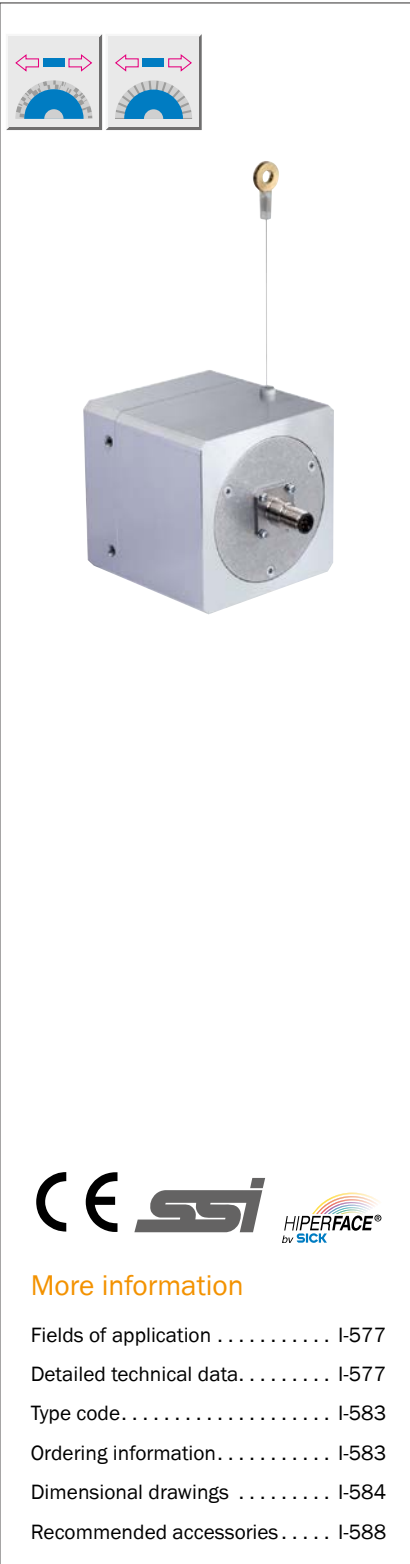


# COMPACT DESIGN - WITH AN INTEGRATED ENCODER



## Product description

In the Compact family, the encoder is integrated into the wire draw mechanics. This integration provides the encoder with the best possible protection in harsh

industrial environments. These encoders provide a measuring range of up to 5 m with high resolution in an absolute or incremental output.

## At a glance

- Measuring lengths from 2 m to 5 m
- Integrated measuring system
- Compact housing (90 mm x 90 mm x 90 mm)

- Incremental and absolute versions
- High resolution

## Your benefits

- Industrial design: the encoder is integrated in the aluminum housing, making it less susceptible to external damage and thus reducing maintenance time and costs
- Extremely precise measurements by eliminating the coupling between the encoder and the mechanism

- Space-saving installation, since the encoder is directly integrated into the wire draw mechanics.
- Very precise measurements thanks to the high resolution



## More information

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## Fields of application

- Automated guided systems (fork height)
- Manned forklift trucks
- Storage and rack operation equipment
- Wood processing machines
- Lifting platforms

## Detailed technical data

### BKS

#### Performance

	BKS02 0 m ... 2 m	BKS05 0 m ... 5 m
Measuring range	0 m ... 2 m	0 m ... 5 m
Linearity	≤ ± 0.7 mm	
Measurement increment	≥ 0.05 mm	
Traversing speed	3.5 m/s	
Typ. repeat accuracy	3 measuring steps	

#### Interfaces

Encoder	Absolute encoder
Electrical interface	12 V ... 30 V SSI
Connection type	M23 male connector, 12-pin
Clock frequency	1 MHz <sup>1)</sup>
Interface signals	Clock +, Clock -, Data +, Data-

<sup>1)</sup> Min. LOW level (Clock +): 500 ns.

#### Electrical data

Initialization time	≥ 200 ms <sup>1)</sup>
Position forming time	0.1 ms
Supply voltage	12 V ... 30 V
Code sequence	Rising at wire pull-out
Code type	24 bit/gray
MTTFd: mean time to dangerous failure	150 years (EN ISO 13849) <sup>2)</sup>

<sup>1)</sup> Valid positional data can be measured once this time has elapsed.

<sup>2)</sup> This product is a standard product and does not constitute a safety component as defined in the Machinery Directive. Calculation based on nominal load of devices, average ambient temperature 40 °C, frequency of use 8760 h/a. All electronic failures are considered hazardous. For more information, see document no. 8015532.

#### Mechanical data

	BKS02 0 m ... 2 m	BKS05 0 m ... 5 m
Mass	1.5 kg	
Measuring wire material	Highly flexible stranded steel (PA 12 sheathed)	
Measuring wire diameter	0.6 mm	
Housing material	Aluminum	
Spring return force	5 N ... 6 N <sup>1)</sup>	4 N ... 6 N <sup>1)</sup>
Service life of wire draw mechanism	800,000 cycles <sup>2) 3)</sup>	
Wire acceleration	≤ 20 m/s <sup>2</sup>	

<sup>1)</sup> These values were measured at an ambient temperature of 25 °C. There may be variations at other temperatures.

<sup>2)</sup> Mean values that depend on the type of load, a cycle is made up of a wire intake and outtake.

<sup>3)</sup> At high operating speeds over great lengths, this figure can decrease; at slow operating speeds over short lengths, it can increase.



## Ambient data

<b>EMC</b>	According to EN 61000-6-2 and EN 61000-6-3
<b>Enclosure rating (encoder)</b>	IP 52 (as per IEC60529), observe specified installation location
<b>Resistance to shocks (according to EN 60068-2-27)</b>	20 g, 6 ms
<b>Resistance to vibration (according to EN 60068-2-6)</b>	10 g, 10 Hz ... 2,000 Hz
<b>Operating temperature range (encoder)</b>	-10 °C ... +70 °C
<b>Storage temperature range</b>	-20 °C ... +80 °C
<b>Relative humidity/condensation</b>	90% <sup>1)</sup>

<sup>1)</sup> Condensation of optical surfaces not permitted.

## XKS

### Performance

	XKS02 0 m ... 2 m	XKS05 0 m ... 5 m
<b>Measuring range</b>	0 m ... 2 m	0 m ... 5 m
<b>Period length</b>	1.1953 mm	
<b>Linearity</b>	$\leq \pm 0.7$ mm	
<b>Non-linearity</b>	$\pm 0.1$ mm	
<b>Measurement increment <sup>1)</sup></b>	$\geq 0.295$ $\mu$ m	
<b>Traversing speed</b>	3.5 m/s	
<b>Wire acceleration</b>	$\leq 20$ m/s <sup>2</sup>	
<b>Typ. repeat accuracy</b>	$\leq 0.15^\circ$	

<sup>1)</sup> With 12 bit resolution.

### Interfaces

<b>Encoder</b>	Absolute encoder
<b>Electrical interface</b>	7 V ... 12 V HIPERFACE®
<b>Connection type</b>	M12 male connector, 8-pin
<b>Interface signals</b>	Process data channel SIN, REFSIN, COS, REFCOS: analog, differential Parameter channel RS 485: digital
<b>Number of sine/cosine periods per revolution</b>	128

### Electrical data

<b>Operating current</b>	60 mA (without load)
<b>Output frequency for sine/cosine signals</b>	0 kHz ... 65 kHz
<b>Available memory area</b>	1,792 bytes
<b>E<sup>2</sup>PROM</b>	2048 Eeprom
<b>Supply voltage</b>	7 V ... 12 V
<b>Code sequence</b>	Rising at wire pull-out
<b>Code type</b>	Binary
<b>MTTFd: mean time to dangerous failure</b>	250 years (EN ISO 13849) <sup>1)</sup>

<sup>1)</sup> This product is a standard product and does not constitute a safety component as defined in the Machinery Directive. Calculation based on nominal load of devices, average ambient temperature 40 °C, frequency of use 8760 h/a. All electronic failures are considered hazardous. For more information, see document no. 8015532.

## Mechanical data

	XKS02 0 m ... 2 m	XKS05 0 m ... 5 m
<b>Mass</b>	1.5 kg	
<b>Measuring wire material</b>	Highly flexible stranded steel (PA 12 sheathed)	
<b>Measuring wire diameter</b>	0.6 mm	
<b>Housing material</b>	Aluminum	
<b>Spring return force</b>	5 N ... 6 N <sup>1)</sup>	4 N ... 6 N <sup>1)</sup>
<b>Service life of wire draw mechanism</b>	800,000 cycles <sup>2) 3)</sup>	
<b>Wire acceleration</b>	≤ 20 m/s <sup>2</sup>	

<sup>1)</sup> These values were measured at an ambient temperature of 25 °C. There may be variations at other temperatures.

<sup>2)</sup> Mean values that depend on the type of load, a cycle is made up of a wire intake and outake.

<sup>3)</sup> At high operating speeds over great lengths, this figure can decrease; at slow operating speeds over short lengths, it can increase.

## Ambient data

<b>EMC</b>	According to EN 61000-6-2 and EN 61000-6-3
<b>Enclosure rating (encoder)</b>	IP 52 (as per IEC 60529), observe specified installation location
<b>Resistance to shocks (according to EN 60068-2-27)</b>	20 g, 6 ms
<b>Resistance to vibration (according to EN 60068-2-6)</b>	10 g, 10 Hz ... 2,000 Hz
<b>Operating temperature range (encoder)</b>	-10 °C ... +70 °C
<b>Storage temperature range</b>	-20 °C ... +80 °C
<b>Relative humidity/condensation</b>	90% <sup>1)</sup>

<sup>1)</sup> Condensation of optical surfaces not permitted.

## PKS

### Performance

	PKS02 0 m ... 2 m	PKS05 0 m ... 5 m
<b>Measuring range</b>	0 m ... 2 m	0 m ... 5 m
<b>Linearity</b>	≤ ± 0.7 mm	
<b>Measurement increment <sup>1)</sup></b>	≥ 0.05 mm	
<b>Traversing speed</b>	3.5 m/s	
<b>Wire acceleration</b>	≤ 20 m/s <sup>2</sup>	
<b>Typ. repeat accuracy</b>	3 measuring steps	

<sup>1)</sup> Based on the assumption that the control/counter evaluates the edges of pulses A and B.

### Interfaces

<b>Encoder</b>	Incremental encoders
<b>Electrical interface</b>	4.5 V ... 5.5 V TTL/RS422
<b>Connection type</b>	M23 male connector, 12-pin

### Electrical data

<b>Operating current</b>	60 mA (without load)
<b>Reference signal</b>	1/765 measuring steps
<b>Maximum load current</b>	≤ 20 mA
<b>Initialization time</b>	≥ 40 ms <sup>1)</sup>
<b>Supply voltage</b>	4.5 V ... 5.5 V
<b>MTTFd: mean time to dangerous failure</b>	400 years (EN ISO 13849) <sup>2)</sup>

<sup>1)</sup> Valid positional data can be measured once this time has elapsed.

<sup>2)</sup> This product is a standard product and does not constitute a safety component as defined in the Machinery Directive. Calculation based on nominal load of devices, average ambient temperature 40 °C, frequency of use 8760 h/a. All electronic failures are considered hazardous. For more information, see document no. 8015532.

### Mechanical data

	PKS02 0 m ... 2 m	PKS05 0 m ... 5 m
<b>Mass</b>	1.5 kg	
<b>Measuring wire material</b>	Highly flexible stranded steel (PA 12 sheathed)	
<b>Measuring wire diameter</b>	0.6 mm	
<b>Housing material</b>	Aluminum	
<b>Spring return force</b>	5 N ... 6 N <sup>1)</sup>	4 N ... 6 N <sup>1)</sup>
<b>Service life of wire draw mechanism</b>	800,000 cycles <sup>2) 3)</sup>	
<b>Wire acceleration</b>	≤ 20 m/s <sup>2</sup>	

<sup>1)</sup> These values were measured at an ambient temperature of 25 °C. There may be variations at other temperatures.

<sup>2)</sup> Mean values that depend on the type of load, a cycle is made up of a wire intake and outtake.

<sup>3)</sup> At high operating speeds over great lengths, this figure can decrease; at slow operating speeds over short lengths, it can increase.

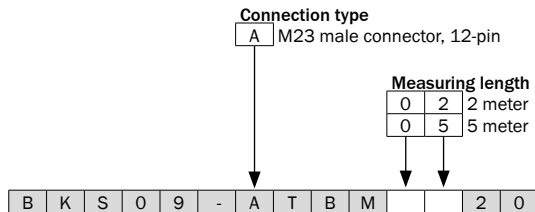
Ambient data

<b>EMC</b>	According to EN 61000-6-2 and EN 61000-6-3
<b>Enclosure rating (encoder)</b>	IP 52 (as per IEC 60529), observe specified installation location
<b>Resistance to shocks (according to EN 60068-2-27)</b>	20 g, 6 ms
<b>Resistance to vibration (according to EN 60068-2-6)</b>	10 g, 10 Hz ... 2,000 Hz
<b>Operating temperature range (encoder)</b>	-10 °C ... +70 °C
<b>Storage temperature range</b>	-20 °C ... +80 °C
<b>Relative humidity/condensation</b>	90% <sup>1)</sup>

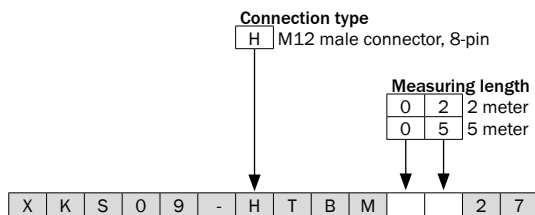
<sup>1)</sup> Condensation of optical surfaces not permitted.

Type code

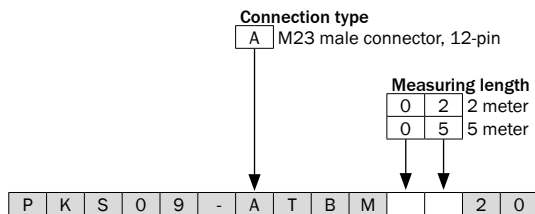
Compact absolute BKS



Compact absolute XKS



Compact incremental PKS



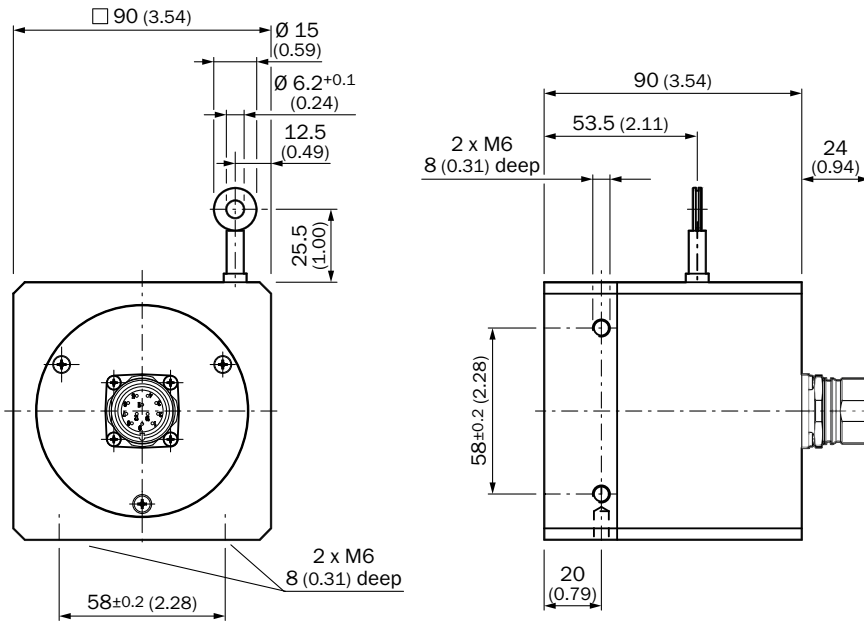
Ordering information

Measuring range	Electrical interface	Connection type	Type	Part no.
0 m ... 2 m	SSI	M23 male connector, 12-pin, radial	BKS09-ATBM0220	1035240
	7 V ... 12 V, HIPERFACE®	M12 male connector, 8-pin, radial	XKS09-HTBM0227	1035436
	4.5 V...5.5 V, TTL/RS422	M23 male connector, 12-pin, radial	PKS09-ATBM0220	1035242

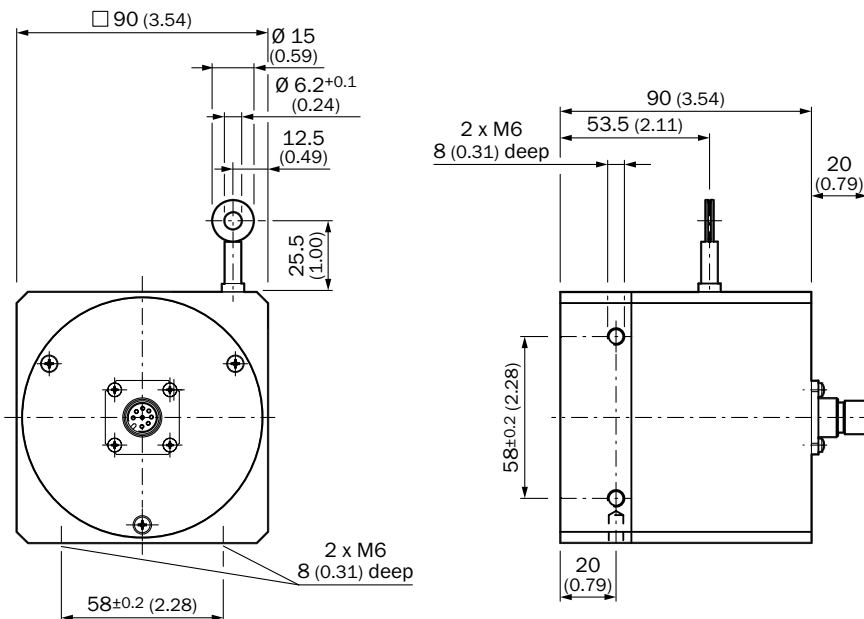
Measuring range	Electrical interface	Connection type	Type	Part no.
0 m ... 5 m	SSI	M23 male connector, 12-pin, radial	BKS09-ATBM0520	1035241
	7 V ... 12 V, HIPERFACE®	M12 male connector, 8-pin, radial	XKS09-HTBM0527	1035437
	4.5 V...5.5 V, TTL/RS422	M23 male connector, 12-pin, radial	PKS09-ATBM0520	1035243

## Dimensional drawings (dimensions in mm)

### BKS and PKS

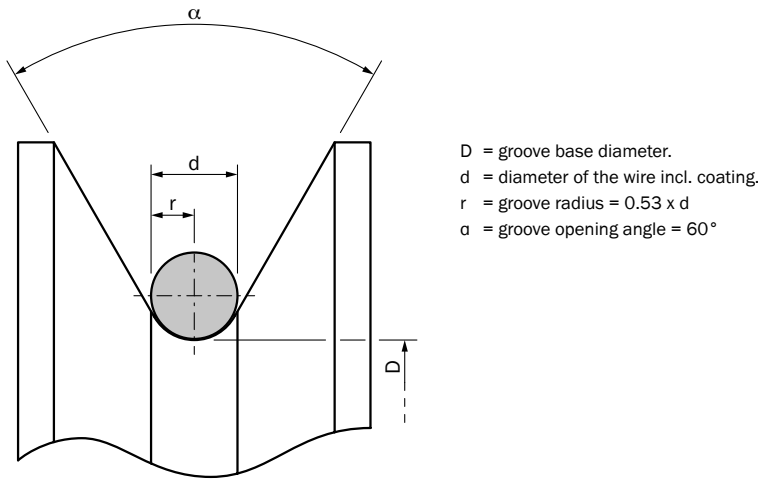


### XKS



### Deflection roller design

With the aid of deflection rollers, it is possible to guide the measuring wire of wire draw encoders over edges and around corners without significantly affecting the life time of the wire draw encoder. In this case, it must be considered that the designs of the deflection roller and of the measuring wire must be compatible in order to avoid damage to the system.



- The groove radius should not be too small – **recommendation: 0.53 x diameter of the wire cable**
- The groove opening angle should be neither too small nor too large – **recommendation: 60°**
- In order to ensure the longest possible system life, the deflection roller material should be neither too soft nor too hard – **recommended material: polyamide**
- The groove base diameter of the deflection roller should not be too small – **see table for recommendations**

### EcoLine

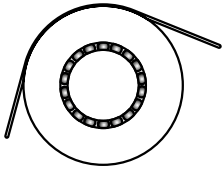
Length	Measuring wire, PA-sheathed	Diameter of the measuring wire	Structure of the measuring wire (strands x cords)	Min. groove base diameter
1.25 m	PA12	0.45 mm	7 x 7	25 mm
3 m	-	0.55 mm	1 x 19	40 mm
5 m	-	0.55 mm	1 x 19	40 mm
10 m	-	0.55 mm	1 x 19	40 mm

### HighLine

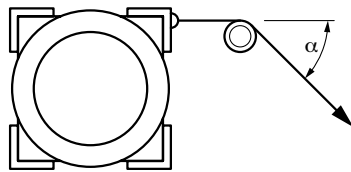
Length	Measuring wire, PA-sheathed	Diameter of the measuring wire	Structure of the measuring wire (strands x cords)	Min. groove base diameter
2 m	-	1.35 mm	7 x 19	35 mm
3 m	-	1.35 mm	7 x 19	35 mm
5 m	-	1.35 mm	7 x 19	35 mm
10 m	-	1.35 mm	7 x 19	35 mm
20 m	-	0.81 mm	7 x 7	35 mm
30 m	-	0.81 mm	7 x 7	35 mm
50 m	-	1.35 mm	7 x 19	35 mm

## Installation of deflection rollers

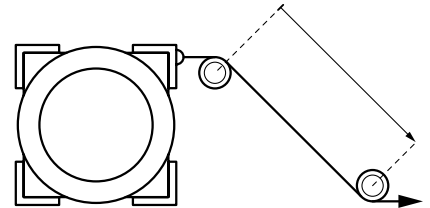
General notes on the installation of deflection rollers



The deflection roller should always be installed in a way which ensures that running is smooth. The deflection roller should ideally have an integrated ball bearing.



The smaller the deflection angle ( $\alpha$ ) achieved by a deflection roller, the less wear will appear on the measuring wire and therefore the longer the service life of the wire draw mechanism.



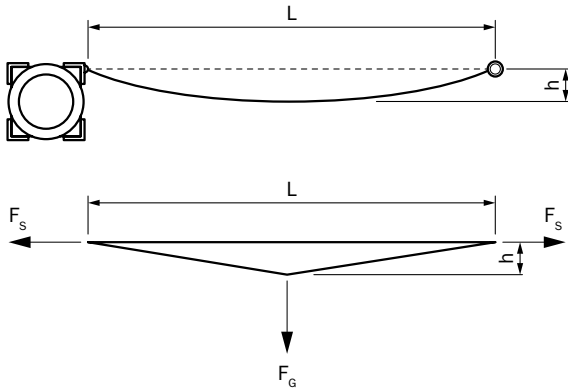
If two or more deflection rollers are needed, then the deflection rollers should always be installed at a distance from one another. The requisite distance between the deflection rollers must be accurately defined on site, accounting for specific customer requirements.

### Wire sag

If the measuring wire is pulled out in a horizontal direction, this creates sag that becomes more pronounced as the wire length increases. This has particular implications for applications with obstacles that could get in the way of the moving measuring wire. However, the change in length that results from the sag, and the measurement error this leads to, are negligible.

### Calculating the wire sag

The mass of the free-hanging measuring wire creates weight-related force, and this causes the wire to bend into a hyperbolic-shaped line. The tension force in the measuring wire acts against the sag. As the measurement length increases, so too does the tension force as a result of the spring drive. We can imagine the hyperbola shape in a simplified format that looks approximately like a triangle.



The weight-related force of the measuring wire can be calculated using **Formula A**.

The spring rate of the spring drive is calculated using **Formula B**.

**Formula C** determines the sag of the measuring wire (the results of Formula A and Formula B are required in order to calculate the wire sag).

**Formula D** is used for calculating the measurement error.

The values found in real life will differ from the theoretical values that are calculated, as the measuring wire itself demonstrates a certain amount of resistance against the sag.

#### Formula A

$$F_G = 0.5 \times m_L \times g \times L$$

$F_G$  = weight-related force of the measuring wire [N]

$m_L$  = length-related mass of the measuring wire [Kg/m]

$g$  = gravitational acceleration 9.81 [m/s<sup>2</sup>]

$L$  = free length of the measuring wire [m]

#### Formula B

$$c = \frac{F_{S \max} - F_{S \min}}{L_{\max}}$$

$c$  = spring rate of the spring drive [N/m]

$F_{S \max}$  = maximum tensile force in the wire [N]

$F_{S \min}$  = minimum tensile force in the wire [N]

#### Formula C

$$h = \frac{L^2 \times g \times m_L}{8 \times (c \times L + F_{\min})}$$

$h$  = wire sag [mm]

$c$  = spring rate of the spring drive [N/m]

$F_{S \min}$  = minimum tensile force in the measuring wire [N]

$g$  = gravitational acceleration 9.81 [m/s<sup>2</sup>]

$m_L$  = length-related mass of the measuring wire [Kg/m]

$L$  = free length of the measuring wire [m]

#### Formula D

$$f = \sqrt{L^2 + 4h^2} - L$$

$f$  = measurement error [m]

$h$  = wire sag [m]






$L$  = free length of the measuring wire [m]

Recommended accessories

Connectivity

Plug connectors and cables



Connecting cables with female connector

Figure	Brief description	Length of cable	Type	Part no.
	Head A: female connector, M23, 12-pin, straight Head B: cable Cable: SSI, PUR, shielded	2 m	DOL-2312-G02MLA5	2030680
		7 m	DOL-2312-G07MLA5	2030683
		10 m	DOL-2312-G10MLA5	2030686
		15 m	DOL-2312-G15MLA5	2030690
		20 m	DOL-2312-G20MLA5	2030693
		25 m	DOL-2312-G25MLA5	2030697
		30 m	DOL-2312-G30MLA5	2030700
	Head A: female connector, M23, 12-pin, straight Head B: cable Cable: SSI, suitable for drag chain, PUR, shielded, 4 x 2 x 0.25 mm <sup>2</sup> + 2 x 0.5 mm <sup>2</sup> + 2 x 0.14 mm <sup>2</sup> , Ø 7.8 mm	1.5 m	DOL-2312-G1M5MA1	2029200
		3 m	DOL-2312-G03MMA1	2029201
		5 m	DOL-2312-G05MMA1	2029202
		10 m	DOL-2312-G10MMA1	2029203
		20 m	DOL-2312-G20MMA1	2029204
	Head A: female connector, M12, 8-pin, straight Head B: cable Cable: incremental, suitable for drag chain, PVC, shielded, 4 x 2 x 0.25 mm <sup>2</sup> , Ø 7.0 mm	2 m	DOL-1208-G02MAC1	6032866
		5 m	DOL-1208-G05MAC1	6032867
		10 m	DOL-1208-G10MAC1	6032868
		20 m	DOL-1208-G20MAC1	6032869
	Head A: female connector, M23, 12-pin, straight Head B: cable Cable: incremental, PUR, shielded, 4 x 2 x 0.25 mm <sup>2</sup> + 2 x 0.5 mm <sup>2</sup> + 1 x 0.14 mm <sup>2</sup> , Ø 7.8 mm <sup>1)</sup>	2 m	DOL-2312-G02MLA3	2030682
		7 m	DOL-2312-G07MLA3	2030685
		10 m	DOL-2312-G10MLA3	2030688
		15 m	DOL-2312-G15MLA3	2030692
		20 m	DOL-2312-G20MLA3	2030695
		25 m	DOL-2312-G25MLA3	2030699
		30 m	DOL-2312-G30MLA3	2030702
	Head A: female connector, M23, 12-pin, straight Head B: cable Cable: incremental, suitable for drag chain, PUR, shielded, 4 x 2 x 0.25 mm <sup>2</sup> + 2 x 0.5 mm <sup>2</sup> + 1 x 0.14 mm <sup>2</sup> , Ø 7.8 mm <sup>1)</sup>	1.5 m	DOL-2312-G1M5MA3	2029212
		3 m	DOL-2312-G03MMA3	2029213
		5 m	DOL-2312-G05MMA3	2029214
		10 m	DOL-2312-G10MMA3	2029215
		20 m	DOL-2312-G20MMA3	2029216
		30 m	DOL-2312-G30MMA3	2029217





<sup>1)</sup> Warning! Only in combination with electrical interfaces A, C, E and P.

Female connectors (ready to assemble)


Figure	Brief description	Type	Part no.
	Head A: female connector, M12, 8-pin, straight Head B: - Cable: shielded	DOS-1208-GA	6028369

Figure	Brief description	Type	Part no.
	Head A: female connector, M23, 12-pin, straight, shielded, for cable diameter 5.5 mm ... 10.5 mm Head B: - Operating temperature: -20 °C ... +130 °C	DOS-2312-G	6027538
	Head A: female connector, M23, 12-pin, straight, shielded, for cable diameter 5.5 mm ... 10.5 mm Head B: - Operating temperature: -40 °C ... +125 °C	DOS-2312-G02	2077057
	Head A: female connector, M23, 12-pin, angled, shielded, for cable diameter 4.2 mm ... 6.6 mm Head B: - Operating temperature: -20 °C ... +130 °C	DOS-2312-W01	2072580

Cables (ready to assemble)

Figure	Brief description	Length of cable	Type	Part no.
	Head A: cable Head B: cable Cable: suitable for drag chain, PUR, halogen-free, shielded, 4 x 2 x 0.15 mm <sup>2</sup> , Ø 5.6 mm	By the meter	LTG-2308-MWENC	6027529
	Head A: cable Head B: cable Cable: PUR, shielded, 4 x 2 x 0.25 mm <sup>2</sup> + 2 x 0.5 mm <sup>2</sup> + 1 x 0.14 mm <sup>2</sup> , Ø 7.5 mm		LTG-2411-MW	6027530
	Head A: cable Head B: cable Cable: suitable for drag chain, PUR, halogen-free, shielded, 4 x 2 x 0.25 mm <sup>2</sup> + 2 x 0.5 mm <sup>2</sup> + 2 x 0.14 mm <sup>2</sup> , Ø 7.8 mm		LTG-2512-MW	6027531
	Head A: cable Head B: cable Cable: suitable for drag chain, PUR, halogen-free, shielded, UV and saltwater-resistant, 4 x 2 x 0.25 mm <sup>2</sup> + 2 x 0.5 mm <sup>2</sup> + 2 x 0.14 mm <sup>2</sup> , Ø 7.8 mm		LTG-2612-MW	6028516
	Cable: unshielded		LTG-3208-MW	6032870

Male connectors (ready to assemble)

Figure	Brief description	Type	Part no.
	Head A: male connector, M23, 12-pin, straight, shielded, for cable diameter 5.5 mm ... 10.5 mm Head B: - Operating temperature: -20 °C ... +130 °C	STE-2312-G	6027537
	Head A: male connector, M23, 12-pin, straight, for cable diameter 5.5 mm ... 10.5 mm Head B: - Operating temperature: -40 °C ... +125 °C	STE-2312-G01	2077273

→ For additional accessories, please see page K-668 onwards