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# **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

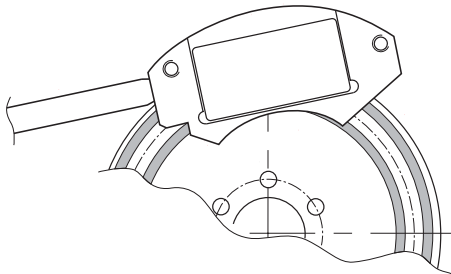
### Fields of application

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

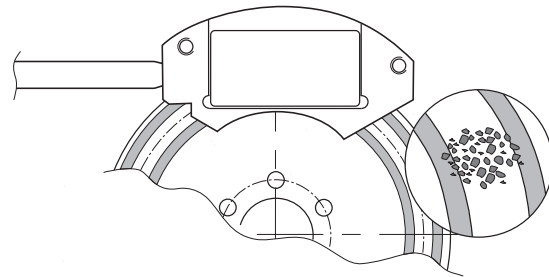
- Automation technology
- Rotary axes
- Drive systems, especially direct drives and torque motors
- Instruments and machines used in semiconductor industry
- Robot and handling technology
- High-precision engineering
- Metrology
- Medical technology

## Dynamic offset and amplitude control

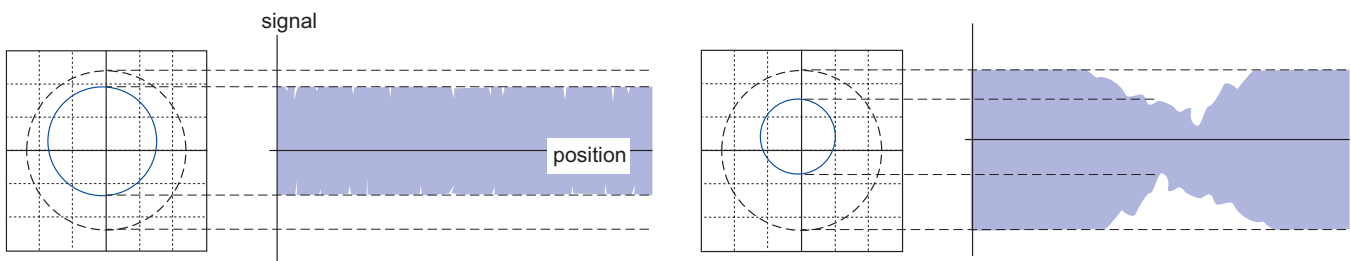
### Incorrect mounting



### Contaminated grating disk



### Scanning signal before offset and amplitude correction



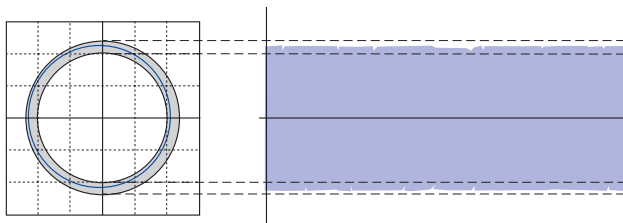
Contamination and mounting errors lead to interferences in the optical scanning of the grating disk by the scanning head and so to periodic deformations of the sinusoidal counting track signals.

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

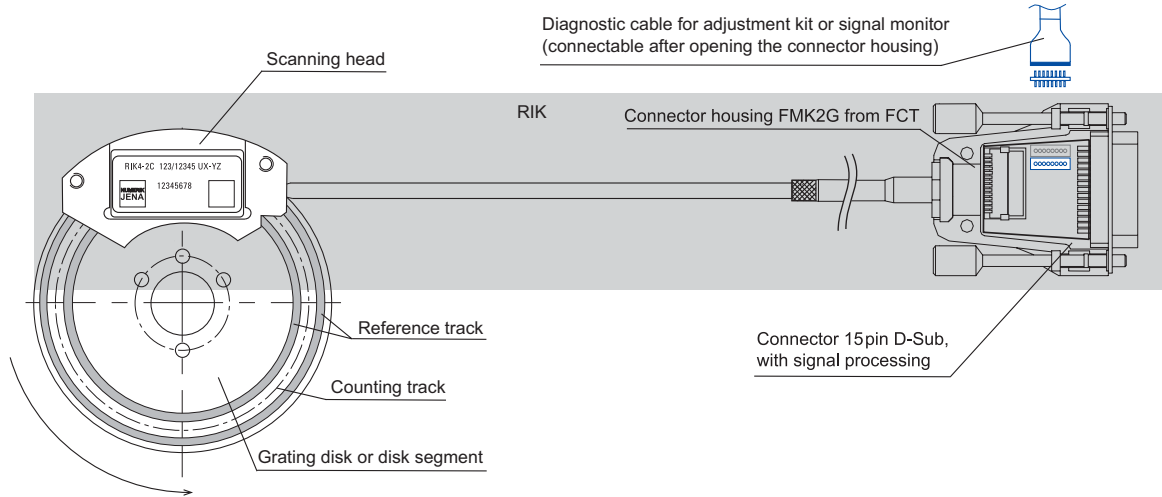
## RIK encoder

Designation example:

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

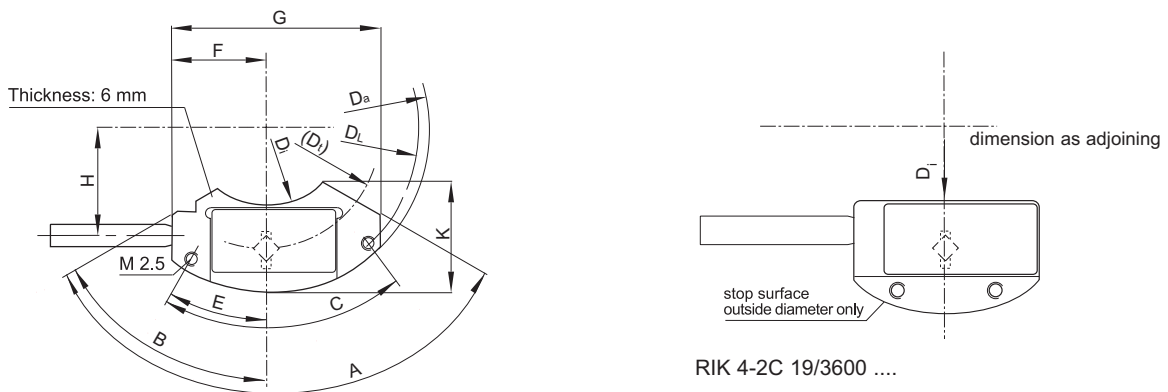
(EPIFLEX measuring module fixed in the scanning head, round cable with 15pin D-sub plug)

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



## Scanning head

Standard C according to ordering key:



$D_a$  Scanning head - outside diameter

$D_i$  Scanning head - inside diameter

$D_t$  middle diameter of grating

$D_L$  Scanning head - diameter for borings of the mounting screws

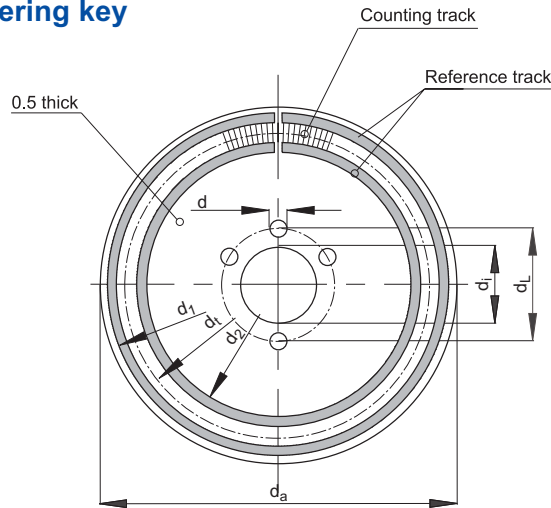
Type	$D_a$	$D_t$	$D_i$	$D_L$	A	B	C	E	F	G	H	K
19	38 <sub>h6</sub>	19	4 mm*	34 ± 0.1	-	-	44°	22°	12	24	8	15.0
29	45 <sub>h6</sub>	29	16 H6	41 ± 0.1	120°	60°	82°	34°	16	34	13	18.8
39	55 <sub>h6</sub>	39	26 H6	51 ± 0.1	120°	60°	70°	30°	16	35	18	18.6
64	82 <sub>h6</sub>	64	50.8 H6	77 ± 0.1	90°	45°	44°	22°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

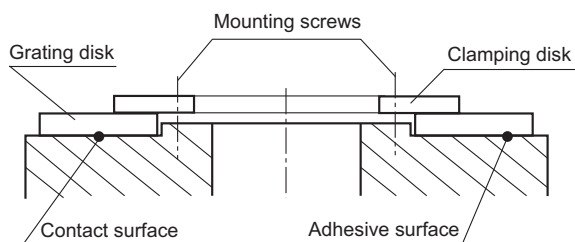
Material: aluminium



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 <sup>-0.2</sup> <sub>-0.5</sub>	19	24	14	-	-	3600
RS 29/16/900	16 + 0.1	36 <sup>-0.2</sup> <sub>-0.5</sub>	29	34	24	-	-	900
RS 29/16/1000	16 + 0.1	36 <sup>-0.2</sup> <sub>-0.5</sub>	29	34	24	-	-	1000
RS 39/10/1800	10 M5	46 <sup>-0.2</sup> <sub>-0.5</sub>	39	44	34	14.5	2.3	1800
RS 39/10/2048	10 M5	46 <sup>-0.2</sup> <sub>-0.5</sub>	39	44	34	14.5	2.3	2048
RS 39/10/3600	10 M5	46 <sup>-0.2</sup> <sub>-0.5</sub>	39	44	34	14.5	2.3	3600
RS 39/25/1800	25 + 0.1	46 <sup>-0.2</sup> <sub>-0.5</sub>	39	44	34	-	-	1800
RS 39/25/2048	25 + 0.1	46 <sup>-0.2</sup> <sub>-0.5</sub>	39	44	34	-	-	2048
RS 39/25/3600	25 + 0.1	46 <sup>-0.2</sup> <sub>-0.5</sub>	39	44	34	-	-	3600
RS 64/48.5/2048	48.5 + 0.1	71 <sup>-0.2</sup> <sub>-0.5</sub>	64	69	59	-	-	2048
RS 64/48.5/9000	48.5 + 0.1	71 <sup>-0.2</sup> <sub>-0.5</sub>	64	69	59	-	-	9000
RS 64/48.5/10000	48.5 + 0.1	71 <sup>-0.2</sup> <sub>-0.5</sub>	64	69	59	-	-	10000
RS 92/70/3600	70 + 0.1	100 <sup>-0.2</sup> <sub>-0.5</sub>	92	97	87	-	-	3600
RS 92/70/9000	70 + 0.1	100 <sup>-0.2</sup> <sub>-0.5</sub>	92	97	87	-	-	9000
RS 92/70/18000	70 + 0.1	100 <sup>-0.2</sup> <sub>-0.5</sub>	92	97	87	-	-	18000
RS 142/120/5400	120 + 0.2	150 <sup>-0.2</sup> <sub>-0.5</sub>	142	147	137	-	-	5400
RS 142/120/18000	120 + 0.2	150 <sup>-0.2</sup> <sub>-0.5</sub>	142	147	137	-	-	18000
RS 192/160/24000	160 + 0.2	200 <sup>-0.2</sup> <sub>-0.5</sub>	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

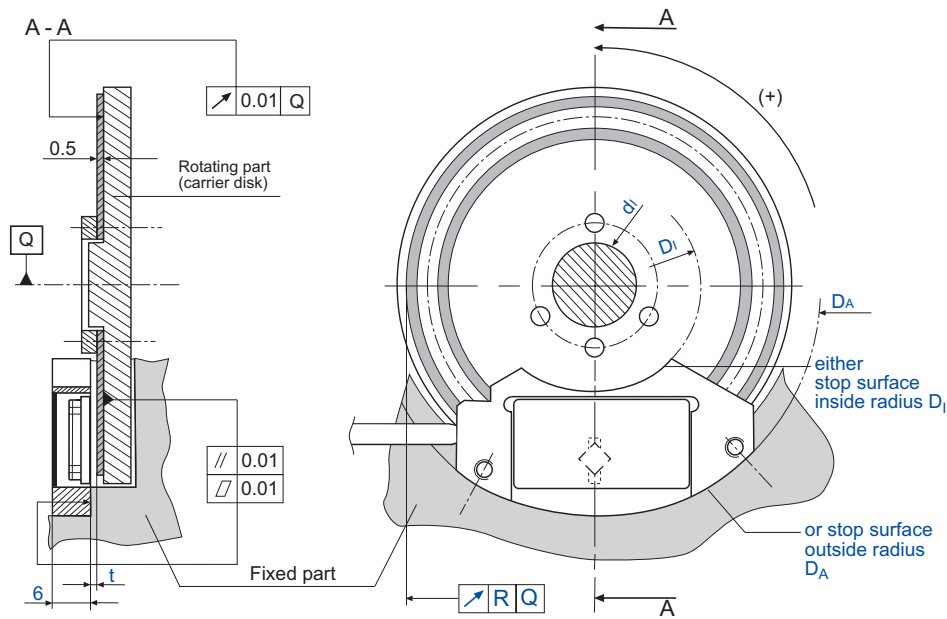


\*) Recommended material:  
 - light metal surface treated  
 - stainless steel passivated

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 $H_6$	-	-	-	-	$0.5 \pm 0.02$
RS 29/16/900	45 $H_6$	16 $h_6$	-	0.015	-	$0.6 \pm 0.05$
RS 29/16/1000	45 $H_6$	16 $h_6$	-	0.015	-	$0.7 \pm 0.05$
RS 39/10/1800	55 $H_6$	26 $h_6$	10 $fg_4$	-	0.01	$0.5 \pm 0.05$
RS 39/10/2048	55 $H_6$	26 $h_6$	10 $fg_4$	-	0.01	$0.7 \pm 0.05$
RS 39/10/3600	55 $H_6$	26 $h_6$	10 $fg_4$	-	0.01	$0.4 \pm 0.05$
RS 39/25/1800	55 $H_6$	26 $h_6$	-	0.015	-	$0.5 \pm 0.05$
RS 39/25/2048	55 $H_6$	26 $h_6$	-	0.015	-	$0.7 \pm 0.05$
RS 39/25/3600	55 $H_6$	26 $h_6$	-	0.015	-	$0.4 \pm 0.05$
RS 64/48.5/2048	82 $H_6$	50.8 $h_6$	-	0.015	-	$0.8 \pm 0.05$
RS 64/48.5/9000	82 $H_6$	50.8 $h_6$	-	0.015	-	$0.9 \pm 0.05$
RS 64/48.5/10000	82 $H_6$	50.8 $h_6$	-	0.015	-	$0.7 \pm 0.05$
RS 92/70/3600	110 $H_6$	78 $h_6$	-	0.015	-	$0.5 \pm 0.05$
RS 92/70/9000	110 $H_6$	78 $h_6$	-	0.015	-	$0.4 \pm 0.05$
RS 92/70/18000	110 $H_6$	78 $h_6$	-	0.015	-	$0.4 \pm 0.05$
RS 142/120/5400	160 $H_6$	126 $h_6$	-	0.015	-	$0.8 \pm 0.05$
RS 142/120/18000	160 $H_6$	126 $h_6$	-	0.015	-	$1.2 \pm 0.05$
RS 192/160/24000	210 $H_6$	180 $h_6$	-	0.015	-	$1.1 \pm 0.05$

$D_A$  Stop surface - outside diameter (for scanning head)

$D_I$  Stop surface - inside diameter (for scanning head)

$d_i$  Diameter of the axis

$R^*$  Grating disk - radial eccentricity of the graduation

$R^{**}$  Radial eccentricity of the disk bearing

$t$  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:

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

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

- 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

### 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

### 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 [ $\mu\text{m}$ ]  
D graduation diameter of the grating disk [mm]

## 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:

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

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

I Interpolation factor

Z Number of lines

SF Safety coefficient = 1.5

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
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Housing – version of attachment

2	thread M 2.5
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Type of housing

C	aluminium
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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 <sub>PP</sub> )
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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 <sup>1</sup>	others on request

Encoder version\*

-	standard
3 <sup>1</sup>	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
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Interface – output signals

C	sinusoidal 1 V <sub>PP</sub>
K	RS 422 square wave without interpolation
L	RS 422 square wave with interpolation 5x
M	RS 422 square wave with interpolation 10x
I <sup>2</sup>	RS 422 square wave with interpolation 25x
N <sup>2</sup>	RS 422 square wave with interpolation 50x
P <sup>2</sup>	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<sup>-9</sup> mbar. The according datasheet can be downloaded at [www.numerikjena.de](http://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 <sub>PP</sub> 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)
<b>Ambient conditions</b>		Permissible bending radius of cables - occasional flexing - constant flexing	8 mm 40 mm
Operating temperature range	0°C ... +55°C		
Storage temperature range	-20°C ... +70°C		
Vibration (50 Hz ... 2000 Hz)	≤ 200 ms <sup>-2</sup>		
Shock (11 ms)	≤ 400 ms <sup>-2</sup>		
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 <sub>PP</sub>	-	-	-	U <sub>0-</sub>	U <sub>2-</sub>	U <sub>1-</sub>	-	5 V	0 V	-	-	U <sub>0+</sub>	U <sub>2+</sub>	U <sub>1+</sub>	-	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	-	-



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