



RIK

Rotary Encoder System

**Compact Model
Range**

Incremental rotary encoder

Features

- Compact design, consisting of scanning head with round cable, 15pin D-sub connector and grating disk
- Minimum dimensions
- Low mass moment of inertia of the grating disk
- High measuring speed
- Dynamic offset and amplitude control
- Optionally: signal interpolation up to 100x in the connector
- electronic signal adjustment possible

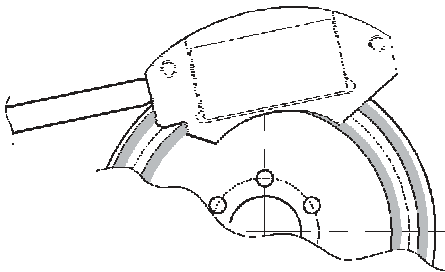
Fields of application

Fields of application where rotational movements, angles or revolutions must be measured in confined installation conditions:

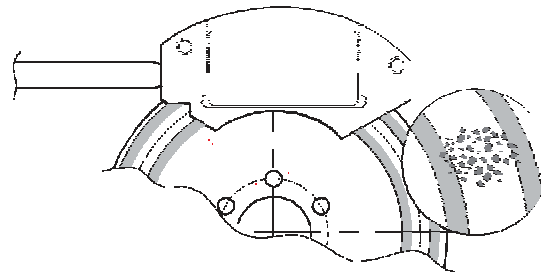
- Automation technology
- Rotary axes
- Drive systems, especially direct drives and torque motors
- Instruments and machines used in semiconductor industry
- Robot and handling technology
- High-precision engineering
- Metrology
- Medical technology

Dynamic offset and amplitude control

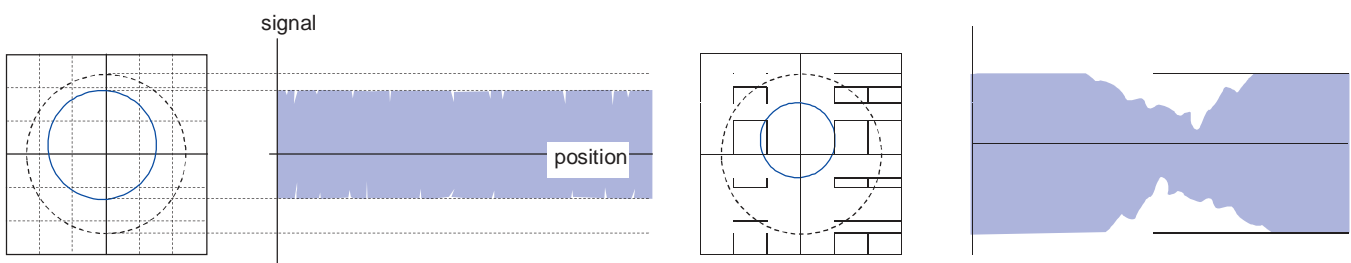
Incorrect mounting



Contaminated grating disk



Scanning signal before offset and amplitude correction

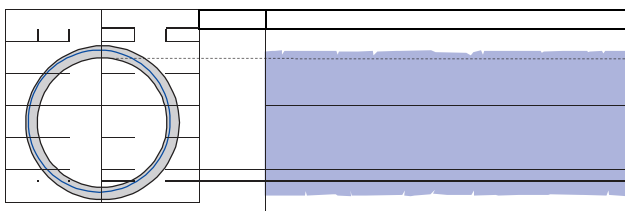


Contamination and mounting errors lead to interferences in the optical scanning of the grating disk by the scanning head and so to periodic deformations of the sinusoidal counting track signals.

These deformations manifest themselves as

- offset deviations and
 - amplitude deviations, as well as
 - amplitude differences between the sine and cosine channel
- and lead to interpolation errors, which determines noise and heat in direct drives.

Scanning signal after offset and amplitude correction



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.

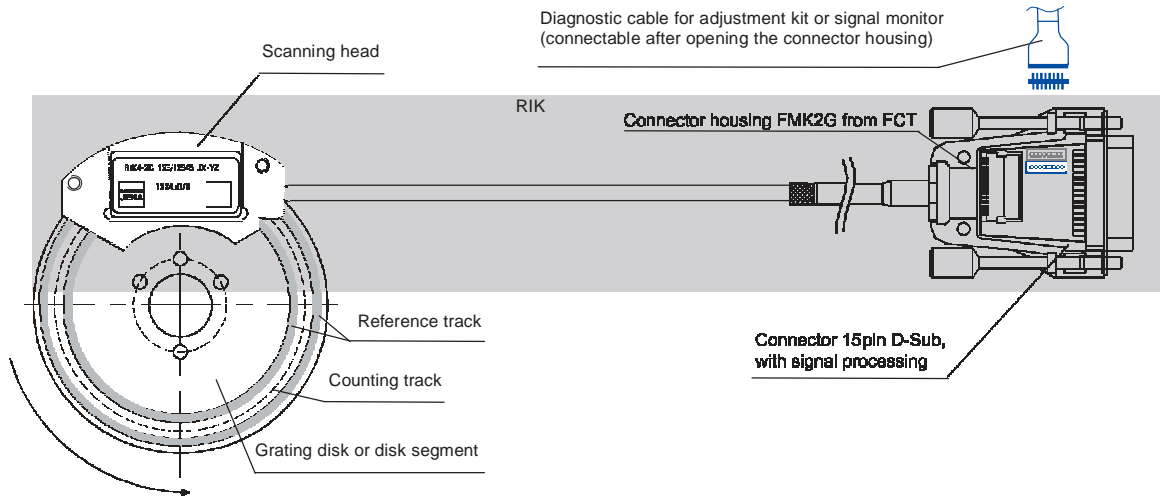
Installation dimensions

RIK encoder

Designation example:

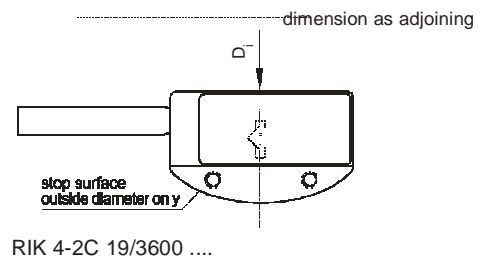
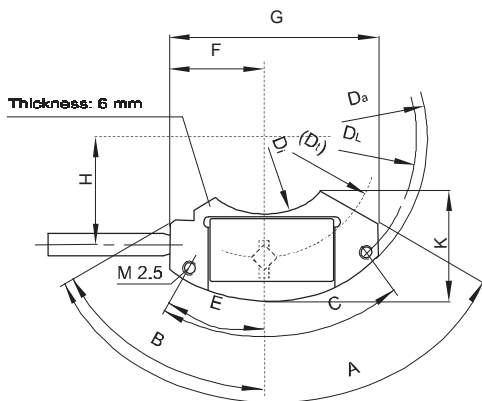
RIK scanning head RIK4 - 2 C 39/3600 L 4 - T Z (see page 8)

Grating disk RS 39/10/3600 (see page 5)



Scanning head

Standard C according to ordering key:



D_a Scanning head - outside diameter

D_t middle diameter of grating

D_i Scanning head - inside diameter

D_L Scanning head - diameter for borings of the mounting screws

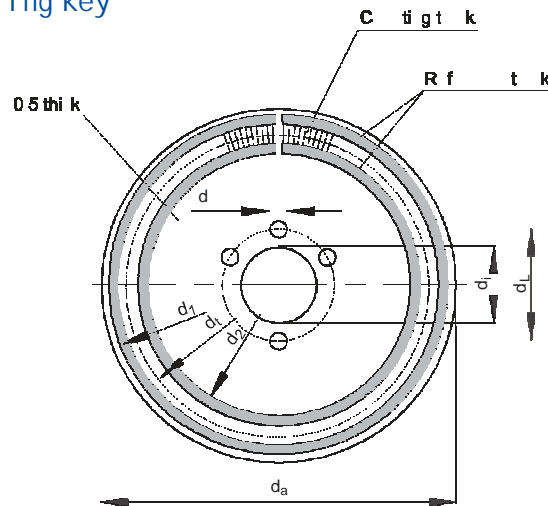
| Type | D_a | D_t | D_i | D_L | A | B | C | E | F | G | H | K |
|------|-------------------|-------|--------------------|-----------|------|-----|-----|-----|----|----|----|------|
| 19 | 38 _{h6} | 19 | 4 mm* | 34 ± 0.1 | - | - | 44° | 22° | 12 | 24 | 8 | 15.0 |
| 29 | 45 _{h6} | 29 | 16 ^{H6} | 41 ± 0.1 | 120° | 60° | 82° | 34° | 16 | 34 | 13 | 18.8 |
| 39 | 55 _{h6} | 39 | 26 ^{H6} | 51 ± 0.1 | 120° | 60° | 70° | 30° | 16 | 35 | 18 | 18.6 |
| 64 | 82 _{h6} | 64 | 50.8 ^{H6} | 77 ± 0.1 | 90° | 45° | 44° | 22° | 18 | 36 | 30 | 19.2 |
| 92 | 110 _{h6} | 92 | 78 ^{H6} | 106 ± 0.1 | 90° | 45° | 34° | 17° | 18 | 36 | 44 | 18.5 |
| 142 | 160 _{h6} | 142 | 126 ^{H6} | 156 ± 0.1 | 90° | 45° | 22° | 11° | 18 | 36 | 69 | 18.7 |
| 192 | 210 _{h6} | 192 | 180 ^{H6} | 206 ± 0.1 | - | - | 10° | 5° | 13 | 26 | 94 | 15.8 |

*distance to the center, do not use as datum dimension

Installation dimensions

Grating disks available—Ordering key

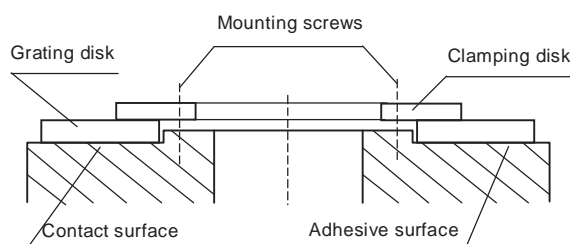
Material: aluminium



| Type-Ordering key | d_i | d_a | d_t | d_1 | d_2 | d_L | d | Z |
|-------------------|--------------|---------------------|-------|-------|-------|-------|-----|-------|
| RS 19/6/3600 | $6 + 0.1$ | $26^{+0.2}_{-0.5}$ | 19 | 24 | 14 | - | - | 3600 |
| RS 29/16/900 | $16 + 0.1$ | $36^{+0.2}_{-0.5}$ | 29 | 34 | 24 | - | - | 900 |
| RS 29/16/1000 | $16 + 0.1$ | $36^{+0.2}_{-0.5}$ | 29 | 34 | 24 | - | - | 1000 |
| RS 39/10/1800 | $10 M5$ | $46^{+0.2}_{-0.5}$ | 39 | 44 | 34 | 14.5 | 2.3 | 1800 |
| RS 39/10/2048 | $10 M5$ | $46^{+0.2}_{-0.5}$ | 39 | 44 | 34 | 14.5 | 2.3 | 2048 |
| RS 39/10/3600 | $10 M5$ | $46^{+0.2}_{-0.5}$ | 39 | 44 | 34 | 14.5 | 2.3 | 3600 |
| RS 39/25/1800 | $25 + 0.1$ | $46^{+0.2}_{-0.5}$ | 39 | 44 | 34 | - | - | 1800 |
| RS 39/25/2048 | $25 + 0.1$ | $46^{+0.2}_{-0.5}$ | 39 | 44 | 34 | - | - | 2048 |
| RS 39/25/3600 | $25 + 0.1$ | $46^{+0.2}_{-0.5}$ | 39 | 44 | 34 | - | - | 3600 |
| RS 64/48.5/2048 | $48.5 + 0.1$ | $71^{+0.2}_{-0.5}$ | 64 | 69 | 59 | - | - | 2048 |
| RS 64/48.5/9000 | $48.5 + 0.1$ | $71^{+0.2}_{-0.5}$ | 64 | 69 | 59 | - | - | 9000 |
| RS 64/48.5/10000 | $48.5 + 0.1$ | $71^{+0.2}_{-0.5}$ | 64 | 69 | 59 | - | - | 10000 |
| RS 92/70/3600 | $70 + 0.1$ | $100^{+0.2}_{-0.5}$ | 92 | 97 | 87 | - | - | 3600 |
| RS 92/70/9000 | $70 + 0.1$ | $100^{+0.2}_{-0.5}$ | 92 | 97 | 87 | - | - | 9000 |
| RS 92/70/18000 | $70 + 0.1$ | $100^{+0.2}_{-0.5}$ | 92 | 97 | 87 | - | - | 18000 |
| RS 142/120/5400 | $120 + 0.2$ | $150^{+0.2}_{-0.5}$ | 142 | 147 | 137 | - | - | 5400 |
| RS 142/120/18000 | $120 + 0.2$ | $150^{+0.2}_{-0.5}$ | 142 | 147 | 137 | - | - | 18000 |
| RS 192/160/24000 | $160 + 0.2$ | $200^{+0.2}_{-0.5}$ | 192 | 197 | 187 | - | - | 24000 |

| | | | |
|-------|------------------------------------|-------|--|
| d_i | Grating disk – inside diameter | d_2 | Reference track – inside diameter |
| d_a | Grating disk – outside diameter | d_L | Grating disk – diameter for borings of the mounting screws |
| d_t | Counting track – center diameter | d | Diameter of the borings |
| d_1 | Reference track – outside diameter | Z | Number of lines of the grating disk |

Proposed mounting of grating disk

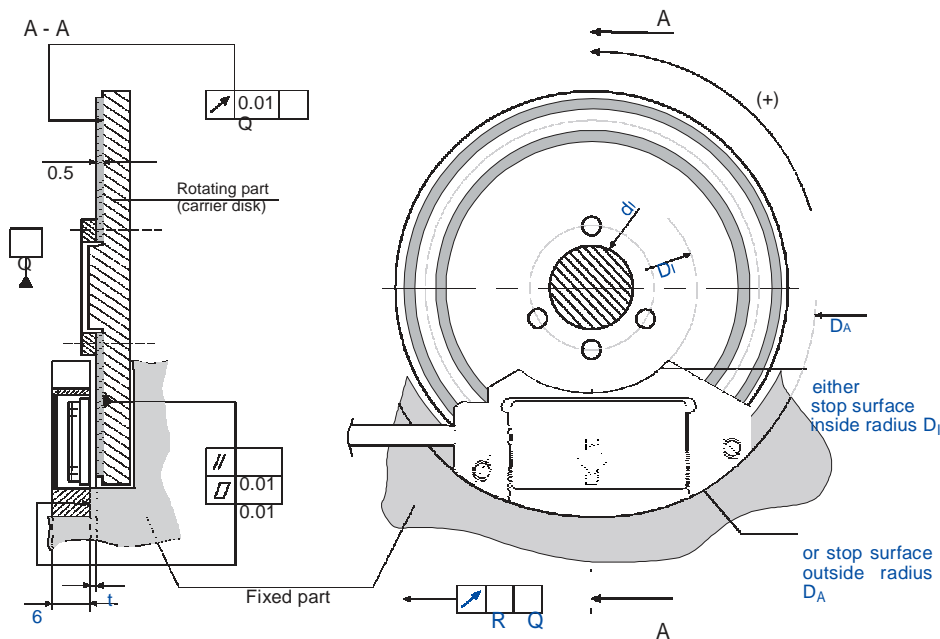


*) Recommended material:
 - light metal surface treated
 - stainless steel passivated

Clamping only for RS 39/10/... otherwise full-surface bonding (without clamping disk)

Installation dimensions

Dimensions and tolerance limits to be observed by the user to ensure proper functioning, without angular error being taken into account



| Type | D_A | D_I | d_I | R^* | R^{**} | t |
|------------------|-----------|------------|-----------|-------|----------|----------------|
| RS 19/6/3600 | 38 H_6 | - | - | - | - | 0.5 ± 0.02 |
| RS 29/16/900 | 45 H_6 | 16 h_6 | - | 0.015 | - | 0.6 ± 0.05 |
| RS 29/16/1000 | 45 H_6 | 16 h_6 | - | 0.015 | - | 0.7 ± 0.05 |
| RS 39/10/1800 | 55 H_6 | 26 h_6 | 10 fg_4 | - | 0.01 | 0.5 ± 0.05 |
| RS 39/10/2048 | 55 H_6 | 26 h_6 | 10 fg_4 | - | 0.01 | 0.7 ± 0.05 |
| RS 39/10/3600 | 55 H_6 | 26 h_6 | 10 fg_4 | - | 0.01 | 0.4 ± 0.05 |
| RS 39/25/1800 | 55 H_6 | 26 h_6 | - | 0.015 | - | 0.5 ± 0.05 |
| RS 39/25/2048 | 55 H_6 | 26 h_6 | - | 0.015 | - | 0.7 ± 0.05 |
| RS 39/25/3600 | 55 H_6 | 26 h_6 | - | 0.015 | - | 0.4 ± 0.05 |
| RS 64/48.5/2048 | 82 H_6 | 50.8 h_6 | - | 0.015 | - | 0.8 ± 0.05 |
| RS 64/48.5/9000 | 82 H_6 | 50.8 h_6 | - | 0.015 | - | 0.9 ± 0.05 |
| RS 64/48.5/10000 | 82 H_6 | 50.8 h_6 | - | 0.015 | - | 0.7 ± 0.05 |
| RS 92/70/3600 | 110 H_6 | 78 h_6 | - | 0.015 | - | 0.5 ± 0.05 |
| RS 92/70/9000 | 110 H_6 | 78 h_6 | - | 0.015 | - | 0.4 ± 0.05 |
| RS 92/70/18000 | 110 H_6 | 78 h_6 | - | 0.015 | - | 0.4 ± 0.05 |
| RS 142/120/5400 | 160 H_6 | 126 h_6 | - | 0.015 | - | 0.8 ± 0.05 |
| RS 142/120/18000 | 160 H_6 | 126 h_6 | - | 0.015 | - | 1.2 ± 0.05 |
| RS 192/160/24000 | 210 H_6 | 180 h_6 | - | 0.015 | - | 1.1 ± 0.05 |

D_A Stop surface - outside diameter (for scanning head) R^* Grating disk - radial eccentricity of the graduation
 D_I Stop surface - inside diameter (for scanning head) R^{**} Radial eccentricity of the disk bearing
 d_I Diameter of the axis t Working distance

Assembly information!

The functionality of the system is warranted if the diameter d_I is aligned to the rotary axis Q so that the concentricity R^* is fulfilled (if a higher accuracy is required, please refer to page 7, section "system accuracy"). It is not sufficient to use the diameters d_a or d_i for mechanical alignment.

NJ provides the possibility to adjust the grating disc on a carrier disc. For this reason it is necessary to provide the carrier disc with a tight tolerated inner or outer diameter. The diameter has to be visible from the top view. The whole assembly will be attached to the rotating machine part.

Accuracy

Resolution

Resolution A is defined as the smallest angular value which is still detected by the evaluating electronics (display, control) when the grating disk is turned relative to measuring head.

The resolution can be calculated using the following formula:

$$A = Z \cdot i \cdot N \quad [\text{increments/revolution}]$$

$$A = \frac{360^\circ}{Z \cdot i \cdot N} \quad [\text{degrees}]$$

N

Z the number of lines on the grating disk
i interpolation factor of the connector board (5x, 10x, 25x, 50x or 100x)

N factor for evaluation mode in the counter

N = 1 for single-edged evaluation
N = 2 for double-edged evaluation
N = 4 for quad-edged evaluation

System accuracy

Accuracy (extremes of direction deviations) is affected by

- graduation errors of the grating disk
- eccentricity of the graduation relative to the axis bearing
- radial eccentricity of the axis bearing
- deviations in the positions of the grating disk and the measuring head (installation tolerance)
- interpolation error in signal processing

The accuracy is largely determined by the eccentricity of the graduation relative to the axis bearing and the radial eccentricity of the axis bearing.

The error resulting from these factors is calculated using the following formula:

$$\Delta\varphi = \pm 412 \frac{e}{D}$$

$\Delta\varphi$ angular error [seconds of arc]
e eccentricity of the graduation relative to the axis of rotation including the radial eccentricity of the axis bearing [μm]
D graduation diameter of the grating disk [mm]

Signal adjustment

The EPIFLEX measuring module can be adjusted to the particular mounting conditions with an electronic fine adjustment. This provides optimal output signals and a reduced interpolation error.

Using the RIK encoder system with 25x interpolation or higher, the electronic signal adjustment is recommended.

The signal adjustment can be done with the following devices:

- Adjustment Kit in connection with an oscilloscope and a PC or
- Signal monitor

Maximum speed

The maximum speed for system versions with interpolation is limited by the system resolution and the input frequency of the evaluation electronics. It can be calculated with the following formula:

$$n_{\max} = \frac{f [\text{MHz}] \cdot 60}{1,000,000 \cdot I \cdot \text{SF} \cdot 4 \cdot Z} \quad [\text{U/min}]$$

f signal input frequency of the evaluation electronics at 4 time evaluation

Z Number of lines

SF Safety coefficient = 1.5

I Interpolation factor

This correlation is stated with the position "X" in the ordering key. If the speed and input frequency are specified the according identifier can be completed by NUMERIK JENA.

For system versions without interpolation the speed is limited by the maximum scanning frequency (500 kHz) of the sensor.

Ordering key

For ordering the grating disk please use the ordering key on page 5.

Designation example
scanning head:

RIK 4 - 2 C 39/3600 L 4 - T Z

Type of sensor

4 one-field - 13 x 8 - SV3

Housing – version of attachment

2 thread M 2.5

Type of housing

C aluminium

Disks

| Optical diameter of graduation | Number of lines |
|--------------------------------|-----------------|
| 19 | 3600 |
| 29 | 900 |
| 29 | 1000 |
| 39 | 1800 |
| 39 | 2048 |
| 39 | 3600 |
| 64 | 2048 |
| 64 | 9000 |
| 64 | 10000 |
| 92 | 3600 |
| 92 | 9000 |
| 92 | 18000 |
| 142 | 5400 |
| 142 | 18000 |
| 192 | 24000 |

Connector type

Z 15pin D-sub; signal processing in the connector (RS 422, 1 V_{PP})

Cable Ø 3.7 mm

| | |
|----------------|-------------------|
| R | 0.3 m |
| S | 0.5 m |
| T | 1.0 m |
| P | 1.5 m |
| V | 2.0 m |
| W | 3.0 m |
| U ¹ | others on request |

Encoder version*

| | |
|----------------|----------------------------|
| - | standard |
| 3 ¹ | non-magnetic scanning head |

Speed factor

| | |
|---|---|
| X | Customer-specific value, depending on the max. speed and max. input frequency of the evaluation electronics; consult NUMERIK JENA |
|---|---|

Interface – output signals

| | |
|----------------|--|
| C | sinusoidal 1 V _{PP} |
| K | RS 422 square wave without interpolation |
| L | RS 422 square wave with interpolation 5x M |
| | RS 422 square wave with interpolation 10x |
| I ² | RS 422 square wave with interpolation 25x |
| N ² | RS 422 square wave with interpolation 50x |
| P ² | RS 422 square wave with interpolation 100x |

1 Supplied for a surcharge

2 Electronic adjustment recommended; requires adjustment kit or signal monitor

* The RIK is also available as vacuum version for pressure ranges up to 10⁻⁹ mbar. The according datasheet can be downloaded at www.numerikjena.de.

Technical specification

| Mechanical data | | Electrical data | | | | | | | | | | | | | | |
|--|---|--|---|-----------------|-----------------|-----------------|---|-----|-----|----|----|-----------------|-----------------|-----------------|----|---------|
| Weight of scanning head without cable | 5.5 g | Scanning frequency | max. 500 kHz | | | | | | | | | | | | | |
| Number of revolutions (see page 7) - without interpolation, e.g. for 1800 numbers of lines - with interpolation 50x e.g. for 1800 numbers of lines | 16,600 U/min 2,400 U/min | Output interfaces - voltage output - square wave output | 1 V _{PP} RS 422 with interpolation up to 100x | | | | | | | | | | | | | |
| Number of lines of the grating disks | 900 ... 24,000 | Connector | 15pin D-sub plug | | | | | | | | | | | | | |
| Number of counting pulses per revolution (including signal interpolation and quad-edged evaluation) | up to 9,600,000 | Supply voltage | 5 V ± 10% | | | | | | | | | | | | | |
| | | Power consumption - voltage output - square wave output | < 50 mA < 150 mA | | | | | | | | | | | | | |
| Diameter of grating disks (Diameter of graduation) | 19.0 mm 29.0 mm 39.0 mm 64.0 mm 92.0 mm 142.0 mm 192.0 mm | Cable diameter | 3.7 mm | | | | | | | | | | | | | |
| | | Cable lengths (cable fixed to the scanning head) - standard lengths - extension cable with 15pin D-sub female possible | 0.3 m; 0.5 m; 1.0 m 1.5 m; 2.0 m; 3.0 m max. 100 m (on request) | | | | | | | | | | | | | |
| Ambient conditions | | | | | | | | | | | | | | | | |
| Operating temperature range | 0°C ... +55°C | | | | | | | | | | | | | | | |
| Storage temperature range | -20°C ... +70°C | | | | | | | | | | | | | | | |
| Vibration (50 Hz ... 2000 Hz) | ≤ 200 ms ⁻² | Permissible bending radius of cables - occasional flexing - constant flexing | 8 mm 40 mm | | | | | | | | | | | | | |
| Shock (11 ms) | ≤ 400 ms ⁻² | | | | | | | | | | | | | | | |
| Humidity | 93% RH (no condensation) | | | | | | | | | | | | | | | |
| Standard pin assignment: 15pin D-sub plug | | | | | | | | | | | | | | | | |
| 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 | R- | B- | A- | - | 5 V | 0 V | - | AS | R+ | B+ | A+ | - | Shield |
| Colour | - | - | VT | PK | RD | BN | - | BU | WH | - | - | GY | BK | GN | - | - |

