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1. Features and Applications

Position encoders in drive systems have to meet high and controversial demands, especially in linear drive systems. The demands opposing each other are high accuracy and resolution on the one hand and low mass, small dimensions and high measuring speed on the other hand.

- The graduated scale is definitive for the quality of a linear encoder. Requirements for maximum position deviations of $\pm 2 \mu\text{m}$ per meter or less are no rarity. The emphasis is mostly on the avoidance of short-range errors, since long-range errors, mostly linear error components, can often be compensated.
- The concentration of multiple axes in motion in very tight spaces, such as in semiconductor-producing machines, requires the miniaturization of the drives, guideways and encoders.
- High machining speeds and therefore high accelerations make low masses of the components in motion essential.

The LIK incremental encoders from NUMERIK JENA are equipped with features which are supposed to fulfill these high requirements in an ideal way.

- Due to an interpolation circuitry which is integrated in a 15-pin D-sub connector, a resolutions down to 50 nm is possible without any additional electronics.
- The permissible traversing speed for a sinusoidal signal output amounts to 10 m/s. A Square wave signal output with a resolution of 0.1 μm allows a permissible traversing speed of 1.6 m/s.
- The short-range position errors (interpolation errors) were significantly reduced by introducing an electronic compensation of amplitude and offset deviations of the coarse signals. This compensation functions without following error in all velocity ranges.

Additional features:

- Reference signal(s) with repeatability accurate to a specific increment, regardless of the direction from which the reference mark(s) is/are traversed
- Compact size and large mounting tolerances
- Possibility of electronic signal adjustment (signal optimization after mounting)
- Special, easy to mount scale tapes (SINGLEFLEX and DOUBLEFLEX) for a variety of applications and ambient conditions

Applications:

- Production and inspection machines for the semiconductor industry
- Linear units, drives and coordinate tables
- Measuring machines and measuring microscopes
- Positioning and measuring devices for medical technology
- Precision devices for reprography
- Precision machining
- Robotics

2. Safety

2.1. General Information

- Make sure to familiarize yourself thoroughly with the contents of these installation instructions before installing and starting up the encoder!
- Please contact the support of NUMERIK JENA GmbH or an authorized representation for further information. Please visit the NUMERIK JENA website to get the contact information.
- NUMERIK JENA GmbH 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 right sequence of the mounting steps during mounting.
- NUMERIK JENA GmbH 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!
- If the machine tolerances exceed the tolerances stated in the mounting instructions, errors can occur in both the operation and during measuring. NUMERIK JENA GmbH 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
 - Controllers
 - Encoders
 - Base mechanical devices (machine tools)
- Please pay attention to the safety instructions and warning symbols!



Danger to the device or to the function of the device!



Pull the plug!



Highly inflammable!

2.2. Notes on Legal Requirements

- The NUMERIK JENA encoders conform to EC standards and carry the CE mark.
- NUMERIK JENA encoders fulfill the requirements of the (German) Product Safety Act (ProdSG) from November 8th, 2011.
- Connect NUMERIK JENA encoders only to subsequent electronics whose power supply is generated from PELV systems (EN 50178).
- NUMERIK JENA encoders fulfill the requirements of standard IEC 61010-1 only if the power is supplied from a secondary circuit with current limitation as per IEC 61010^{3rd Ed.}, Section 9.4 or with power limitation as per IEC 60950-1^{2nd Ed.}, Section 2.5 or from a Class 2 secondary circuit as specified in UL1310.*
- This user manual supersedes all previous editions, which thereby become invalid. The basis for ordering from NUMERIK JENA is always the user manual edition valid when the contract is made.
- Standards (ISO, EN, etc.) apply only where explicitly stated in the user manual.

* In place of IEC 61010-1^{3rd Ed.}, Section 9.4, the corresponding sections of standards DIN EN 61010-1, EN61010-1, UL 61010-1 and CAN/CSA-C22.2 No. 61010-1 can be applied and in place of IEC 60950-1^{2nd Ed.}, Section 2.5 the corresponding sections of standards DIN EN60950-1, EN60950-1, UL60950-1, CAN/CSA-C22.2 No. 60950-1 can be applied.

2.3. Notes on Transport, Storage and Handling



Encoder

- 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 to the length.

DOUBLEFLEX Scale Tape

- In no case the DOUBLEFLEX scale tape should 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 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 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 metrological properties can be guaranteed anymore. Please return the scale tape to NUMERIK JENA GmbH for repair! Unfortunately a repair at the customer site is not possible.**
- When removing the DOUBLEFLEX scale tape from the packaging, the sag must not exceed more than 100 mm.
- After removing the greatest distance between two supports must not be more than 800 mm. Scale tapes up to 1,200 mm must be supported approx. 300 mm from the ends and longer scale tapes must be supported correspondingly.

2.4. Notes on Operation



- Do not connect or disconnect plugs if the power is on!
- Only operate the encoder with the supply voltage stated in this product data sheet.
- Comply with applicable PIN assignment if auxiliary electronic units are connected (e.g. controller or display)!
- Integrate exposed encoders in instruments, devices or machines in such a way that they are protected against contamination.
- Protect the scale tape against mechanical damage.
- Protect the scanning head against shock, impact and humidity.

2.5. Notes on Maintenance

- The encoder requires no maintenance whatsoever, but must be cleaned occasionally, depending on the ambient conditions.
- Modifications and repairs of the encoder may only be carried out by NUMERIK JENA GmbH or appropriately authorized persons.
- NUMERIK JENA GmbH is not liable for damages caused by unauthorized handling of the encoder. All warranty claims are forfeited by unauthorized handling.
- Exposed measuring systems are sensitive to contamination, especially the scale surface and the scanning windows for the counting and reference tracks on the scanning head.
- Particularly critical are rough and irregular contamination and deposits (e.g. oil, grease or water).
- The user has to protect the encoder from contamination by way of appropriate design measures.



- **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!**
- **Please also pay attention to the notes in chapter 7 „Cleaning“.**

3. Technical Data

3.1 Resolution and Accuracy (Definition)

Basically one has to differentiate between the resolution and the accuracy of a measuring system. The two parameters are not directly interdependent and may differ from each other.

Resolution

The resolution of linear system describes the least possible displacement of scanning head against the scale which can still be discerned by the evaluation electronics (display, control). It depends on (see chart 1)

- the graduation period of the scale
- the signal interpolation factor (internally or in auxiliary electronic unit)
- the evaluation mode in the counter

Accuracy

The accuracy of linear measuring systems is specified in accuracy classes.

The extreme error values for any max. one-meter section of the measured length lie within the specified accuracy class of $\pm a \mu\text{m}$ with respect to their mean value.

For measuring length up to 1 m, the tolerance ($\pm a \mu\text{m}$) refers to the actual measuring lengths. The accuracy applies to a reference temperature of 20°C.

With exposed linear measuring systems, the definition of the accuracy class applies only to the scale. This is called scale accuracy.

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

Chart 1

3.2 Mechanical Data

| LIK 41 | |
|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Dimensions of scan head (in mm) | 24 x 11 x 6 |
| Weight of scan head (w/o cable) | 3.0 g |
| recommended measuring steps | 0.05 µm, 0.1 µm, 0.2 µm, 0.5 µm, 1.0 µm, 5.0 µm |
| Traversing speed | |
| Maximum | 10 m/s (without interpolation) |
| Depending on the evaluation electronics | see chart 4 |
| Scale tape | |
| Material | Stainless Steel |
| Grating period (TP) | 20 µm |
| Reference marks | <ul style="list-style-type: none"> In the middle of the measuring length (ML) Others on request |
| Measuring length (ML) | |
| SINGLEFLEX scale tape | up to 400 mm |
| DOUBLEFLEX* scale tape | 100 to 400 mm |
| Linear thermal expansion coefficient | |
| SINGLEFLEX scale tape | $10.6 \times 10^{-6} \text{ K}^{-1}$ (expansion will be influenced by the mounting surface) |
| DOUBLEFLEX* scale tape | $10.6 \times 10^{-6} \text{ K}^{-1}$ |
| Accuracy classes (a) | |
| SINGLEFLEX, DOUBLEFLEX* scale tape | <ul style="list-style-type: none"> ±1 µm ±2 µm ±3 µm ±5 µm |
| Cable | |
| Cable diameter | 3.7 mm |
| Permissible bending radius | <ul style="list-style-type: none"> Occasional flexing ~8 mm Constant flexing ~40 mm |
| From scan head to the D-Sub connector | 0.3 m, 0.5 m, 1.0 m, 1.5 m, 2.0 m, 3.0 m (other on request) |
| From D-Sub connector to the controller (extension cable) | max. 100 m (The necessary supply voltage must be ensured!) |

* not suitable for vacuum applications

Chart 2

3.3 SINGLEFLEX and DOUBLEFLEX Scale Tape

The steel scale tapes from NUMERIK JENA are available in two different versions:

- SINGLEFLEX
- DOUBLEFLEX (not suitable for vacuum applications)

SINGLEFLEX

The SINGLEFLEX-scale tape consists of a single steel tape with an applied incremental track and one or more reference marks. The scale tape is equipped with a double-sided adhesive tape and can be mounted easily on the machine element.

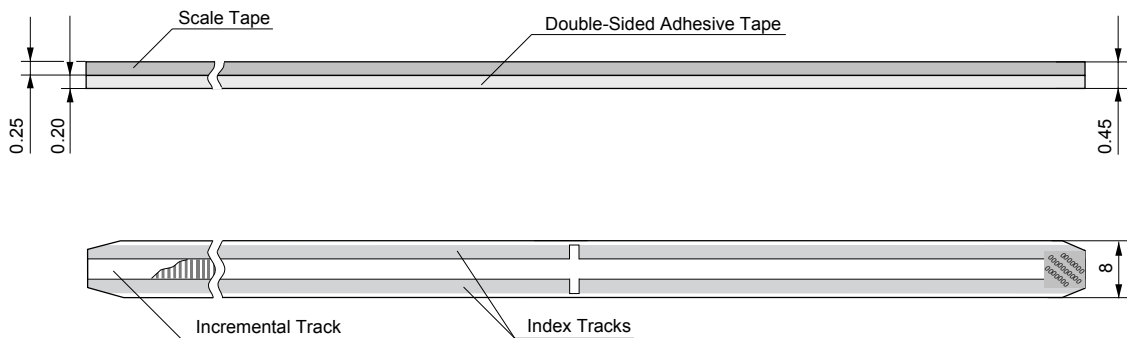


Image 1

DOUBLEFLEX

The DOUBLEFLEX-scale tape consists of two superimposed steel tapes. Both of them are divided by a tension uncoupled sheen of oil which ensures the adhesion between the steel tapes. The incremental track and one or more reference marks are applied on the upper steel tape. The lower steel tape is equipped with a double-sided adhesive tape and can be mounted easily on the machine element.

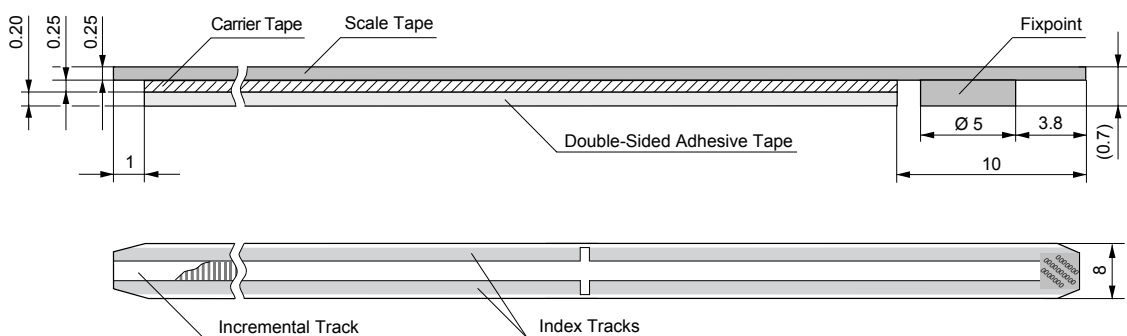


Image 2

The two steel tapes are uncoupled mechanically. This ensures that the upper steel tape can expand independently of the lower steel tape due to thermal variations of the ambient temperature. By reference of the ambient temperature and the expansion coefficient of the steel tape it is possible to determine occurring length deviation of the increments. This allows to subtract out the deviation of the measurement results.

3.4 Electrical Data

| LIK 41 | |
|---------------------|-------------------------------------------|
| Scanning frequency | max. 500 kHz |
| Supply voltage | 5 V \pm 10% |
| Output interfaces | |
| Voltage output | 1 V _{PP} |
| Square wave output | RS 422 with interpolation up to 100-times |
| Current consumption | |
| Voltage output | \leq 80 mA* |
| Square wave output | \leq 210 mA* |

* with 120 Ω load resistance

Chart 3

3.5 Switch-On Behaviour

During power-up procedure of the encoder system the level of power voltage and signal lines must be below 250 mV.



If the encoder system will be powered-up at a residual voltage between a range of 250 and 400 mV, internal sensor parameter will not set correctly. This will lead to incorrect encoder signals.

This behaviour has to be observed especially during reset routines of controllers.

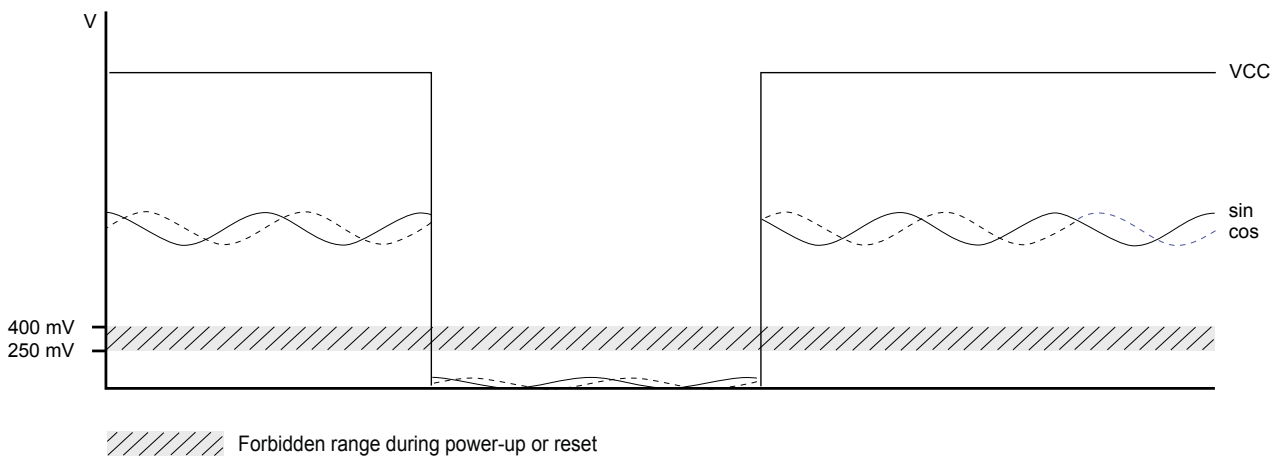


Image 3

3.6 Attainable Traversing Speed

The maximum attainable traversing speed of the encoder 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 (v_{\max}) is calculated according to the following formula:

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

- f Output frequency set by the manufacturer for 4-times evaluation by the interpolator [MHz]
- TP Grating period [μm]
- i Interpolation factor (5-times, 10-times, 25-times, 50-times oder 100-times)
- SF Safety factor = 1.5

v_{\max} dependent on the interpolation factor and the clock frequency of the counter

| Interpolation | w/o | 5-times | | 10-times | | 25-times | | 50-times | | 100-times | |
|-------------------------------------------|-----|---------|-------|----------|-------|----------|-------|----------|-------|-----------|-------|
| Resolution (μm) | 5 | 1 | | 0.5 | | 0.2 | | 0.1 | | 0.05 | |
| Min. clock frequency of the counter (MHz) | 2 | 4 | 16 | 4 | 24 | 4 | 24 | 4 | 24 | 4 | 24 |
| Min. edge separation (μs) | 0.5 | 0.25 | 0.063 | 0.25 | 0.042 | 0.25 | 0.042 | 0.25 | 0.042 | 0.25 | 0.042 |
| Max. traversing speed (m/s) | 10 | 2.66 | 10 | 1.33 | 8 | 0.53 | 3.2 | 0.27 | 1.6 | 0.13 | 0.8 |

• with 4-times evaluation

Chart 4

3.7 Ambient Conditions

| | LIK 41 |
|--------------------------------|-------------------------------------------------|
| Operating temperature range | 0°C to +55°C (+32°F to +131°F) |
| Storage temperature range | -20°C to +70°C (-4°F to +158°F) |
| Vibration (50 Hz ... 2,000 Hz) | ≤200 ms ⁻² (20 g) |
| Shock (11 ms) | ≤400 ms ⁻² (40 g) |
| Humidity | 93% relative humidity (no condensation forming) |

Chart 5

3.8 Cable

Scanning Head Cable (Connection Cable from Scanning Head to D-Sub Connector)

- Please mount the scanning head preferably 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 (e.g. mains cables, fuses, motors, magnetic valves or power supplies). Normally a distance of ≥100 mm will be sufficient.
- Install the cable in a way that it cannot be damaged by the moving carriage. Please pay attention to the permissible bending radius (see also point 4.2 - "Mechanical data")!

Extension Cable (Connection Cable from D-Sub Connector to Controller)

- Use preferably original extension cables made by NUMERIK JENA. This guarantees an optimum compatibility with the encoders and ensures a maximum protection against electromagnetic interferences.
- Please consult the technical support of NUMERIK JENA before using selfmanufactured extension cables.
- Do not install any other signal lines in the encoder cable!

3.9 Connector

15-pin D-Sub Connector

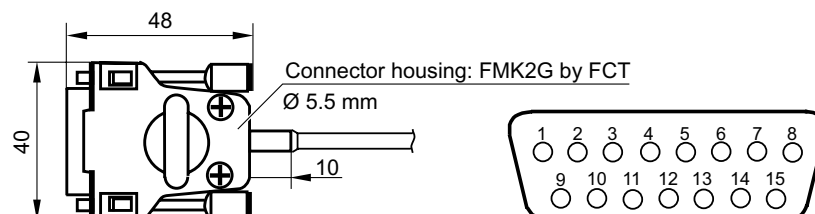


Image 4

3.10 PIN Assignment

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₋ | - | 5V | 0V | - | - | U ₀₊ | U ₂₊ | U ₁₊ | - | Shield |
| RS 422 | - | - | NAS | Z ₀₋ | Z ₂₋ | Z ₁₋ | - | 5V | 0V | - | AS | Z ₀₊ | Z ₂₊ | Z ₁₊ | - | Shield |
| Cable Ø 3.7 mm | - | - | vt | pk | rd | bn | - | bu | wh | - | ye | gy | bk | gn | - | - |

1 V_{PP}

| | |
|-----------------|-----------------------------|
| U ₁₊ | Counting signal 0° (sin) |
| U ₁₋ | Counting signal 180° (-sin) |
| U ₂₊ | Counting signal 90° (cos) |
| U ₂₋ | Counting signal 270° (-cos) |
| U ₀₊ | Reference signal |
| U ₀₋ | Neg. reference signal |

RS 422

| | |
|-----------------|---------------------------------|
| Z ₁₊ | Counting signal 0° |
| Z ₁₋ | Neg. counting signal 0° (180°) |
| Z ₂₊ | Counting signal 90° |
| Z ₂₋ | Neg. counting signal 90° (270°) |
| Z ₀₊ | Reference signal |
| Z ₀₋ | Neg. reference signal |

| | |
|-----|-----------------------------------------------------------------------------|
| 0V | Ground (GND) |
| 5V | Operating voltage (U _B) |
| AS | Error signal (monitoring signal) |
| NAS | Neg. error signal |
| | NAS high: Input signal within the tolerance range |
| | NAS low: Input signal outside the tolerance range (check measuring system!) |
| SCL | Programming wire clock |
| SDA | Programming wire data |

3.11 Electromagnetic Compatibility (EMC)



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

- The encoder must be mounted to a galvanic conductive surface. The mounting surfaces, the threads of the mounting screws and the threads in the machine must be free from electrically non-conductive coatings.
- Maintain the NUMERIK JENA shielding concept for the measuring system!
- 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, etc.) are used, connect the external shields of the cables with each other and with the shielding of the cable connector
- When using additional electronics, connect the housing electrically conducting to ensure good galvanic conductivity. For insulated installation the housing should be connected at the shortest distance by an additional potential equalization line (Cu line with cross section $\geq 6 \text{ mm}^2$) with the machine's protective ground.
- Please contact the NUMERIK JENA support or that of the appropriate manufacturer if you experience any problems when working with specific display or control units.

3.12 Shielding Concepts

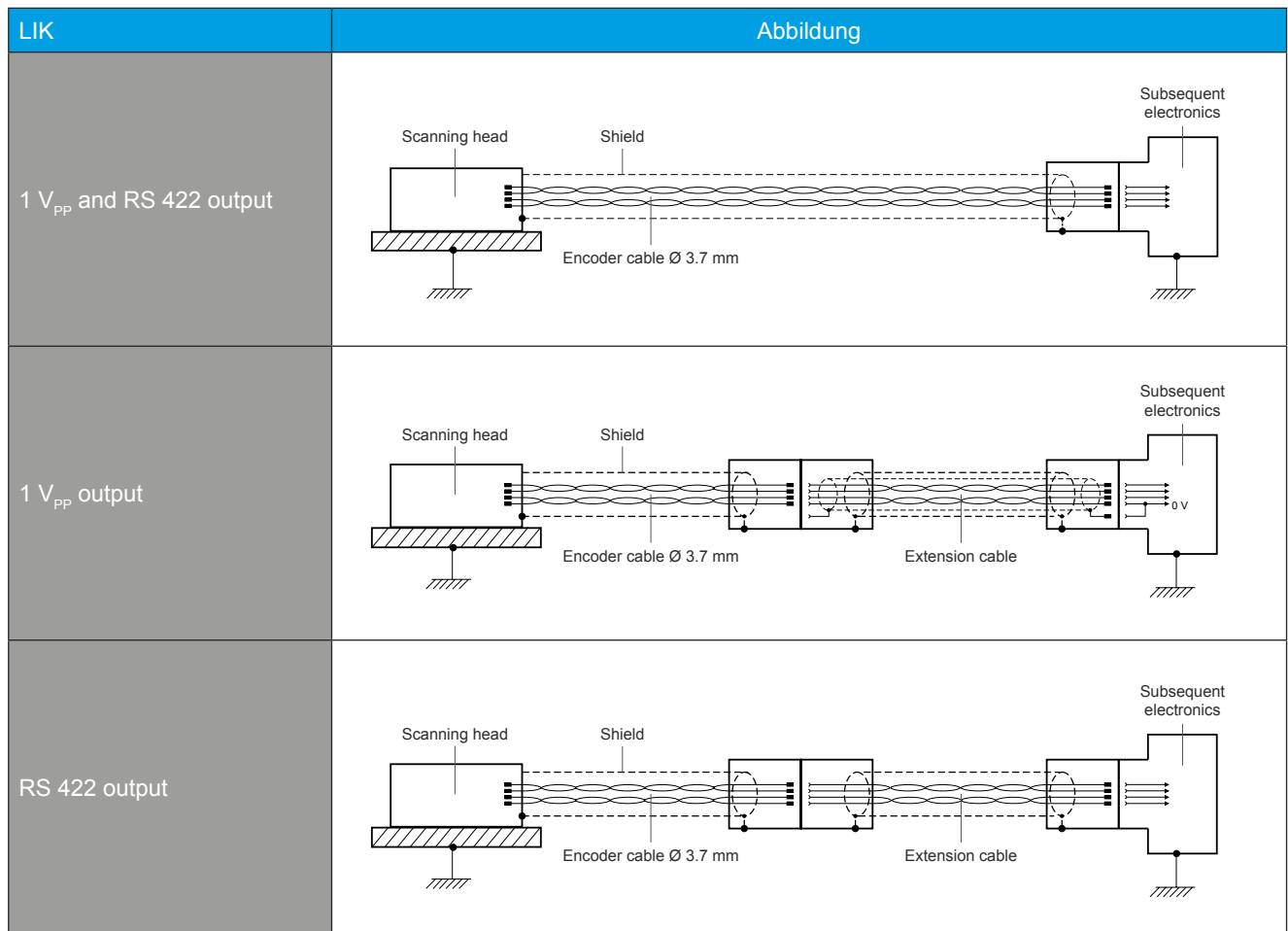


Chart 6

3.13 Voltage Output $1 V_{PP}$

Optimal Connection Circuit

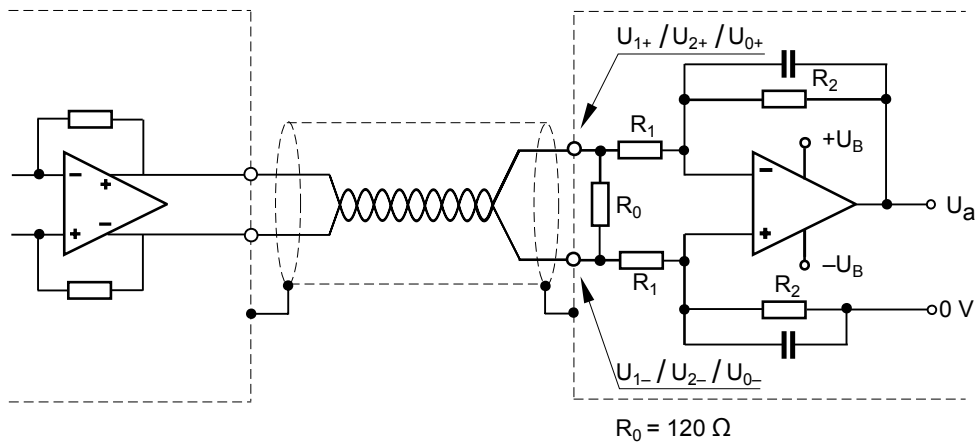


Image 5

Signal Curve

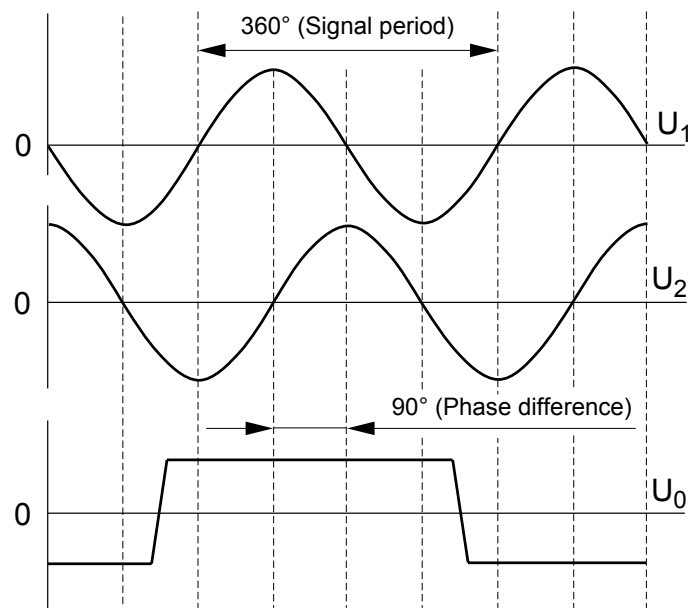


Image 6

Difference signals measured at R_0 :

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

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

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

3.14 Square-Wave Output RS 422

Optimal Connection Circuit

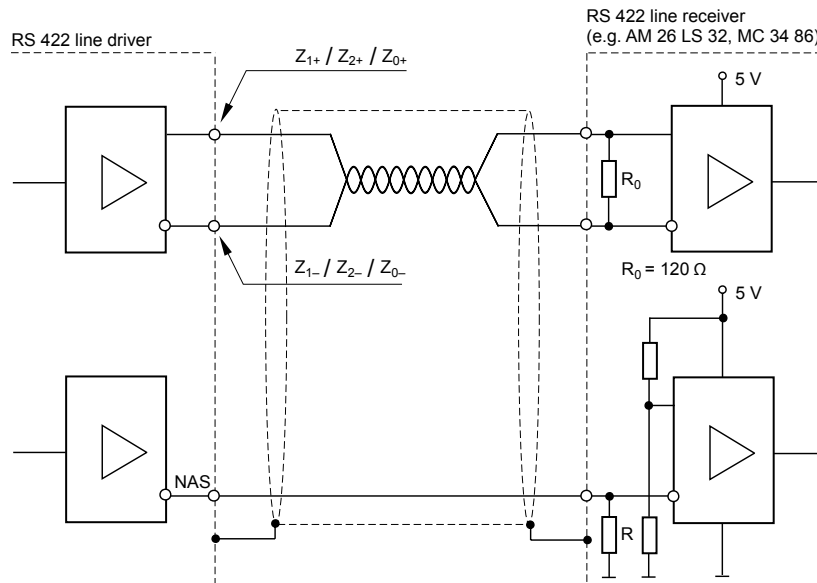


Image 7

Signal Curve

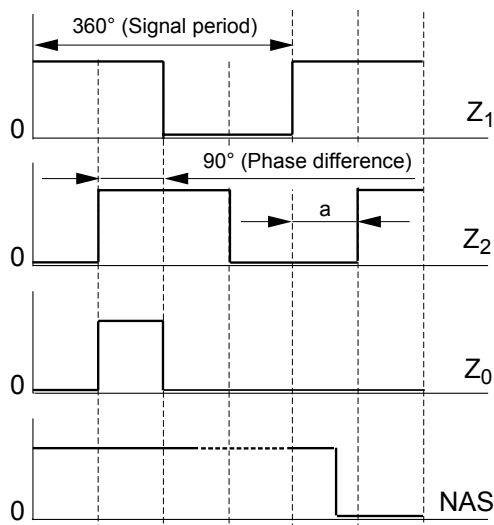


Image 8

NAS high:

Encoder functioning properly, input signals within tolerance range

NAS low:

Check the measuring system

a:

Minimum edge separation as a function of the interpolation factor and traversing speed (see point 4.5)

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 or acceleration controller) ensure that the resulting terminal resistance of these inputs is $R_{0res} \approx 120 \Omega$.

3.15 Online Compensation (Offset and Amplitude Control)

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 grating disk before activation of the online compensation.

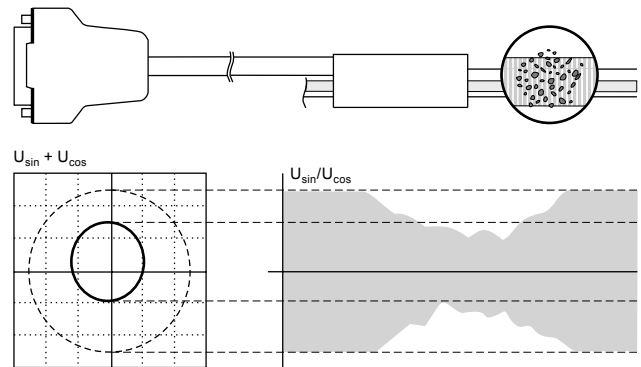


Image 9

Incorrect Mounting

Scanning head signal with faulty mounting before activation of the online compensation.

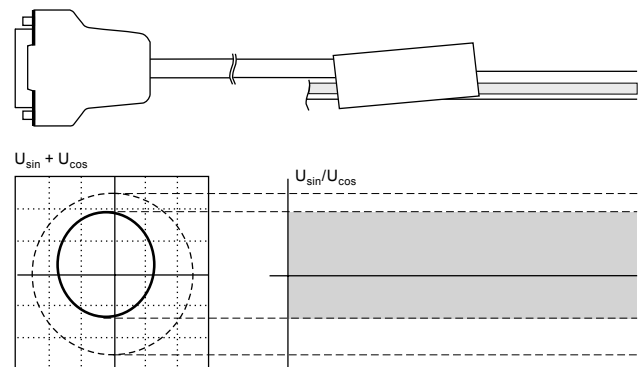


Image 10

Active Online Compensation

Scanning head signal with contaminated grating disk and/or faulty mounting after activation of the online compensation.

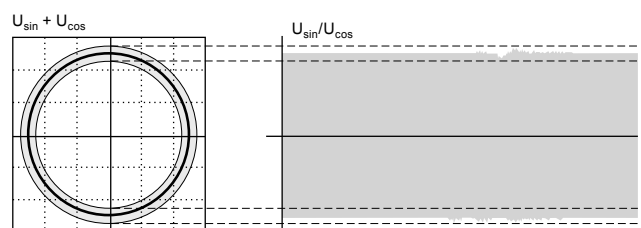


Image 11

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.

4. General Installation Notes

4.1 Scope of Delivery

Standard

- LIK 41 scanning head (according to the ordered specification)
- SINGLEFLEX or DOUBLEFLEX scale tape (according to the ordered specification)
- Spacing gage for mounting the scanning head (made of plastic with marking „0,6“)
- Information sheet

Optional

- Extension cable

4.2 Installation Position



- The installation position of the measuring system is arbitrary.
- In order to avoid contamination deposits, a vertical position for the scale tape is recommended.
- The operator of the measuring system 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 window of the scanning head should be easily accessible for cleaning. Prevent contamination and foreign elements from having an influence on the operation!
- Use preferably slots or edges 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 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 you mount the DOUBLEFLEX scale tape vertically, the fixing point must be located at the top. Otherwise the scale tape can detach itself from the carrier tape!
- If you mount the DOUBLEFLEX scale tape perpendicular, the scale tape must lie on the carrier tape.

4.3 Mounting Steps

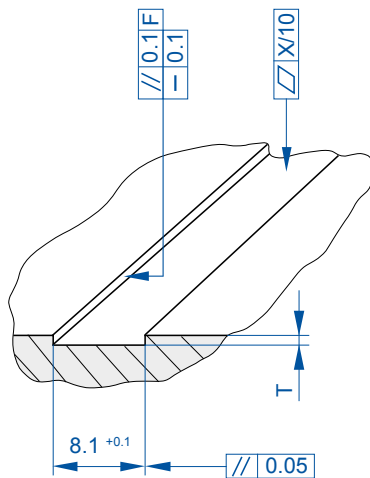


Hereafter the mounting steps for a LIK measuring system from NUMERIK JENA will be described.

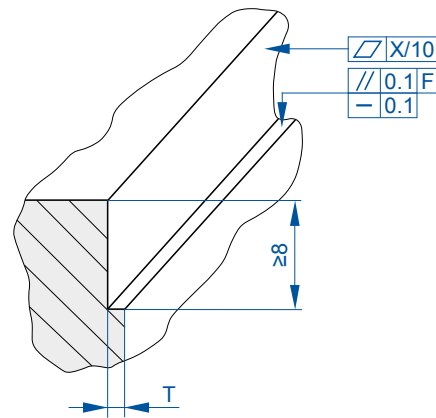
- Please read the notes mentioned to the particular mounting steps thorough and follow the indicated sequence of mounting steps exactly!
- The mounting steps for the LIK series are basically the same.
- Maintain a tightening torque of 1 Nm for all screws!

1

- Preferably the tape should be mounted in a slot or along an edge.
- Please mark the future location of the scale tape before starting with the mounting.
- The alignment of the scale tape depends on the installation position of the scan head.
- Ensure that the scanning head's scanning fields for the counter and reference tracks are over the corresponding tracks on the scale tape (see also scheme step 5).



Mounting slot



Mounting edge

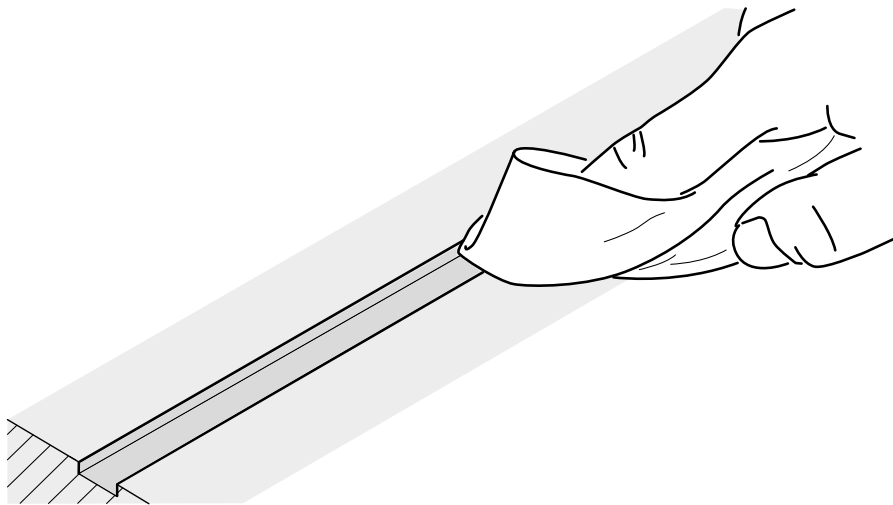
| Accuracy class | X |
|---------------------|-------|
| $\pm 1 \mu\text{m}$ | 0.003 |
| $\pm 2 \mu\text{m}$ | 0.006 |
| $\pm 3 \mu\text{m}$ | 0.009 |
| $\pm 5 \mu\text{m}$ | 0.009 |

| Scale tape | T |
|------------|--------------|
| SINGLEFLEX | $0.5_{-0.1}$ |
| DOUBLEFLEX | $0.7_{-0.1}$ |

F = Machine guideway

2

- Use a solvent to clean the adhesion surface of the machine (e.g. Acetone or Alcohol).
- 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.
- ATTENTION: Acetone and Alcohol are inflammable liquids!



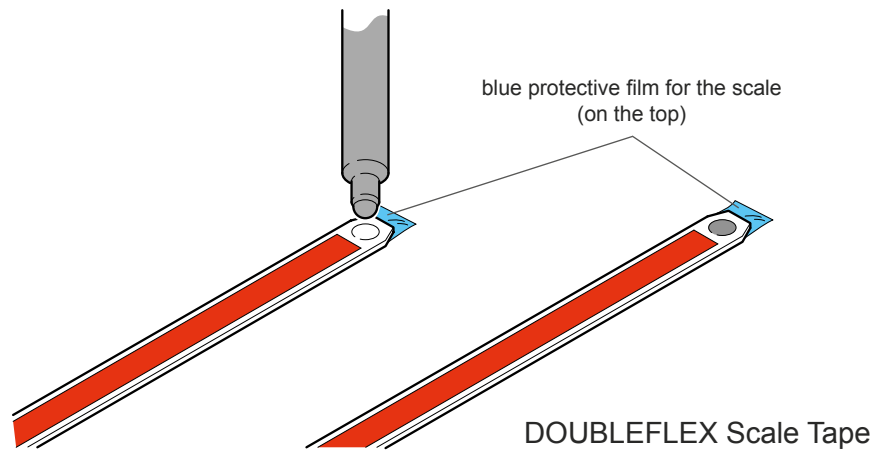
Information on installation of SINGLEFLEX and DOUBLEFLEX scale tapes



- The mounting steps of SINGLEFLEX and DOUBLEFLEX scale tapes are basically the same. But please pay attention to the following information on installation!
- The scale tape can be mounted in a slot already on the machine or along an edge already on the machine.
- 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.

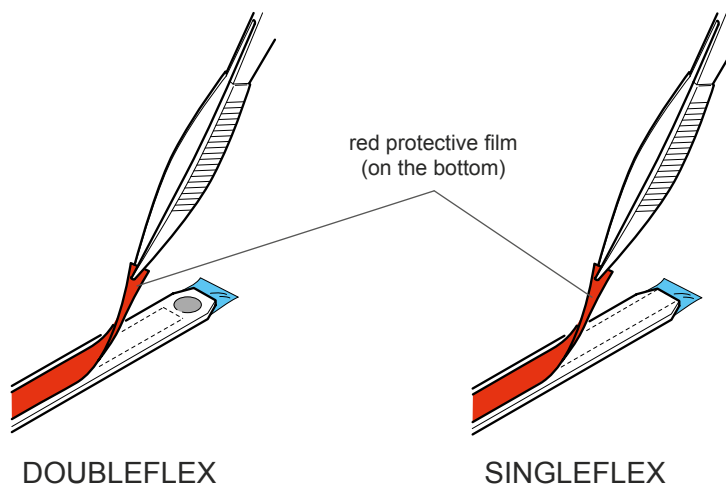
3

- If you use a DOUBLEFLEX scale tape, glue the fixing point first.
- Please pay attention to the use and safety instructions from the manufacturer of the adhesive!
- Place a drop of adhesive on the center of the fixing point.
- Recommended adhesives:
 - Cyanoacrylate adhesives such as Loctite 480 or Loctite 401
 - Epoxy resin



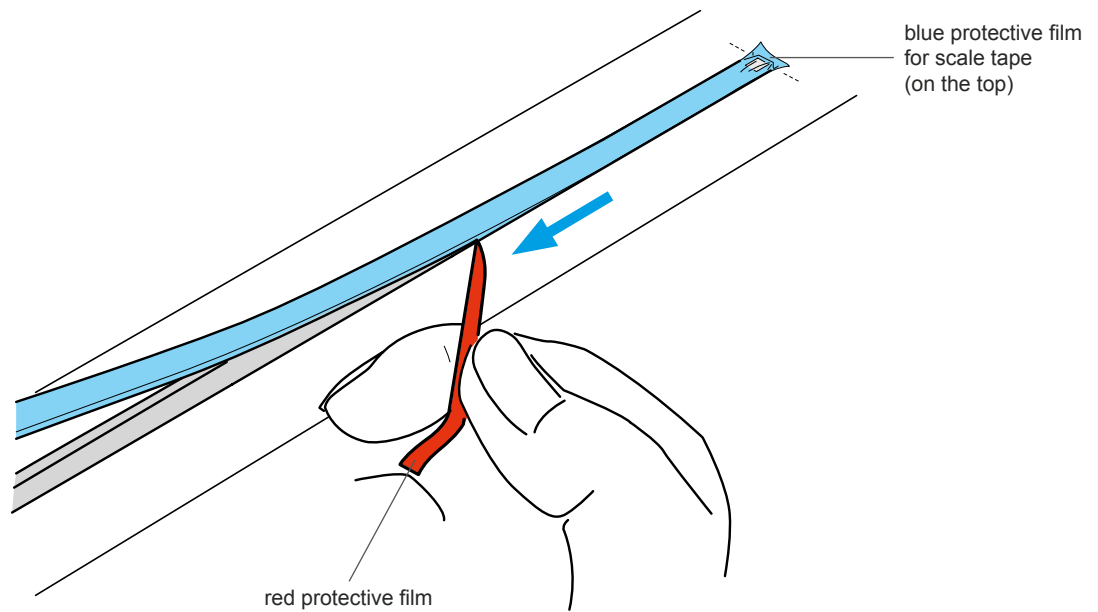
4

- Peel off ca. 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 blue transparent protective film from the scale tape yet!



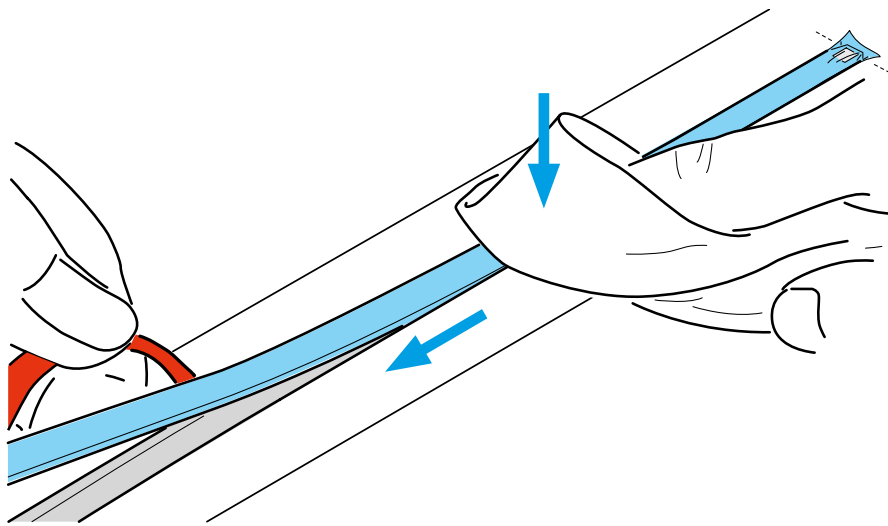
5

- Do not remove the blue transparent protective film from the scale tape yet!
- 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 ca. 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).



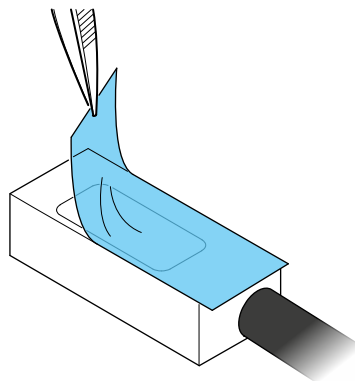
6

- Do not remove the blue transparent protective film from the scale tape yet!
- Press the scale tape with your forefinger and by the help of a soft, lint-free rag against the carrier over the entire length. Pull off the red protective film to the side. The pressure point should always be ca. 30 mm to 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 and avoid lateral forces!**



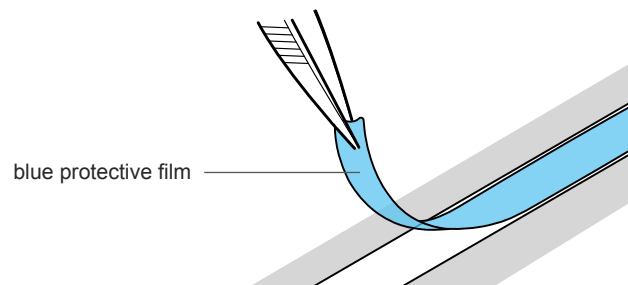
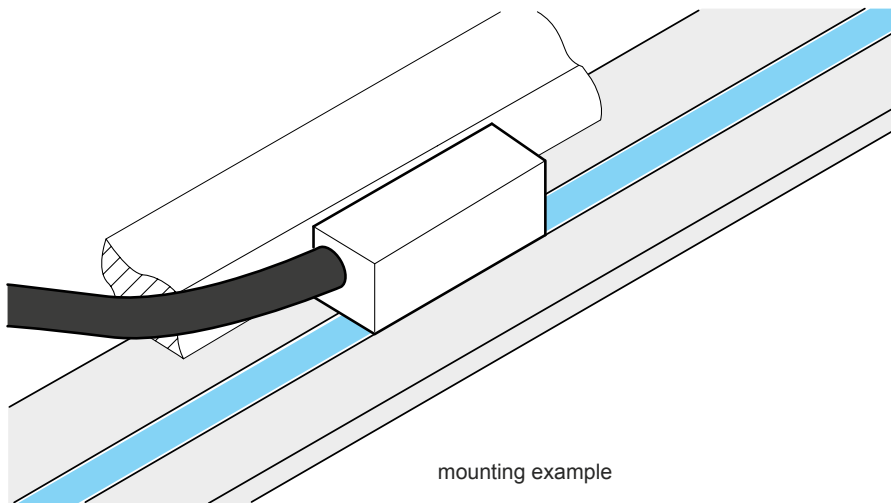
7

- Clean the mounting surfaces of the scanning head and the machine element.
- Remove the protective film from the scanning head.
- Clean the sensor surface of the scanning head with a soft and lint-free rag. Use a solvent if necessary (e.g. Acetone or Alcohol).
- **ATTENTION: Acetone and Alcohol are inflammable liquids!**



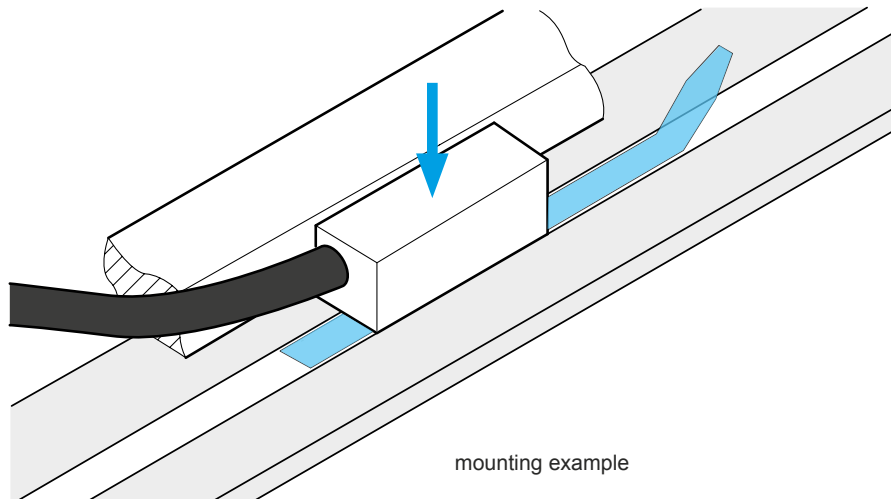
8

- Screw the scanning head onto the prepared mounting surface such that there is still some vertical clearance.
- Remove the blue transparent protective film (in case of DOUBLEFLEX scale tape, always begin at the fixing point) from the graduation of the scale tape.
- Clean the scale tape surface (graduation) of the scanning head with a soft and lint-free rag. Use a solvent if necessary (e.g. Acetone or Alcohol).
- ATTENTION: Acetone and Alcohol are inflammable liquids!



9

- 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 alternatingly and evenly (tightening torque = 1 Nm). The spacing gage should barely be movable.
- Check the parallelism of the scanning head to the scale tape. Push the spacing gage ca. 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 cautiously. If it is difficult to remove the spacing gage, loosen the scanning head and repeat the mounting procedure. Otherwise the surface of the sensor module can be damaged!



10

- Position the encoder cable including the strain relief near the scanning head.
- Connect the encoder cable to the evaluation electronics and pay attention to the pin assignment. The evaluation electronics must be switched off!
- After connecting the encoder cable switch the evaluation electronics on and test the functionality.
- If there are errors in the function or during measurement, please read chapter 8 "Troubleshooting" first. If these information are not helpful for your problem, please contact the technical support of NUMERIK JENA or an authorized representation in your country.

5. Signal Adjustment with ADJUSTMENT TOOL

Before delivery the encoders from NUMERIK JENA will be tested and electronically adjusted under ideal mounting conditions. Furthermore, the sensor modules offer the possibility of an electronic signal adjustment after the mounting into the application. This allows the user optimize the encoder signals regarding to the mechanical mounting conditions (tolerances).

The ADJUSTMENT TOOL and the related EPIFLEX software was designed to simplify and make the signal adjustment more effective.

5.1 Functions of the ADJUSTMENT TOOL

- Representation of the sinusoidal counting signals with amplitude, offset and phase position
- Representation of the position and width of the index signal
- Evaluation of the mechanical mounting conditions
- Automatic signal adjustment and programming of the sensor module
- Electronic readjustment of the amplitude and offset of the sensor signals
- Adjustment of the position and width of the index signal

5.2 Dynamic Offset and Amplitude Control (Online Compensation)

The encoders of NUMERIK JENA are equipped with a dynamic amplitude and offset control (online compensation). The analog diode signals will be corrected to their nominal values in real time. This reduces measuring errors caused by contamination as well as from inaccuracies. The phase position between the sine and cosine signals and the position of the index signal are not influenced by the online compensation.

With help of the EPIFLEX Software the preadjusted nominal values of the online compensation can be influenced.

5.3 Scope of Delivery

- ADJUSTMENT TOOL black box
- Diagnostic cable to connect the measuring system
- USB cable to connect a PC
- USB - D-SUB - adapter cable (15-pin)
- Exchangeable 8-pin plug connectors



Image 12

5.4 EPIFLEX Software

The EPIFLEX software was especially designed for the ADJUSTMENT TOOL. It offers the user versatile possibilities to bring the encoder into service. It also allows the user to display the sensor signals and evaluate them without using an oscilloscope or other expensive hardware. Furthermore it is possible to program respectively optimize the encoder to the existing mounting conditions automatically.

The EPIFLEX software is available for free via download on the NUMERIK JENA website under www.numerikjena.de. Furthermore, one can order the software with an optional USB flash drive.

The EPIFLEX software is suitable for the following operating systems:

- Windows 7 / 8 (32 or 64 bit)

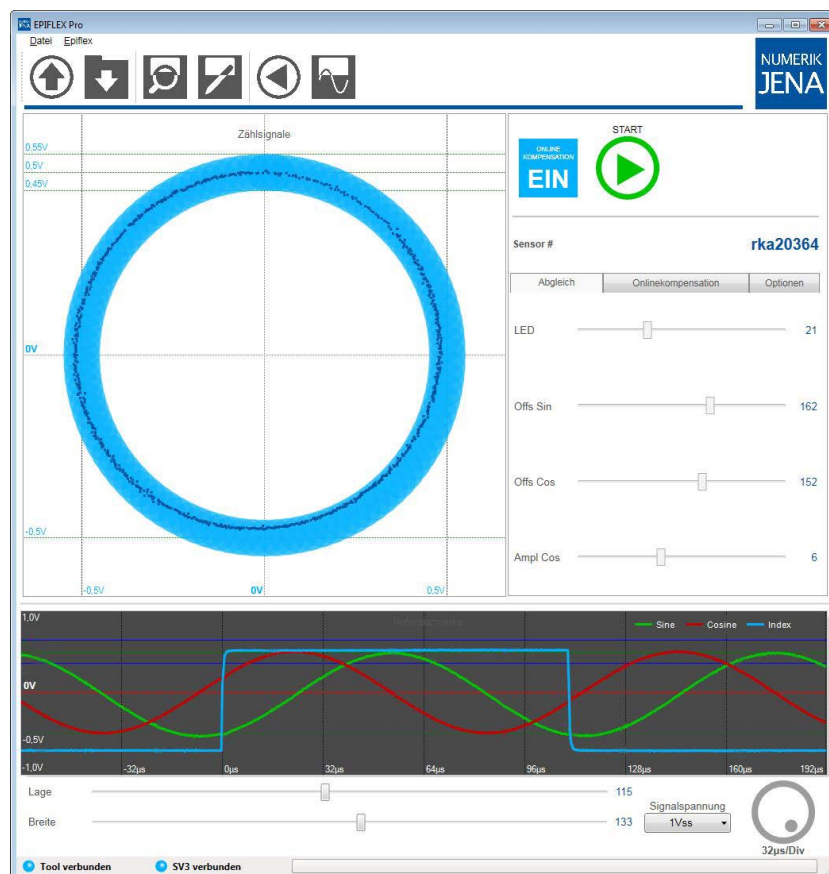
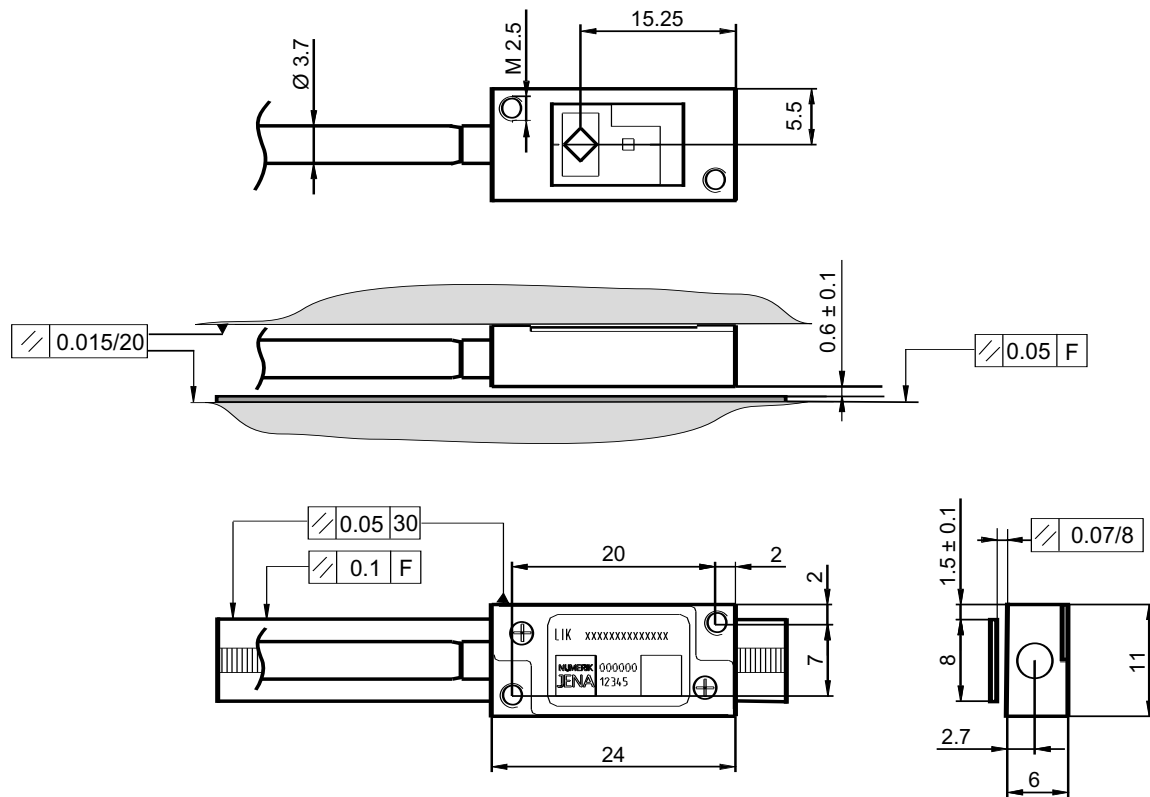


Image 13

Further information about the ADJUSTMENT TOOL and the EPIFLEX software can be found on the NUMERIK JENA website.

6. Mounting Drawing - LIK 41

6.1 Scanning Head LIK 41

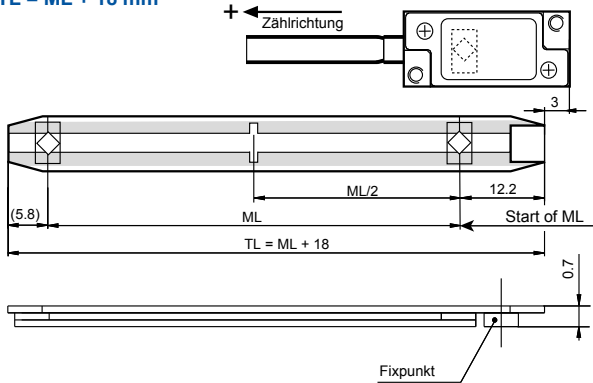


| | |
|---|------------------|
| F | Machine guideway |
|---|------------------|

6.2 Assignment of Scanning Head, Scale Tape and Measuring Length

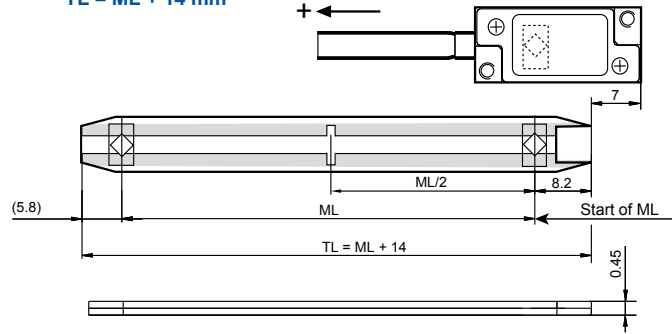
MT 10 - DOUBLEFLEX with name plate

$$TL = ML + 18 \text{ mm}$$



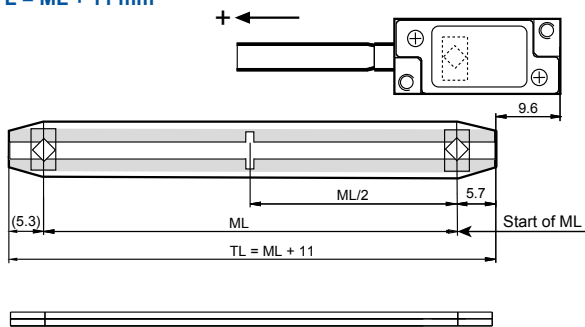
MT 11 - SINGLEFLEX with name plate

$$TL = ML + 14 \text{ mm}$$



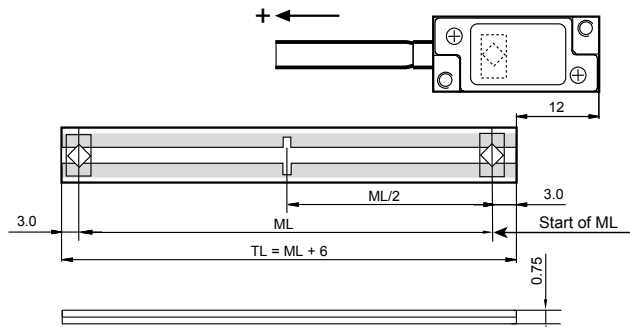
MT 15 - SINGLEFLEX minimum ML w/o name plate

$$TL = ML + 11 \text{ mm}$$



MT 26 - Glass minimum ML w/o name plate

$$TL = ML + 6 \text{ mm}$$



ML - Measuring length

TL - Total Length

7. Cleaning

- Depending on the measuring system's mounting attitude and the ambient conditions, it may be necessary to clean the scale 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 and lint-free rag for cleaning. Use a solvent if necessary (e.g. Acetone or Alcohol).
- Avoid to contact the solvent and the adhesive tape! This could start to dissolve the adhesive and reducing the adhesive force. Furthermore the scale tape can be detached totally.
- Please always wipe the DOUBLEFLEX scale tape lengthwise. Wiping it crosswise could result in an offset of the scale tape relative to the carrier tape and leading to errors in the function of the measuring system.
- 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.

ATTENTION: Acetone and Alcohol are inflammable liquids!



8. Troubleshooting

The functions of all scanning heads and accuracy of all scale tapes are tested before the encoders are shipped. However, if troubles or problems should occur, please read the following points in the chart and proceed according to this information.

If this is not helpful, please contact the technical support of NUMERIK JENA GmbH or one of our authorized representations. You will find respective contact data on the NUMERIK JENA website www.numerikjena.de.

| Error | Possible causes | Solution |
|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| No measuring signal | No power at the scanning head | <ul style="list-style-type: none"> • 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 | <ul style="list-style-type: none"> • Check the assignment of the scale tape to the scanning head • p.r.n. readjust mechanically • Readjust electronically with ADJUSTMENT TOOL* |
| Rough, loud motor running (for linear motors) | Irregular edge separations of the counting signals due to interpolation errors | |
| Counting error (compared to a standard) | Mounting error | |
| No reference signal | Mounting error (results in faulty gating of the reference signal and counting signal) | |
| Reference mark can only be detected from one direction | | |
| Reference mark appears twice | | |
| Not all reference marks are detected | | |
| Failure signal reports (for RS 422) | Mounting error (results in level of the analog signal from the sensor being too low) | Clean the scale tape |
| | Contamination on the scale tape (results in level of the analog signal from the sensor being too low) | |
| | Encoder function operating error | Contact the technical support of NUMERIK JENA |

Chart 7

* see also chapter 5

9. Ordering Key

9.1 Scanning Head

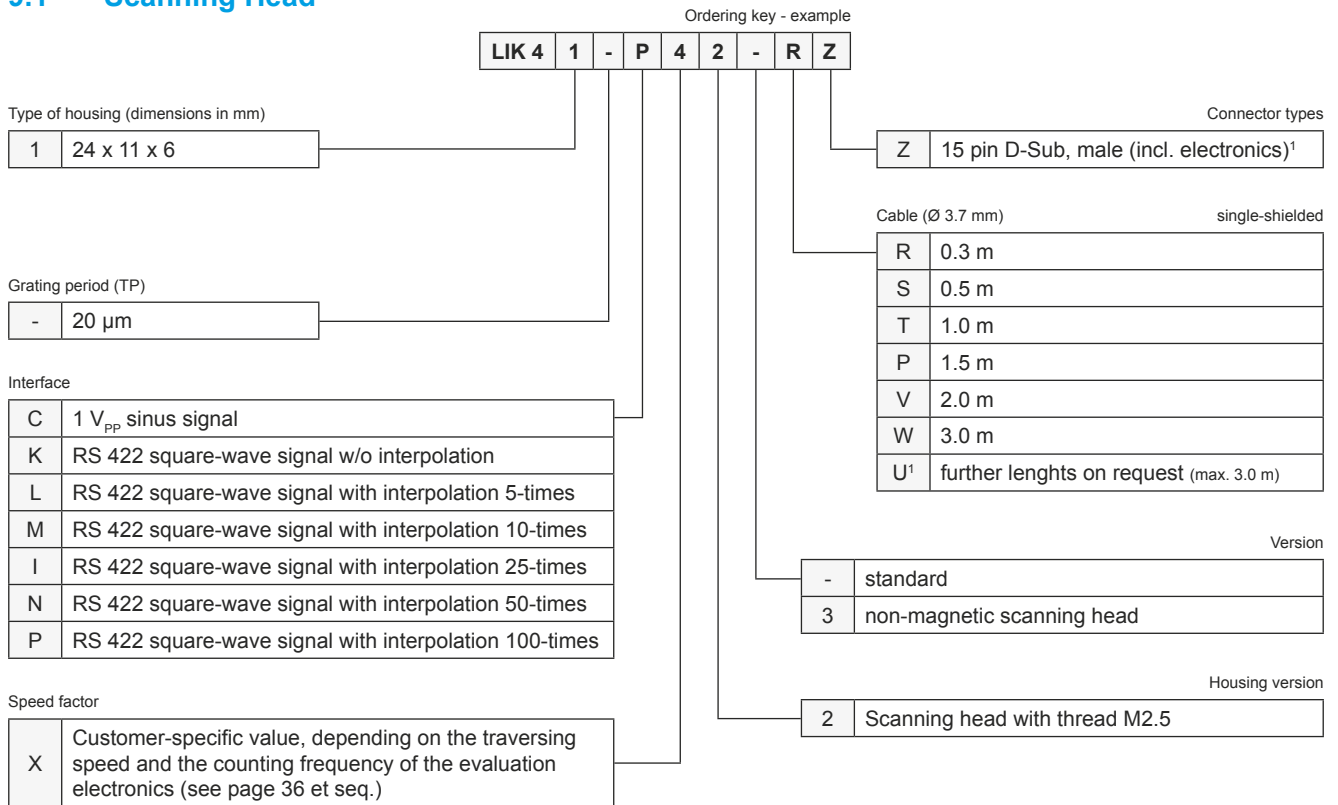


Image 14

¹ Straight cable outlet

9.2 Speed Chart for LIK Series

9.2.1 LIK Series with Op-Amp

The maximum attainable traversing speed of the encoder is determined by the maximum output frequency of the interpolator and/or the maximum counting frequency of the operator's evaluation electronics (e.g. controller or display).

Please take the suitable values for your application from the following charts and enter it into the corresponding place (for "X") in the ordering key. Pay attention to your chosen interpolation factor and the targeted traversing speed first. If you have found the respective information, please check if your evaluation electronics is able to achieve the needed counting frequency.

The maximum scanning frequency of the encoder amounts to 200 kHz standardly, hence the maximum attainable traversing speed will be derived from that. The op-amp decouples parasitic frequencies and improves the interference immunity of the encoder under unfavorable conditions. The encoders from NUMERIK JENA are available without op-amp also. Thus it is possible to increase the scanning frequency which consequently enables higher traversing speeds up to 10 m/s.

C Without interpolation factor

| Value for X | Max. traversing speed (in m/s) | Max. scanning frequency of the measuring system (in kHz) | Min. counting frequency of the evaluation electronics without 4-edge evaluation (in MHz) | Min. counting frequency of the evaluation electronics with 4-edge evaluation (in MHz) |
|-------------|--------------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 0 | 4.00 | 200 | 0.75 | 3 |

L Interpolation factor = 5

| Value for X | Max. traversing speed (in m/s) | Max. scanning frequency of the measuring system (in kHz) | Min. counting frequency of the evaluation electronics without 4-edge evaluation (in MHz) | Min. counting frequency of the evaluation electronics with 4-edge evaluation (in MHz) |
|-------------|--------------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1 | 0.67 | 33 | 0.25 | 1 |
| 2 | 1.33 | 67 | 0.50 | 2 |
| Y | 2.00 | 100 | 0.75 | 3 |
| 3 | 2.67 | 133 | 1.00 | 4 |
| Z | 4.00 | 200 | 1.50 | 6 |

M Interpolation factor = 10

| Value for X | Max. traversing speed (in m/s) | Max. scanning frequency of the measuring system (in kHz) | Min. counting frequency of the evaluation electronics without 4-edge evaluation (in MHz) | Min. counting frequency of the evaluation electronics with 4-edge evaluation (in MHz) |
|-------------|--------------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1 | 0.33 | 17 | 0.25 | 1 |
| 2 | 0.67 | 33 | 0.50 | 2 |
| Y | 1.00 | 50 | 0.75 | 3 |
| 3 | 1.33 | 67 | 1.00 | 4 |
| Z | 2.00 | 100 | 1.50 | 6 |
| 4 | 2.67 | 133 | 2.00 | 8 |
| 5 | 4.00 | 200 | 3.00 | 12 |

The listed values in the charts refer to a grating period (TP) of 20 µm.

I Interpolation factor = 25

| Value for X | Max. traversing speed (in m/s) | Max. scanning frequency of the measuring system (in kHz) | Min. counting frequency of the evaluation electronics without 4-edge evaluation (in MHz) | Min. counting frequency of the evaluation electronics with 4-edge evaluation (in MHz) |
|-------------|--------------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1 | 0.13 | 7 | 0.25 | 1 |
| 2 | 0.27 | 13 | 0.50 | 2 |
| Y | 0.40 | 20 | 0.75 | 3 |
| 3 | 0.53 | 27 | 1.00 | 4 |
| Z | 0.80 | 40 | 1.50 | 6 |
| 4 | 1.07 | 53 | 2.00 | 8 |
| 5 | 1.60 | 80 | 3.00 | 12 |
| 6 | 2.13 | 107 | 4.00 | 16 |
| 7 | 2.67 | 133 | 5.00 | 20 |
| 8 | 3.20 | 160 | 6.00 | 24 |

N Interpolation factor = 50

| Value for X | Max. traversing speed (in m/s) | Max. scanning frequency of the measuring system (in kHz) | Min. counting frequency of the evaluation electronics without 4-edge evaluation (in MHz) | Min. counting frequency of the evaluation electronics with 4-edge evaluation (in MHz) |
|-------------|--------------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1 | 0.07 | 3 | 0.25 | 1 |
| 2 | 0.13 | 7 | 0.50 | 2 |
| Y | 0.20 | 10 | 0.75 | 3 |
| 3 | 0.27 | 13 | 1.00 | 4 |
| Z | 0.40 | 20 | 1.50 | 6 |
| 4 | 0.53 | 27 | 2.00 | 8 |
| 5 | 0.80 | 40 | 3.00 | 12 |
| 6 | 1.07 | 53 | 4.00 | 16 |
| 7 | 1.33 | 67 | 5.00 | 20 |
| 8 | 1.60 | 80 | 6.00 | 24 |

P Interpolation factor = 100

| Value for X | Max. traversing speed (in m/s) | Max. scanning frequency of the measuring system (in kHz) | Min. counting frequency of the evaluation electronics without 4-edge evaluation (in MHz) | Min. counting frequency of the evaluation electronics with 4-edge evaluation (in MHz) |
|-------------|--------------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1 | 0.03 | 2 | 0.25 | 1 |
| 2 | 0.07 | 3 | 0.50 | 2 |
| Y | 0.10 | 5 | 0.75 | 3 |
| 3 | 0.13 | 7 | 1.00 | 4 |
| Z | 0.20 | 10 | 1.50 | 6 |
| 4 | 0.27 | 13 | 2.00 | 8 |
| 5 | 0.40 | 20 | 3.00 | 12 |
| 6 | 0.53 | 27 | 4.00 | 16 |
| 7 | 0.67 | 33 | 5.00 | 20 |
| 8 | 0.80 | 40 | 6.00 | 24 |

The listed values in the charts refer to a grating period (TP) of 20 µm.

9.2.2 LIK Series without Op-Amp

The maximum scanning frequency of the encoder without op-amp amounts to 500 kHz, hence the maximum attainable traversing speed will be derived from that. This enables traversing speeds up to 10 m/s.

C (1 VSS) or K (RS 422) Without interpolation factor

| Value for X | Max. traversing speed (in m/s) | Max. scanning frequency of the measuring system (in kHz) | Min. counting frequency of the evaluation electronics without 4-edge evaluation (in MHz) | Min. counting frequency of the evaluation electronics with 4-edge evaluation (in MHz) |
|-------------|--------------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| for C: A | 10.00 | 500 | 0,75 | 3 |
| for K: 0 | | | | |

L Interpolation factor = 5

| Value for X | Max. traversing speed (in m/s) | Max. scanning frequency of the measuring system (in kHz) | Min. counting frequency of the evaluation electronics without 4-edge evaluation (in MHz) | Min. counting frequency of the evaluation electronics with 4-edge evaluation (in MHz) |
|-------------|--------------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| B | 0.67 | 33 | 0.25 | 1 |
| C | 1.33 | 67 | 0.50 | 2 |
| D | 2.00 | 100 | 0.75 | 3 |
| E | 2.67 | 133 | 1.00 | 4 |
| G | 4.00 | 200 | 1.50 | 6 |
| 4 | 5.33 | 267 | 2.00 | 8 |
| 5 | 8.00 | 400 | 3.00 | 12 |
| 6 | 10.00 | 500 | 4.00 | 16 |

M Interpolation factor = 10

| Value for X | Max. traversing speed (in m/s) | Max. scanning frequency of the measuring system (in kHz) | Min. counting frequency of the evaluation electronics without 4-edge evaluation (in MHz) | Min. counting frequency of the evaluation electronics with 4-edge evaluation (in MHz) |
|-------------|--------------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| B | 0.33 | 17 | 0.25 | 1 |
| C | 0.67 | 33 | 0.50 | 2 |
| D | 1.00 | 50 | 0.75 | 3 |
| E | 1.33 | 67 | 1.00 | 4 |
| G | 2.00 | 100 | 1.50 | 6 |
| R | 2.67 | 133 | 2.00 | 8 |
| S | 4.00 | 200 | 3.00 | 12 |
| 6 | 5.33 | 267 | 4.00 | 16 |
| 7 | 6.67 | 333 | 5.00 | 20 |
| 8 | 8.00 | 400 | 6.00 | 24 |

The listed values in the charts refer to a grating period (TP) of 20 µm.

I Interpolation factor = 25

| Value for X | Max. traversing speed (in m/s) | Max. scanning frequency of the measuring system (in kHz) | Min. counting frequency of the evaluation electronics without 4-edge evaluation (in MHz) | Min. counting frequency of the evaluation electronics with 4-edge evaluation (in MHz) |
|-------------|--------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| B | 0.13 | 7 | 0.25 | 1 |
| C | 0.27 | 13 | 0.50 | 2 |
| D | 0.40 | 20 | 0.75 | 3 |
| E | 0.53 | 27 | 1.00 | 4 |
| G | 0.80 | 40 | 1.50 | 6 |
| R | 1.07 | 53 | 2.00 | 8 |
| S | 1.60 | 80 | 3.00 | 12 |
| T | 2.13 | 107 | 4.00 | 16 |
| U | 2.67 | 133 | 5.00 | 20 |
| V | 3.20 | 160 | 6.00 | 24 |

N Interpolation factor = 50

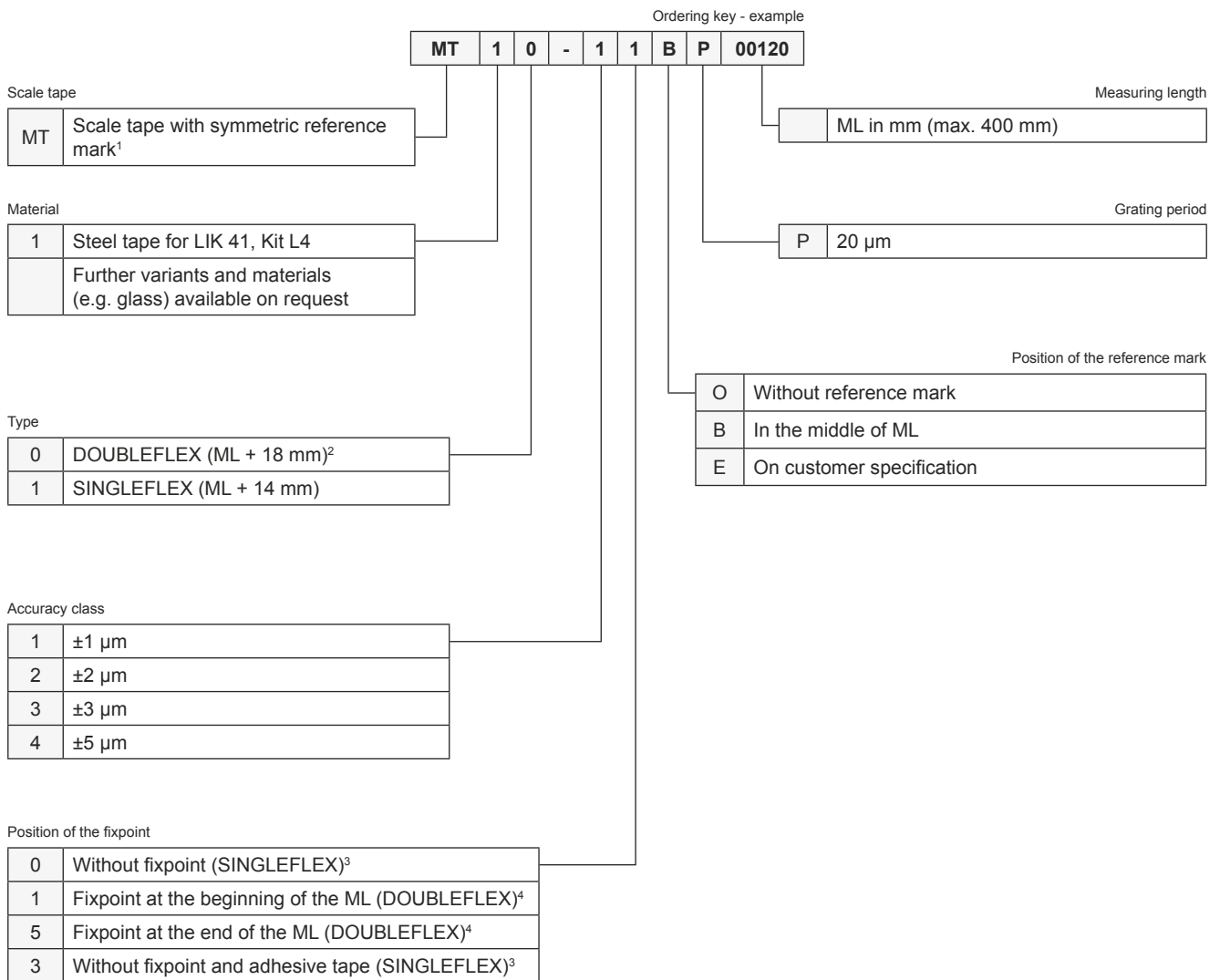
| Value for X | Max. traversing speed (in m/s) | Max. scanning frequency of the measuring system (in kHz) | Min. counting frequency of the evaluation electronics without 4-edge evaluation (in MHz) | Min. counting frequency of the evaluation electronics with 4-edge evaluation (in MHz) |
|-------------|--------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| B | 0.07 | 3 | 0.25 | 1 |
| C | 0.13 | 7 | 0.50 | 2 |
| D | 0.20 | 10 | 0.75 | 3 |
| E | 0.27 | 13 | 1.00 | 4 |
| G | 0.40 | 20 | 1.50 | 6 |
| R | 0.53 | 27 | 2.00 | 8 |
| S | 0.80 | 40 | 3.00 | 12 |
| T | 1.07 | 53 | 4.00 | 16 |
| U | 1.33 | 67 | 5.00 | 20 |
| V | 1.60 | 80 | 6.00 | 24 |

P Interpolation factor = 100

| Value for X | Max. traversing speed (in m/s) | Max. scanning frequency of the measuring system (in kHz) | Min. counting frequency of the evaluation electronics without 4-edge evaluation (in MHz) | Min. counting frequency of the evaluation electronics with 4-edge evaluation (in MHz) |
|-------------|--------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| B | 0.03 | 2 | 0.25 | 1 |
| C | 0.07 | 3 | 0.50 | 2 |
| D | 0.10 | 5 | 0.75 | 3 |
| E | 0.13 | 7 | 1.00 | 4 |
| G | 0.20 | 10 | 1.50 | 6 |
| R | 0.27 | 13 | 2.00 | 8 |
| S | 0.40 | 20 | 3.00 | 12 |
| T | 0.53 | 27 | 4.00 | 16 |
| U | 0.67 | 33 | 5.00 | 20 |
| V | 0.80 | 40 | 6.00 | 24 |

The listed values in the charts refer to a grating period (TP) of 20 µm.

9.3 Scale Tape



¹ This type is suitable for the following measuring systems with one-field scanning: LIK 41, Kit L4

² Min. ML = 100 mm; max. ML = 400 mm

³ Only for SINGLEFLEX scale tape

⁴ Only for DOUBLEFLEX scale tape

ML - Measuring length

TP - Grating period

9.4 ADJUSTMENT TOOL

| Name | Scope of delivery / Description | Order-no. |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| ADJUSTMENT TOOL | <ul style="list-style-type: none"> • ADJUSTMENT TOOL black box • Diagnostic cable to connect the measuring system • USB cable to connect a PC • USB - D-SUB - adapter cable (15-pin) • Exchangeable 8-pin plug connectors | 344220-33 |

Optional Single Components

| Name | Description | Order-no. |
|--------------------------------------|----------------------------------------------------------|-----------|
| EPIFLEX software - USB flash drive | External flash drive with saved EPIFLEX software | 686802-02 |
| USB - D-SUB - adapter cable (15-pin) | to supply the measuring system with voltage via PC | 341693-0M |
| 8-pin plug connector | to connect the diagnostic cable to the diagnostic socket | 348958-01 |



USB - D-SUB - adapter cable (15-pin)

Image 15

Required components (not included):

- PC with OS Windows 7 / 8 (32 or 64 bit)



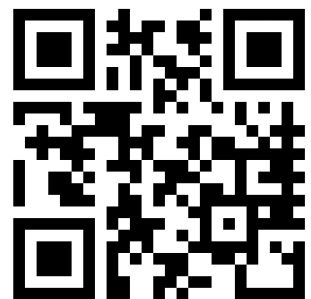
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