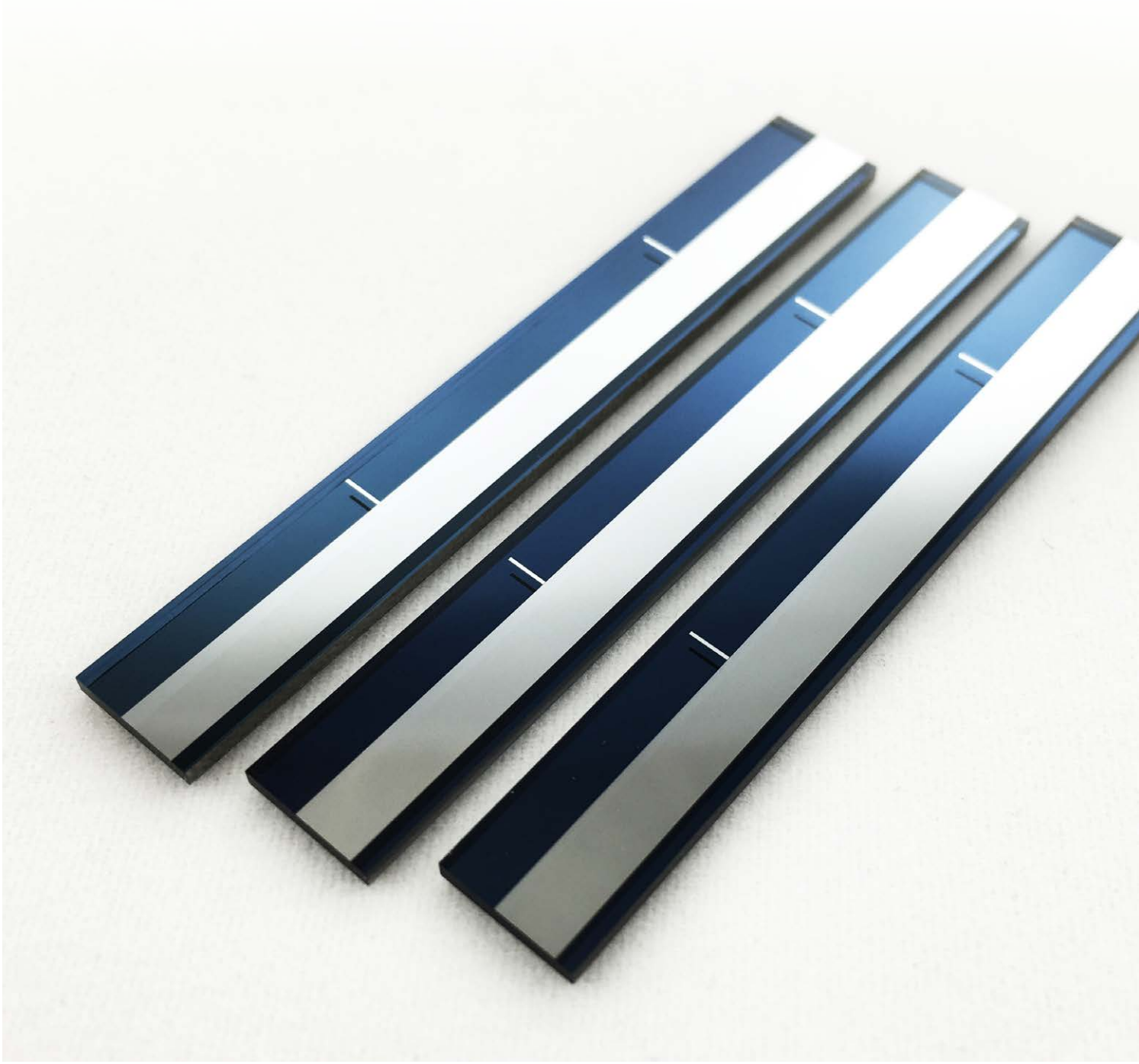
NUMERIK JENA

SIMPLY PRECISE



DATASHEET

# SCALE TAPE

Properties of Linear Scale Tapes

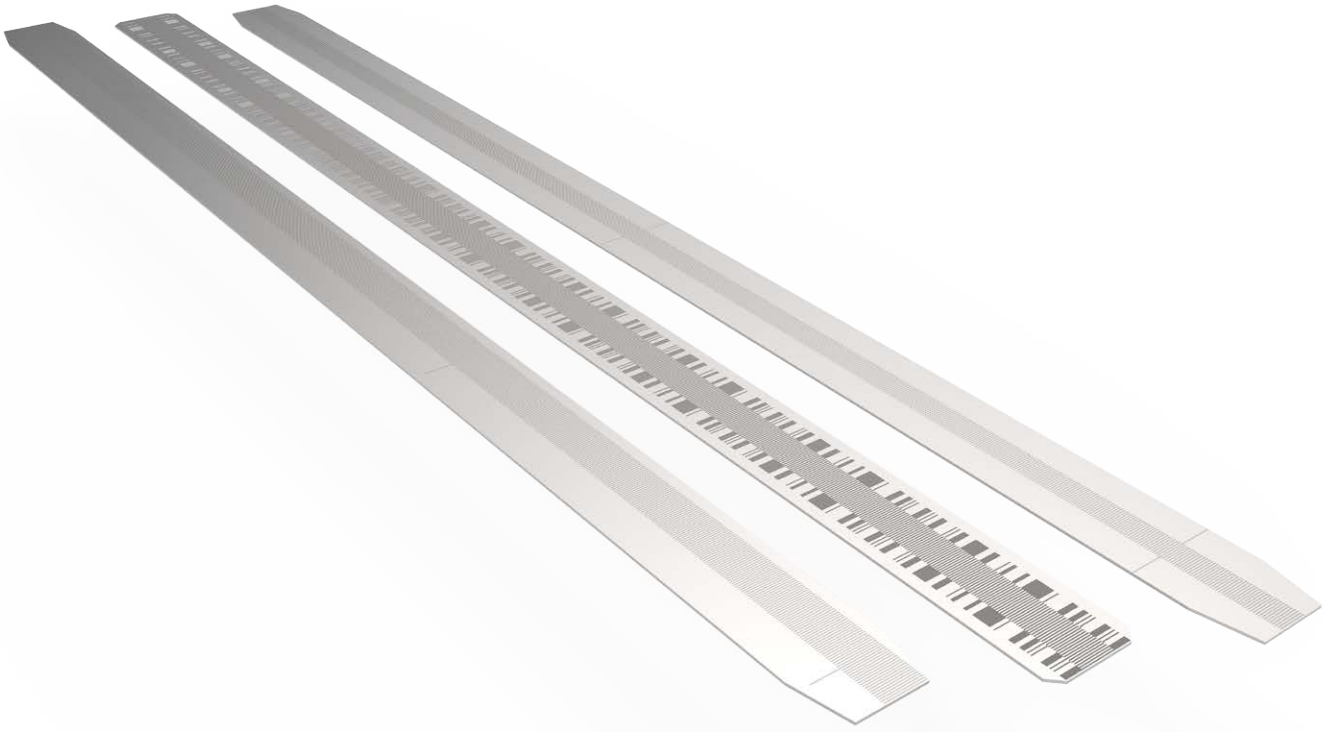
## Index

## 1. Overview

The standards from NUMERIK JENA are available in different types and materials:

- Stainless steel
- Floatglas
- BOROFLOAT® 33 Borosilicate Glass
- ROBAX® Glass ceramic

In the following we have listed the properties of the standards.



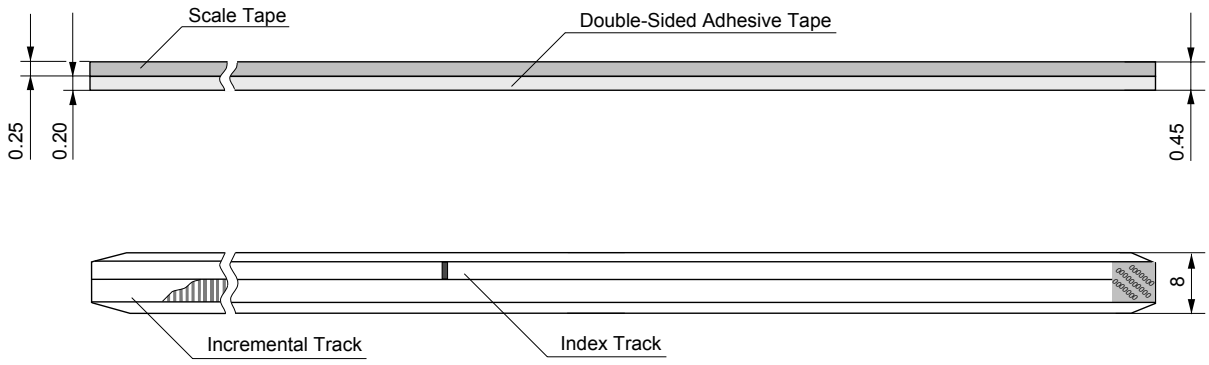
## 2. Steel - Standards

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

- SINGLEFLEX
- DOUBLEFLEX (not suitable for vacuum applications)

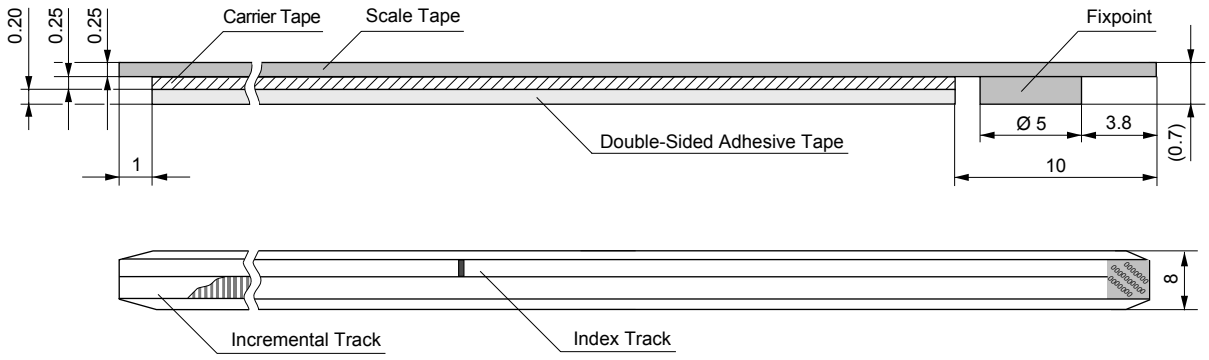
### 2.1. SINGLEFLEX

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




### 2.2. DOUBLEFLEX

The DOUBLEFLEX-scale tape consists of two superimposed stainless 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 or a PRC code 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.



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 you to substract out the deviation of the measurement results.

| Properties - Stainless steel scale tape (directed and polished) | | |
|---|---|---|
| Indication | Sandvik 7C27Mo2 | EN 1.4034 |
| Mechanical Properties | Density ρ (at 25 °C) | 7.7 g/cm$^3$ |
| | Tensile strength | 1730 N/mm$^2$ |
| Thermal Properties | Coefficient of linear thermal expansion α | 10.6 x 10$^{-6}$ K$^{-1}$ |
| | Specific thermal capacity cp $_{(20 - 100\ °C)}$ | 460 J x (kg x K)$^{-1}$ |
| | Specific thermal conductivity λ $_{(20\ °C)}$ | 24 W x (m x K)$^{-1}$ |
| Geometric Properties | Peak-to-valley height of Ra | 10 nm |
| | Width | 8.0 (±0.03) mm |
| | Thickness | 0.254 (±0.004) mm |
| | Flatness | < 0.3 % of width |
| | Straightness | constrained to 1.0 mm/m |
| | Ring bending | < 10 mm / 300 mm |

## 3. Glass - Standards

The standards from NUMERIK JENA are available in different types of glas:

- Floatglas
- BOROFLOAT® 33 Borosilicate Glass
- ROBAX® Glass Ceramic

In the following we have listed the properties of the glas types.

| Properties - Floatglas | | |
|---|---|---|
| Mechanical Properties | Density ρ (at 25 °C) | 2.49 g/cm$^3$ |
| | Young's modulus E (at 25 °C) | 70 kN/mm$^2$ |
| | Poisson's ratio μ | 0.23 |
| Thermal Properties | Coefficient of linear thermal expansion $\alpha_{(0 - 300\ °C)}$ | 9.7 x $10^{-6}$ $K^{-1}$ |
| | Specific thermal capacity $cp_{(20\ °C)}$ | 0.72 KJ x $(kg \times K)^{-1}$ |
| | Point of deformation | 490 °C (± 10 °C) |
| Optical Properties | Refraction index $n_d$ | 1.52 (588 nm) |
| Chemical Properties | Main constituents | SiO2 (69 - 74%), CaO (5 - 12%), NaO (12 - 16%), MgO (0 - 6%), AlO (0 - 3%) |

## Properties - BOROFLOAT® 33 Borosilicate Glass

| | | |
|---|---|---|
| Mechanical Properties | Density ρ (at 25 °C) | 2.2 g/cm$^3$ |
| | Young's modulus E (at 25 °C) | 64 kN/mm$^2$ (to DIN 13316) |
| | Knoop hardness ($^{HK}$ 0.1/20) | 480 (to ISO 9385) |
| | Poisson's ratio μ | 0.2 (to DIN 13316) |
| | Bending strength δ | 25 Mpa (to DIN 52292 T 1) |
| | Impact resistance | The impact resistance of BOROFLOAT® 33 is dependent on the way it is fitted, panel size and thickness, the type of impact it is subjected to and certain other parameters not indicated here. |

| | | |
|---|---|---|
| Thermal Properties | Coefficient of linear thermal expansion $\alpha_{(20 - 180\ °C)}$ | 3.25 x 10$^{-6}$ K$^{-1}$ (to ISO 7991) |
| | Specific thermal capacity cp $_{(20 - 100\ °C)}$ | 0.83 KJ x (kg x K)$^{-1}$ |
| | Specific thermal conductivity λ $_{(90\ °C)}$ | 1.2 W x (m x K)$^{-1}$ |
| | Maximum operating temperature | |
| | for short-term usage δmax $_{(< 10\ h)}$ | 500 °C |
| | for long-term usage δmax $_{(< 10\ h)}$ | 450 °C |
| | Resistance of thermal gradients (RTG) | |
| | 1 - 100 h | 90 K |
| | > 100 h | 80 K |

| | | |
|---|---|---|
| Chemical Properties | Main constituents | $SiO_2$ (81%), $Al_2O_3$ (2%), $Na_2O/K_2O$ (4%), $B_2O_3$ (13%) |
| | Hydrolytic resistance | |
| | to ISO 719 / DIN 12 111 | Class HGB 1 |
| | to ISO 720 | Class HGA 1 |
| | Acid resistance | |
| | to ISO 1776 / DIN 12 116 | 1 |
| | Alkali resistance | |
| | to ISO 695 / DIN 52 322 | A2 |

## Properties - ROBAX® Glass Ceramic

| | | |
|---|---|---|
| Mechanical Properties | Density ρ (bei 25 °C) | 2.6 g/cm$^3$ |
| | Young's modulus E | 93 kN/mm$^2$ (to DIN 13316) |
| | Poisson's ratio μ | 0.25 (to DIN 13316) |
| | Bending strength δ | 35 Mpa (to DIN 52292 T 1) |
| | Impact resistance | The strength of glass ceramic is material constant. It is dependent on the size and thickness of the panel, the finish condition (edge working, drillings, etc.), usage conditions, (kind and distribution of defects on the surface), and the time related and kind of impact load and the type of panel installation. |
| Thermal Properties | Coefficient of mean linear thermal expansion $\alpha_{(20 - 700\ °C)}$ | (0 ± 0.5) x 10$^{-6}$ K$^{-1}$ |
| | Specific heat $c_p$ $_{(20 - 100\ °C)}$ | 0.8 x 10$^3$ J x (kg x K)$^{-1}$ |
| | Thermal conductivity $\lambda_{(90\ °C)}$ | 1.6 W x (m x K)$^{-1}$ |
| Chemical Properties | The chemical composition of ROBAX® complies with the requirements for glass ceramic in accordance with EM 1748 T2. ROBAX® is made of ecologically safe raw materials. The glass can be re-used through recycling of the material. | |

Please find further information of our linear measuring systems in the respective data sheets or visit our website www.numerikjena.com.

## 4. 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!

## 5. Ordering Key - MV (incremental)

Ordering key - example

| MV | 5 | 0 | - | 1 | 1 | B | P | 00770 |
|---|---|---|---|---|---|---|---|---|

Scale tape

| | |
|---|---|
| MV | Scale tape with asymmetric reference mark[1] |

Material

| | |
|---|---|
| 5 | Stainless Steel |
| | Further types and materials on request |

Type

| | |
|---|---|
| 0 | DOUBLEFLEX[2] |
| 1 | SINGLEFLEX[3] |
| 2 | DOUBLEFLEX + Guide Tape[2] |
| 3 | SINGLEFLEX + Guide Tape[3] |
| B | SINGLEFLEX + QUICK GUIDE[4] |

Accuracy class

| | |
|---|---|
| 1 | ±1 µm[5] |
| 2 | ±2 µm[5] |
| 3 | ±3 µm |
| 4 | ±5 µm |

Position of the fixpoint

| | |
|---|---|
| 0 | Without fixpoint (SINGLEFLEX)[6] |
| 1 | Fixpoint at the beginning of the ML (DOUBLEFLEX)[7] |
| 5 | Fixpoint at the end of the ML (DOUBLEFLEX)[7, 8] |
| 3 | Without fixpoint and adhesive tape (SINGLEFLEX)[6] |

Position of the index mark

| | |
|---|---|
| O | Without index mark |
| B | In the middle of ML |
| E | On customer specification |
| F | Distance coded at 1000 x TP[9] |
| N | At 50 mm spacings starting in the middle of ML |

Grating period

| | |
|---|---|
| P | 20 µm |

Measuring length

| | |
|---|---|
| | ML in mm[10] |

[1] This type is suitable for the following measurings systems with two-field scanning: LIA 20/21, LIK 21/22/23, Kit L2
[2] DOUBLEFLEX min. ML = 100 mm; max. ML = 5,000 mm
[3] SINGLEFLEX max. ML = 30,000 mm
[4] SINGLEFLEX + GUICK GUIDE max. ML = 1,950 mm
[5] Max. ML = 500 mm
[6] Only for SINGLEFLEX scale tape
[7] Only for DOUBLEFLEX scale tape
[8] Only for LIA 20
[9] SINGLEFLEX max. ML = 8,750 mm / DOUBLEFLEX max. ML = 5,000 mm
[10] Total length = ML + x (SINGLEFLEX x = 30 mm, DOUBLEFLEX x = 30 mm, QUICK GUIDE x = 52 mm)

ML - Measuring length
TP - Grating period

## 6. Ordering Key - MT (incremental)

Ordering key - example

| MT | 1 | 0 | - | 1 | 1 | B | P | 00120 |
|---|---|---|---|---|---|---|---|---|

Scale tape

| | |
|---|---|
| MT | Scale tape with symmetric reference mark[1] |

Material

| | |
|---|---|
| 1 | Stainless Steel |
| | Further variants and materials (e.g. glass) available on request |

Type

| | |
|---|---|
| 0 | DOUBLEFLEX[2] |
| 1 | SINGLEFLEX |

Accuracy class

| | |
|---|---|
| 1 | ±1 µm |
| 2 | ±2 µm |
| 3 | ±3 µm |
| 4 | ±5 µm |

Position of the fixpoint

| | |
|---|---|
| 0 | Without fixpoint (SINGLEFLEX)[3] |
| 1 | Fixpoint at the beginning of the ML (DOUBLEFLEX)[4] |
| 5 | Fixpoint at the end of the ML (DOUBLEFLEX)[4] |
| 3 | Without fixpoint and adhesive tape (SINGLEFLEX)[3] |

Position of the index mark

| | |
|---|---|
| O | Without index mark |
| B | In the middle of ML |
| E | On customer specification |

Grating period

| | |
|---|---|
| P | 20 µm |

Measuring length

| | |
|---|---|
| | ML in mm (max. 400 mm)[5] |

[1] This type is suitable for the following measurings 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
[5] Total length = ML + x (SINGLEFLEX x = 14 mm, DOUBLEFLEX x = 18 mm)

ML - Measuring length

## 7. Ordering Key - MA (absolute)

Ordering key - example

| MA | 1 | 1 | - | 3 | 0 | 0 | P | 00100 |
|---|---|---|---|---|---|---|---|---|

Scale tape

| | |
|---|---|
| MA | Scale tape for absolute encoders |

Material

| | |
|---|---|
| 1 | Stainless steel |

Type

| | |
|---|---|
| 0 | DOUBLEFLEX[1,2] |
| 1 | SINGLEFLEX |
| 2 | DOUBLEFLEX with guide tape[1,2] |
| 3 | SINGLEFLEX with guide tape |
| 4 | QUICK GUIDE[3] |

Accuracy class

| | |
|---|---|
| 3 | ±3 µm |

Position of the fixpoint / Mounting

| | |
|---|---|
| 0 | Without fixpoint[4] |
| 1 | Fixpoint at the beginning of the ML[5] |
| 5 | Fixpoint at the end of the ML[6] |
| 3 | w/o double-sided adhesive tape[4] |

Measuring length

| | |
|---|---|
| | ML in mm (max. 1,200 mm)[7] |

Grating period of the incremental track

| | |
|---|---|
| P | 20 µm |

Encoding of position

| | |
|---|---|
| 0 | max. 1,200 m measuring length |

[1] Min. ML = 100 mm; max. ML = 1,200 mm
[2] Not suitable for vacuum applications
[3] In combination with fixpoint at the beginning of the ML only
[4] Only for SINGLEFLEX
[5] Only for DOUBLEFLEX scale tapes and QUICK GUIDE
[6] Only for DOUBLEFLEX scale tapes
[7] Total length = ML + x (SINGLEFLEX x = 17 mm, DOUBLEFLEX x = 25 mm, QUICK GUIDE x = 33 mm)

ML - Measuring length

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