request to the device.

The device sends measured values as follows:

- Values with a leading “+” or “–” sign are interpreted as a decimal value (ASCII notation)
- Values without a leading "+" or "–" are interpreted as a hexadecimal value (ASCII notation)
- The different notations can be mixed within the telegram

Variable types

The variable types are specified in the description of the measured value output telegram, the following variable types are possible:

Variable type	Length (Byte)	Value range	Algebraic signs
uint_8	1	0 ... 255	No
uint_16	2	0 ... 65.535	No
uint_32	4	0 ... 4.294.967.295	No
int_32	4	–2.147.483.648 ... +2.147.483.647	Yes
float_32	4	$-10^{-44.85}$ ... $+10^{38.53}$	Yes
String	Depending on context	Important: Strings are not null-terminated	

Important

- The information in the “Length” column of the table refers to the binary transmission of the numeric values.
- The information in the "Value range" column in the table refers to the value range mathematically possible for the variable type. The actual value ranges for the parameters may be different, see also *Chapter 5.3 Format for output of measured values, page 22*.

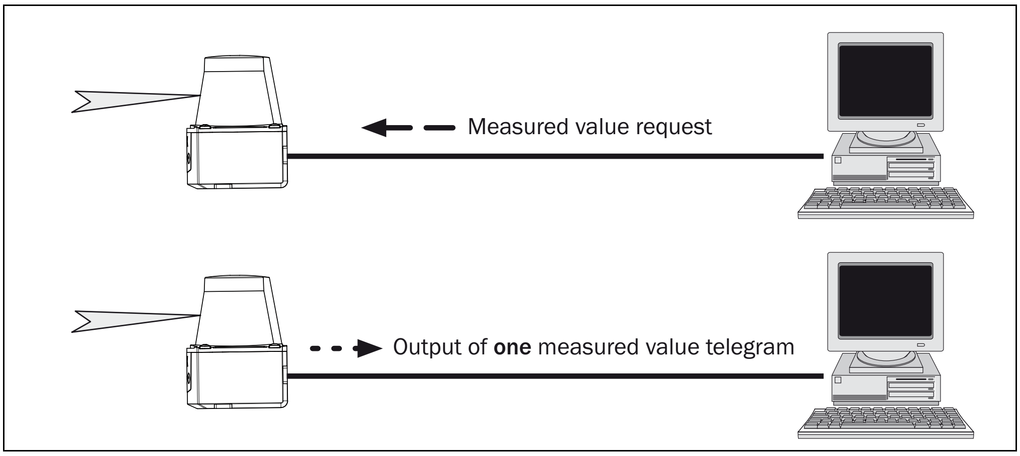
5.2 Measured value request

After switching on the supply voltage, the device initializes and the green light emitting diode b will light up to indicate its readiness for operation.
The device begins its readiness to measure automatically. It continuously scans the surrounding contour in its field of vision at a frequency of 15 Hz. It continuously saves the values determined in each measuring process (scan) in its measured value memory by overwriting the previous values.

5.2.1 One-off output of measured values

If the data from a measuring process is required, the device sends the measured values from the most recent scan.

Example for one-off output of measured values



Requirement:

<STX>sRN LMDscandata<ETX>

Response from the device:

<STX>sRA LMDscandata (for content, see *Chapter 5.3 Format for output of measured values, page 22*) <ETX>

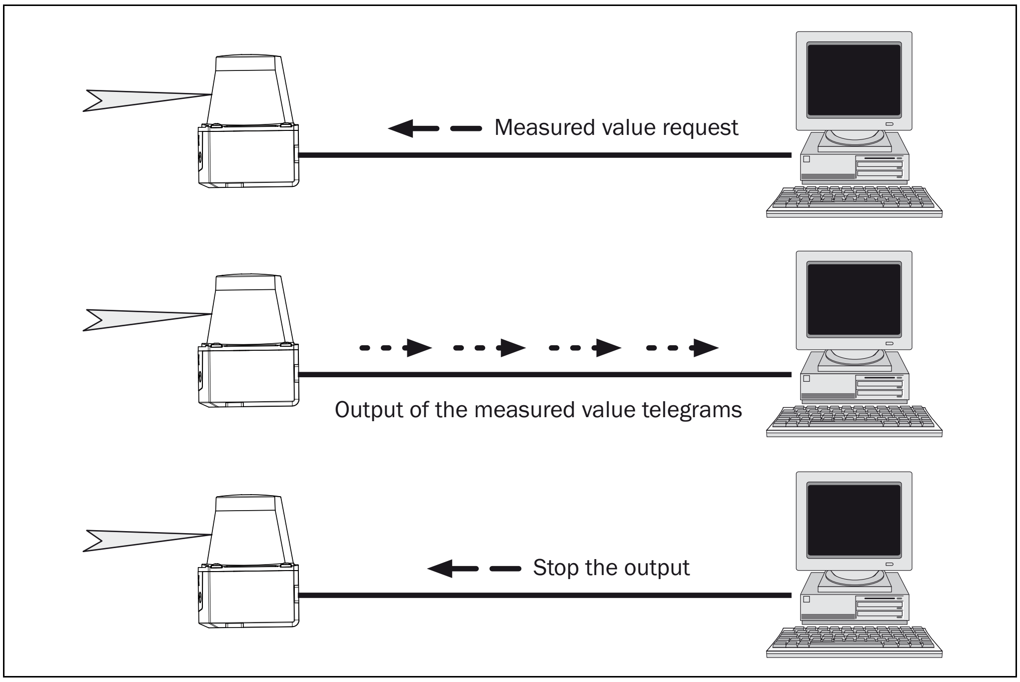
Telegram structure: **sRN LMDscandata**

Telegram part	Description	Variable type	Length (Byte)	Value range
Command type	Request (SOPAS read by name)	String	3	**sRN**
Command	Request data	String	11	**LMDscandata**

5.2.2 Continuous output of measured values

If the data from ongoing measuring processes is required, the device sends measured values from successive scans until the output of measured values is stopped again using the same telegram.

Example for continuous output of measured values



1. Starting output of measured values

Requirement:

<STX>sEN LMDscandata 1<ETX>

Response from the device (confirmation of request):

<STX>sEA LMDscandata 1<ETX>

Response from the device (measurement data output):

<STX>sSN LMDscandata (for contents, see *Chapter 5.3 Format for output of measured values, page 22*) <ETX>

2. Stopping output of measured values

Requirement:

<STX>sEN LMDscandata 0<ETX>

Response from the device (confirmation of request):

<STX>sEA LMDscandata 0<ETX>

Telegram structure: **sEN LMDscandata** MeasurementStartStop

Telegram part	Description	Variable type	Length (Byte)	Value range
Command type	Request (SOPAS event by name)	String	3	**sEN**
Command	Request data	String	11	**LMDscandata**
StartStop measurement		Enum8	1	**0** Stop output of measured values **1** Start output of measured values

5.3 Format for output of measured values

Important The information in gray writing in the following table is not output by the device (substitute value is “0”).

Telegram part		Description	Variable type	Length (Byte)	Value range
	Command type	Request (**S**OPAS **r**ead **a**nswer/**S**OPAS **s**ent **e**vent)	String	3	**sRA/sSN**
	Command	Request data	String	11	**LMDscandata**
	Version number	Firmware version information	uint_16	2	**0000h ... FFFFh**
Device information	Device number	Device ID as configured with SOPAS ET	uint_16	2	**0000h ... FFFFh**
Device information	Serial number	Serial number from the factory	uint_32	4	**00000000h ... FFFFFFFFh**
Device information	Device status	Status of the device	uint_x	2 x 1	**00 00h** Device OK **00 01h** Device error
Status information	Telegram counter	Counter, starting with the first measured value telegram (cyclic data) after confirmation of the measured value request. The counter restarts at 0 once 255 has been exceeded.	uint_16	2	**0000h** 0 **FFFFh** 65.535
Status information	Scan counter	Counter, starting with the first scan after confirmation of the measured value request. When the upper limit is reached, the numbering starts again from 0 (= 1st scan).	uint_16	2	**0000h** 0 **FFFFh** 65.535
Status information	Switch-on time	Time period since the device was switched on until the end of the scan; in microseconds (μs)	uint_32	4	**00000000h** 0 **FFFFFFFFh** 4.294.967.295
Status information	Transmission Duration	Time period since the device was switched on until the time of sending the telegram; in microseconds (μs)	uint_32	4	**00000000h** 0 **FFFFFFFFh** 4.294.967.295
Status information	Input status	The least significant byte reflects the state of the digital switching inputs bit by bit. The least significant bit corresponds to input 1.	uint_x	2 x 1	**00 00h** All switching inputs off
Status information	Output status	The least significant byte reflects the state of the digital switching outputs bit by bit. The least significant bit corresponds to output 1.	uint_x	2 x 1	**00 00h** All switching outputs off **00 0Bh** All switching outputs on
Status information	Checksum	8-bit checksum XOR operation	uint_8	1	**00h to FFh**
Status information	Reserved byte A	Reserved	uint_16	2	–

Telegram part		Description	Variable type	Length (Byte)	Value range
Measurement parameters	Scanning frequency	Specification in 1/100 Hz	uint_32	4	**1500** 15 Hz
	Measuring frequency	Frequency between two individual measurements in 100 Hz	uint_32	4	**00000000h … FFFFFFFFh**
Number of encoders		Specifies how many encoders output data	uint_16	2	**0** No encoder (cannot be changed)
Encoder	Encoder position	Specification in ticks	uint_32	4	**00000000h … FFFFFFFFh**
	Encoder speed	Specification in ticks/mm	uint_16	2	**0000h … FFFFh**
Number of 16 bit channels		Specifies in how many 16 bit output channels the device outputs measurement data. If “0 output channels” is selected, the device does not output any data.	uint_16	2	**1** The TiM51x outputs the distance values as a 16-bit value via a channel
Output channels 1 … 4 (16 bit)	Measurement data content	The telegram part determines the content of the output channel.	String	5	**DIST1** Radial distance of the first reflection pulse
	Scaling factor	Multiplier for the values in the Data_1 to Data_n telegram parts	float_32	4	**00000000h … FFFFFFFFh**
	Scaling offset	At TiM51x always 0	float_32	4	**00000000h … FFFFFFFFh**
	Start angle	Specification in 1/10,000 degrees	Int_32	4	–450,000 … + 2,250,000
	Angular increment	Specification in 1/10,000 degrees	uint_16	2	30.000
	Number of pieces of data	Specifies how many pieces of measurement data the device outputs	uint_16	2	91
	Data_1 … Data_n	Output of the measured values 1 to n. The contents and the unit depend on the “Measured data content” telegram part. DIST in mm	uint_16	2	**0000h … FFFFh**
Number of 8 bit channels		Specifies in how many 8 bit output channels the device outputs measurement data. If “0 output channels” is selected, the device does not output any data.	uint_16	2	**1** The TiM51x outputs the RSSI values as an 8-bit value via a channel
RSSI = Received Signal Strength Indicator					

(cont.)

	Telegram part	Description	Variable type	Length (Byte)	Value range
Position		Specifies whether the device outputs position data	uint_16	2	**0** No position data (cannot be changed)
Position information	X position	XN coordinates of the sensor in a coordinate system	Real	4	**00000000h … FFFFFFFFh**
	Y position	YN coordinates of the sensor in a coordinate system	Real	4	**00000000h … FFFFFFFFh**
	Z position	ZN coordinates of the sensor in a coordinate system	Real	4	**00000000h … FFFFFFFFh**
	X rotation	XN coordinates of the sensor in a coordinate system	Real	4	**00000000h … FFFFFFFFh**
	Y rotation	YN coordinates of the sensor in a coordinate system	Real	4	**00000000h … FFFFFFFFh**
	Z rotation	ZN coordinates of the sensor in a coordinate system	Real	4	**00000000h … FFFFFFFFh**
	Rotation type	Type of rotation	Enum8	1	**0** No rotation **1** Pitching **2** Rolling **3** Free rotation
Name		Specifies whether the device outputs configured device names with SOPAS ET	uint_16	2	**0** No device name (cannot be changed)
	Device name	Flexible range from 0 to 16 characters (20h … FFh)	String	0 … 16	....
Comment		Specifies whether the device outputs configured comments with SOPAS ET	uint_16	2	**0** No comments (cannot be changed)
	Comment content	Configured comments	String	0 … 128	....
Time specifications		Specifies whether the device outputs time information	uint_16	2	**0** No time information (cannot be changed)
Time information	Year	Year (4 digits)	uint_16	2	**0000h … 270Fh**
	Month	Month (1 to 12)	uint_8	1	**00h … 0Ch**
	Day	Day of the month (1 to 31)	uint_8	1	**00h … 1Fh**
	Hour	Hour (0 to 23)	uint_8	1	**00h … 17h**
	Minute	Minute (0 to 59)	uint_8	1	**00h … 3Bh**
	Seconds	Second (0 to 59)	uint_8	1	**00h … 3Bh**
	Microsecond	Microseconds (0 to 999.999)	uint_32	4	**00000000h … 000F423Fh**
Result information		Specifies whether the device outputs result information	unit_16	2	**0** No result information (cannot be changed)
Result information	Result type	Fast digital input event	String	4	FDIN
	Encoder position	Position of the encoder at the time of the event, specification in ticks	uint_32	4	**00000000h … FFFFFFFFh**
	Event time	Time period since the sensor was switched on until the end of the result; specification in microseconds (µs)	uint_32	4	**00000000h** 0 **FFFFFFFFh** 68.719.476.735
	Angular position	Angular position of the sensor at the time of the event, specified in 1/10,000 degrees	int_32	4	–450,000 … + 2,250,000

(cont.)

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