



NUMERIK JENA

LIA Series

Exposed Linear Encoder with Signal Control

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- **Make sure to familiarize yourself thoroughly with the contents of these installation instructions before installing and starting up the encoder.**
 - Please contact the Service departments of NUMERIK Jena GmbH or an authorized agency for further information.
 - The manufacturer is not liable for damages caused by unauthorized handling of the encoders. Any unauthorized handling leads to forfeiture of all warranty claims.
 - The encoders are guaranteed to function if the mounting and operating conditions are maintained as stated in these mounting instructions.
 - Make sure to follow the instruction sequence during mounting.
 - The manufacturer does not assume any liability for any damages or operating errors caused by incorrect installation or operation.
 - The stated tolerances must be maintained in order to achieve the accuracies listed in the specifications.
The linear coefficient of expansion of the machine plays a significant role for the SINGELFLEX scale tape.
- If the machine tolerances exceed the tolerances stated in the mounting instructions, errors can occur in both the operation and during measuring. The manufacturer assumes no liability for this.
 - Please refer to the operating manuals and safety instructions included with the devices to ensure the reliable operation of the encoder systems; especially pertaining to
 - Auxiliary electronic units
 - Counters
 - Displays
 - Controls
 - Encoders
 - Base mechanical devices (machine tools)
 - Pay attention to safety instructions and warning symbols.



Danger to the device!



Pull the plug!



Highly inflammable!

- The encoders conform to EC standards and carry the CE mark.
- The encoders comply with the directives in the law governing technical work equipment (Equipment Safety Law) in the version from May 11, 2001, as well as the guidelines for accident avoidance.
- The directives of the Equipment Safety Law for the complete system, consisting of the base mechanical device, the encoder, and the subsequent electronics, must be complied with by the manufacturer of the complete system.
- The encoders comply with IEC 1010-1 „Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use.“

- The manufacturer of the complete system is also liable for the regulations concerning electromagnetic compatibility (EMC).
- The electromagnetic compatibility (EMC) for industrial areas was established by type testing according to EC Guideline 89/336/EEC; testing according to EN 61000-6-2 (08/2002)

IEC 61000-4-2

Immunity against electrostatic discharge:

Air discharge 8 kV

Contact discharge 4 kV

IEC 61000-4-4

Immunity against bursts

The noise emission depends on the evaluation electronics and power supply being used.

- In order to maintain this status, the encoders must only be operated appropriately.

1 Safety

Encoders

- Use only the original packaging for transportation.
- If possible, use only the original packaging for storage.

SINGLEFLEX scale tape

- Can be rolled up;
minimum bending radius: 140 mm.
- No restrictions regarding the length.

DOUBLEFLEX scale tape



In no case should the DOUBLEFLEX scale tape be stored, transported or used when rolled up.

- Use only the original packaging for transportation.
Lengths up to ~ 3 m – stretched out
Lengths above 3 m – tape laid down as a figure eight
- Use only the original packaging for storage.
- Damages to the adhesive layer between the scale tape and carrier tape must absolutely be avoided, since otherwise the beneficial measuring properties of the DOUBLEFLEX scale tape are lost.
- Only remove the DOUBLEFLEX scale tape from the packaging on site, directly before mounting.

- Do not separate the scale tape and carrier tape from each other; avoid any unintentional separation of the scale tape from the carrier tape—even just partial separation.
- Avoid radial or axial offsetting between the scale tape and carrier tape.



If a radial offset between the scale tape and carrier tape occurs (e.g., during transportation), correct it with lateral pressure only.

If the scale tape should become partially or completely separated from the carrier tape—even for just a very short time—simply pressing them together again will not result in sufficient adhesion. In this case neither the operational reliability nor the beneficial metrological properties can be guaranteed.

Return the scale tape to the supplier for repair!

- When removing the DOUBLEFLEX scale tape from the packaging, it must not be allowed to bend more than 100 mm.
- The greatest distance between two supports must not be more than 800 mm;
Support scale tapes up to 1200 mm approx. 300 mm from the ends;
Longer scale tapes must be supported correspondingly.



Do not connect or disconnect plugs if the power is on.

- Only operate the encoders with the supply voltage stated in the installation instructions.
- Comply with applicable pin assignment if auxiliary electronic units are connected (counter, displays, controls).

- Integrate exposed encoders in instruments, devices or machines in such a way that they are protected against contamination.
- Protect the scale against mechanical damage.
- Protect the scanning head which contains electronic units against shock, impact and humidity.

- Modifications and repairs of encoders may only be carried out by the manufacturer or appropriately authorized persons. The manufacturer is not liable for damages caused by unauthorized handling of the encoders. All warranty claims are forfeited by unauthorized handling.
- The encoders require no maintenance whatsoever, but must be cleaned occasionally, depending on the ambient conditions.
- Exposed encoders are sensitive to contamination, especially the scale surface and the scanning windows for the counting and reference tracks on the scanning head.
- They are particularly sensitive to rough and irregular contamination and deposits (oil, grease, water).

- The operator must protect the encoders from contamination by way of appropriate design measures.
- Clean the encoders as described in the chapter „Cleaning“.



When cleaning the encoder, ensure that no solvent flows under the scale tape!



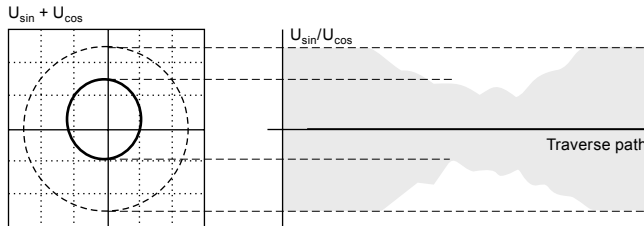
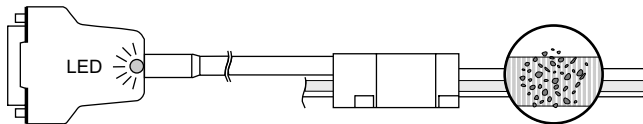
When cleaning the components, ensure that the scanning window and scale tape are not scratched by any deposited particles!

Contamination and mounting errors lead to interferences in the optical scanning of the scale by the scanning head, and so to periodic deformations of the sinusoidal counting track signals, which are exemplified as

- offset deviations
- amplitude deviations
- amplitude differences between the sine and cosine channels

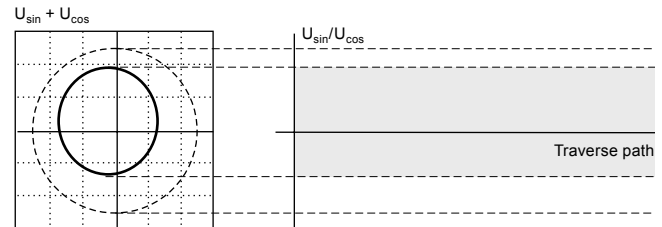
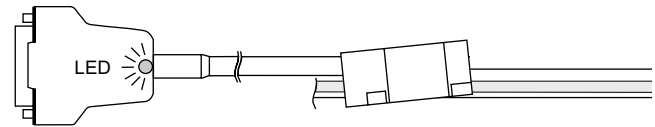
and lead to interpolation errors.

Contaminated scale tape

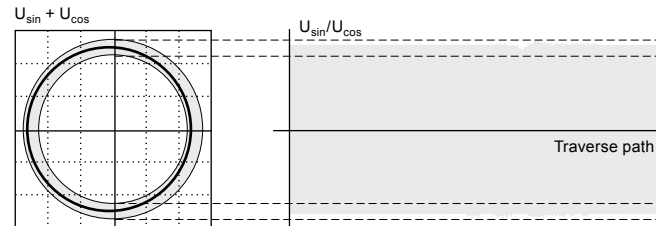


Scanning head signal with **contaminated scale tape** before offset and amplitude control

Incorrect mounting



Scanning head signal with **faulty mounting** before offset and amplitude control



Scanning head signal with **contaminated scale tape** and/or **faulty mounting** after offset and amplitude control

Through the **offset and amplitude control** the signals generated by the measuring module are automatically corrected within the sensor without following error over the entire velocity range.

This measure not only increases the accuracy, but also the reliability of the encoder.

The **mounting LED** is an aid for displaying deviations of the optical scanning signals from a given nominal value, in order to

- check and optimize the mounting of the scanning head (and readjust it if necessary)
- and**
- check the degree of contamination of the scale tape (and clean it if necessary).

The signal for triggering the LED is gained from the coarse sensor signals before the offset and amplitude control.

Signaling of mounting errors:

- The LED is dark when the encoder is optimally mounted according to the prescribed tolerances.
- The LED begins to shine when deviations from the optimal mounting state occur.
The larger the deviations, the brighter the LED shines.

Signaling of scale-tape contamination:

- The LED lights up briefly when contaminated positions of the scale are traversed.
The stronger the contamination, the brighter the LED shines.



Detection of the reference mark cannot be checked with the mounting LED, therefore this must be tested separately.

If necessary, readjust the scanning head physically, or use the adjustment kit from NUMERIK Jena to perform an electronic fine adjustment.

The use of switch sensors results in no additional switches being needed. This saves cable material and time for installation.

The opto-electronic switch sensors integrated in the scanning head can be used

- to detect limit positions with left/right distinction, **or**
- to indicate the scanning head position within the measuring range, **or**
- to enable a reference mark (selection of **one** reference mark from **n** marks)

It is possible to combine these variations.

The **LIA 21** scanning head is equipped with **one** switch sensor.

The **LIA 22** scanning head is equipped with **two** switch sensors.

As viewed from the direction of measurement, the switch sensors of the LIA 22 can be aligned differently:

S1 + S2 Sequential alignment in one track **or**

S1 + S2 Alignment next to each other in two parallel tracks

The switch sensors can be used universally depending on the various output settings (order options):

- TTL low active or
TTL high active
- open collector low active or
open collector high active
- MOS relay opening or
closing to 300 V switching voltage

- In order to use the switch signals, a switch foil must also be applied.
- The guide tape is intended for use as the carrier for the switch foil(s).
At least one guide tape is necessary for this.
- If no guide tapes are used, a reflecting foil is used as the carrier for the switch foil.
- If the scale tape is mounted in a slot or along an edge, the switch foil can be stuck on the machine element together with the reflecting foil.



The surfaces of the switch foil and the scale tape must be at the same level!

- First the reflecting foil is glued onto the scale-tape carrier over the entire measuring length.
Then the switch foil is glued to the reflecting foil

Whether using guide tapes or the reflecting foil as switch foil carrier, there are two options for mounting the switch foil (see the chapter „Mounting“).

1. Precise mounting

Achievable accuracy: $\sim \pm 1$ mm

Reproducibility of the switch signal: ± 0.1 mm

2. Reference to a machine datum

Minimization of the position deviation of the switch signal with the aid of the evaluation electronics

Achievable accuracy of the position signal: ± 0.7 mm

Reproducibility of the switch signal: ± 0.1 mm

Standard

- LIA 20/21/22 scanning head according to the specification
- Mounting screws (M3) for the scanning head (only for scanning heads with through holes)
- DOUBLEFLEX scale tape according to the specification **or**
- SINGLEFLEX scale tape according to the specification
- Black switch foil for LIA 21 and LIA 22
- Spacing gage for mounting the scanning head (plastic; code „0,6“)
- Mounting instructions

Optional

- Guide tapes for DOUBLEFLEX scale tape; if slot or edge are not used for mounting
- Guide tapes for SINGLEFLEX scale tape; if slot or edge are not used for mounting
- Guide tape mounting device (FAV) for guide tapes
- Spacing gage for guide-tape applicator (steel; code „FAV“)
- Extension cable
- Reflecting foil, if guide tapes are not used

- The encoders can be mounted in any position.
- In order to avoid contamination deposits, a vertical position is recommended for the scale tape.
- The operator is responsible for appropriate design measures to protect the encoders from contamination.
- The counting direction of the encoders is positive (increasing measuring values) in any case if the scanning head opposite the scale tape moves in the direction of the cable outlet.



In any installation position the scale-tape surface and scanning windows should be easily accessible for cleaning. Prevent contamination and foreign elements from having an influence on the operation!

- If there is no edge or slot for guiding the scale tape, then guide tapes from NUMERIK Jena are recommended. Use the FAV to apply the guide tapes.
- Guide tapes are suited for both the DOUBLEFLEX and SINGLEFLEX scale tapes.

- However, they have different thicknesses and are adapted to the thickness of the scale tapes:

for DOUBLEFLEX scale tapes: $d = 0.7 \text{ mm}$
 for SINGLEFLEX scale tapes: $d = 0.5 \text{ mm}$



Ensure that the guide tapes for DOUBLEFLEX scale tapes are not used for SINGLEFLEX scale tapes, and vice versa.

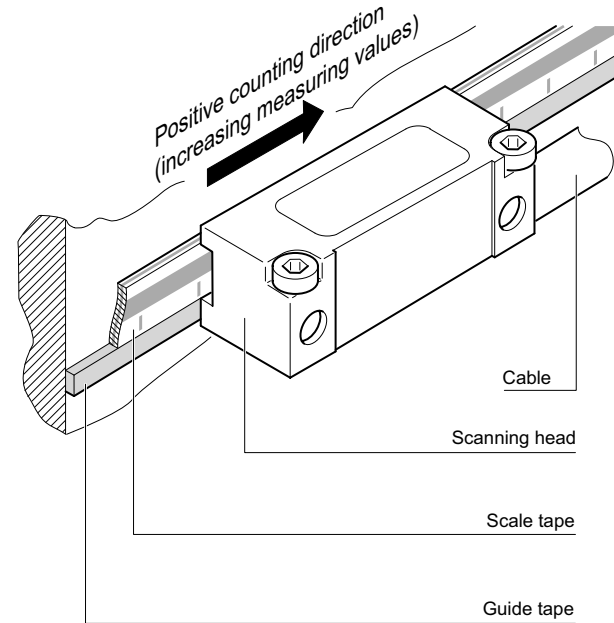
- The guide tapes, slots or edges serve as an installation orientation for straight mounting of the scale tapes, particularly very long ones.
- For DOUBLEFLEX scale tapes, slots and edges also serve as a stop to prevent any displacement between the scale tape and the carrier tape.



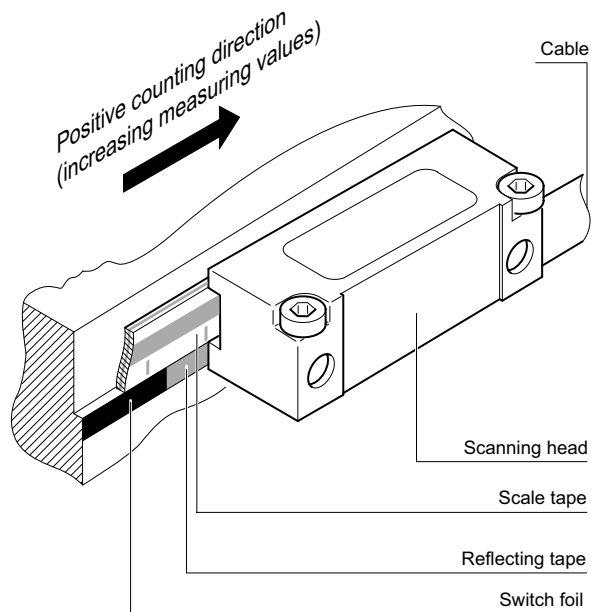
The beneficial measuring properties of the DOUBLEFLEX scale tape are the result of the adhesive layer between the scale tape and the carrier tape.

Do not displace the scale tape and carrier tape relative to each other, or separate them from each other!

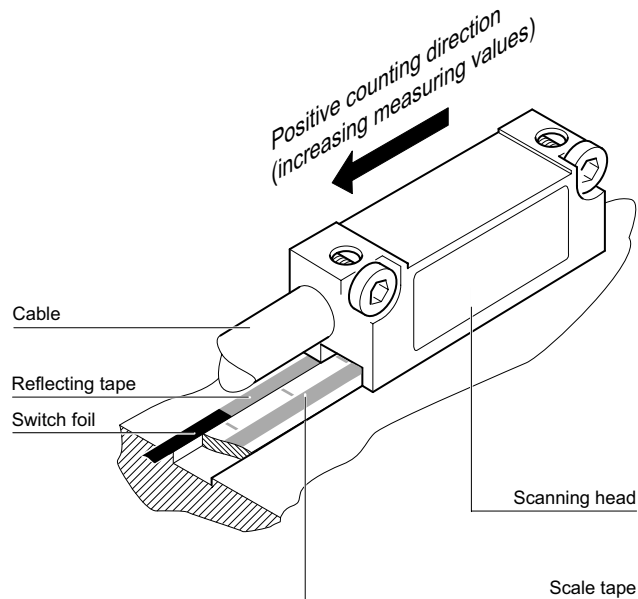
- If DOUBLEFLEX scale tapes are mounted vertically, mount them so that the scale tapes lie adjacent to the guide tapes.



*Example:
 Vertical position of the surface of a
 DOUBLEFLEX scale tape without slot or edge,
 with one guide tape*



Example:
Vertical position of the surface of a
DOUBLEFLEX scale tape on an edge,
with reflecting tape and switch foil



Example:
Horizontal position of the surface of a
SINGLEFLEX scale tape in a slot,
with reflecting tape and switch foil

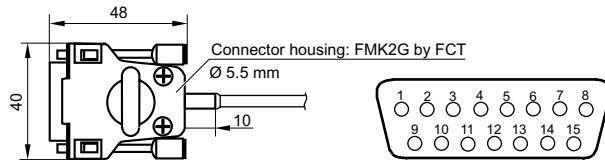
Scanning head cable

- Mount the scanning head on the rigid part and the scale tape on the mobile part of the machine. If this is not possible, provide a strain relief for the cable near the scanning head. .
- The encoder cables and connecting cables must be laid away from sources of interference (mains cables, fuses, motors, magnetic valves, power supplies); normally, a distance of 100 mm will be sufficient.
- Locate the cable so that it is not damaged by the moving carriage; pay attention to the permissible bending radius.

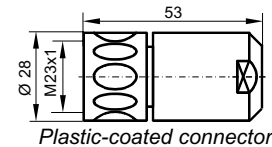
Extension cables

- Use original extension cables.
This guarantees optimum compatibility with the encoders and ensures maximum protection against interference.
- Please consult the supplier before using self-manufactured extension cables.
- Do not lay any other signal lines in the encoder cable!

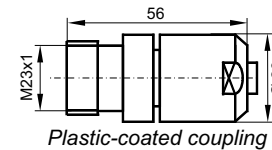
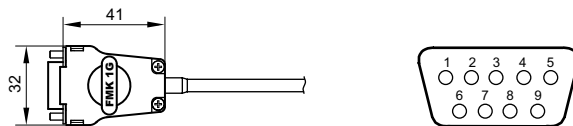
15-pin D-sub



12-pin round



9-pin D-sub



Legend

U_{1+}	sine signal; counting track	Sine signals	Z_{1+}	Counting signal 0°	Square-wave signals	U_B	Operating voltage (5 V)
U_{2+}	cosine signal; counting track		Z_{2+}	Counting signal 90°		GND	Ground (0 V)
U_{1-}	– sine signal; counting track		Z_{1-}	Negated counting signal 0° (180°)			
U_{2-}	– cosine signal; counting track		Z_{2-}	Negated counting signal 90° (270°)			
U_{0+}	Reference signal		Z_{0+}	Reference signal			
U_{0-}	– Reference signal		Z_{0-}	Negated reference signal			
AS	Monitoring signal						
NAS	Negated monitoring signal <i>NAS high: Input signal within the tolerance range, encoder functioning properly</i> <i>NAS low: Input signal outside the tolerance range, check the encoder!</i>						

LIA 20 – 15-pin D-sub PIN assignment

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Housing
1 V _{PP}	–	–	–	U_{0-}	U_{2-}	U_{1-}	–	5 V	0 V	–	–	U_{0+}	U_{2+}	U_{1+}	–	Shield
RS 422	–	–	NAS	Z_{0-}	Z_{2-}	Z_{1-}	–	5 V	0 V	–	AS	Z_{0+}	Z_{2+}	Z_{1+}	–	Shield
Cable Ø 5.1 mm	–	–	violet	pink	red	yellow	–	brown	white	–	black	gray	blue	green	–	–
Cable Ø 3.7 mm	–	–	violet	pink	red	brown	–	blue	white	–	yellow	gray	black	green	–	–

LIA 20 – 9-pin D-sub connector

PIN	1	2	3	4	5	6	7	8	9	Housing
1 V _{PP}	U ₁₋	0 V	U ₂₋	-	U ₀₋	U ₁₊	5 V	U ₂₊	U ₀₊	Shield
RS 422	Z ₁₋	0 V	Z ₂₋	NAS	Z ₀₋	Z ₁₊	5 V	Z ₂₊	Z ₀₊	Shield
Cable Ø 5.1 mm	yellow	white	red	violet	pink	green	brown	blue	gray	-
Cable Ø 3.7 mm	brown	white	red	violet	pink	green	blue	black	gray	-

LIA 20 – 12-pin round connector (Ø 28; M 23 x 1)

PIN	1	2	3	4	5	6	7	8	9	10	11	12	Housing
1 V _{PP}	U ₂₋	5 V	U ₀₊	U ₀₋	U ₁₊	U ₁₋	-	U ₂₊	-	0 V	0 V	5 V	Shield
RS 422	Z ₂₋	5 V	Z ₀₊	Z ₀₋	Z ₁₊	Z ₁₋	NAS	Z ₂₊	-	0 V	0 V	5 V	Shield
Cable Ø 5.1 mm	red	brown	gray	pink	green	yellow	violet	blue	-	white	white	brown	-
Cable Ø 3.7 mm	red	blue	gray	pink	green	brown	violet	black	-	white	white	blue	-

Pins 2 and 12 bridged, pins 10 and 11 bridged

LIA 21 – 15-pin D-sub connector

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Housing
1 V _{PP}	–	–	–	U _{0–}	U _{2–}	U _{1–}	–	5 V	0 V	S1	–	U ₀₊	U ₂₊	U ₁₊	–	Shield
RS 422	–	–	NAS	Z _{0–}	Z _{2–}	Z _{1–}	–	5 V	0 V	S1	AS	Z ₀₊	Z ₂₊	Z ₁₊	–	Shield
Cable Ø 5.1 mm	–	–	violet	pink	red	yellow	–	brown	white	–	black	gray	blue	green	–	–

For switch sensors with **TTL** or **Open Collector output**:

S1 at pin 10

For switch sensors with **relay output**:

S1 at pin 7 and pin 10

LIA 22 – 15-pin D-sub connector

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Housing
1 V _{PP}	–	S1	–	U _{0–}	U _{2–}	U _{1–}	–	5 V	0 V	S2/S3	–	U ₀₊	U ₂₊	U ₁₊	–	Shield
RS 422	–	S1	NAS	Z _{0–}	Z _{2–}	Z _{1–}	–	5 V	0 V	S2/S3	AS	Z ₀₊	Z ₂₊	Z ₁₊	–	Shield
Cable Ø 5.1 mm	–	–	violet	pink	red	yellow	–	brown	white	–	black	gray	blue	green	–	–

For switch sensors with **TTL** or
Open Collector output:

S1 at pin 2

S2 or S3 at pin 10

For switch sensors with **relay output**

for RS 422 without interpolation or for **1 V_{pp}**:

S1 at pins 1 and 2

S2 or S3 at pins 7 and 10

For switch sensors with **relay output**
for RS 422 with interpolation:

S1 at pins 7 and 2

S2 or S3 at pins 7 and 10

Observe the following to ensure maximum protection against electrical and magnetic fields:

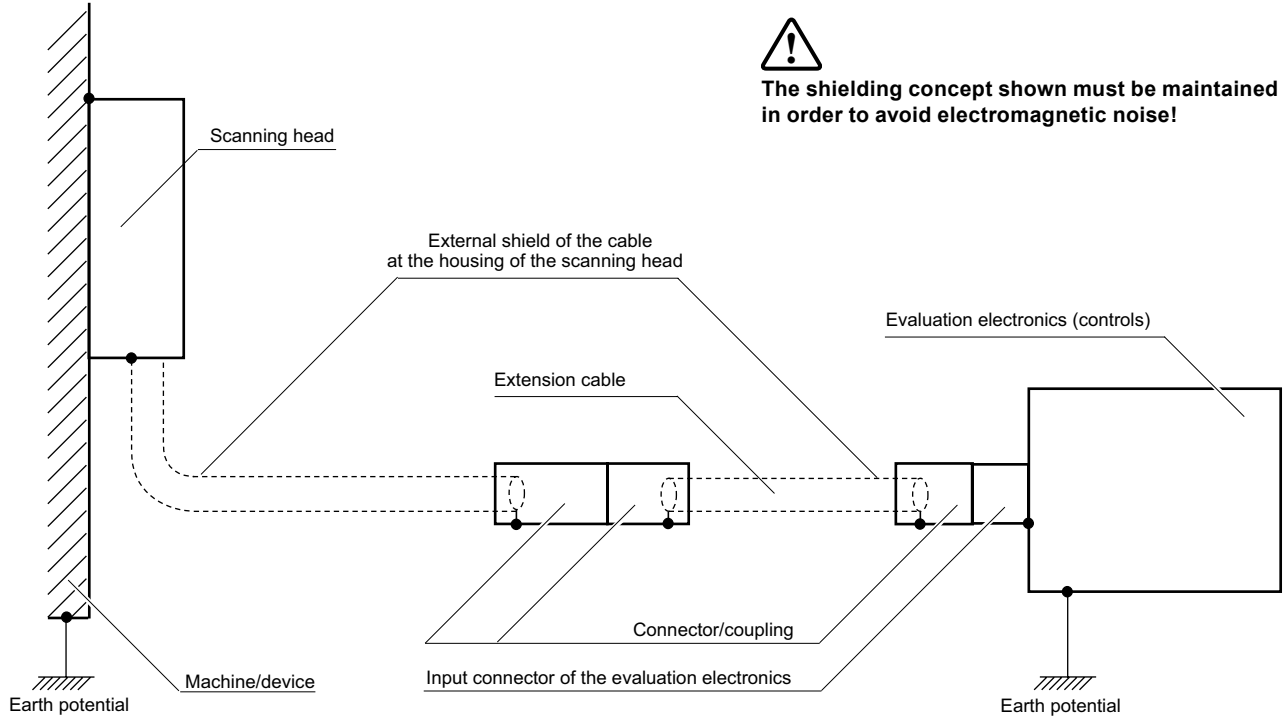
- Mount the encoders to ensure galvanic conductivity:
 - Mounting surfaces free from paint
 - Conductive threads of mounting screws and threads in machine component
- Maintain the shielding concept for encoders with cable connectors designed by the manufacturer.
- Shielding for encoders without connectors:
 - When connected directly with the evaluation electronics, ensure that the external shield of the cable is well grounded
 - If cable connectors (e.g., terminal strips) are used, connect the external shields of the cables with each other and with the shielding of the cable connector
 - Use shielded connectors
- When using additional electronics connect the housing to ensure good galvanic conductivity; or for insulated installation connect the housing at the shortest distance by an additional potential equalization line with the machine's protective ground (Cu line with cross section $\geq 6 \text{ mm}^2$).

Please contact our service department or that of the appropriate manufacturer if you experience any problems when working with specific display or control units.

The encoders satisfy EU guideline 89/336/EEC. Testing is according to EN 61000-6-2 (08/2002) – Immunity for Industrial Environments–.

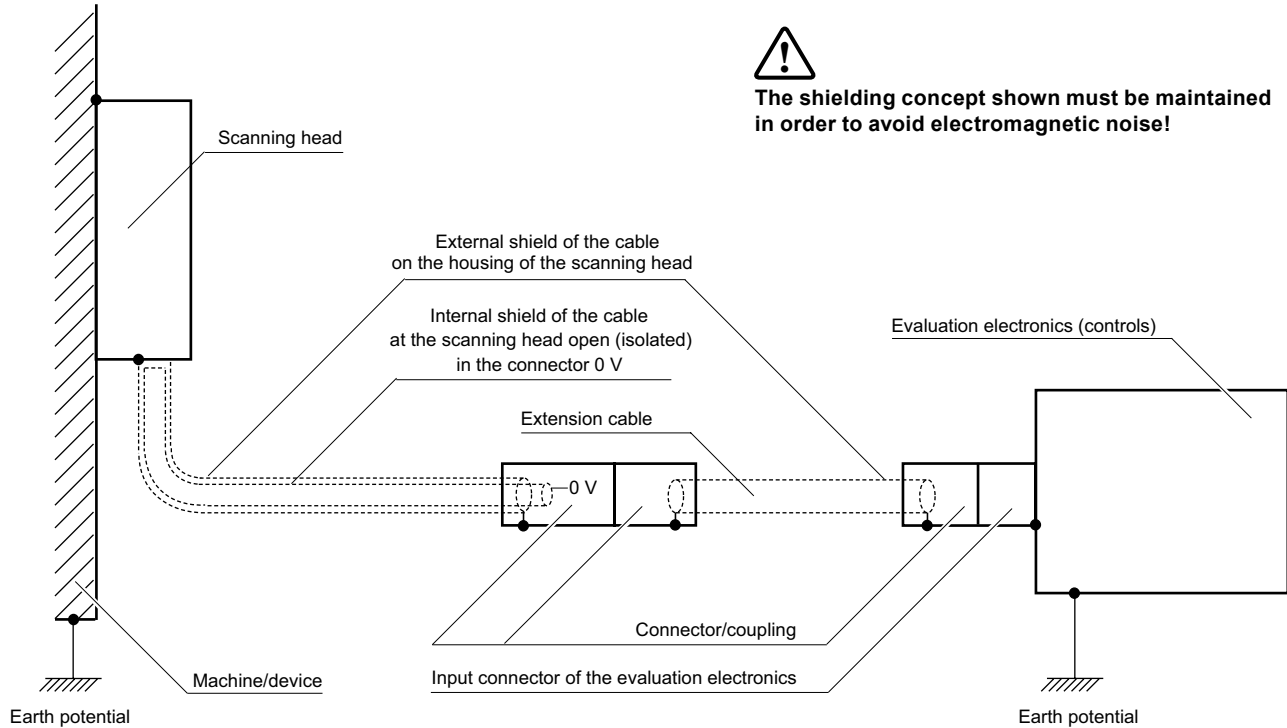
Shielding concept with single-shielded encoder cable

- Only for LIA 20 with
- encoder cable \varnothing 3.7 or
 - encoder cable \varnothing 5.1 and electronics in the scanning head



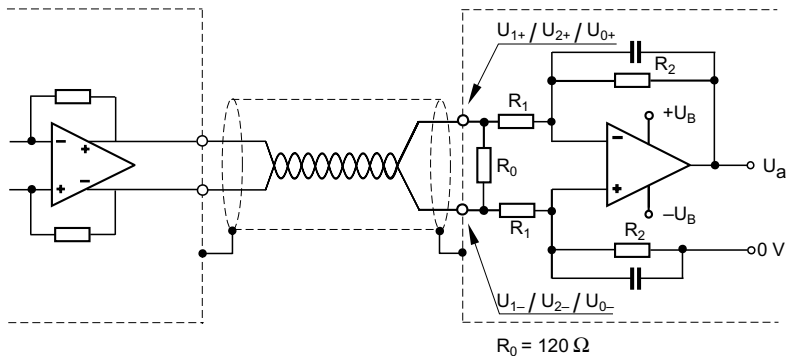
Shielding concept with double-shielded encoder cable Ø 5.1

- For
- LIA 21 and LIA 22 **und**
 - LIA 20 with electronics in the connector

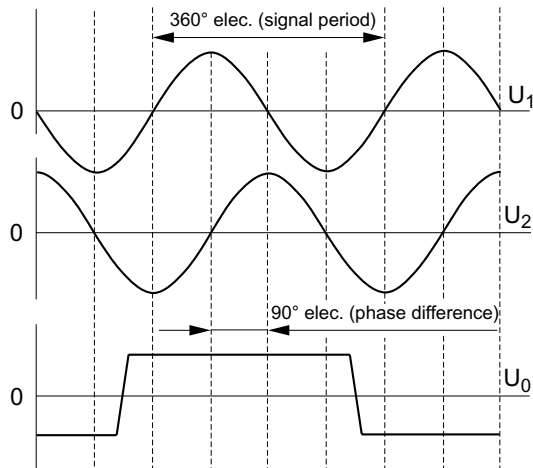


3 Installation Conditions

Optimal Connection Circuit



Signal curve



Difference signals measured at R_0 :

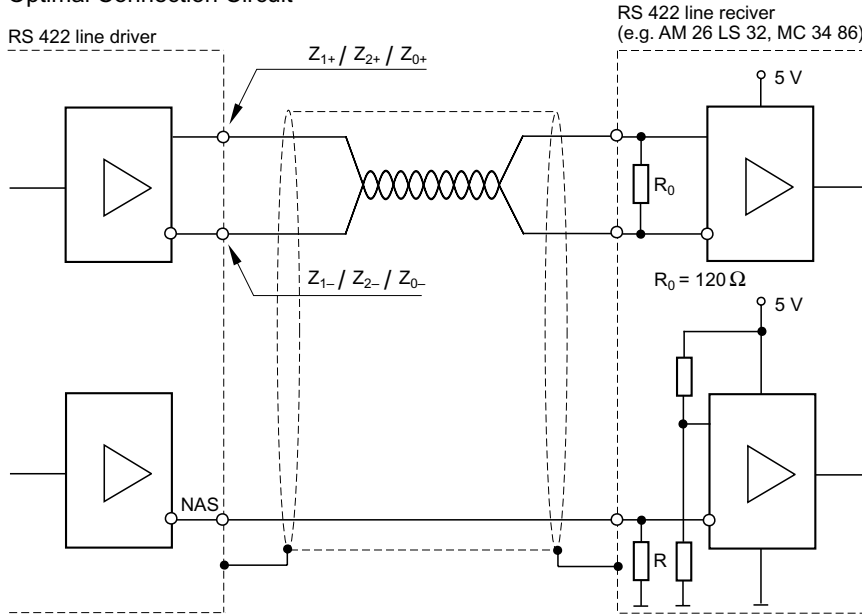
$$U_1 = U_{1+} - U_{1-} = 0.6 \dots 1.2 V_{PP} \quad (\text{rated voltage: } 1 V_{PP})$$

$$U_2 = U_{2+} - U_{2-} = 0.6 \dots 1.2 V_{PP} \quad (\text{rated voltage: } 1 V_{PP})$$

$$U_0 = U_{0+} - U_{0-} = 0.5 \dots 1.2 V \quad (\text{rated voltage: } 0.8 V)$$

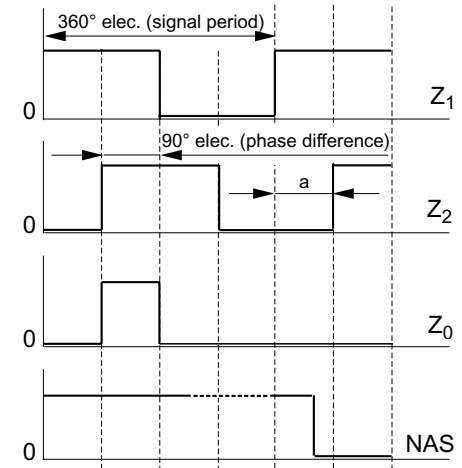
Voltage Output 1 V_{PP}

Optimal Connection Circuit



In order to avoid electromagnetic interference, the cable adaptation with a terminal resistor of $R_0 = 120 \Omega$ is necessary. When connecting more than one parallel signal input to an encoder output signal (e.g., linear motors with parallel connection to position controller, speed controller, acceleration controller), ensure that the resulting terminal resistance of these inputs is $R_{0res} \approx 120 \Omega$.

Signal curve

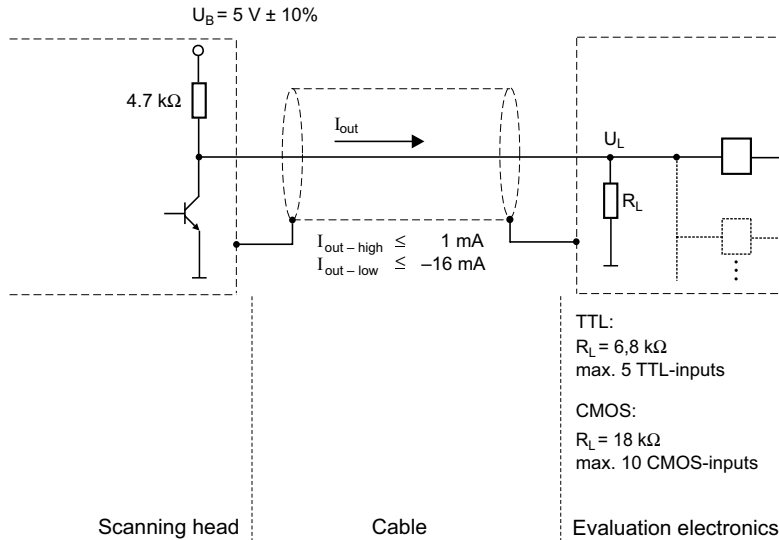


NAS high:
encoder functioning properly;
input signals within tolerance range

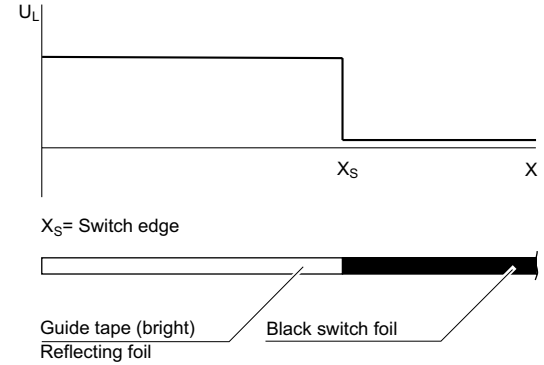
NAS low:
Check encoder

a: minimum edge separation as a function of the interpolation factor and traversing speed (see "Specifications")

Optimal Connection Circuit

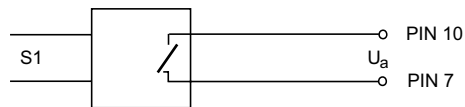


Signal curve (low active)



Output circuitry of the switch signals for LIA 21

or RS 422 with interpolation, for RS 422 without interpolation and for sine signal 1 V_{pp}



Electrically isolated switch contact

Max. switch voltage (DC or AC):

$$U_{a_{\text{max}}} = 300\text{ V}$$

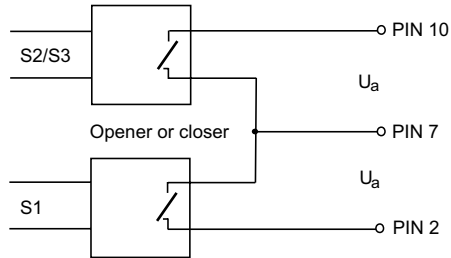
Max. continuous current:

$$I_{\text{max}} = 0.1\text{ A}$$

Max. power loss:

$$P_{\text{max}} = 300\text{ mW}$$

Output circuitry of the switch signals for LIA 22 for RS 422 with interpolation



Electrically isolated switch contact

Max. switch voltage (DC or AC):

$$U_{a_{max}} = 300 \text{ V}$$

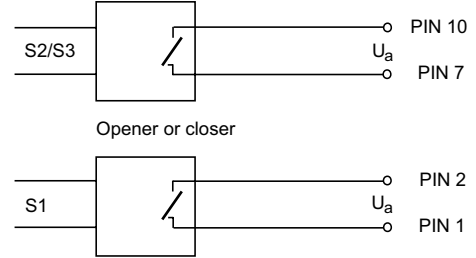
Max. continuous current:

$$I_{max} = 0,1 \text{ A}$$

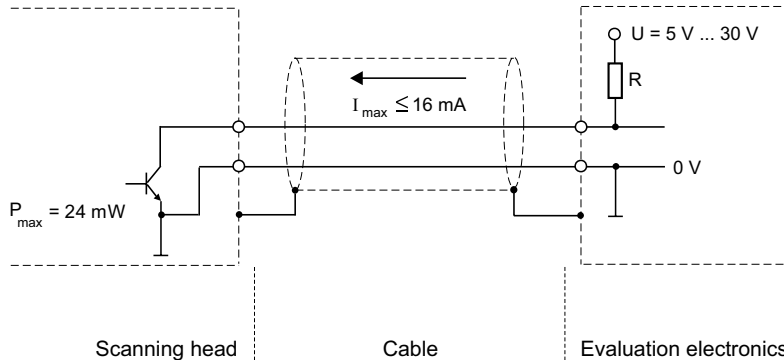
Max. power loss:

$$P_{max} = 300 \text{ mW}$$

Output circuitry of the switch signals for LIA 22 for RS 422 without interpolation and for sine signal $1 V_{pp}$



Optimal Connection Circuit



$$R_{min} (5 \text{ V}) \geq 330 \ \Omega$$

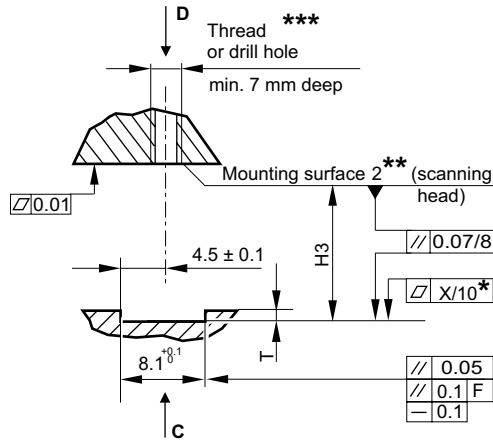
$$R_{min} (12 \text{ V}) \geq 750 \ \Omega$$

$$R_{min} (24 \text{ V}) \geq 1,5 \text{ k}\Omega$$

$$P_{max} = \text{max. power loss}$$



Under all circumstances: avoid a short circuit of the Open Collector output with the supply voltage U. The encoder could be destroyed if there is a short circuit!

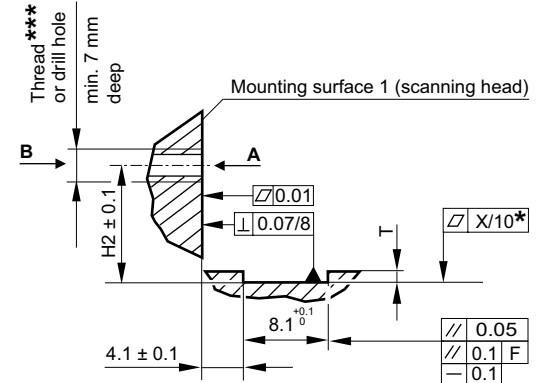


F = machine guideway

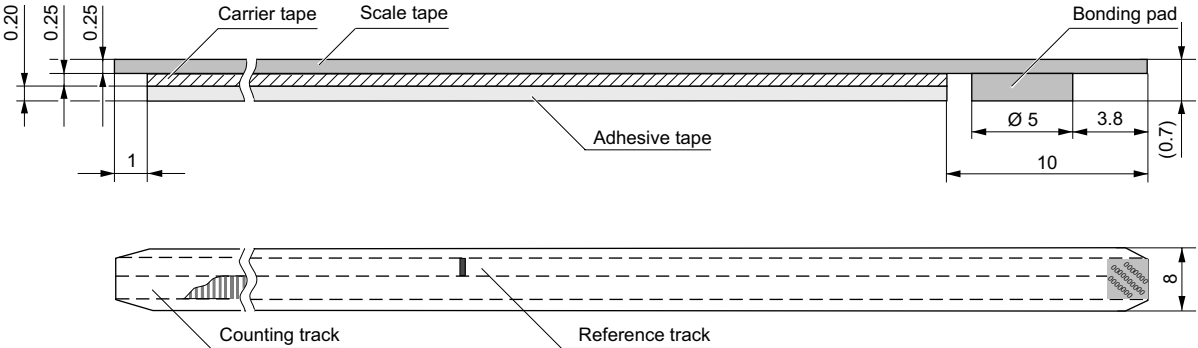
*	Deviation X per 10 mm of scale-tape length (see table at bottom right)
**	The mounting surface 2 must be vertically adjustable to ensure that the distance parameter $H1 \pm 0.1$ and the parallelism 0.025 can be achieved (for H1 see the mounting drawings for the scanning head)

Grating period GP	H2		H3	
	DOUBLEFLEX scale tape	SINGLEFLEX scale tape	DOUBLEFLEX scale tape	SINGLEFLEX scale tape
20 μ m	11.1 mm	10.9 mm	13.7 mm	13.5 mm
100 μ m	11.8 mm	11.6 mm	14.4 mm	14.1 mm

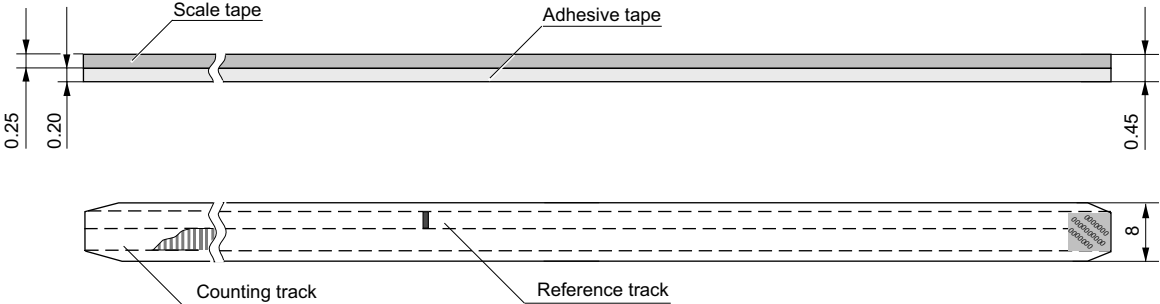
Right figure ***
M3 when screwed from side A for LIA 20/21/22;
$\varnothing 4.6$ when screwed from side B for LIA 20/21/22
*** Left figure
M3 when screwed from side C for LIA 20/21
M2.5 when screwed from side C for LIA 22
$\varnothing 4.6$ when screwed from side D for LIA 20/21/22



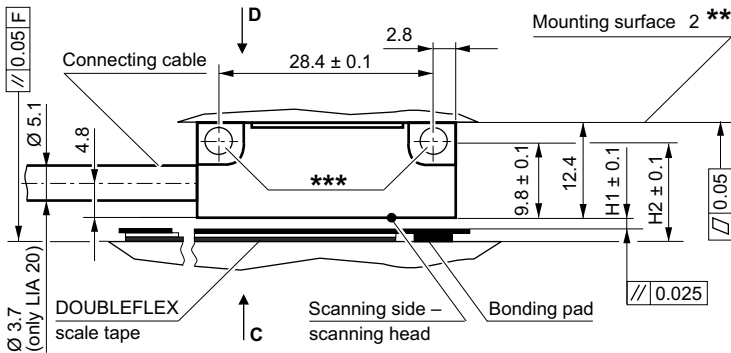
Version of scale tape	T
SINGLEFLEX	0.4 – 0.05
DOUBLEFLEX	0.7 – 0.1
Accuracy class	X
$\pm 1 \mu$ m	0.003
$\pm 2 \mu$ m	0.006
$\pm 3 \mu$ m	0.009
$\pm 5 \mu$ m	0.009



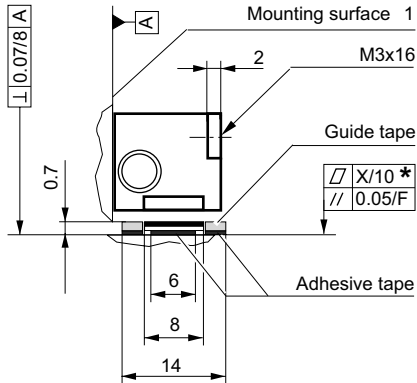
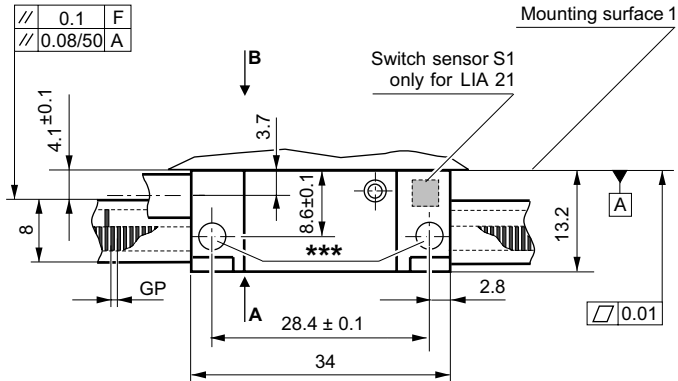
DOUBLEFLEX Scale Tape



SINGLEFLEX Scale Tape

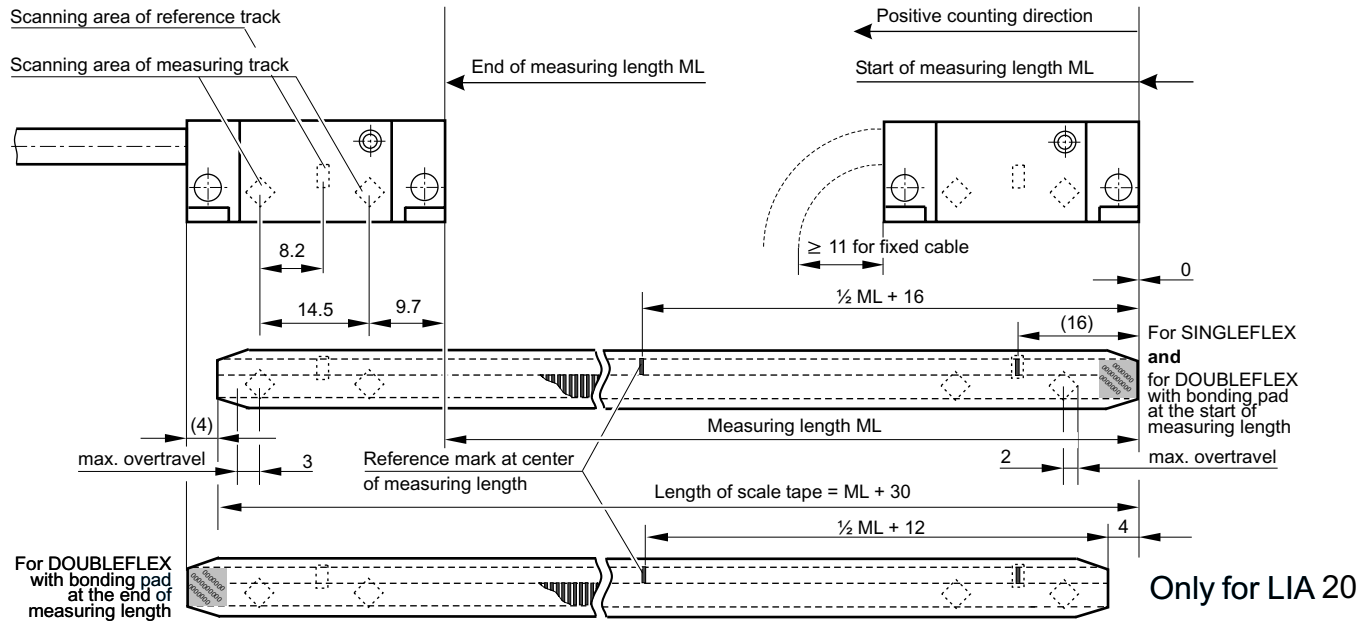


Shown with DOUBLEFLEX scale tape

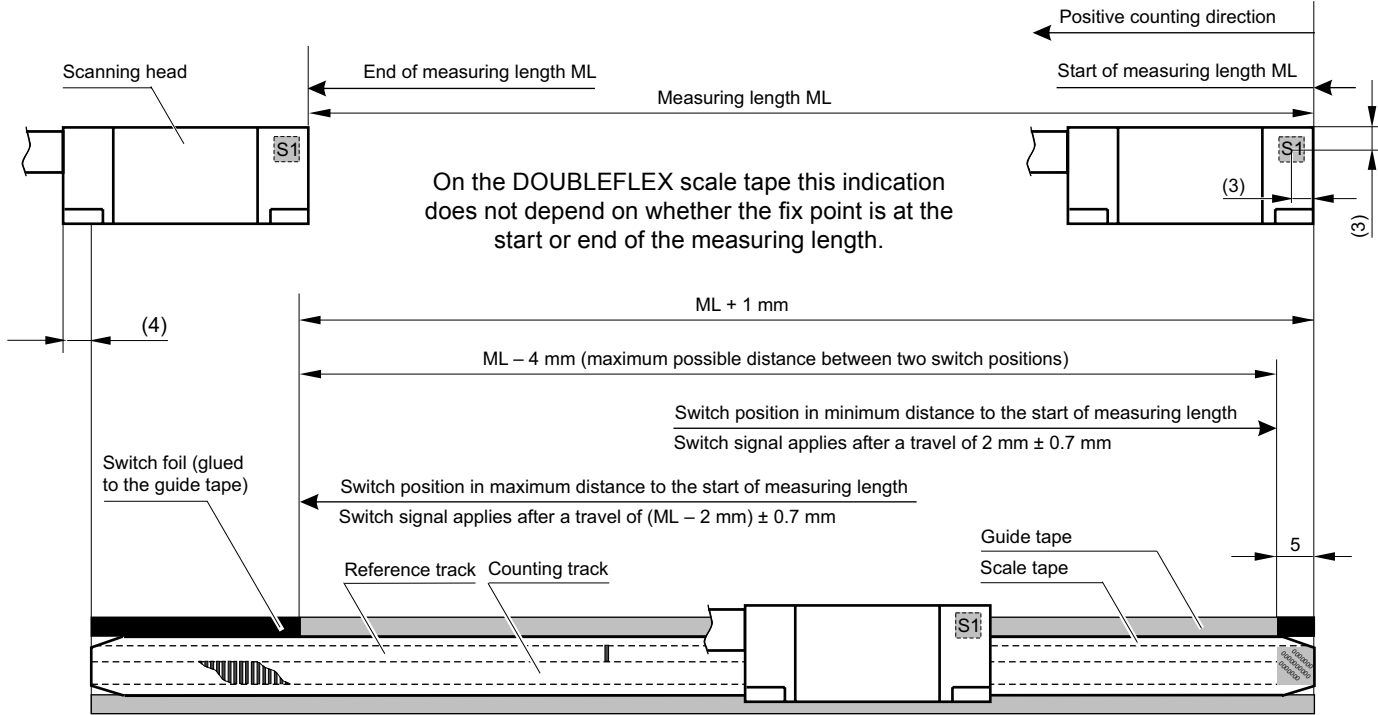


*	Deviation X per 10 mm of scale-tape length (see table below)
**	The mounting surface 2 must be vertically adjustable to ensure that the distance parameter $H1 \pm 0.1$ and the parallelism 0.025 can be achieved
***	Ø 3.6 for M3 screws from side A or C, M4-6H for screws from side B or D

	GP [µm]	H1 [mm]	H2 [mm]	Accuracy class	X
DOUBLEFLEX scale tape	20	0.6	11.1	± 1 µm	0.003
	100	1.3	11.8	± 2 µm	0.006
SINGLEFLEX scale tape	20	0.6	10.9	± 3 µm	0.009
	100	1.3	11.6	± 5 µm	0.009

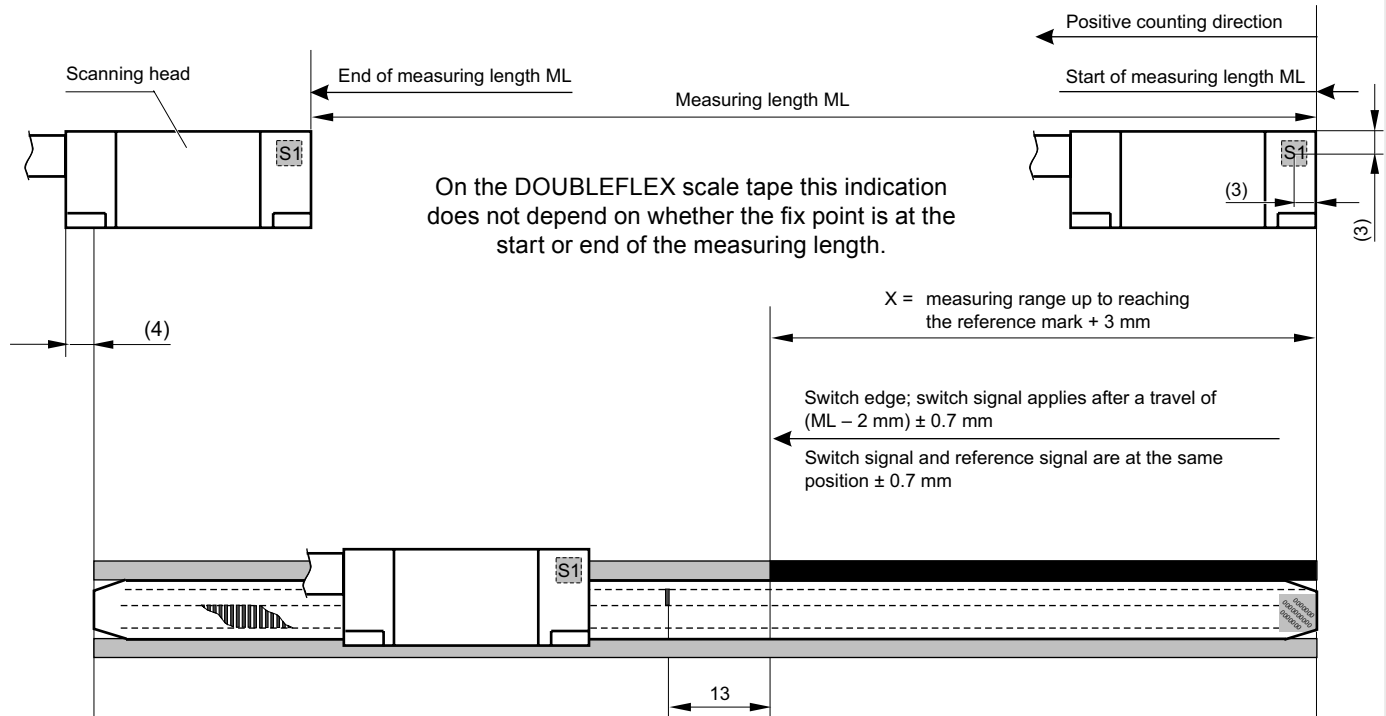


Scanning head shown with lateral offset to the scale tape;
seen from above through the scanning head to the scale tape

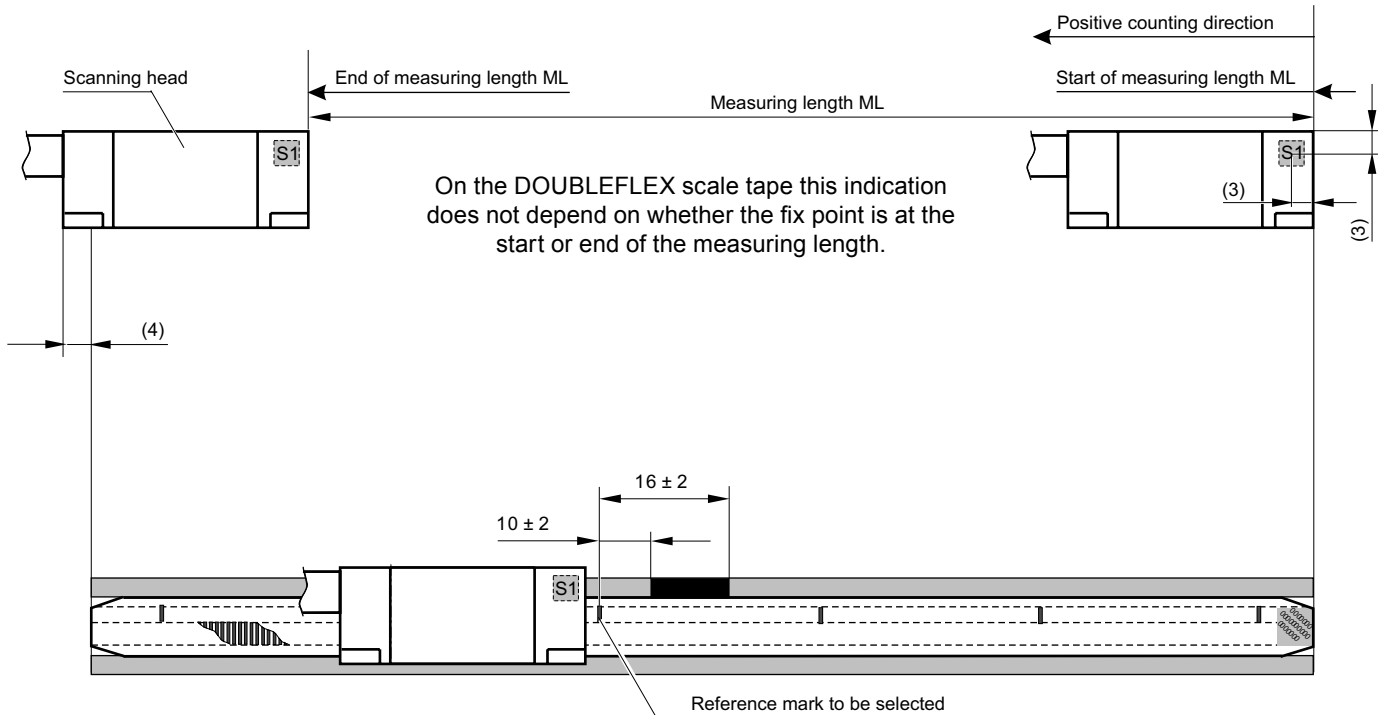


Using Switch Sensors and the Switch Foil

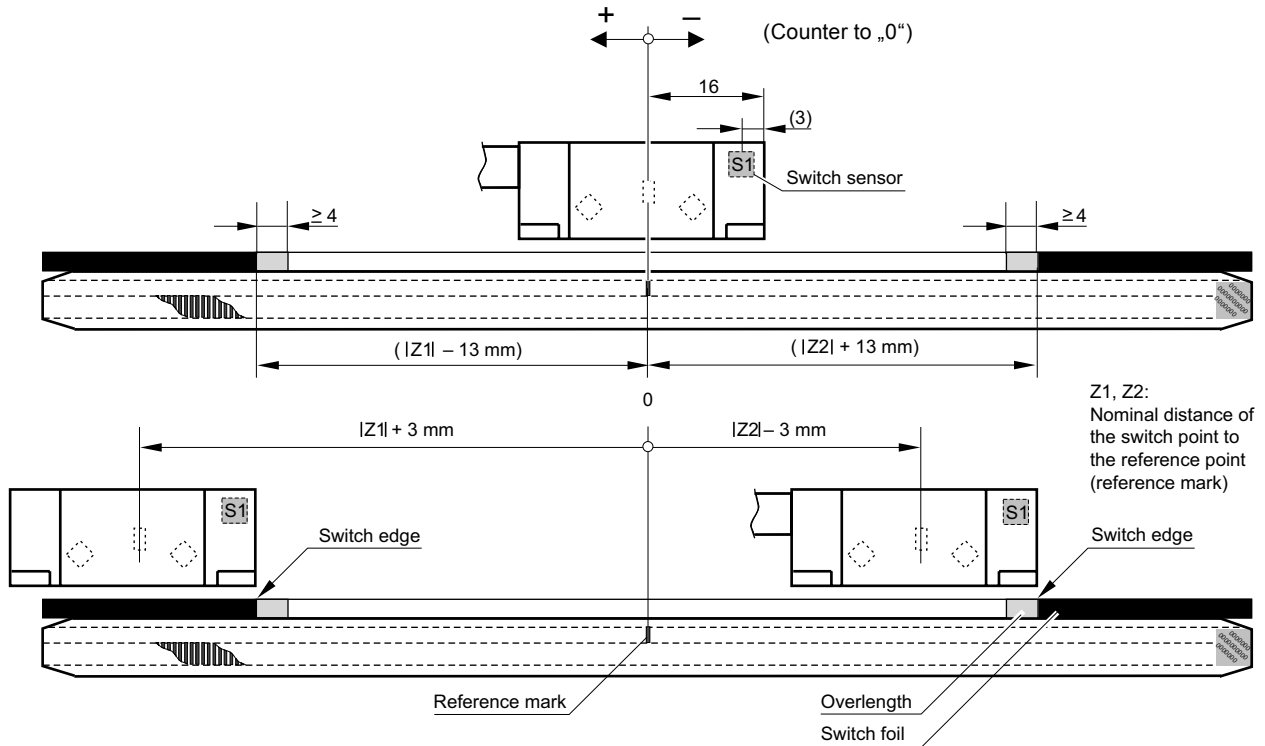
Indication of the end position(s)



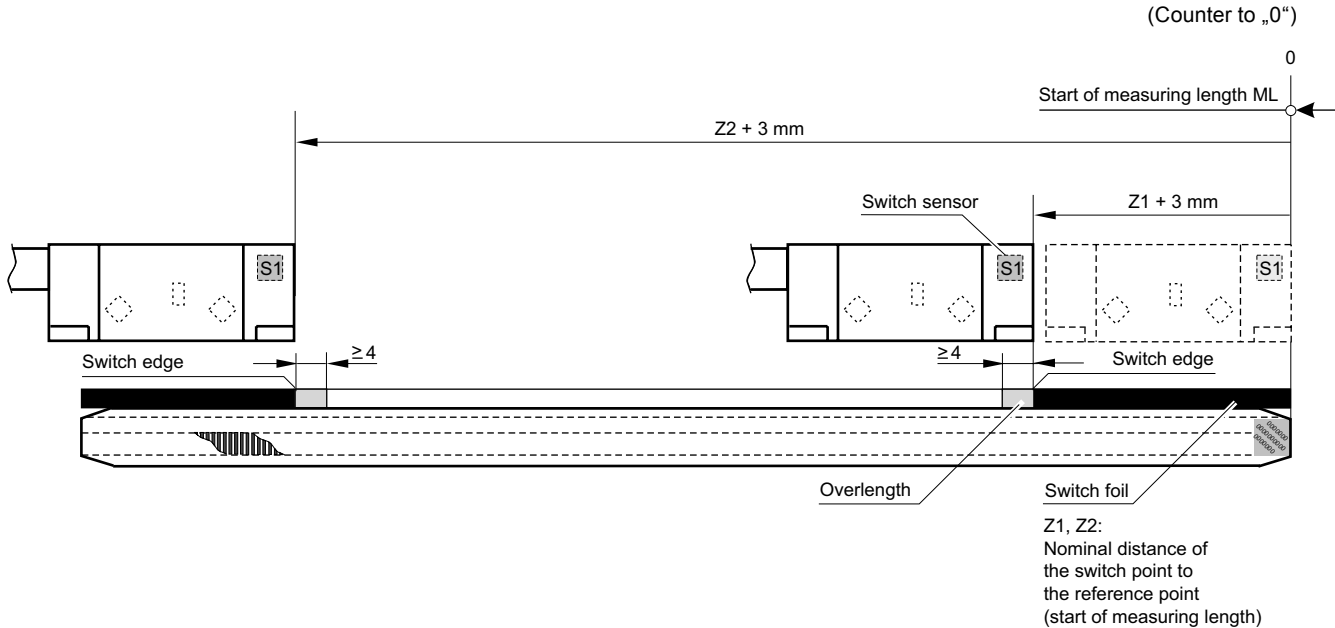
Indication of the scanning head position within the measuring range



Enabling of the reference signal, i.e. selection of **one** reference mark from **n** reference marks

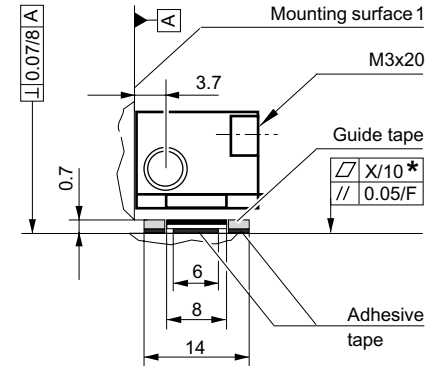
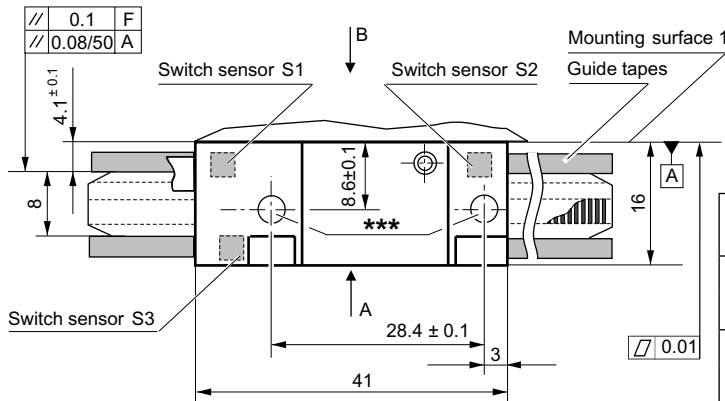
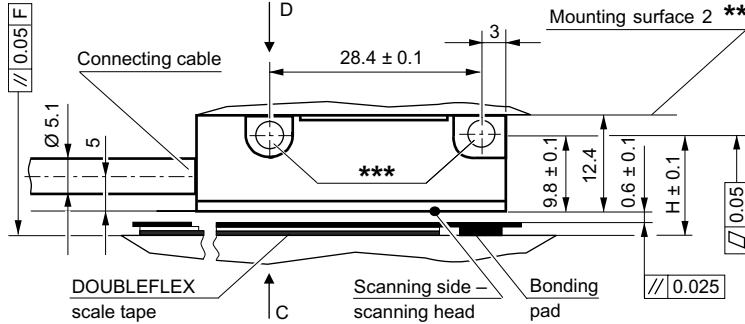


Specification of the switch point/edge to the reference point: Reference mark



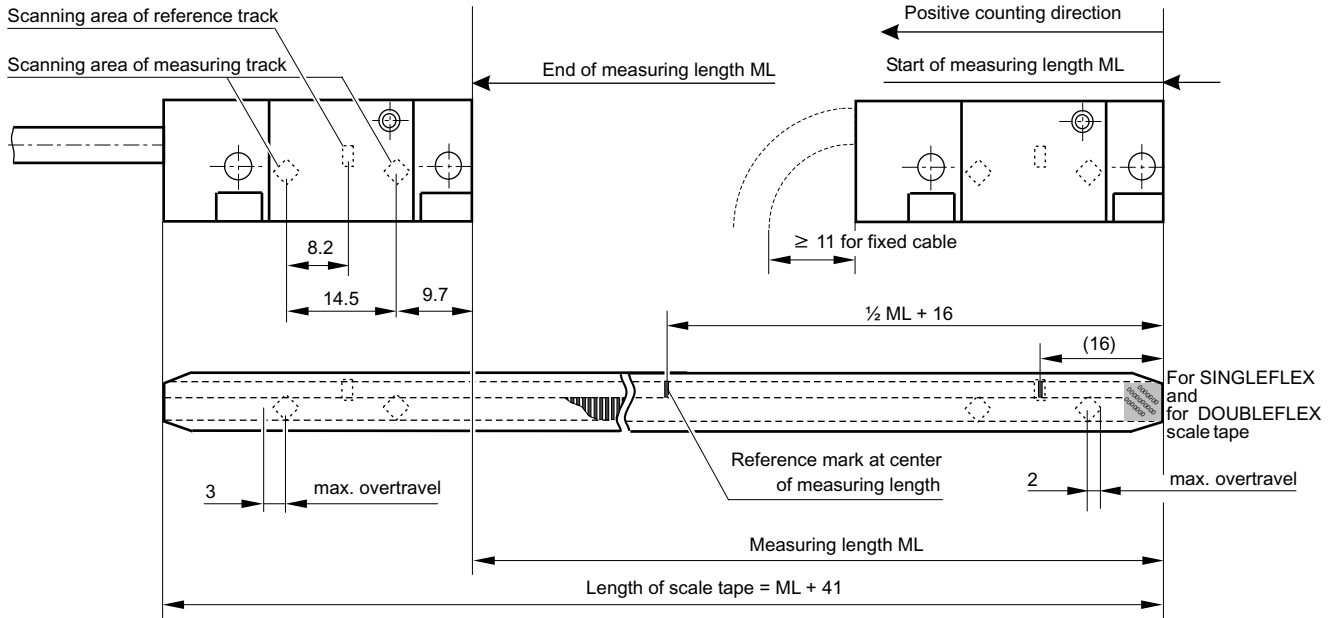
Specification of the switch point/edge to the reference point: Start of measuring length

Using Switch Sensors and the Switch Foil

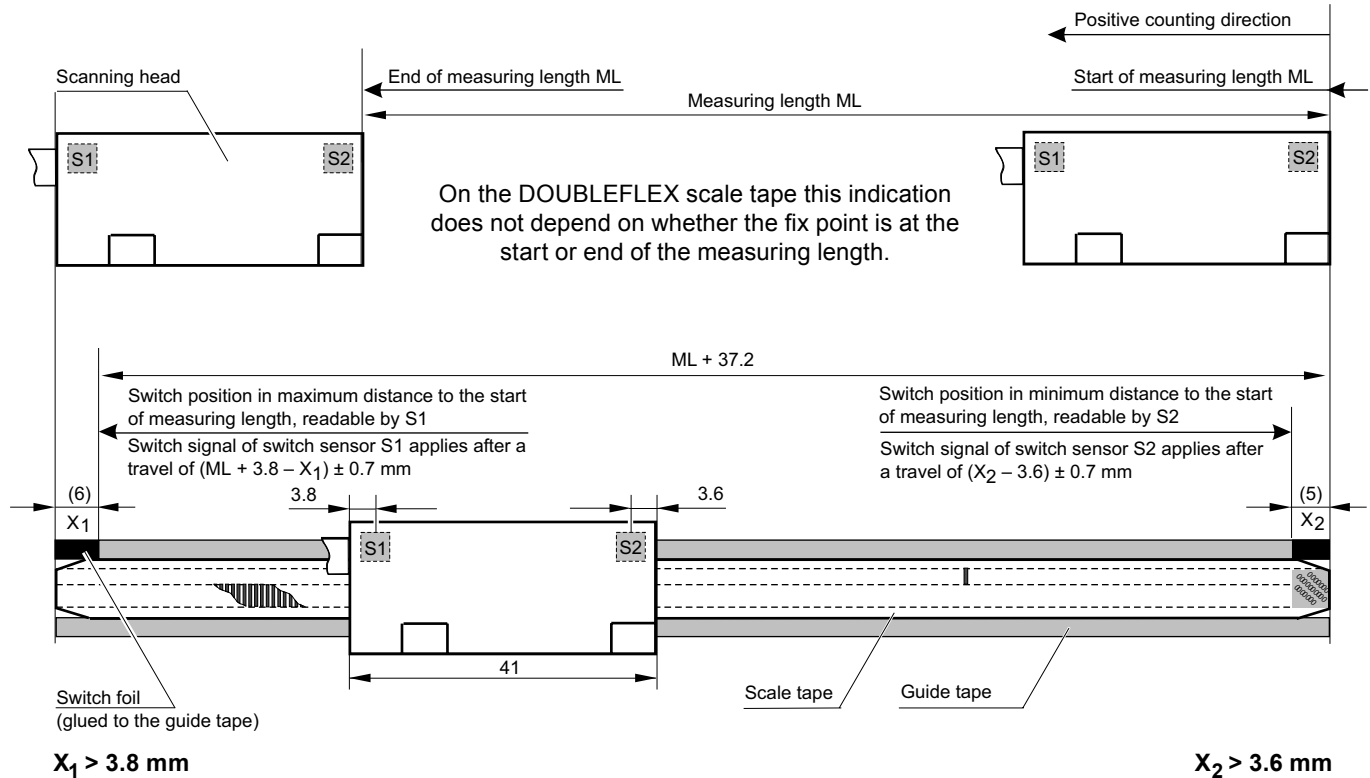


*	Deviation X per 10 mm of scale-tape length (see table below)
**	The mounting surface 2 must be vertically adjustable to ensure that the distance parameter $H1 \pm 0.1$ and the parallelism 0.025 can be achieved
***	$\varnothing 3.6$ for M3 screws from side A and $\varnothing 2.7$ for M2.5 screws from side C or M4-6H screws from side B or D

	GP [μm]	H1 [mm]	H2 [mm]	Accuracy class	X
DOUBLEFLEX scale tape	20	0.6	11.1	$\pm 1 \mu\text{m}$	0.003
	100	1.3	11.8	$\pm 2 \mu\text{m}$	0.006
SINGLEFLEX scale tape	20	0.6	10.9	$\pm 3 \mu\text{m}$	0.009
	100	1.3	11.6	$\pm 5 \mu\text{m}$	0.009

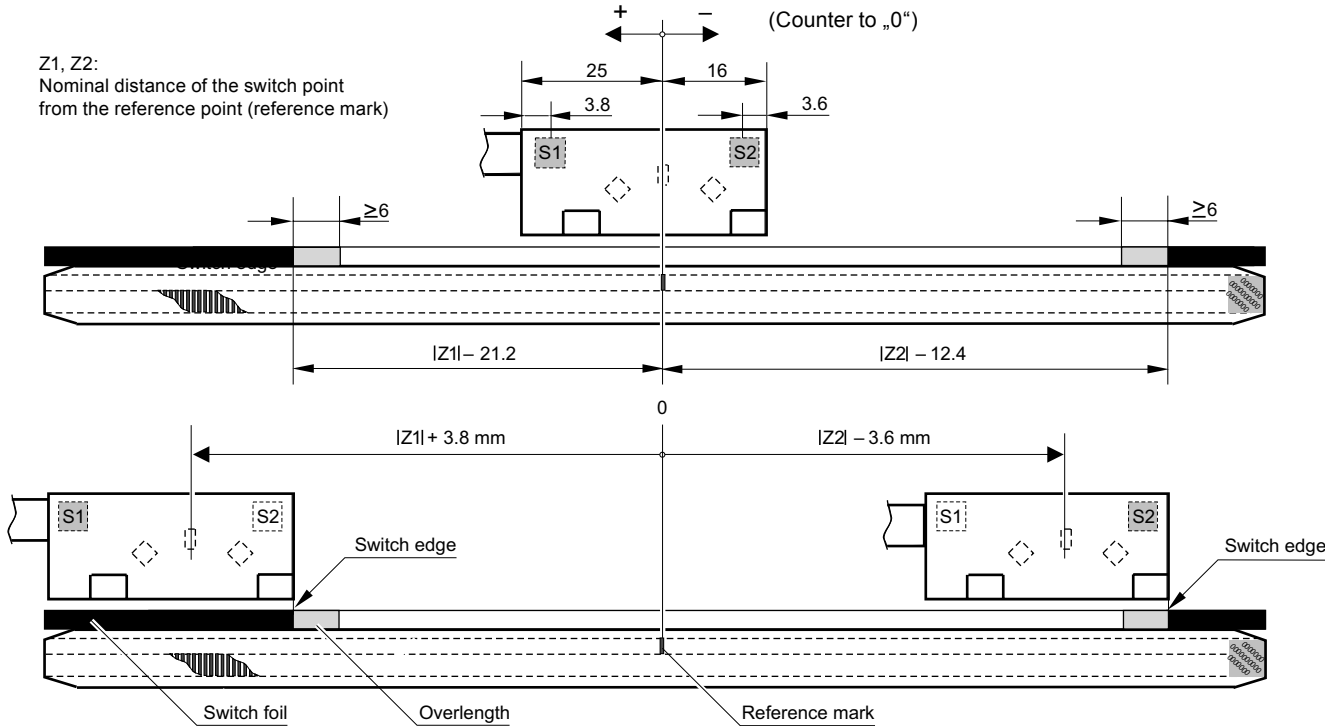


Scanning head shown with lateral offset to the scale tape;
seen from above through the scanning head to the scale tape

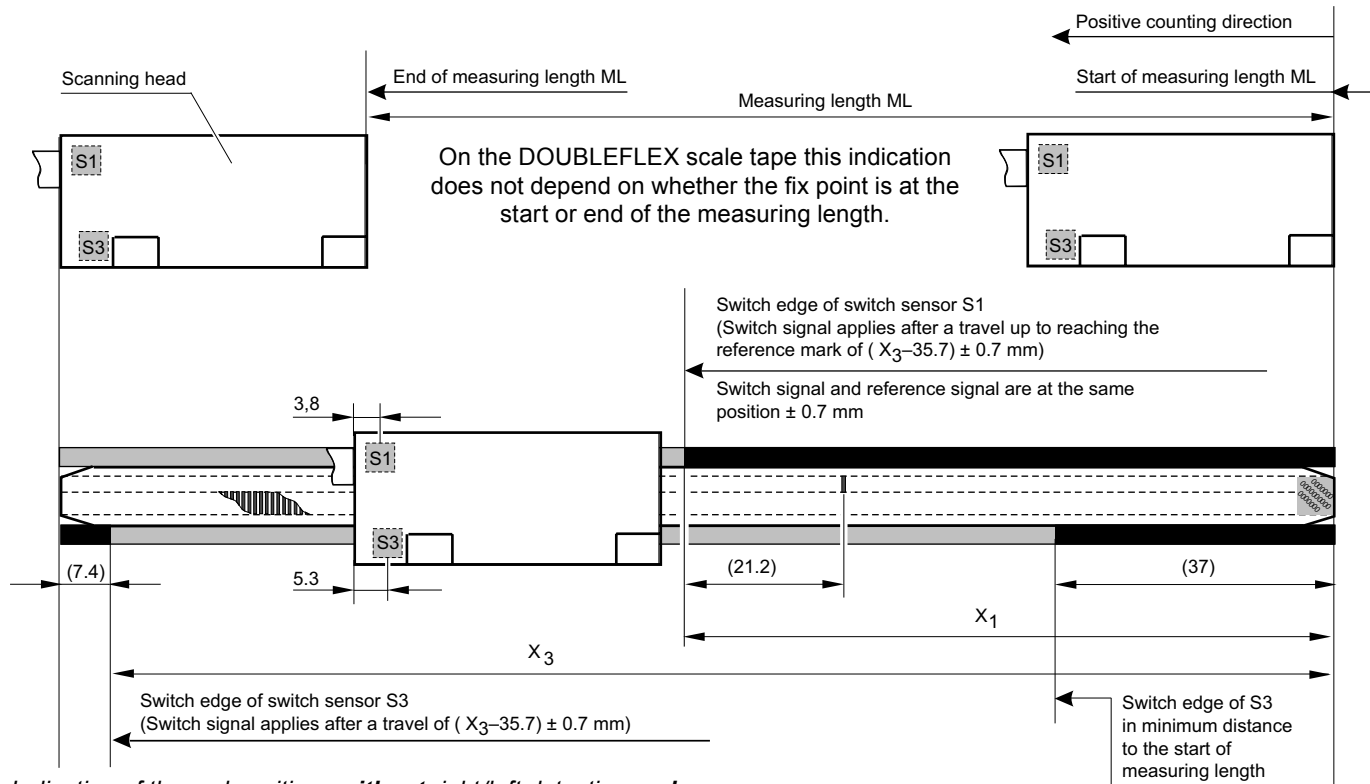


Indication of the end positions **with** right/left detection

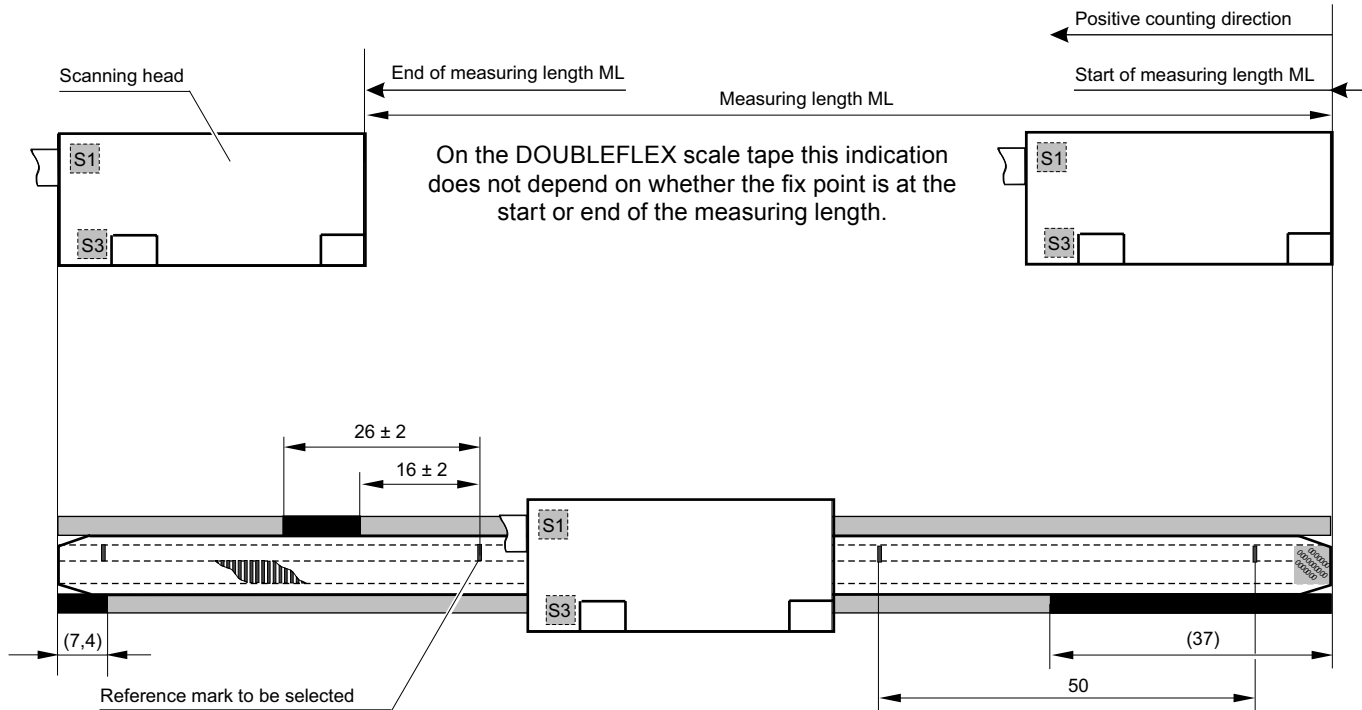
Z1, Z2:
Nominal distance of the switch point
from the reference point (reference mark)



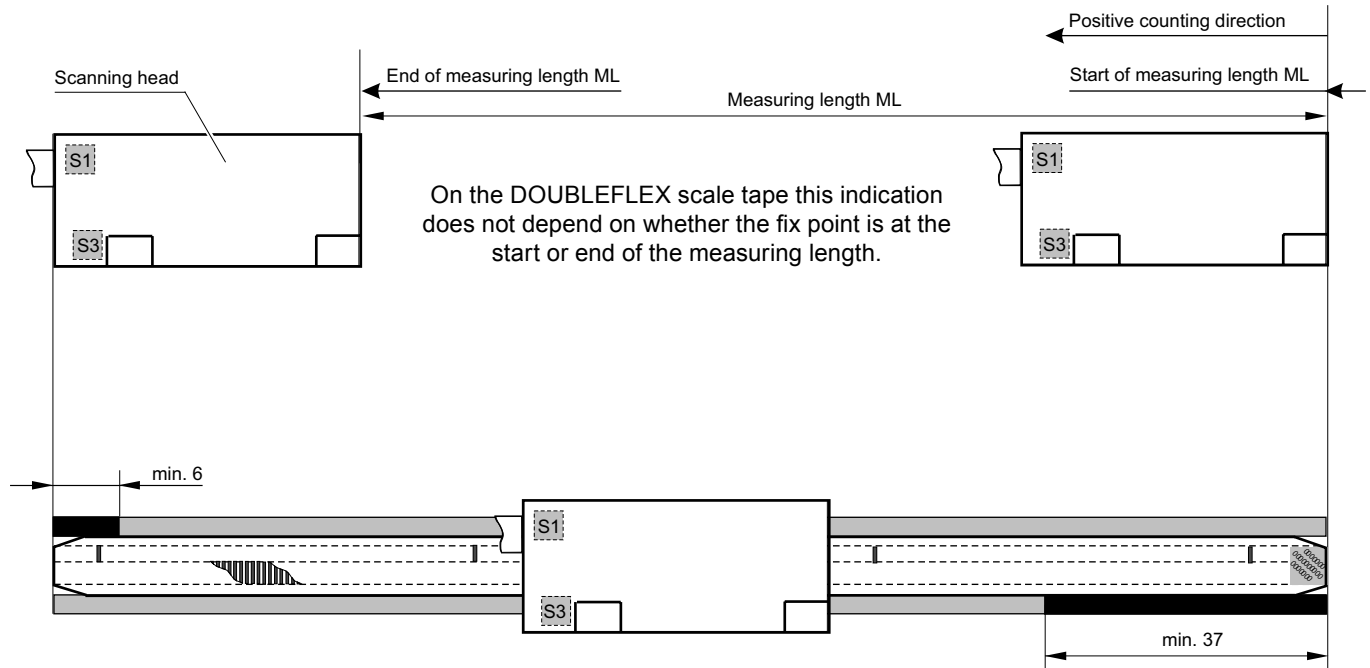
Specification of the switch point/edge to the reference point: Reference mark
Switch sensor S1 + switch sensor S2



Indication of the end positions **without** right/left detection **and** indication of the scanning head position within the measuring range, e.g. to the left or right of the reference mark

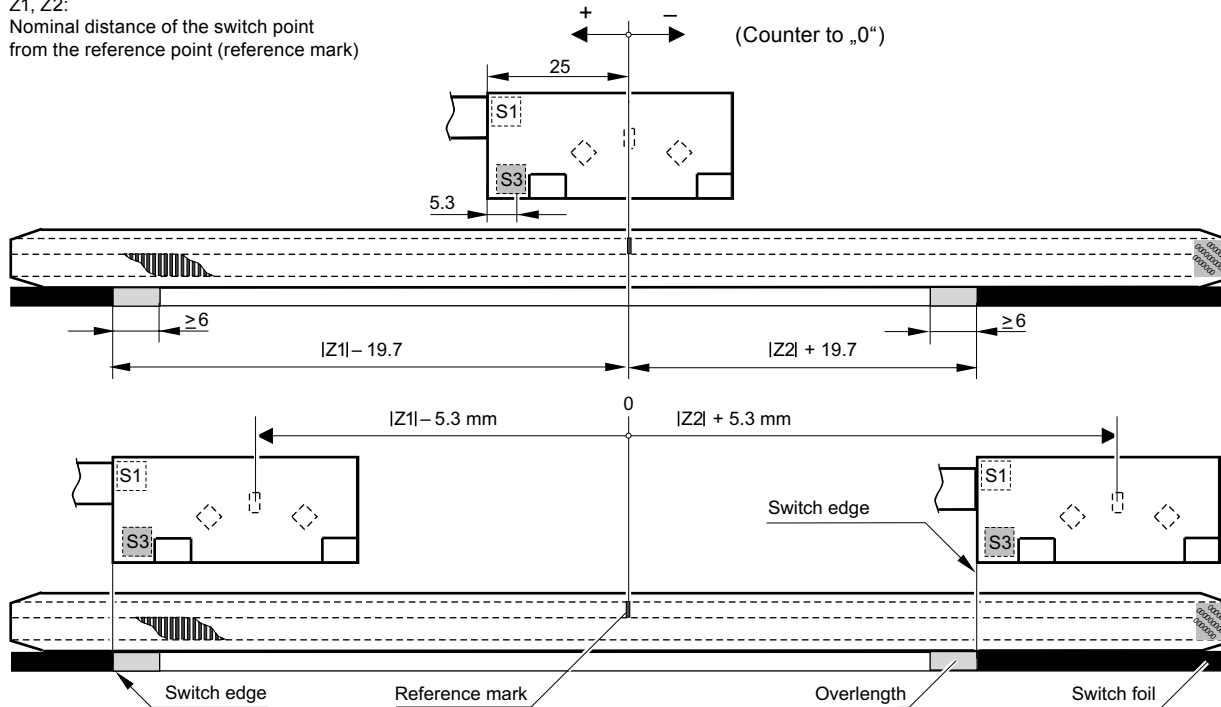


Indication of the end positions **without** right/left detection **and** enabling of the reference signal, i.e. selection of **one** reference mark from **n** reference marks



Indication of the end positions **with** right/left detection in separate tracks

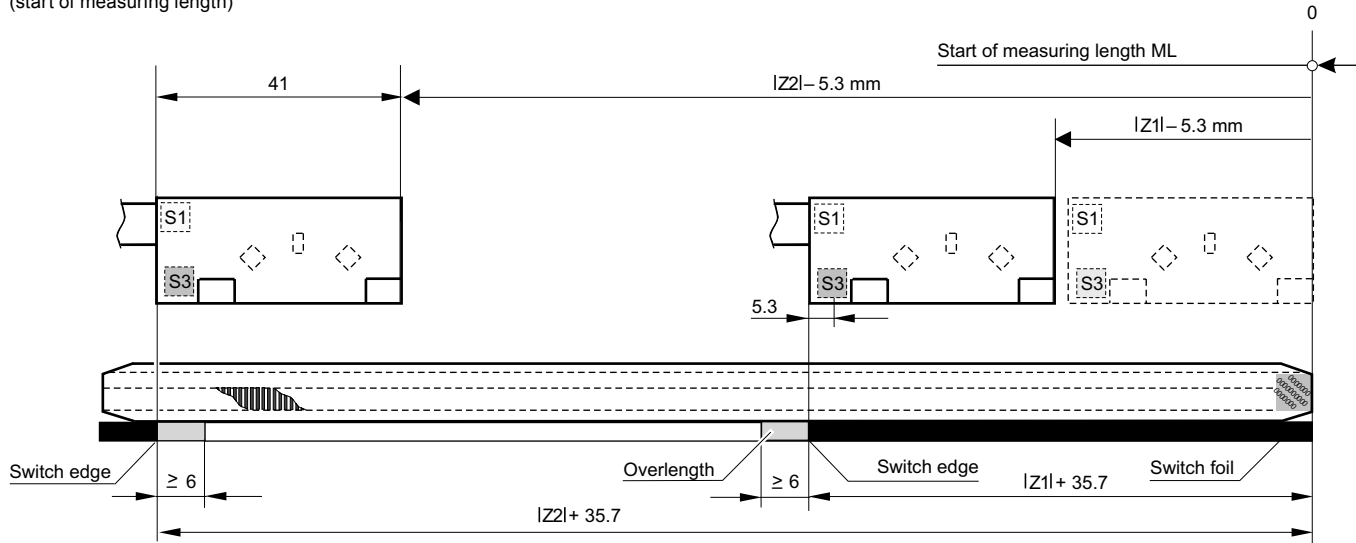
Z1, Z2:
Nominal distance of the switch point
from the reference point (reference mark)



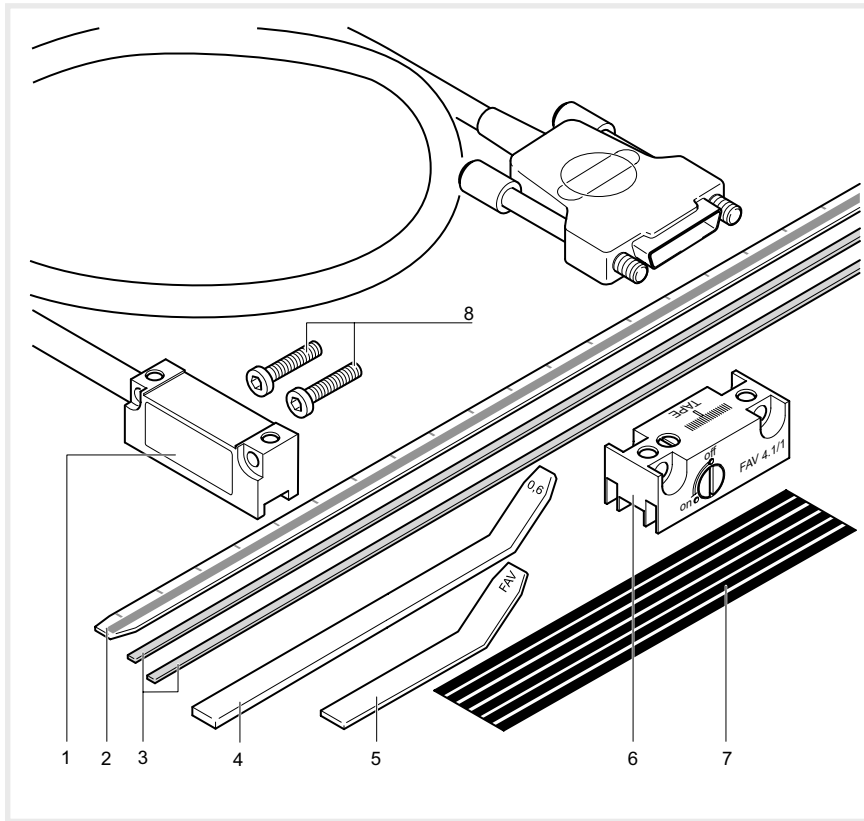
*Specification of the switch point/edge to the reference point: Reference mark
Switch sensor S3*

Z1, Z2:
Nominal distance of the switch point
from the reference point
(start of measuring length)

(Counter to „0“)



Specification of the switch point/edge to the reference point: Start of measuring length
Switch sensor S3



The mounting steps for the LIA 20, LIA 21 and LIA 22 are basically all the same.



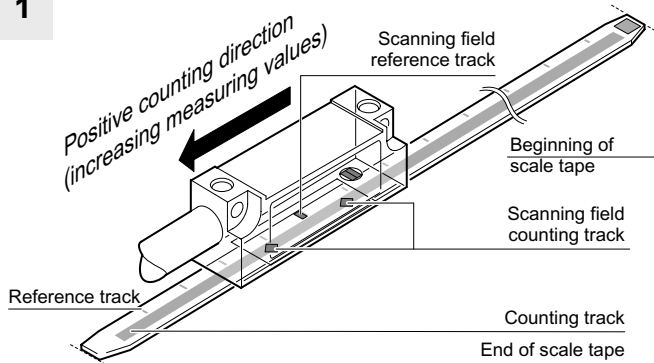
The indicated sequence of mounting steps must be followed exactly!



Maintain a tightening torque of 1 Nm for all screws.

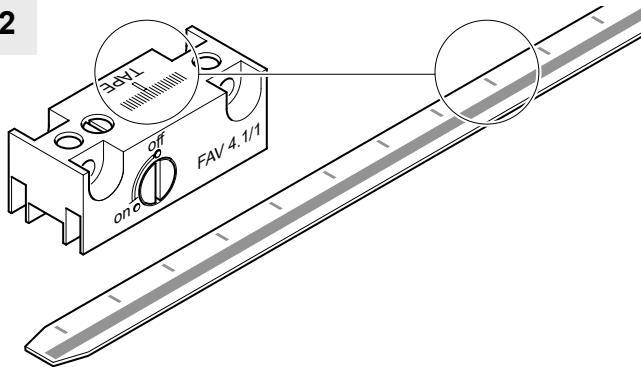
- 1 Scanning head with cable and connector
- 2 Scale tape
- 3 Guide tapes (optional)
- 4 Spacing gage for scanning head with the code
„0,6“ for GP = 20 µm and
„1,3“ for GP = 100 µm
- 5 Spacing gage for guide-tape applicator with the code „FAV“
- 6 Guide tape mounting device (FAV) (optional)
- 7 Switch foil (for LIA 21 and LIA 22)
- 8 Mounting screws (M3) for scanning head (only for scanning heads with through holes)

1



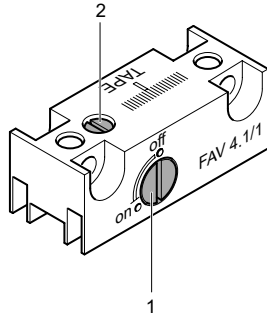
- Before mounting, mark the future location of the scale tape.
- The alignment of the scale tape depends on the installation position of the scanning head.
- Ensure that the scanning head's scanning fields for the counter and reference tracks are over the corresponding tracks on the scale tape.

2



- Note the installation position of the guide-tape applicator. The grating structure shown on the FAV must coincide with the grating structure of the steel tape.

3



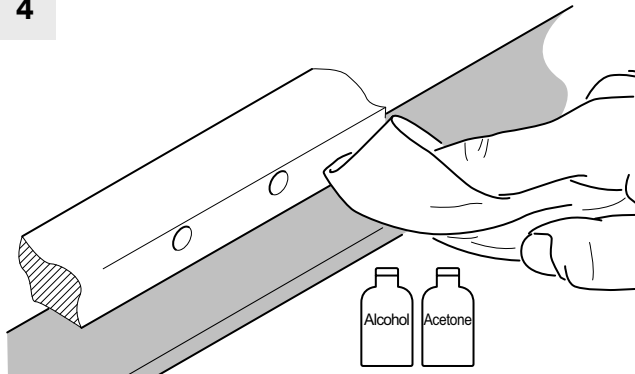
- Before mounting the FAV, turn the setting screws 1 and 2 to the „off“ position.

1 – Turn the screw to the right until the slot points to „off“

2 – Turn the screw to the left until it is even with the surface of the FAV housing

- Use setting screw 1 for standard mounting.
- If the mounting conditions prevent access to setting screw 1, use setting screw 2.

4



- Use a solvent to clean the adhesion surface of the machine.

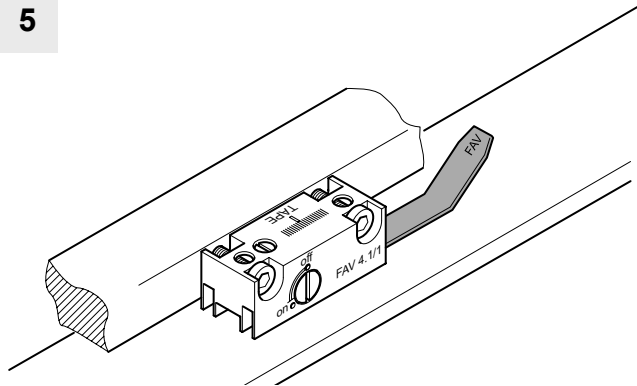


Make sure that no alien elements are left on the machine's adhesion surface.



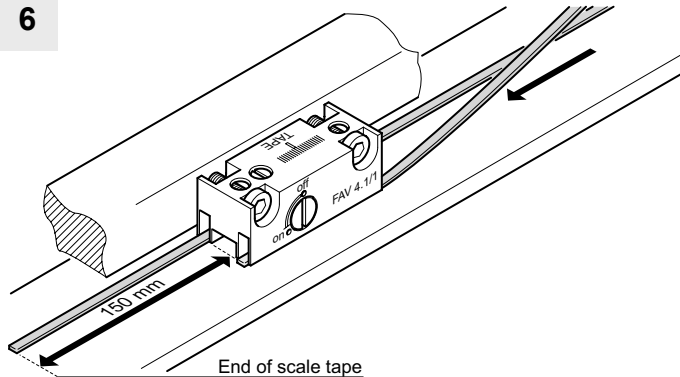
Acetone and alcohol are inflammable liquids!

5



- Screw the FAV in place of the LIA scanning head in the appropriate location on the machine. Use the spacing gage (code „FAV“) to set a distance of 0.25 mm between the tape seating surface and the bottom of the FAV.

6



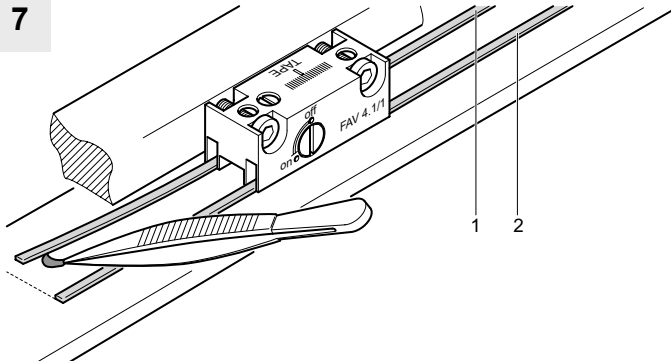
- Position the FAV ~ 150 mm to the right of the scale-tape end by traversing the machine/encoder carriage.
- Slide the guide tapes from the right into the slots in the FAV, inserting them up to the end of the tape.



Make sure that guide tapes with the correct thickness for the scale tape are used!

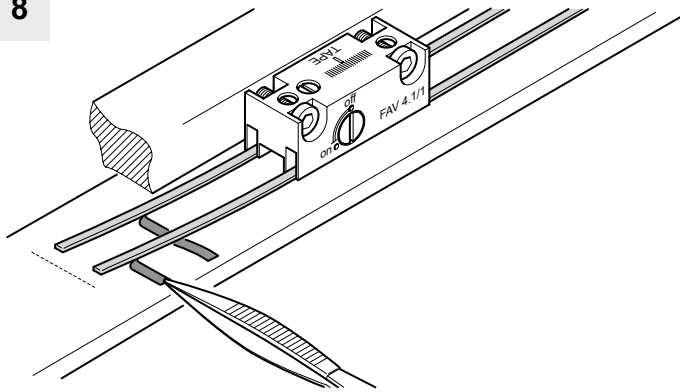
SINGLEFLEX scale tape: yellow protective film
DOUBLEFLEX scale tape: red protective film

7



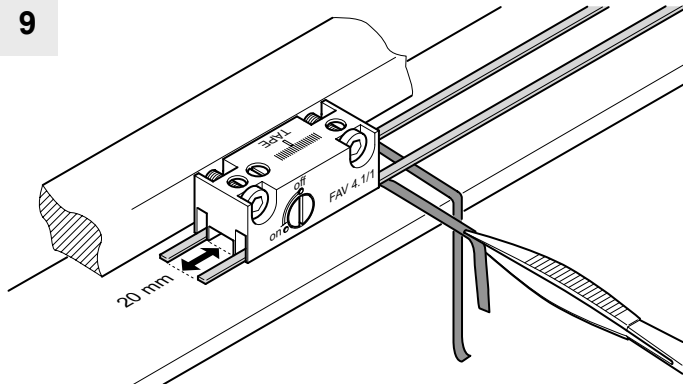
- Lift guide tape 1.
- Pull off the protective film of the tape ~ 10 mm in the direction of guide tape 2.
- Replace guide tape 1 on the carrier.

8



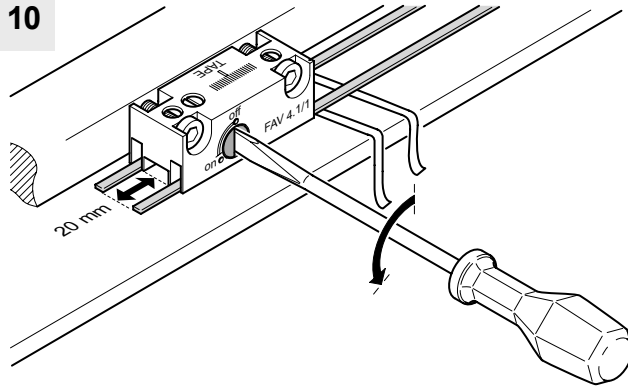
- Lift guide tape 2.
- Pull off the protective film of tape 1 ~ 20 ... 30 mm beneath guide tape 2.
- Pull off the protective film of tape 2 ~ 10 ... 20 mm diagonally to the front.
- Replace guide tape 2 on the carrier.

9



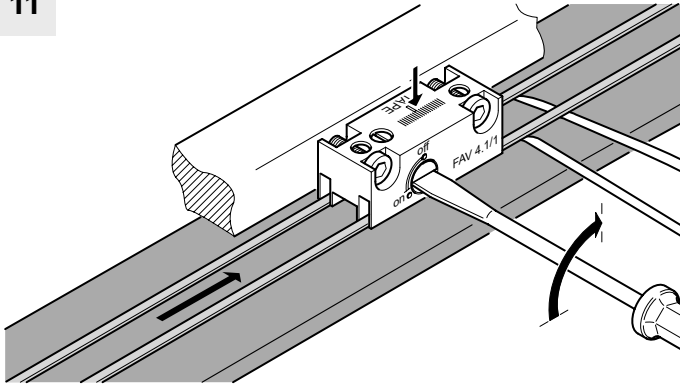
- Move the FAV to position 2, which is ~ 20 mm to the right of the scale-tape end by traversing the machine/encoder carriage.
- Remove both protective films until the right edge of the FAV is reached.

10



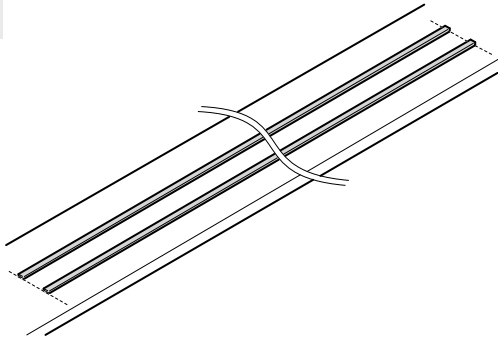
- Turn setting screw 1 to the left to the „on“ position, i.e. until the slot points to „on.“
- The guide tapes are now pressed against the carrier by the spring force.

11



- Retract the FAV to right end of the scale tape with the carriage.
Remove the protective films synchronously to the carriage/FAV motion in front of the FAV until they are completely removed.
- Return setting screw 1 to the „off“ position.
- Remove the FAV from the machine part.
- Press the right ends of the guide tapes against the carrier.
Avoid any lateral offset of the tapes.

12



- The guide tapes are now aligned and attached parallel to the carriage motion, in the correct position relative to the scanning head windows, and at the correct distance from each other.
- The scale tape can now be mounted in the slot formed by the guide tapes.
- One of the guide tapes can be omitted if there is only limited mounting space.
- The scale tape can then be mounted along the edge formed by the guide tape.

Installation of DOUBLEFLEX and SINGLEFLEX scale tapes

The mounting steps of DOUBLEFLEX and SINGLEFLEX scale tapes are basically the same.

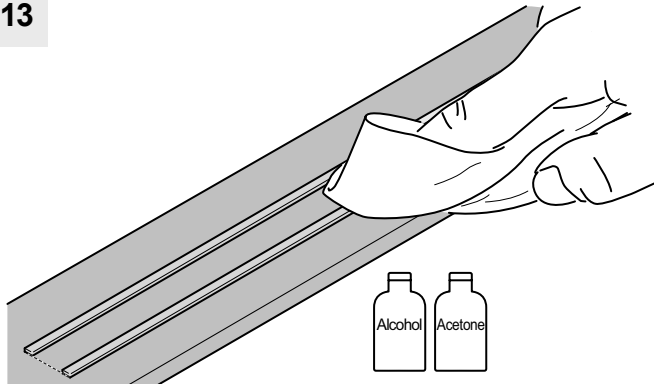
The scale tape can be mounted:

- In the slot or along the edge formed by the guide tapes,
- in a slot already on the machine or
- along an edge already on the machine.

In each case you must note the following:

- Place the edge of the scale tape exactly on the marking for the beginning of the scale tape.
- Run the scale tape exactly along the slot or edge when applying it.
- If DOUBLEFLEX scale tapes are mounted vertically, mount them so that the scale tapes lie adjacent to the stop edge (see the chapter „Mounting Conditions“).

13

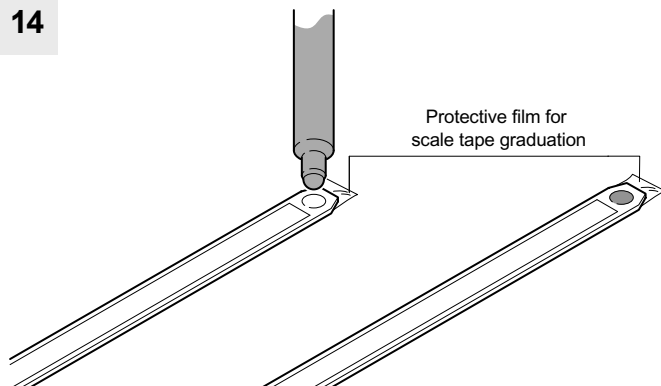


- Use a solvent to clean the adhesion surface of the machine.
- Check whether the guide tapes are firmly glued over the entire measuring length.



Make sure that no contaminations remain on the machine's adhesion surface. Alien elements between the machine and scale tape cause local differences in the spacing between the scale tape and the scanning head. This may diminish the encoder's functionality and/or result in measuring errors.

14



- On the DOUBLEFLEX scale tape, first glue the fix point.



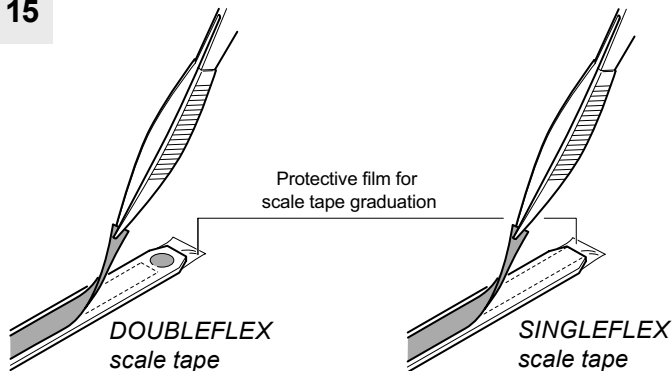
Pay attention to the use and safety instructions from the manufacturer of the adhesive!

- Place a drop of adhesive on the center of the fix point.

Recommended adhesives:

- Cyanoacrylate adhesives such as Loctite 480, Loctite 401
- Epoxy resin

15



- Peel off ~ 70 mm of the red protective film on the back of the scale tape.

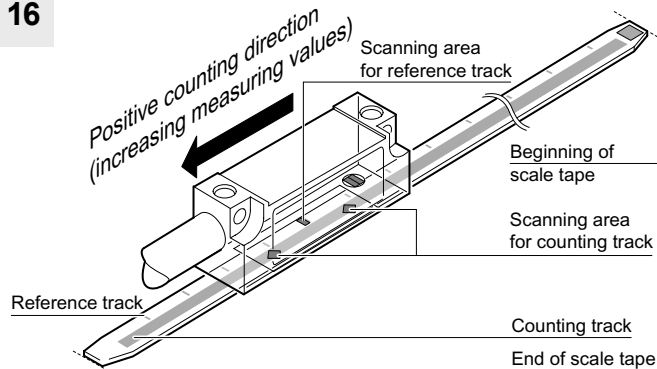


The adhesive tape now exposed must not come into contact with other materials due to its strong adhesive force.



Do not remove the transparent protective film from the scale tape yet!

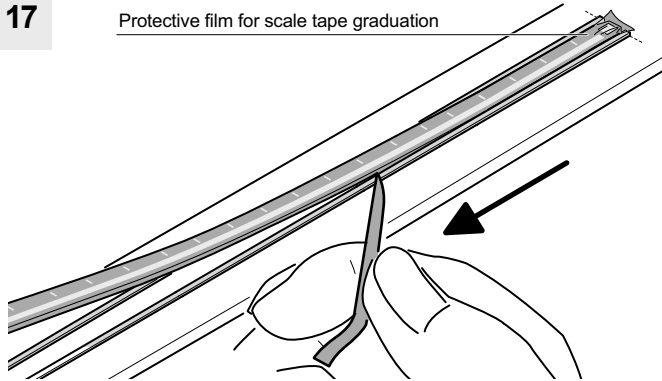
16



When securing the scale tape, pay attention to the alignment of the scanning head's windows for the counting and reference tracks.

17

Protective film for scale tape graduation

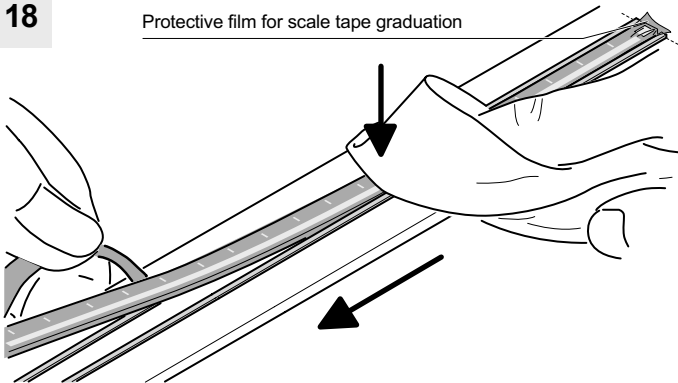


Do not remove the transparent protective film from the scale-tape graduation!

- Remove the red protective film from the slot or edge.
- On the DOUBLEFLEX scale tape, apply the fix point with the drop of adhesive (at either the beginning or end of the scale tape) and at the same time secure the first ~ 50 mm of the scale tape.
- Place the end of the SINGLEFLEX scale tape from which the protective film has been removed against the front end stop (slot) or lateral stop (edge).

18

Protective film for scale tape graduation



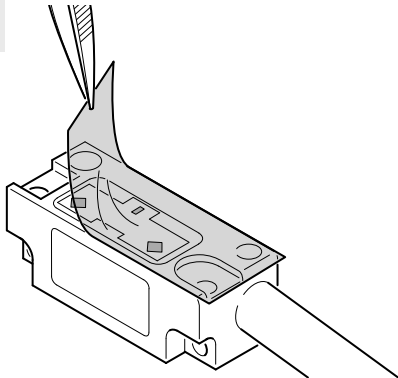
- Press the scale tape against the carrier over the entire length, and pull off the red protective film to the side. The pressure point should always be ~ 30 mm ... 50 mm behind the point where the adhesive tape and the red protective film are being separated.



**Only apply pressure to the scale tape from above.
Avoid lateral forces!**

Do not remove the transparent protective film from the scale-tape graduation!

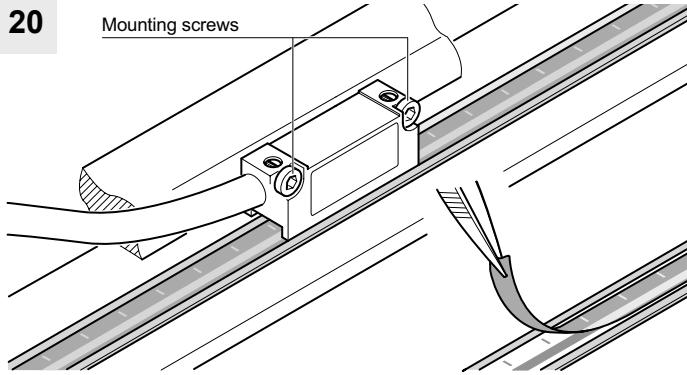
19



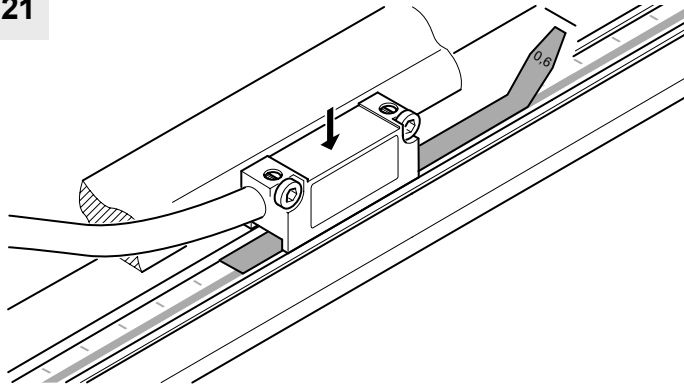
- Clean the mounting surfaces of the scanning head and the machine element.
- Remove the protective film from the scanning head.
- Carefully cleaning the sensor surface of the scanning head with a lint-free cloth. Use a solvent if necessary (see the chapter „Cleaning“).

20

Mounting screws



21



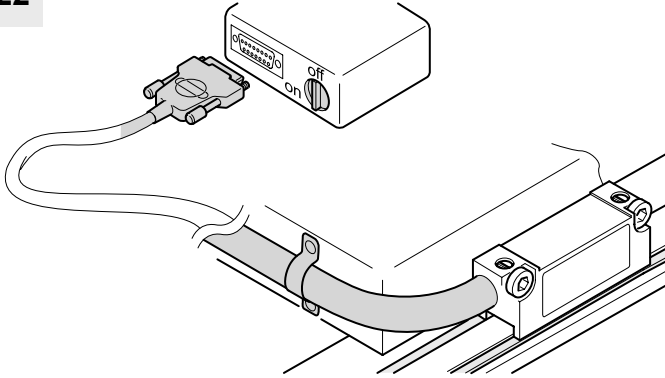
- Screw the scanning head onto the prepared mounting surface such that there is still some vertical clearance.
- Remove the transparent protective film from the graduation of the scale tape.
- Carefully cleaning the scale-tape surface (graduation) of the scanning head with a lint-free cloth. Use a solvent if necessary (see the chapter „Cleaning“).

- Insert the spacing gage lengthwise between the scale-tape surface and the scanning head.
- Push the scanning head against the spacing gage and tighten the two mounting screws alternately and evenly (tightening torque: 1 Nm). The spacing gage should barely be movable.
- Check the parallelism of the scanning head to the scale. Push the spacing gage ~ 5 mm to the left and right between the scanning head and scale tape, checking whether the clearance is the same.
- Remove the spacing gage.



If it is difficult to remove the spacing gage, loosen the scanning head and repeat the mounting procedure.

22



- Position the encoder cable (including the strain relief) near the scanning head.
- Connect the encoder cable to the evaluation electronics (pay attention to the pin assignment).



The evaluation electronics must be switched off!

- Switch the evaluation electronics on.
- Test the functionality.
- If there are errors in the function or during measurement, see the chapter „Troubleshooting“.

Optimizing the mounting conditions

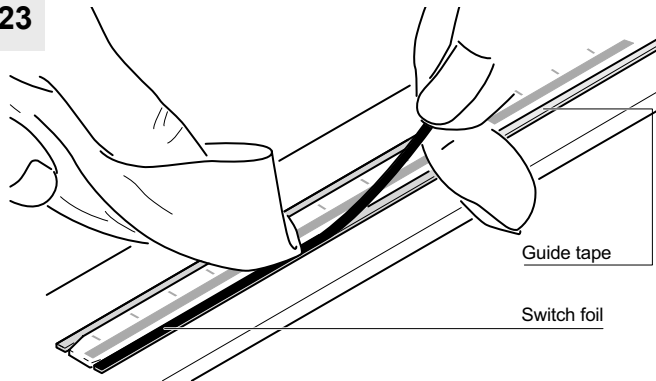
Electrical fine adjustment:

- Encoders from NUMERIK JENA offer the possibility of electrical fine adjustment of the encoder signals (please consult the supplier).
- Connect the encoder to the diagnostic device (**adjustment kit or signal monitor**) via a diagnosis cable.
- The encoder's sinusoidal signals are displayed and can be optimized without changing the mechanical arrangement.
- This minimizes short-wave position errors (interpolation errors), positively affecting the operational behavior of the encoder.

Encoders with Mounting LED:

- If the LED is not shining, then the scanning head is adjusted optimally.
- Test the detection of the reference mark separately. It cannot be tested with the mounting LED.
- If the LED is shining, see the chapter „Troubleshooting“.

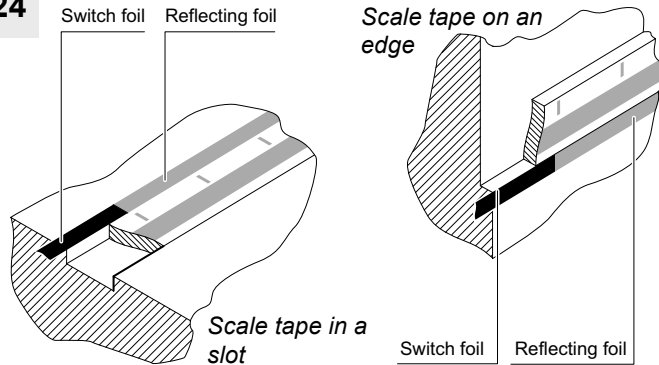
23



Clean the adhesion surface with solvent before applying the switch foil or reflecting foil.

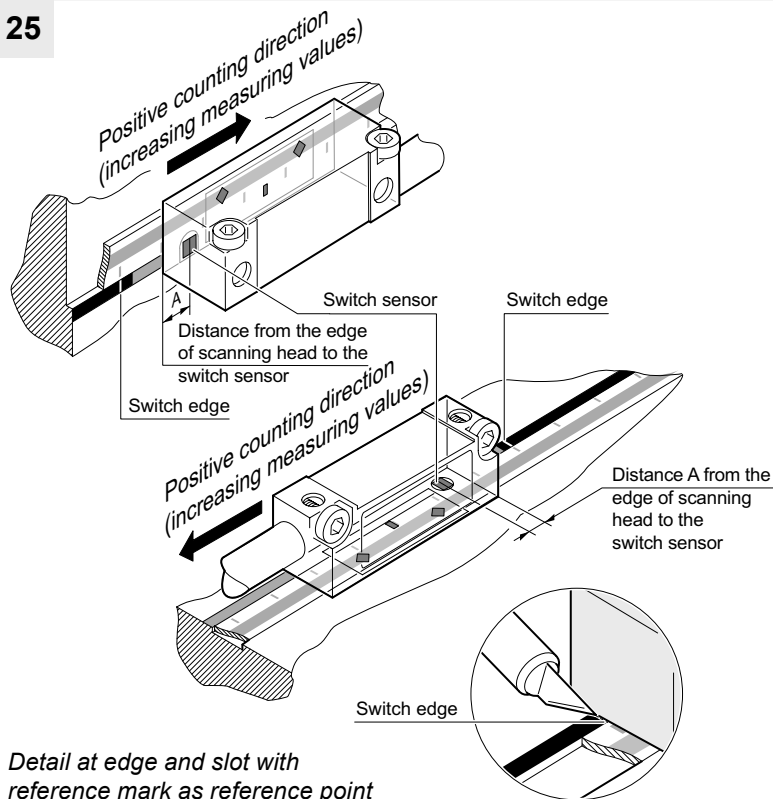
- Apply the standard self-adhesive switch foil to the guide tape
 - appropriately for the desired position for the switching point (see the chapter „Mounting Drawings – Using Switch Sensors and the Switch Foil“) **and**
 - appropriately for the desired position accuracy (see the chapter „Functional Elements“).

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- If no guide tapes are used, first apply the reflecting foil as the carrier for the switch foil over the entire measuring length to the slot or edge of the scale-tape carrier (machine/device).
 - Apply the switch foil
 - appropriately for the desired position for the switching point **and**
 - appropriately for the desired position accuracy (see the chapter „Functional Elements“).
- to the reflecting foil. The surfaces of the scale tape and the switch foil must be in the same level (tolerance: ± 0.1 mm).

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Specification of the switch point/ edge to the reference point with the help of the evaluation electronics

- Mount the switch foil with an overlength of at least **4 mm** (see the chapter „Mounting Drawings“).
- Connect the scanning head to the evaluation electronics (control, display, adjuster).
- Reset the counter at the reference point for the switch signals.
- Move the nominal distance $Z1/Z2$ between the reference point (either a reference mark or the start of the measuring length) and the switch point.
- Depending on the direction of traverse, add or subtract the distance A between the edge of the scanning head and the switch sensor to/from the nominal distance.
Distance A for switch sensor **S1**: ± 3 mm.
- Cut the switch foil with a sharp blade at the desired switch edge and remove the extra piece.

Specification of the switch point/edge to the reference point with the help of the evaluation electronics

- Mount the switch foil with an overlength of at least **6 mm** (see the chapter „Mounting Drawings“).
- Connect the scanning head to the evaluation electronics (control, display, adjuster).
- Reset the counter at the reference point for the switch signals.
- Move the nominal distance Z1/Z2 between the reference point (either a reference mark or the start of the measuring length) and the switch point.
- Depending on the direction of traverse, add or subtract the distance A between the edge of the scanning head and the switch sensor to/from the nominal distance.
- Cut the switch foil with a sharp blade at the edge of the scanning head and remove the extra piece.

<p align="center">Distance A between the edge of the scanning head and the switch sensor</p> <p align="center">The direction depends on the side from which the switch edge is approached</p>			
Reference point: Reference mark		Reference point: Start of measuring length	
Switch sensor S1		Switch sensor S1	- 3.8 mm
S1 + S2 (in series)	+ 3.8 mm		
S1 + S3 (parallel)	± 3.8 mm		
Switch sensor S2	- 3.6 mm	-	-
Switch sensor S3	± 5.3 mm	Switch sensor S3	- 5.3 mm

- Depending on the system's mounting attitude and the ambient conditions, it may be necessary to clean the tape surface and sensor surface of the scanning head (scanning window for counting and reference track) occasionally.
- If the monitoring signal output by the scanning head is used, the encoder indicates that cleaning is necessary.



When cleaning the components, ensure that the scanning window and scale tape are not scratched by any deposited particles!

- Dirt should be removed using a soft brush or oil-free compressed air.
- Use cotton balls or a soft cloth for touch-up cleaning.
- Use acetone or alcohol for stronger contamination.



Acetone and alcohol are flammable liquids!

- Always wipe the DOUBLEFLEX scale tape lengthwise. Wiping it crosswise could result in an offset of the scale tape relative to the carrier tape, leading to errors in the function of the encoder.
- Ensure that no solvent seeps under the scale tape. This could adversely affect the adhesive layer between the scale tape and carrier tape, thereby loosening the scale tape.

- Do not let the solvent touch the adhesive tape. This could start to dissolve the adhesive, reducing the adhesive force.

The functions of all scanning heads and accuracy of all scale tapes are tested before the encoders are shipped. However, if problems should occur, proceed according to the following table. If this does not work, please contact NUMERIK Jena: Telephone +49 3641 47 28 28 or +49 3641 47 28 26.

Error	Possible causes	Solution
No measuring signal	No power at the scanning head	Check the status of the evaluation electronics
		Check the connection assignment between the encoder and the evaluation electronics
Error message from the evaluation electronics	Following error due to temporary failure of the measuring signal	Check the assignment of the scale tape to the scanning head
		Mechanical readjustment
		Electronic readjustment with the adjustment kit* or signal monitor*
Rough, loud motor running (for linear motors)	Irregular edge separations of the counting signals due to interpolation errors	Check the assignment of the scale tape to the scanning head
		Mechanical readjustment
		Electronic readjustment with the adjustment kit* or signal monitor*
Counting error (compared to a standard)	Mounting error	Check the assignment of the scale tape to the scanning head
		Mechanical readjustment
		Electronic readjustment with the adjustment kit* or signal monitor*

Error	Possible causes	Solution
No reference signal	Mounting error; results in faulty gating of the reference signal and counting signal	Check the assignment of the scale tape to the scanning head
Reference mark can only be detected from one direction		Mechanical readjustment
Reference mark appears twice		Electronic readjustment with the adjustment kit* or signal monitor*
Not all reference marks are detected		Check the assignment of the scale tape to the scanning head
Failure signal reports (for RS 422)	Mounting error; results in level of the analog signal from the sensor being too low	Mechanical readjustment
		Electronic readjustment with the adjustment kit* or signal monitor*
		Clean the scale tape (see the chapter „Cleaning“)
	Contamination on the scale tape; results in level of the analog signal from the sensor being too low	Contact your supplier
	Encoder function operating error	

Error	Possible causes	Solution
Mounting LED is shining	Mounting error; results in level of the analog signal from the sensor being outside the permissible tolerances	Check the assignment of the scale tape to the scanning head
		Mechanical readjustment
		Electronic readjustment with the adjustment kit* or signal monitor*
	Contamination on the scale tape; results in level of the analog signal from the sensor being outside the permissible tolerances	Clean the scale tape (see the chapter „Cleaning“)
Switch signal does not function	Scanning gap incorrect	Compare the gap between the switch sensor and reflective surface in the mounting drawing; adjust if necessary
	Reflective capacity of the switch-foil carrier insufficient, if no guide tapes are used for applying the switch foils	use reflecting foil; can be requested from your supplier
	Control requests a different type of switch sensor	Check the type of switch sensor

*) The adjustment kit and signal monitor are tools which allow to adjust encoders from NUMERIK Jena **electronically** after mounting. You can find further information on the Internet at www.numerikjena.de.

11 Ordering Key

LIA 2 2 - P 4 2 1 - F Z

(ordering example)

Sensor type

2	Double-field- SV3 - R
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Number of switch sensors

0	No switch sensor
1	1 switch sensor
2	2 switch sensors

Grating period

-	GP = 20 µm
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Interface – counting signals

C	Sinusoidal 1 V _{pp}
K	RS 422 square-wave signal without interpolation
L	RS 422 square-wave signal with interpolation 5x
M	RS 422 square-wave signal with interpolation 10x
I	RS 422 square-wave signal with interpolation 25x
N	RS 422 square-wave signal with interpolation 50x
P	RS 422 square-wave signal with interpolation 100x

Speed factor

X	Customer-specific value, depending on the max. traversing speed and max. input frequency of the evaluation electronics; request from NUMERIK Jena
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See next page for interfaces and switch sensors

Connector types

A ²	Open with 10-pin JST test connector
D ²	9-pin, D-sub, PIN, straight
H ²	12-pin; round; PIN; plastic-coated
O ²	15-pin, D-sub, PIN, straight
S ²	Special connector upon customer request ¹
Z	15-pin, D-sub, signal processing in connector

See next page for cables

Version

-	Standard (without mounting LED)
3 ¹	without mounting LED, non-magnetic scanning head
K ^{1,3}	with mounting LED
N ^{1,3}	with mounting LED, non-magnetic scanning head

Installation Conditions

1 ⁴	Scanning head with 3.6 mm through hole
2	Scanning head with M4 thread

Interface switch sensors for LIA 20

0	Without switch sensor
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Interface switch sensors for LIA 21

1	One sensor – TTL – low active
5	One sensor – TTL – high active
A	One sensor – open collector – low active
D	One sensor – open collector – high active
G	One sensor – MOS relay – opener
H	One sensor – MOS relay – closer

Interface switch sensors for LIA 22

2	Two sensors in sequence – TTL – low active
3	Two sensors in parallel – TTL – low active
6	Two sensors in sequence – TTL – high active
7	Two sensors in parallel – TTL – high active
B	Two sensors in sequence – open collector – low active
C	Two sensors in parallel – open collector – low active
E	Two sensors in sequence – open collector – high active
F	Two sensors in parallel – open collector – high active
K	Two sensors in sequence – MOS relay – opening
L	Two sensors in sequence – MOS relay – closing
M	Two sensors in parallel – MOS relay – opening
N	Two sensors in parallel – MOS relay – closing

Cable types

Cable Ø 5.1 mm ^{5, 6}	
A	0.3 m
B	0.5 m
F	1.0 m
E	1.5 m
G	2.0 m
K	3.0 m
Ø 1	others on request

Cable Ø 3.7 mm ^{2, 7}	
R	0,3
S	0,5
T	1,0
P	1,5
V	2,0
W	3,0
U 1	others on request

- 1) No standard, supplied for a surcharge
- 2) Only for LIA 20
- 3) Only for RS 422 with interpolation in the connector
- 4) LIA 22:
Ø 3.6 for M3 screws from side A **and**
Ø 2.7 for M2.5 screws from side C
- 5) Double-shielded cable for LIA 21 and for LIA 22 and for LIA 20 with interpolation in the connector
- 6) Single-shielded cable for LIA 20 with interpolation in the scanning head
- 7) Single-shielded cable (only for LIA 20 all versions)

11 Ordering Key

(ordering example)

MV 8 2 - 1 1 B P 00770

Material

5	Steel tape for LIA 20 Steel tape for LIA 21
8	Steel tape for LIA 22

Design type

0	DOUBLEFLEX, standard
1	SINGLEFLEX, standard
2	DOUBLEFLEX with guide tape
3	SINGLEFLEX with guide tape

Accuracy class

1	± 1 µm
2	± 2 µm
3	± 3 µm
4	± 5 µm

Position of reference point

0	None ²
1	At start of measuring length ³
5 ¹	At end of measuring length ^{3,4}

Measuring length (ML) [mm]

Grating period

P GP = 20 µm

Position of reference mark

O	without reference mark
B	Reference mark in the center of the ML
E ¹	Special customized version
F	Distance-coded at 1000 x GP
N	In 50 mm increments, start at the center of the measuring length

- 1) Not standard, supplied at surcharge
- 2) Only for SINGLEFLEX scale tape
- 3) Only for DOUBLEFLEX scale tape
- 4) Only for LIA 20 and LIA 22

**A distinction must be made between the resolution and the accuracy of an encoder.
The two parameters are not directly interdependent and may differ from each other.**

Resolution

The resolution of a linear encoder describes the least possible displacement of the scanning head relative to the scale which can still be discerned by the evaluation electronics (display, control).

It depends on (see Table 1):

- Grating period of the scale
- Signal interpolation factor (internally or in the subsequent electronics)
- Evaluation mode in the counter

Table 1

Grating period of the scale tape	Signal period of sine signals	Interpolation factor	Signal period after interpolation	Resolution after evaluation in counter		
				1-fold	2-fold	4-fold
20 µm	20 µm	none	20 µm	20 µm	10 µm	5 µm
		5-fold	4 µm	4 µm *	2 µm	1 µm
		10-fold	2 µm	2 µm	1 µm	0.5 µm
		25-fold	0.8 µm	0.8 µm *	0.4 µm *	0.2 µm
		50-fold	0.4 µm	0.4 µm	0.2 µm *	0.1 µm
		100-fold	0.2 µm	0.2 µm	0.1 µm	0.05 µm

*) No preferred variant

Accuracy

The accuracy of linear encoders is expressed in terms of accuracy classes.

The extreme values of error with reference to their mean value lie within $\pm a$ µm for a position within any maximum one-meter section of the measuring length.

For measuring lengths up to 1 m, the tolerance ($\pm a$ µm) refers to the actual measuring length. The accuracy values apply for a reference temperature of 20 °C (68 °F).

With exposed linear encoders, the definition of the accuracy class applies only to the scale.

In this case it is referred to as the scale accuracy.

12 Specifications

Mechanical Data for Encoder

LIA Series	LIA 20	LIA 21	LIA 22
Dimensions of the scanning head [mm]	34 x 13.2 x 12.4	34 x 13.2 x 12.4	41 x 16 x 12.4
Weight of the scanning head without cable	≤ 20 g	≤ 20 g	≤ 30 g
Number of switch sensors	-	1	2
Recommended measuring steps	0.05 μm 0.1 μm 0.2 μm	0.5 μm 1.0 μm	5.0 μm
Maximum traversing speed (depending on the evaluation electronics)	<ul style="list-style-type: none"> • Without interpolation: 600 m/min • With 100-fold interpolation: 48 m/min 		
Permissible cable bending radii • Rigid configuration • Frequent flexing	8 mm (for cable Ø 3.7 mm) 40 mm (for cable Ø 3.7 mm)		10 mm (for cable Ø 5.1 mm) 50 mm (for cable Ø 5.1 mm)

Mechanical Data for Scale Tape

Material	Steel		
Grating period GP	20 μm (standard), 100 μm		
Reference marks	<ul style="list-style-type: none"> • Periodic at a distance of 50 mm, starting from the center of the ML • Distance-coded at 1000 x GP • In the center of the ML • Others on request 		
Linear thermal expansion coefficient • DOUBLEFLEX scale tape • SINGLEFLEX scale tape	$10.5 \times 10^{-6} \text{ deg}^{-1}$ depending on the material of the mounting surface		
Accuracy classes • DOUBLEFLEX scale tape • SINGLEFLEX scale tape	*) accuracy classes for a grating period of 100 μm only $\pm 1 \mu\text{m}; \pm 2 \mu\text{m}; \pm 3 \mu\text{m}^*; \pm 5 \mu\text{m}^*$ $\pm 5 \mu\text{m}^*; \text{others on request}$		
Repetition accuracy of the switch sensors	-	0.1 mm	

LIA Series	LIA 20	LIA 21	LIA 22
Operating temperature range	0 °C ... +55 °C (32 °F ... 131 °F)		
Storage temperature range	-20°C ... + 70°C (-4 °F ... +158 °F)		
Vibration (50 Hz ... 2000 Hz)	≤ 200 ms ⁻²		
Shock (11 ms)	≤ 400 ms ⁻²		
Humidity	93% relative humidity (no condensation forming)		

The maximum attainable traversing speed of the encoders is determined by the maximum output frequency of the interpolator and/or the maximum counting frequency of the operator's evaluation electronics.

In order to avoid counting errors, the interpolator's output frequency is matched to the counting frequency of the operator's evaluation electronics.

This adaptation is possible **in discrete frequency steps**.

The maximum attainable traversing speed is calculated according to the following formula:

$$v_{\max} = \frac{f \cdot GP}{i \cdot SF \cdot 4} \text{ [m/s]}$$

f = Output frequency set by the manufacturer for 4-fold evaluation by the interpolator [MHz]

GP = Grating period [μm]

i = Interpolation factor
(5-fold, 10-fold, 25-fold, 50-fold, 100-fold)

SF = Safety factor = 1.5

12 Specifications

LIA Series	LIA 20	LIA 21		LIA 22	
Scanning frequency	Max. 500 kHz				
Output interface for counting signals <ul style="list-style-type: none"> Voltage output Square-wave output 	1 V _{PP} with integrated line driver RS 422 with 5/10/25/50/100-fold signal interpolation in the connector or scanning head (only LIA 20)				
Output interface for switch signals	-	TTL	high active	Output voltage	U _{out low} ≤ 0.4 V U _{out high} ≥ 2.4 V
			low active		
		Open collector	high active	Output current Max. power loss	I _{out high} ≤ 1 mA I _{out low} ≤ -16 mA P _{max} = 24 mW
			low active		
		MOS relay	Opening	Max. switch voltage Max. continuous current Max. power loss	U _{max} = 300 V I _{max} = 0.1 A P _{max} = 300 mW
			Closing		
Supply voltage	5 V ± 10%				
Power consumption <ul style="list-style-type: none"> Voltage output Square-wave output 	< 60 mA < 200 mA	< 70 mA < 210 mA	< 90 mA < 230 mA		
Cable lengths Cable secured to scanning head Max. cable length with extension cable	Up to 3 m (standard lengths: 0.3 m; 0.5 m; 1.0 m; 2.0 m; 3.0 m) 100 m for 1 V _{PP} and RS 422				



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