

SINGLE-BEAM PHOTOELECTRIC SAFETY SWITCH TYPE 4

Models: SH4/*-**** ; SH5/*-****; TH6/*-K** ; TH7/*-K**

INSTALLATION MANUAL



Micro Detectors

Strada S. Caterina, 235 - 41122
Modena Italy
Tel. +39 059 420411
Fax +39 059 253973
www.microdetectors.com
info@microdetectors.com

1 ABOUT THIS DOCUMENT

Please read these operating instructions carefully before you work with, mount, operate or maintain the single-beam photoelectric safety switch SH, TH. Particularly observe Chapter 2 "On safety". This document is a translation of the original document.

1.1 Function of this document

These operating instructions are designed to address the technical personnel of the machine manufacturer or the machine operator in regards to safe mounting, electrical installation, commissioning, operation and maintenance of the single-beam photoelectric safety switch SH, TH. However, the planning and use of protective devices such as the single-beam photoelectric safety switch SH, TH also require specific technical skills which are not detailed in this documentation. When operating the single-beam photoelectric safety switch SH, TH the national, local and statutory rules and regulations must be observed.

1.2 Symbols used

Warning! A warning notice indicates an actual or potential risk or health hazard. They are designed to help you to prevent accidents. Read carefully and follow the warning notices.

Sender
The symbol denotes the sender

Receiver
The symbol denotes the receiver.

2 ON SAFETY

Warning! During application of the device it is to be ensured that the combination of photoelectric switch and test device meets the requirements in accordance with IEC 61496 Type 4.

Warning! Pay attention to the safety instructions and warnings in the documentation for the test device connected.

2.1 Specialist personnel

The single-beam photoelectric safety switch SH, TH must be installed, commissioned, tested, serviced and used only by specialist personnel. Specialist personnel are defined as persons who
- have undergone the appropriate technical training, and
- have been instructed by the responsible machine operator in the operation of the machine and the current valid safety guidelines, and
- have access to these operating instructions.

2.2 Applications of the device

The single-beam photoelectric safety switch SH, TH is, in conjunction with an external test device as per IEC 61496 Type 4, an item of electro-sensitive protective equipment (ESPE) Type 4 in accordance with IEC 61496-1 and IEC 61496-2. In combination they can be used in safety applications up to **Category 4** as per EN ISO 13849, **SIL CL 3** as per EN 62061 or up to **PL e** as per EN 13849.

The switch meets the requirements of the Machinery Directive 2006/42/EC and is used for
- Hazardous area protection
- Access protection

The photoelectric switches must be installed such that the hazardous area can only be reached by interrupting the light path between sender and receiver. It must not be possible to start the plant/system as long as personnel are within the hazardous area.

2.3 Correct use

The single-beam photoelectric safety switch SH, TH must be used only as defined in chapter 2.2 "Applications of the device". If the device is used for any other purposes or modified in any way also during mounting and installation any warranty claim against Techno GR shall become void.

2.4 General safety notes and protective measures

Safety notes! Please observe the following items in order to ensure the correct and safe use of the single-beam photoelectric safety switch SH, TH.

- The national and international rules and regulations apply to the installation, commissioning, use and periodic technical inspections of the single-beam photoelectric safety switch SH, TH, in particular:
 - Machine Directive 2006/42/EC
 - Work Equipment Directive 89/655/EEC
 - The work safety regulations and safety rules
 - Other relevant health and safety regulations
- Manufacturers and operators of the machine on which the single-beam photoelectric safety switch SH, TH is used are responsible for ensuring that all applicable safety regulations and rules are agreed with the appropriate authorities and also observed.
- The test notes in these operating instructions (see chapter 6 "Commissioning") must be observed.
- The tests must be carried out by specialist personnel or specially qualified and authorised personnel and must be recorded and documented to ensure that the tests can be reconstructed and retraced at any time.
- These operating instructions must be made available to the operator of the machine where the single-beam photoelectric safety switch SH, TH is fitted. The machine operator is to be instructed in the use of the device by specialist personnel and must be instructed to read the operating instructions.

2.5 Disposal

Always dispose of unserviceable or irreparable devices in compliance with local/national rules and regulations on waste disposal.

3 PRODUCT DESCRIPTION

These single-beam photoelectric safety switches belong to the SH, TH sensor family and are optoelectronic sensors with emitter units SH (TH)*/E... and a receiver units SH(TH)*/R... Emitters showing a red light and have a test input (which can be used to monitor the proper functioning of the couple).

Models are available that combine several function:
- models with standard Test Input or Output logic levels (H), SH*/*-**IC and TH*/*-**IC.
- models with complementary Test Input or Output logic levels (L), SH*/*-**IA and TH*/*-**IA.
- M18 models, metal or plastic housing with radial optic SH*/*-3*** or SH*/*-2***;
- M18 models, metal or plastic housing with axial optic SH*/*-1*** or SH*/*-0***;
- M30 models, only metallic housing with axial optics TH*/***.
Ranges are respectively 5, 10 and 60m. For all models two different frequencies are available:
- a standard operating frequency of 123KHz, SH4/*-**** e TH6/*-****;
- a special operating frequency of 83KHz, SH5/*-**** e TH7/*-****.
The two different frequencies can be used to avoid interference between transmitters and receivers not belonging to the same unit.
The photoelectric switches SH, TH are suitable for safety applications when used in conjunction with an external test device **Category 4** (EN ISO 13849), **SIL CL 3** (EN 62061) or **PL e** (EN ISO 13849).
The inputs and outputs on the SH, TH single-beam photoelectric safety switches comply with the requirements of EN 61131.

4 MOUNTING

Safety distance for access:

A safety distance must be maintained between the beams of the photoelectric switch and the hazardous point. This safety distance ensures that the hazardous point can only be reached after the dangerous state of the machine has been completely stopped.

The safety distance as defined in EN 999+A1 (in future EN ISO 13855) and EN ISO 13857 depends on:

- The stopping/run-down time of the machine or system (the stopping/run-down time is shown in the machine documentation or must be determined by measurements)
- The response time of the entire protective device
- The approach speed
- Number of beams/beam gap.

Risk of failure to detect!
Persons who are in the hazardous area but not in the light path between sender and receiver are not detected. It is therefore to be ensured that any dangerous state can only be initiated if there are no personnel in the hazardous area.
The single-beam photoelectric safety switch SH, TH is not allowed to be used for hand and finger protection.

No protective function without sufficient safety distance!
The reliable protective effect of the photoelectric switches depends on the system being mounted with the correct safety distance from the hazardous point. The photoelectric switches are to be fitted such that when the light beam is interrupted, the hazardous point is only reached when the dangerous state is no longer present.

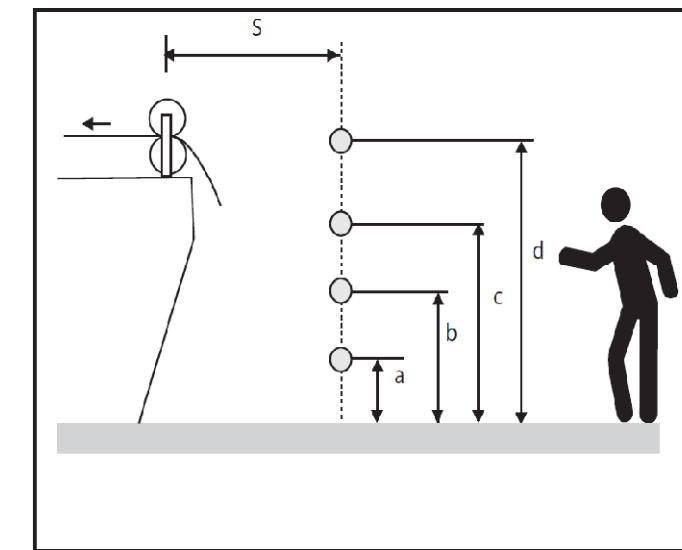


Fig. 1: Access protection using the single-beam photoelectric safety switch SH, TH

How to calculate the safety distance S according to EN 999+A1 (in future EN ISO 13855) and EN ISO 13857:

The following calculation shows an example calculation of the safety distance. Depending on the application and the ambient conditions, a different calculation may be necessary. The response time of the emitter/receiver and test device combination is calculated from the response time of the test device plus the test period of the test device.

- Calculate S using the following formula:

$$S = K * T + C \text{ [m]}$$

Where ...

- S = Safety distance [m]
- K = Approach speed 1.6 [m/s]
- T = Stopping/run-down time of the machine + response time of the entire protective device [s]
- C = Supplement, depending on the number of beams (1, 2, 3 or 4) see Tab. 1.

Nr. beams	a [m]	b [m]	c [m]	d [m]	Supplement C [m]
1	0,75				1,20
2	0,40	0,90			0,85
3	0,30	0,70	1,10		0,85
4	0,30	0,60	0,90	1,20	0,85

Tab. 1: Variables for calculating the safety distance

4.1 Minimum distance to reflective surfaces

The light beams from the sender may be deflected by reflective surfaces. This problem can result in failure to detect people. All reflective surfaces and objects (e.g. material bins) must therefore be kept a minimum distance from the photoelectric switch beams (see Fig.2).

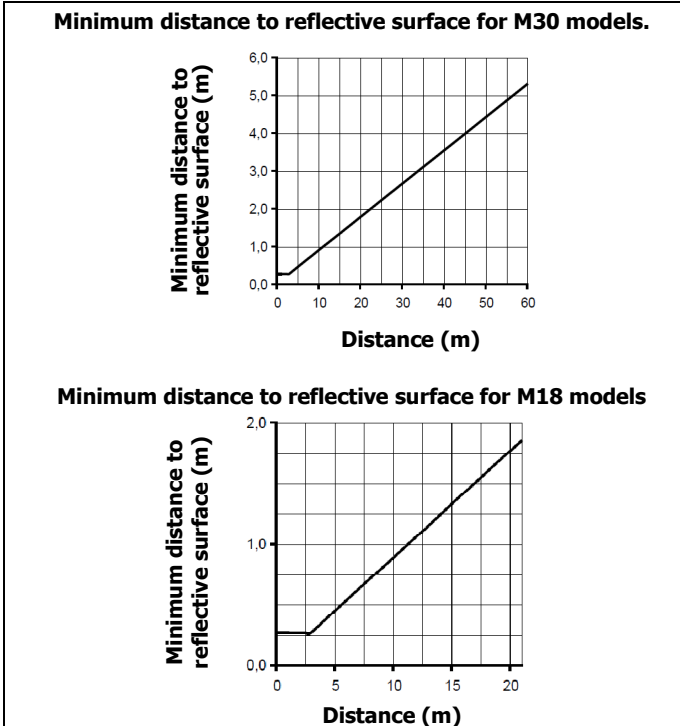


Fig. 2: Minimum distance to reflective surfaces

How to determine the minimum distance from reflective surfaces:

- Measure the Distance [m] between sender and receiver.
- Read the Minimum distance to reflective surface [m] from the graph.

Note

The minimum distances to reflective surfaces only apply when the light path is clear. On the usage of transparent guard windows, these values may change. Please note the information from the related manufacturer.

Prevent that the safety light beams interfere each other!

- a) If more than one pair of single-beam sensors are connected in cascade, different beams of the same chain must not interfere each other.
- b) If more than one pair of single-beam sensors are connected to the same control unit and this unit does not prevent the mutual interference between different channels, the angle of emission / reception of a couple of sensors must not interfere with other sensors connected with the same unit.
- c) If more control units are used in the same system it is possible that couples of sensors from different units can interfere, in this case systematic or sporadic errors may occur. Only in this case, to avoid interference can be used sensors with different frequency modulation.

5 ELECTRICAL INSTALLATION

Secure the plant/system. No dangerous state possible!
Ensure that the dangerous state of the machine is (and remains) switched off. As per IEC 61496 type 4, the single-beam photoelectric safety switches must be monitored by an external test device. When connecting to the sensors, observe the related operating instructions for the external test device and higher level control.

Lay emitter and receiver cables separately!
Lay the emitter and receiver cables outside the control cabinet as separate plastic-sheathed cables. Avoid long travel of sensor's cables in ducts with noisy power cables.

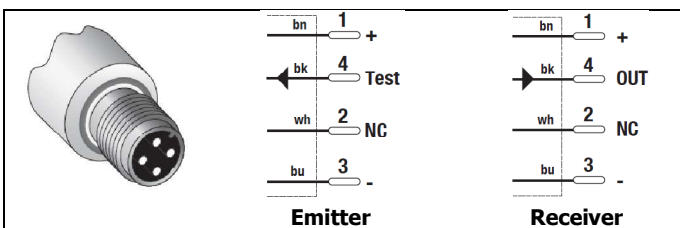


Fig. 3: Connection type plug, 4pin, M12.

5.1 Connection

The connectors must be applied and tightened to the sensors in the absence of power. For each pair, directly connected to the test unit, is allowed a cable length of 100m for each sensor, for chain connection of two couples do not exceed the total length of 100m. Under the conditions specified above the cable section must not be less than 0.25mm² or AWG #23.

See also the control unit specification.

5.2 Usage in cascade

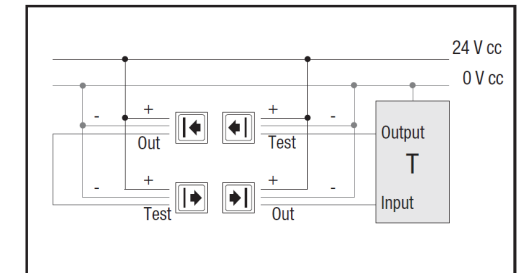


Fig. 4: Example for SH, TH connection in a two device cascade (T = test device).

The remote pairs, consisting of a transmitter and a receiver connected in chain, running the repeater function, must be homogeneous, ie be composed of a transmitter and a receiver both with the same test logic and output logic. Couples connected to the tests unit must obviously be compatible with the logic of that unit. It is recommended not to exceed a maximum of three pairs of sensors connected in the chain.

6 COMMISSIONING

6.1 Aligning the sensors and LED indications

6.1.1 Aligning the sensors.

Once installed and connected all the components, emitters and receivers must be aligned. During the alignment is not advisable to connect the inputs of the first emitter and the output of the last receiver to the unit. It is also advisable, only at this time, connect only the power wires of the sensors to the unit or use an equivalent power supply. These sensors use a visible wavelength, so it is not necessary to use a laser alignment device.

To force the projector to transmit at full intensity, connect the test input of the first emitter to an appropriate level depending on the model (for models SH*/*-**IC and TH*/*-**IC connect to the +, for models SH*/*-**IA e TH*/*-**IA connect to the GND or leaves open).

If a section is composed of elements connected in chain: starts with the alignment of the first pair in the chain, otherwise the downstream projectors may not emit light.

- Align emitters and receivers as accurately as possible and fix both temporarily in position.
- Apply a piece of white paper (can be sufficient for short run) or better a piece of reflector sheet 100mm x 100mm with a hole (corresponding to the cross section of sensor) in the centre of the receiver.
- Align the emitter so that the light reflected off the reflector, applied to the receiver, reaches maximum intensity and the spot of light is centred.
- !!! To observe the light reflected off the reflector is necessary to look at the reflector from behind the emitter, or at least from a point very close to the optical axis.

- Moves on the receiver and aligns it on the emitter, continue until the yellow LED has a stable lighting.
- In the case of daisy-chaining: Continue with the next pair as indicated by 2) to 4). In the case of interposition of deflection mirrors, follow these additional instructions:
 - Try to align the mirror so that from the previous emitter you can see the next receiver.
 - Apply at the centre of the mirror a piece of reflective paper (100mm x 100mm).
 - Align the emitter so that the light reflected off the reflector reaches its maximum intensity and the spot of light is centred.
 - Removes the reflector and transfers it to the downstream receiver, now align the mirror so that the light reflected off reflector reaches its maximum intensity and the spot of light is centred.
- Moves on the receiver and aligns it until the yellow LED has a stable lighting.
- To check the light power received, partially cover the lens of the emitters and receivers, emitter and receivers are correctly aligned if the LED on the receivers begins to flash when at least half the surface of the lens is covered.
- In case of failure of the procedure, repeats it so that refine the alignments.
- Lock the sensors aligned in this position; with the unit not powered, restore the connections of the sensors.
- Power cycle the unit and verify proper operation.

Pay attention to correct mounting!
Ensure the devices are correctly mounted and secured against moving after adjustment.

6.1.2 LED indications

Display (Orange LED)	Emitter status, models SH*/E-**IC and TH*/E-KIC.
Does not illuminate	Emitter not active. No voltage supply or in the test mode (Test input: L)
Illuminates	Emitter active (Test input: H)

Display (Orange LED)	Emitter status, models SH*/E-**IA and TH*/E-KIA.
Does not illuminate	To verify if powered and active observe the emitted light: with emitted light present, emitter active (Test input: L)
Illuminates	Emitter not active Emitter powered and in test mode (Test input: H)

Tab. 2: Emitter status indications.

Display (Yellow LED)	Receivers status, all models SH*/R-K** and TH*/R-K**
Does not illuminate	No voltage supply or light path interrupted or in the test mode.
Flashes	Weak signal, e.g. due to contamination or poor alignment or too long range.
Illuminates	Light path clear, enough signal.

Tab. 3: Receiver status indications.

6.2 Test notes

The purpose of the tests described in the following is to confirm the safety requirements specified in the national/international rules and regulations, especially in the Machine and Work Equipment Directive (EU directive conformity). These tests are also used to identify if the protection is affected by external light sources or other unusual ambient effects. These tests must therefore always be performed.

6.2.1 Tests before the first commissioning

- It must only be possible to access the hazardous area by interrupting the light path between sender and receiver.
- It must not be possible to climb over, to crawl beneath or to circumnavigate the light path between sender and receiver.
- Check also the effectiveness of the protective device mounted to the machine, using all selectable operating modes.
- Ensure that the operating personnel of the machine protected by the single-beam photoelectric safety switch SH, TH are correctly instructed by specialist personnel before being allowed to operate the machine. Instructing the operating personnel is the responsibility of the machine owner.
- To ensure correct function, check the related chapter 6.2.3 "Regular functional checks of the protective device".

6.2.2 Regular inspection of the protective device by qualified personnel

- Check the system following the inspection intervals specified in the national rules and regulations. This procedure ensures that any changes on the machine or manipulations of the protective device after the first commissioning are detected.
- If major changes have been made to the machine or the protective device, or if the single-beam photoelectric safety switch has been modified or repaired, check the system again in the same way as for initial commissioning.

6.2.3 Regular functional checks of the protective device

The effectiveness of the protective device must be checked on a regular basis, e.g. daily or prior to the start of work by a specialist or by authorised personnel, using the correct test object.

- Completely cover each light beam with a test rod that is not transparent to light (at least 30 mm diameter) at the following positions:
- Immediately in front of the sender
- In the middle between sender and receiver (or between the deflector mirrors)
- Immediately in front of the receiver

- When using deflector mirrors, immediately before and after the mirror

This must produce the following result:

- As long as the light beam is interrupted, it must not be possible to initiate the dangerous state.

6.2.4 EC declaration of conformity

The single-beam photoelectric safety switches SH, TH sensor family have been manufactured in accordance with the following directives:

- the Machinery Directive 2006/42/EC.
- the EMC directive 2004/108/EC.

You can obtain the complete EC declaration of conformity on the Internet at: <http://www.technogr.com>

7 TECHNICAL SPECIFICATIONS

7.1 General system data

	Minimum	Typical	Maximum
Range, M18 with axial optics (1)	0 m	10 m	16 m
Range, M18 with radial optics (1)	0 m		5 m
Range, M30 (axial optics) (1)	0 m		60 m
Wavelength		660 nm	
Effective Aperture Angle			± 2,5°
Standard modulation frequency		123KHz	
Special modulation frequency		83KHz	
Beam diameter M18			12 mm
Beam diameter M30			26 mm
U _B , supply voltage at the device (2)	19,2 V	24 V	28,8V
Residual ripple (5)			5V
Power consumption emitter/receiv. (6)			20 mA / 30 mA
Output signal switching device (7)		Totem pole	
Output signal voltage HIGH	U _B - 3,2 V	U _B - 2,5 V	
Output signal voltage LOW			5 V
Output current		50 mA	70 mA
Output response time (Receiver) for LIGHT to DARK transition (8)	200 µs, from DARK transition to LOW transition for models SH*/R-***IC e TH*/R-KIC to HIGHT for models SH*/R-***IA e TH*/R-KIA		
Output response time (Receiver) for DARK to LIGHT transition (8)	400 µs, from LIGHT transition to HIGHT transition for models SH*/R-***IC e TH*/R-KIC to LOW for models SH*/R-***IA e TH*/R-KIA.		
Safety response time	Response time + test period of the test device < 5 V		
Test input LOW level (Emitter)	(models SH*/E-***IC, TH*/E-KIC no emission); (models SH*/E-***IA, TH*/E-KIA emission), > 15 V		
Test input HIGHT level (Emitter)	(models SH*/E-***IC, TH*/E-KIC, emission); (models SH*/E-***IA, TH*/E-KIA no emission).		
Output signal level	For models SH*/R-***IC e TH*/R-KIC, LOW=DARK; HIGH=LIGHT. For models SH*/R-***IA e TH*/R-KIA HIGH=DARK; LOW=LIGHT.		
VDE protection class	III (double insulation)		
Enclosure rating	IP67		
Working temperature (1)	-20°C (-40 °C)		+55 °C
Storage temperature	-40 °C		+75 °C
Air humidity	15 %		95 %
M18 Weight plastic/metallic		30 / 67 g	
M30 Weight		212 g	
M18 Materials	Lens: Glass with PBT ring; Housing: Brass nickel-plated or PBT; M12 plug: PC.		
M30 Materials	Lens: Glass with aluminium ring; Housing: Brass nickel plated; End cap: PC; M12 plug: PBT		

Tab.:4

- 1) The ranges refer to an ambient temperature of -20°C ... +55°C. For temperature -40°C ... -20°C, ranges are reduced as shown in Fig.: 10-11-12. Check these charts in chapter 7.4.
- 2) The external voltage supply of the devices must be capable of buffering brief mains voltage failures of 20 ms as specified in EN 60204. Suitable power supplies are available as accessories.
- 3) Power supply mains have to be protected for a maximum of 8A. The connections are reversed polarity protected.
- 4) The SH-TH and the higher level test device must be connected to the same GND (0 V).
- 5) May not exceed or fall below of UB tolerances.
- 6) Without load.
- 7) The output of the sensor normally connected to the test device, isn't an OSSD. The output is short-circuit protected.
- 8) Time measured with a resistive load, reactive components (eg. filtering capacitors) may lead to an increase of time.

7.2 Safety specification

Type ⁹⁾	4 (IEC 61496)
Safety Integrity Level (SIL) ⁹⁾	SIL3 (IEC 61508), SIL CL 3 (EN 62061)
Category ⁹⁾	4 (EN/ISO 13849)
Performance Level ⁹⁾	PL e (EN/ISO 13849)
PFHd ¹⁰⁾	8,1 x 10 ⁻¹⁰
TM (life time)	20 years

Tab.:5

9) Data valid only in conjunction with suitable test device (the alone sensors can not be used as a safety device).

10) Average probability of failure per hour, due to a serious error.

Note: For detailed information on the exact design of your machine/system, please contact your M.D. Micro Detectors subsidiary.

7.3 DIMENSIONAL DRAWING

(all dimensions in mm)

Models : SH*/*-0E** and SH*/*-1E**

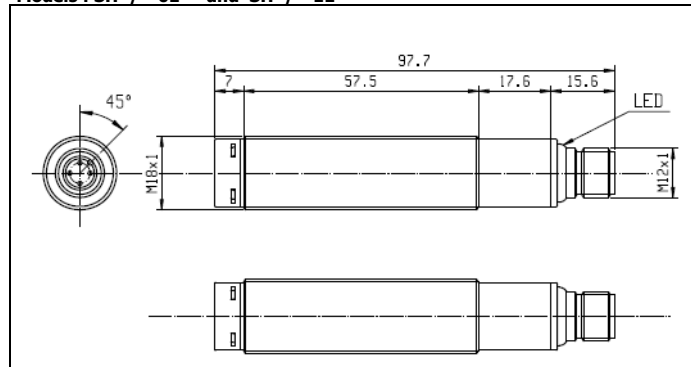


Fig.:5

Models : SH*/*-2E** and SH*/*-3E**

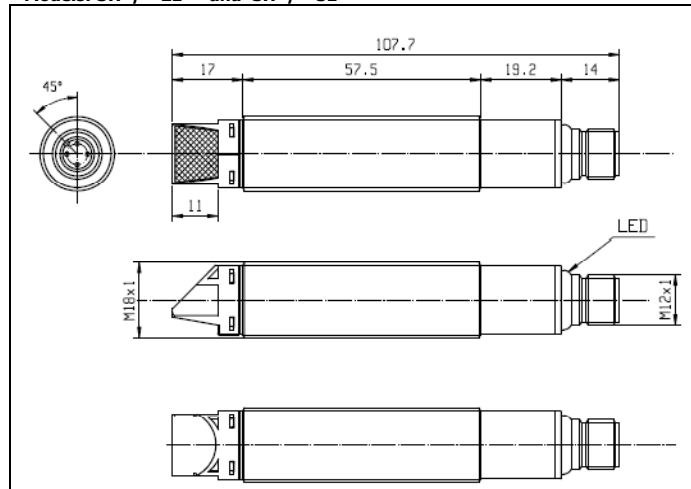


Fig.:6

Models : SH*/*-0C** and SH*/*-1C**

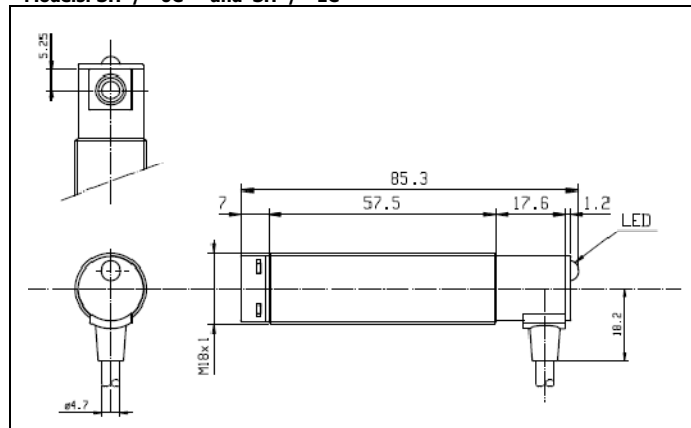


Fig.:7

Models: SH*/*-0K** and SH*/*-1K**

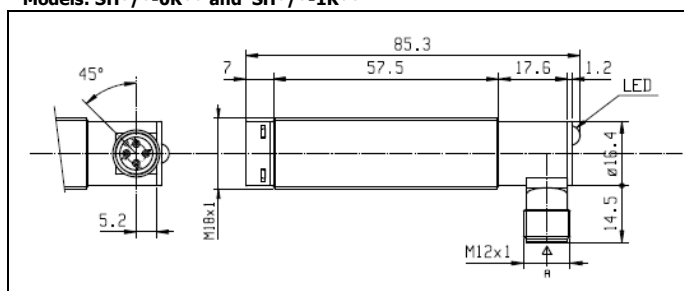


Fig.:8

Models: TH*/*-K**

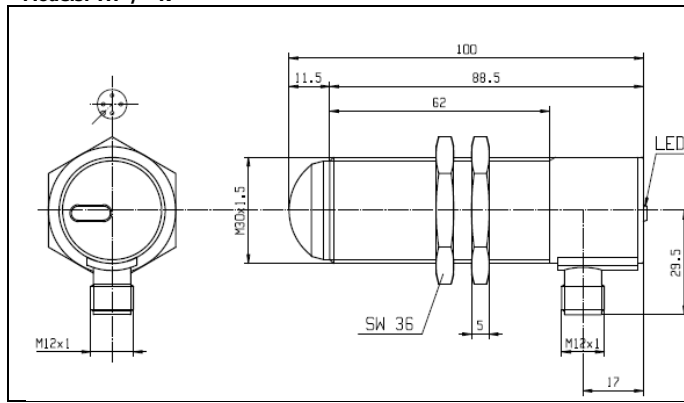


Fig.:9

7.4 Maximum scanning ranges as a function of temperature

Models: TH*/*-K**

(M30 Housing)

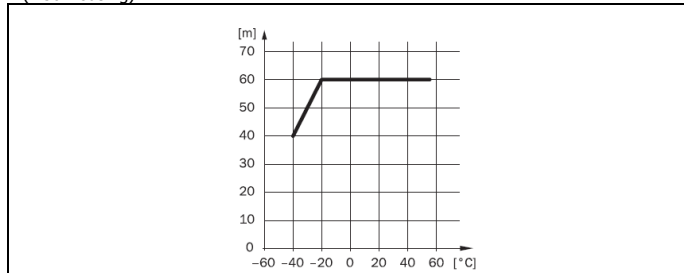


Fig.:10

Models: SH*/*-0** and SH*/*-1**

(M18 Housing, axial optic)

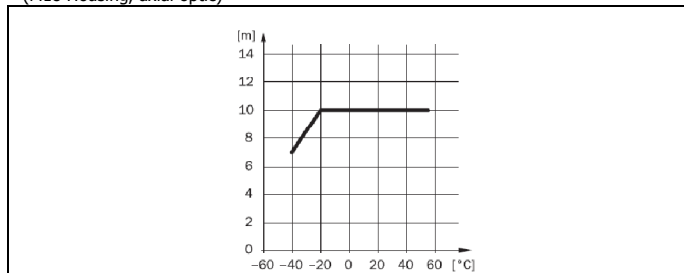


Fig.:11

Models: SH*/*-2E** and SH*/*-3E**

(M18 Housing, radial optic)

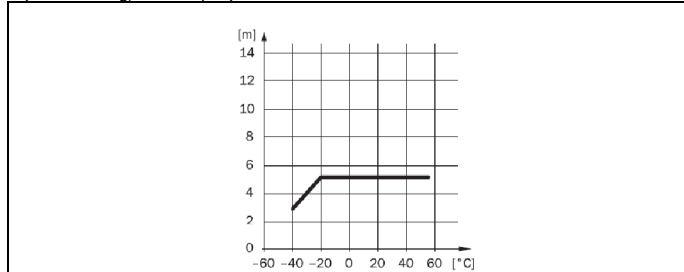


Fig.:12

7.5 Code system

M18 models

POSIZIONE	CODICE	DESCRIZIONE
1	SH	Single beam safety cylindrical sensor, M18 housing
2	4	Type 4, modulation 123KHz (standard)
	5	Type 4, modulation 83KHz
3	/	Separator
	E	Emitter
	R	Receiver
4	-	Separator
	0	Plastic housing, axial optic (standard) (with all termination type)
	1	Metal housing, axial optic (standard) (with all termination type)
	2	Plastic housing, radial optic (only with M12 axial plug)
5	3	Metal housing, radial optic (only with M12 axial plug)
	C	Radial cable exit (only with axial optic)
6	E	M12 axial plug (standard)
	K	M12 radial plug
IC	H	Emitter test logic H= Emission (standard)
	L	Receiver : L= Light
IA	H	Emitter test logic H= Emission (standard)
	L	Receiver : L= Light

Tab. :6

M30 models

POSIZIONE	CODICE	DESCRIZIONE
1	TH	Single beam safety cylindrical sensor, M30 metal housing, axial optic.
2	6	Type 4, modulation 123KHz (standard)
	7	Type 4, modulation 83KHz
3	/	Separator
	E	Emitter
	R	Receiver
5	-	Separator
	K	M12 radial plug
	IC	Emitter test logic H= Emission (standard)
	L	Receiver : L= Light
IA	H	Emitter test logic H= Emission (standard)
	L	Receiver : L= Light

Tab. :7

8 STANDARD MODELS

Short range sensors

Rif.	Modello	Descrizione
a	SH4/E-0EIC	Emitter Type 4, M18 plastic housing, working frequency 123KHz, axial optic, 10m range, M12 axial plug, Test logic H.
b	SH4/R-0EIC	Receiver Type 4, M18 plastic housing, working frequency 123KHz, axial optic, 10m range, M12 axial plug, Output logic H.

Tab.:8

Rif.	Modello	Descrizione
c	SH4/E-1EIC	Emitter Type 4, M18 metal housing, working frequency 123KHz, axial optic, 10m range, M12 axial plug, Test logic H.
d	SH4/R-1EIC	Receiver Type 4, M18 metal housing, working frequency 123KHz, axial optic, 10m range, M12 axial plug, Output logic H.

Tab.:9

Long range sensor

Rif.	Modello	Descrizione
e	TH6/E-KIC	Emitter Type 4, M30 metal housing, working frequency 123KHz, axial optic, 60m range, M12 axial plug, Test logic H.
f	TH6/R-KIC	Receiver Type 4, M30 metal housing, working frequency 123KHz, axial optic, 60m range, M12 axial plug, Test logic H.

Tab.:10