

# Wire draw encoders

Technical additions to the product

Wire sag, installation and information about the deflection roller



---

de

---

en

---

**Described product**

Wire draw encoders

**Manufacturer**

SICK AG  
Erwin-Sick-Str. 1  
79183 Waldkirch  
Germany

**Legal information**

This work is protected by copyright. Any rights derived from the copyright shall be reserved for SICK AG. Reproduction of this document or parts of this document is only permissible within the limits of the legal determination of Copyright Law. Any modification, abridgment or translation of this document is prohibited without the express written permission of SICK AG.

The trademarks stated in this document are the property of their respective owner.

© SICK AG. All rights reserved.

**Original document**

This document is an original document of SICK AG.

# Seilzug-Encoder

Technische Ergänzungen zum Produkt

Seildurchhang, Installation und Informationen zur Umlenkrolle

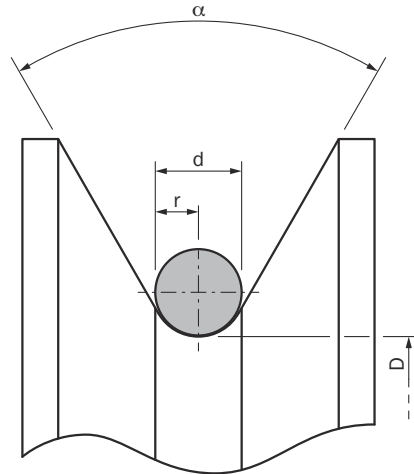
**SICK**  
Sensor Intelligence.

de

en

## 1 Umlenkrollen-Design

Mit der Hilfe von Umlenkrollen ist es möglich das Messeil von Seilzug-Encodern über Kanten und um Ecken zu leiten ohne die Lebenszeit des Seilzug-Encoders signifikant zu beeinflussen. Dabei muss darauf geachtet werden, dass die Designs der Umlenkrolle und des Messeils aufeinander abzustimmen sind, um Schäden am System zu vermeiden.



D = Rillengrunddurchmesser  
 d = Durchmesser des r = Rillenradius = 0,53 x d  
 r = Drahtseiles inkl. Ummantelung  
 α = Rillenöffnungswinkel = 60°

- Der Rillenradius sollte nicht zu klein sein – **Empfehlung: 0,53 x Durchmesser des Drahtseils**
- Der Rillenöffnungswinkel sollte weder zu klein noch zu groß sein – **Empfehlung: 60°**
- Um eine größtmögliche Lebenszeit des Systems zu gewährleisten, sollte das Material der Umlenkrolle weder zu weich noch zu hart sein – **Empfohlenes Material: Polyamid**
- Der Rillengrunddurchmesser der Umlenkrolle sollte nicht zu klein sein – Für Empfehlungen siehe Tabelle

### 1.1 EcoLine

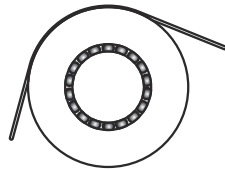
Länge	Messeil-PA ummantelt	Durchmesser des Messeils	Aufbau des Messeils (Litzen x Drähte)	Min. Rillengrunddurchmesser
1,25 m	PA12	0,45 mm	7 x 7	25 mm
3 m	-	0,55 mm	1 x 19	40 mm
5 m	-	0,55 mm	1 x 19	40 mm
10 m	-	0,55 mm	1 x 19	40 mm

## 1.2 HighLine

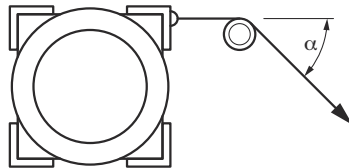
Länge	Messeil PA-ummantelt	Durchmesser des Messeils	Aufbau des Messeils (Litzen x Drähte)	Min. Rillengrunddurchmesser
2 m	-	1,35 mm	7 x 19	35 mm
3 m	-	1,35 mm	7 x 19	35 mm
5 m	-	1,35 mm	7 x 19	35 mm
10 m	-	1,35 mm	7 x 19	35 mm
20 m		0,81 mm	7 x 7	35 mm
30 m		0,81 mm	7 x 7	35 mm
50 m		1,35 mm	7 x 19	35 mm

## 2 Installation von Umlenkrollen

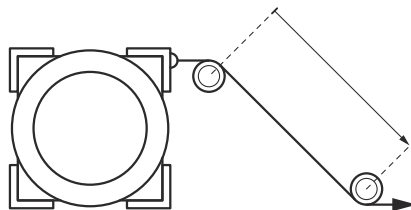
### Generelle Hinweise zur Installation von Umlenkrollen



Die Umlenkrolle sollte immer leichtgängig montiert werden. Im Idealfall hat die Umlenkrolle ein integriertes Kugellager.



Je kleiner der Umlenkwinkel ( $\alpha$ ), der durch eine Umlenkrolle realisiert wird, desto kleiner die Verschleißerscheinungen am Messeil und desto länger die Lebensdauer der Seilzugmechanik.



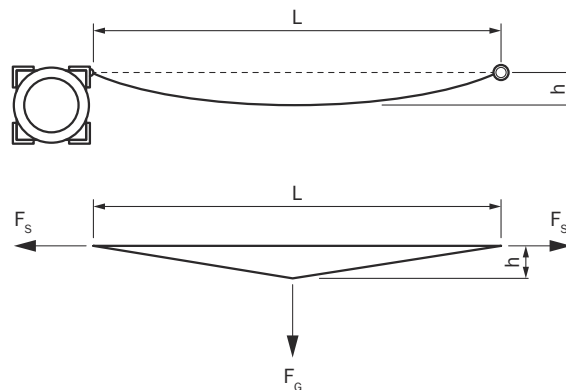
Werden zwei oder mehrere Umlenkrollen benötigt, sollten die Umlenkrollen immer mit einem Abstand zueinander installiert werden. Eine genaue Definition des Abstandes der Umlenkrollen muss kundenspezifisch vor Ort geschehen.

### 3 Seildurchhang

Wird das Messseil in waagerechter Richtung ausgezogen, so ergibt sich ein mit zunehmender Seillänge größer werdender Durchhang des Messseils. Dies ist insbesondere dann von Bedeutung, wenn dem bewegten Messseil in der Anwendung Hindernisse im Weg sein können. Die sich durch den Durchhang ergebende Längenänderung und der dadurch verursachte Messfehler sind vernachlässigbar klein.

#### 3.1 Berechnung des Seildurchhangs

Die Masse des frei gespannten Messseils bewirkt eine Gewichtskraft, welche das Messseil an einer hyperbelförmigen Linie durchbiegt. Der Durchbiegung entgegen wirkt die Spannkraft im Messseil. Diese nimmt durch den Federantrieb mit zunehmender Messlänge zu. Mit ausreichender Näherung lässt sich die Hyperbelform zugunsten eines einfachen Dreiecks vereinfachen.



Die Gewichtskraft des Messseils lässt sich nach **Formel A** berechnen.

Die Federrate des Federantriebs entspricht **Formel B**.

**Formel C** bestimmt den Durchhang des Messseils (die Ergebnisse aus Formel A und Formel B werden für die Berechnung des Seildurchhangs benötigt).

**Formel D** dient zur Errechnung des Messfehlers.

Die praktischen Werte weichen von den theoretisch berechneten Werten ab, da das Messseil selbst einen gewissen Widerstand gegen die Durchbiegung besitzt.

##### 3.1.1 Formel A

$$F_G = 0,5 \times m_L \times g \times L$$

$F_G$  = Gewichtskraft des Messseils [N]

$m_L$  = Längenbezogene Masse des Messseils [kg/m]

$g$  = Fallbeschleunigung 9,81 [m/s<sup>2</sup>]

$L$  = Freie Länge des Messseils [m]

##### 3.1.2 Formel B

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

$c$  = Federrate des Federantriebs [N/m]

$F_{S \max}$  = Größte Zugkraft im Seil [N]

$F_{S \min}$  = Kleinste Zugkraft im Seil [N]

### 3.1.3 Formel 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]

### 3.1.4 Formel D

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

$f$  = Messfehler [m]

$h$  = Seildurchhang [m]

$L$  = Freie Länge des Messseils [m]

# Wire draw encoders

Technical additions to the product

Wire sag, installation and information about the deflection roller

**SICK**  
Sensor Intelligence.

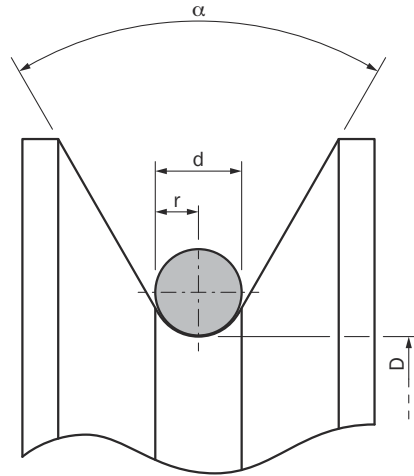
de

en



## 1 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.



D = groove base diameter.  
 d = diameter of the wire cable incl. sheath.  
 r = groove radius = 0.53 x d  
 α = groove opening angle = 60°

- 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**

### 1.1 EcoLine

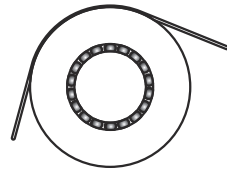
Length	Measuring wire, PA-sheathed	Diameter of the measuring wire	Structure of the measuring wire (strands x cords)	Min. groove base diameter
1.25 m	PA12	0.45 mm	7 x 7	25 mm
3 m	-	0.55 mm	1 x 19	40 mm
5 m	-	0.55 mm	1 x 19	40 mm
10 m	-	0.55 mm	1 x 19	40 mm

## 1.2 HighLine

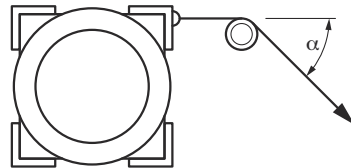
Length	Measuring wire, PA-sheathed	Diameter of the measuring wire	Structure of the measuring wire (strands x cords)	Min. groove base diameter
2 m	-	1.35 mm	7 x 19	35 mm
3 m	-	1.35 mm	7 x 19	35 mm
5 m	-	1.35 mm	7 x 19	35 mm
10 m	-	1.35 mm	7 x 19	35 mm
20 m		0.81 mm	7 x 7	35 mm
30 m		0.81 mm	7 x 7	35 mm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

## 2 Installation of deflection rollers

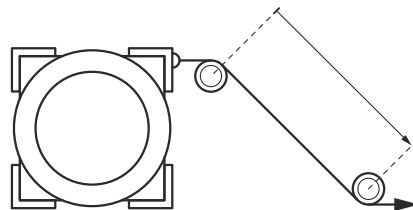
### General notes on the installation of deflection rollers



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.



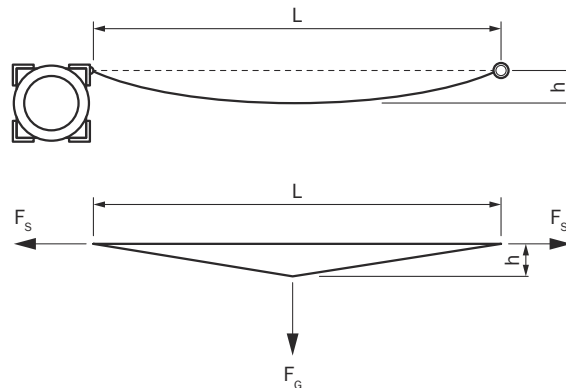
If two or more deflection rollers are needed, then the deflection rollers should always be installed at some distance from one another. The requisite distance between the deflection rollers must be accurately defined on site, accounting for specific customer requirements.

### 3 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.

#### 3.1 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 hyperbola-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.

##### 3.1.1 Formel 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]

##### 3.1.2 Formel 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]

**3.1.3 Formel D**

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

f = measurement error [m]

h = wire sag [m]

L = free length of the measuring wire [m]

**Australia**

Phone +61 (3) 9457 0600  
1800 33 48 02 – tollfree  
E-Mail sales@sick.com.au

**Austria**

Phone +43 (0) 2236 62288-0  
E-Mail office@sick.at

**Belgium/Luxembourg**

Phone +32 (0) 2 466 55 66  
E-Mail info@sick.be

**Brazil**

Phone +55 11 3215-4900  
E-Mail comercial@sick.com.br

**Canada**

Phone +1 905.771.1444  
E-Mail cs.canada@sick.com

**Czech Republic**

Phone +420 234 719 500  
E-Mail sick@sick.cz

**Chile**

Phone +56 (2) 2274 7430  
E-Mail chile@sick.com

**China**

Phone +86 20 2882 3600  
E-Mail info.china@sick.net.cn

**Denmark**

Phone +45 45 82 64 00  
E-Mail sick@sick.dk

**Finland**

Phone +358-9-25 15 800  
E-Mail sick@sick.fi

**France**

Phone +33 1 64 62 35 00  
E-Mail info@sick.fr

**Germany**

Phone +49 (0) 2 11 53 010  
E-Mail info@sick.de

**Greece**

Phone +30 210 6825100  
E-Mail office@sick.com.gr

**Hong Kong**

Phone +852 2153 6300  
E-Mail ghk@sick.com.hk

**Hungary**

Phone +36 1 371 2680  
E-Mail ertekesites@sick.hu

**India**

Phone +91-22-61119 8900  
E-Mail info@sick-india.com

**Israel**

Phone +972 97110 11  
E-Mail info@sick-sensors.com

**Italy**

Phone +39 02 27 43 41  
E-Mail info@sick.it

**Japan**

Phone +81 3 5309 2112  
E-Mail support@sick.jp

**Malaysia**

Phone +603-8080 7425  
E-Mail enquiry.my@sick.com

**Mexico**

Phone +52 (472) 748 9451  
E-Mail mexico@sick.com

**Netherlands**

Phone +31 (0) 30 229 25 44  
E-Mail info@sick.nl

**New Zealand**

Phone +64 9 415 0459  
0800 222 278 – tollfree  
E-Mail sales@sick.co.nz

**Norway**

Phone +47 67 81 50 00  
E-Mail sick@sick.no

**Poland**

Phone +48 22 539 41 00  
E-Mail info@sick.pl

**Romania**

Phone +40 356-17 11 20  
E-Mail office@sick.ro

**Russia**

Phone +7 495 283 09 90  
E-Mail info@sick.ru

**Singapore**

Phone +65 6744 3732  
E-Mail sales.gsg@sick.com

**Slovakia**

Phone +421 482 901 201  
E-Mail mail@sick-sk.sk

**Slovenia**

Phone +386 591 78849  
E-Mail office@sick.si

**South Africa**

Phone +27 10 060 0550  
E-Mail info@sickautomation.co.za

**South Korea**

Phone +82 2 786 6321/4  
E-Mail infokorea@sick.com

**Spain**

Phone +34 93 480 31 00  
E-Mail info@sick.es

**Sweden**

Phone +46 10 110 10 00  
E-Mail info@sick.se

**Switzerland**

Phone +41 41 619 29 39  
E-Mail contact@sick.ch

**Taiwan**

Phone +886-2-2375-6288  
E-Mail sales@sick.com.tw

**Thailand**

Phone +66 2 645 0009  
E-Mail marcom.th@sick.com

**Turkey**

Phone +90 (216) 528 50 00  
E-Mail info@sick.com.tr

**United Arab Emirates**

Phone +971 (0) 4 88 65 878  
E-Mail contact@sick.ae

**United Kingdom**

Phone +44 (0)17278 31121  
E-Mail info@sick.co.uk

**USA**

Phone +1 800.325.7425  
E-Mail info@sick.com

**Vietnam**

Phone +65 6744 3732  
E-Mail sales.gsg@sick.com

Detailed addresses and further locations at [www.sick.com](http://www.sick.com)