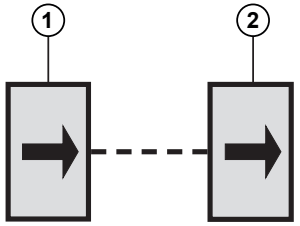
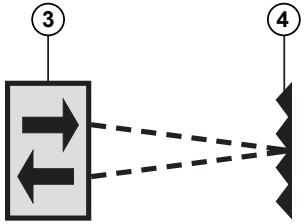
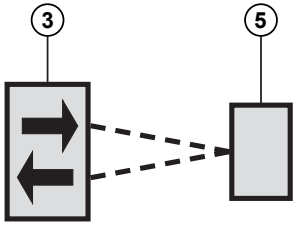
2 Function

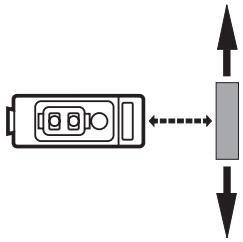
Operating principle of a photoelectric sensor		
Through-beam sensor	The transmitter (1) and the receiver (2) are in separate housings. The objects are detected by interruption of the light beam.	
Retro-reflective sensor	The transmitter and receiver are integrated in one housing (3). The light beam is reflected by a reflector (4). The objects are detected by interruption of the light beam.	
Diffuse reflection sensor	The transmitter and receiver are integrated in one housing (3). The light beam is reflected by an object (5). The objects are detected by reflection of the light beam based on the energetic, the triangulation or the time-of-flight principle. **Energetic principle:** The range depends on the energy of the reflected light. Depending on the object surface the light is reflected more or less well: • good reflection: smooth / light object. • poor reflection: rough / dark object.	 1: Transmitter 2: Receiver 3: Transmitter and receiver 4: Reflector 5: Object
Diffuse reflection sensor with background suppression	**Triangulation:** Evaluates the position where reflected light falls as the distance to an object changes. The range is largely independent of the energy of the reflected light.	

Operating principle of a photoelectric sensor	
Distance sensor with background suppression	**Time-of-flight (ToF) principle:** The time of flight to the object is measured. This is proportional to the range. The range is largely independent of the energy of the reflected light. Reflections on the object do not lead to a falsification of the measured value. The majority of sensors in this class provide “absolute measurements” (measuring distance is output via IO-Link, for example). It is recommended that the light beam is terminated within the range of the effective background suppression and does not radiate “infinitely” far.

3 Technical data

Response time	< 1/f (typically 1/2 f) unless indicated otherwise (f = switching frequency) Distance sensors: In situations with a brightness ratio (object to background) of 1:1, the response time is approx. 2 / measuring frequency.	
Output function	Light-on mode:	The receiver "sees" light and the output is switched. Through-beam and reflective = NC Diffuse = NO
	Dark-on mode:	The receiver "sees" dark and the output is switched. Through-beam and reflective = NO Diffuse = NC
	Programmable:	Choice between light-on mode or dark-on mode.
	Positive switching:	Positive output signal (to L-).
	Negative switching:	Negative output signal (to L+).
Rated insulation voltage	AC units depending on UB: 140 V AC / 250 V AC DC units with protection class II: 250 V AC DC units with protection class III: 60 V DC	
Rated frequency of the supply network	50 Hz / 60 Hz or direct voltage	
Rated short-circuit current	For short-circuit-proof units: 100 A	
Rated impulse withstand voltage	AC units depending on UB: 140 V AC = 2.5 kV or 250 V AC = 4 kV (≙ overvoltage category III) DC units with protection class II: 4 kV (≙ overvoltage category III) DC units with protection class III: 60 V DC: 1 kV (≙ overvoltage category II)	
Power-on delay time	The time the sensor needs to be ready for operation after application of the operating voltage (typically < 300 ms).	
Operating voltage	Voltage range in which the sensor operates reliably. Use stabilised and smoothed direct current. Take into account the residual ripple.	

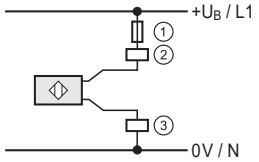
EMC	Photoelectric sensors meet the requirements of EN 60947-5-2 so that • there are no noise levels that affect other equipment in their intended operation. • they are sufficiently insensitive to electromagnetic interference to be expected during intended operation.
Detection zone change	Used for sensors with background suppression. Ability to recognise objects with different reflections at the same distance.
Excess gain	Ratio between the received amount of light and the light amount required for switching.
Utilisation category	AC units: AC-140 (control of small electromagnetic loads with holding currents < 200 mA) DC units: DC-13 (control of solenoids)
Accuracy graph	Minimum distance between object and background depending on the range.
Background suppression	Optical process of the diffuse reflection sensor / distance sensor to distinguish the object from a reflective surface behind.
Hysteresis	Difference between switch-on and switch-off point <20% of the set range.
Short-circuit protection	Units with pulsed short-circuit protection can react sensitively to incandescent lamps, electronic relays and other low-resistance loads.
Measuring frequency	Used for distance sensors. Number of measurements per second (Hz). In situations with a brightness ratio (object to background) of 1:1, the switching frequency is approx. measuring frequency / 3.
Minimum load current	Smallest operating current to maintain the conductivity of the switching element.
Polarisation filter	A very fine filter which only allows light waves on a specific plane to pass (for example: horizontal light waves).
Product standard	IEC 60947-5-2
Range	The maximum usable distance between transmitter and receiver (through beam) or sensor and reflector (reflective).
Leakage current	Current for the internal supply of 2-wire units; also flows through the load when the output is blocked.
Switching frequency	Maximum number of signal changes at the switching output per second (in Hz).
Protection rating	Describes the protection of electric equipment by means of housings, covers, enclosures and is indicated by the IP code.
Voltage drop	Voltage across the output switching element in the conductive state. ≤ 2.5 V unless indicated otherwise.
Reflective objects	With reflective objects it may make sense to align the unit at an angle of approx. 5° - 10° to the object.
Radiation power	Classification of the radiation power: • laser classes according to EN60825-1:2014-05 • LED units according to DIN EN62471:2009, risk group 0
Current consumption	No-load current for internal supply of 3 or 4-wire DC units.

Transport and storage conditions	Unless indicated otherwise in the data sheet, the following applies: Transport and storage temperature: Min. = - 40 °C. Max. = max. ambient temperature according to the data sheet. The relative air humidity (RH) must not exceed 50 % at +70 °C. At lower temperatures, a higher air humidity is permissible. Shelf life: 5 years. Transport and storage height: no restrictions.
Range	The mechanically usable distance between photoelectric sensor and object referred to white paper 200mm x 200mm, 90% remission.
Degree of soiling	The products are designed for degree of soiling 3.
Preferred direction	Note: The objects to be detected should move transversely to the lens of the sensor. In case of other directions of movement it should be tested before whether a safe switching function is guaranteed. 
Wave lengths	according to the data sheet
Repeatability	< 10% of the set range unless indicated otherwise.

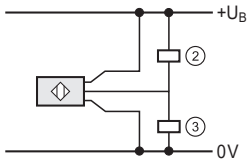
4 Electrical connection

Connection systems

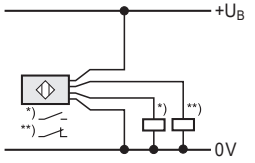
2-wire technology
(negative **or** positive switching)



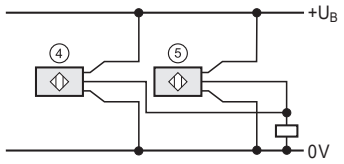
3-wire technology
(negative **or** positive switching)



4-wire technology
(positive switching, normally closed and normally open)



1:	Use a miniature fuse according to the technical data sheet, if specified. Recommendation: Check the safe functioning of the unit after a short circuit.		
2:	Negative switching:	4:	Sensor 1
3:	Positive switching:	5:	Sensor n

Parallel connection (OR)	
Parallel connection 3-wire units The current consumption of all non-switched units adds up. The units can be used in combination with mechanical switches.  	Parallel connection 2-wire units Not possible.

Series connection (AND) is not recommended since the power-on delay times, voltage drops and current consumption add up. UB_{min} (sensor) and $U_{HIGH\ min}$ (load) must remain unchanged.

4.1 Pin configuration of connectors and cables

Standard configuration 3-wire DC:			
	Cable	Terminal chamber	US-100 connector
L+	BN	1 / 3	Pin 1 / BN
L-	BU	2 / 4	Pin 3 / BU
Output	BK	X	Pin 2 / WH Pin 4 / BK

Colours	
BK: Black	BN: Brown
BU: Blue	WH: White

4.2 Pin configuration of the US-100 connectors

View on the connector on the unit:		
Pin 4: BK		Pin 3: BU
Pin 1: BN		Pin 2: WH

Cable and connector configuration as well as unit data of special variants → Data sheet.

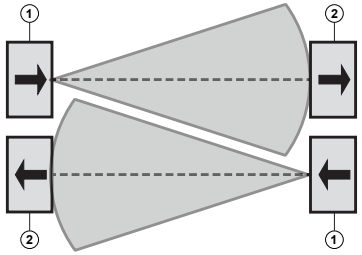
5 Installation

5.1 Minimum clearance for installing sensors of the same type

Malfunction of the units possible.
Units of the same kind can influence each other when they are mounted side by side.

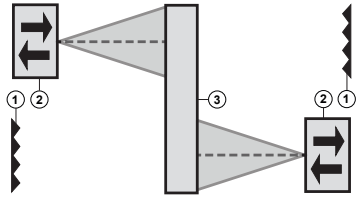
► Observe the following installation notes.

Through beam sensors



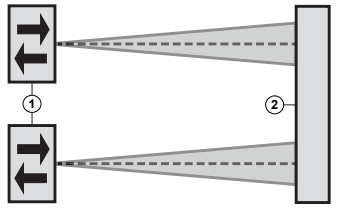
1: Transmitter
2: Receiver

Retro-reflective sensors



1: Reflector
2: Transmitter and receiver
3: Object

Diffuse sensors



1: Transmitter and receiver
2: Object

Photoelectric sensors with red or infrared light emit a cone-shaped light beam.

Depending on the application there are other possible solutions.