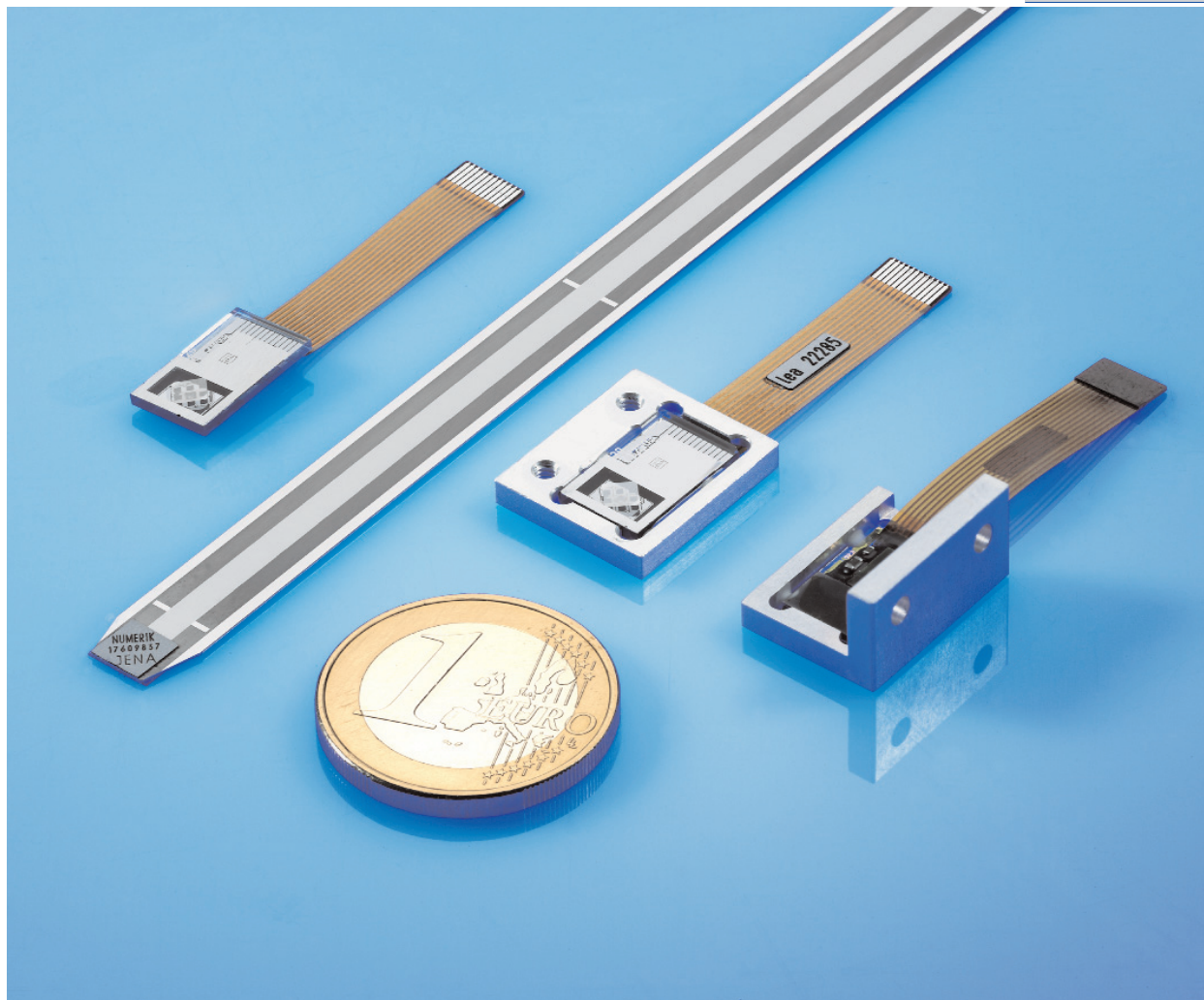


**we set the standards**



# **Encoder Kit L4**

**Minimized Components  
for Linear Measurement**

## Components for linear measurement - Kit L4

The Encoder Kit L4 is a minimum configuration of a length-measuring system for use in situations where installation space is limited. The kit is based on the miniaturized and multifunctional EPIFLEX measuring module and on graduated scales. The scales are scanned in reflected light.

### Features

- Compact, highly integrated design of the EPIFLEX measuring module; all functional components of a measuring system have been deposited on a glass substrate using microelectronic technologies
- Variable use due to modular design
- Minimum dimensions of the EPIFLEX measuring module
- Extremely flat design
- Allows rough installation tolerance limits; user-friendly pre-alignment of the measuring module in a mechanical frame
- High resolution and accuracy
- Defined thermal behavior, no thermally and no mechanically induced warping of the DOUBLEFLEX scale tapes
- High measuring speed based on the high limit frequency of the EPIFLEX measuring module
- Variable signal interface
- High accuracy of interpolation by introducing an internal electronic compensation of amplitude and offset deviations
- With integrated switch sensor(s) on request

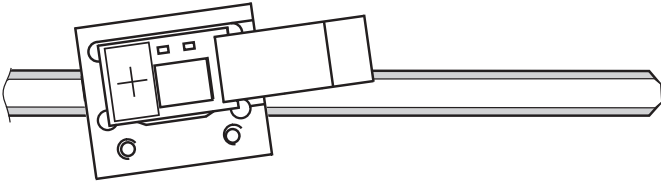
### Fields of application

Fields of application where linear movements or lengths must be measured in confined installation conditions:

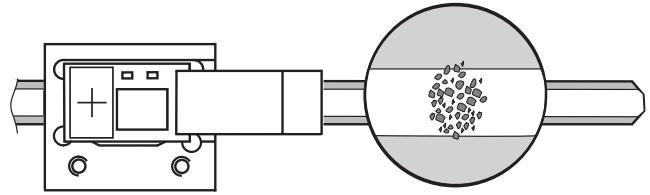
- Linear axes
- Instruments and machines used in the microelectronic industry
- Plotter
- Printer
- Instruments in reprographics
- Robots and handling technics
- Precision devices
- Probes
- X/Y-stages
- Medical systems

## Dynamic offset and amplitude control

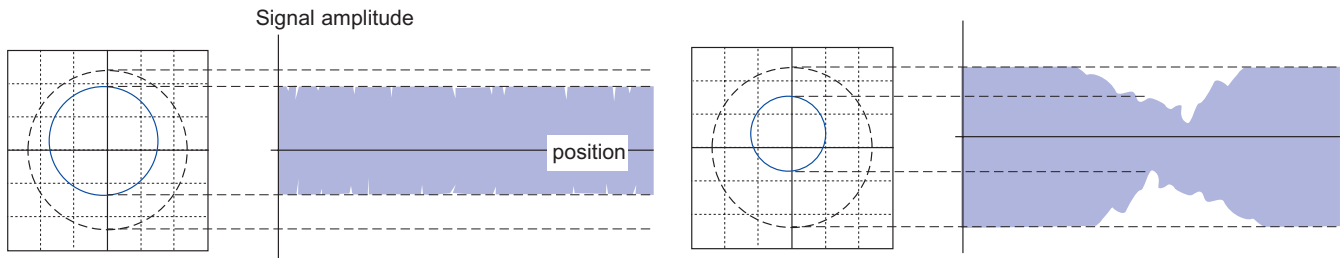
### Incorrect mounting



### Contaminated scale tape



### Scanning signals before offset and amplitude correction

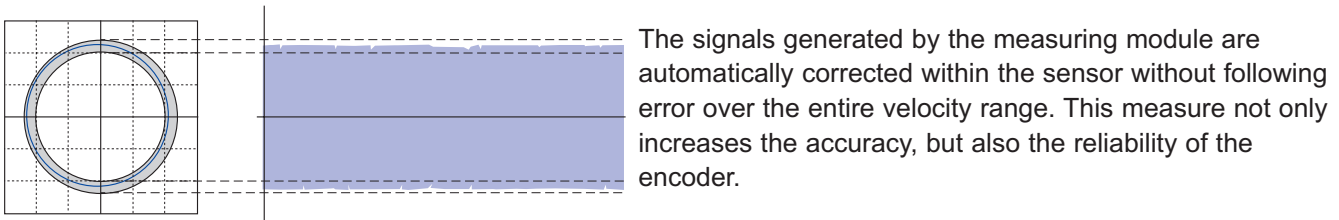


Contamination and mounting errors lead to interferences in the optical scanning of the scales by the scanning head and so to periodic deformations of the sinusoidal counting track signals.

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 signals after offset and amplitude correction



### Signal adjustment

After mechanical installation, electronic signal adjustment is possible to optimize measuring module output signals.

This can result in

- a reduction of the interpolation error, and
- activation of functional reserves.

Signal adjustment can be performed with the aid of

- the adjustment kit together with an oscilloscope and PC or
- the signal monitor.

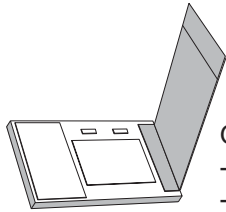
Electronic adjustment is recommended for Encoder Kit L4 with 25-fold interpolation and higher.

**An electronic adjustment is essential if the measuring module is used without frame and in a custom-designed frame!**

## Modular design - components

In the standard versions, the EPIFLEX measuring modules are placed in steel or aluminum frames and adjusted to the mounting surface or reference surface of the frame. The customer fastens the framed measuring module with screws. For extremely crowded installing conditions the EPIFLEX measuring module can be used without frame. The measuring module is pre-adjusted and needs to be adjusted electronically by the user after the mounting process. The measuring module without frame is fastened by adhesive in the user's machine component.

### EPIFLEX measuring module with flex print cable



Output interfaces:  
 - voltage output 1 V<sub>PP</sub>  
 - square wave output RS 422

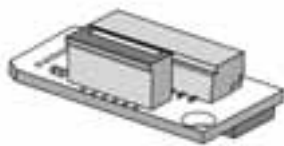
Line filters and diagnostic connectors have to be implemented by the customer if necessary. The EPIFLEX measuring module will be glued in a frame.

### Frames



Mechanical frames for the EPIFLEX measuring module are available in different versions. The frames will be fixed with screws.

### Connector board

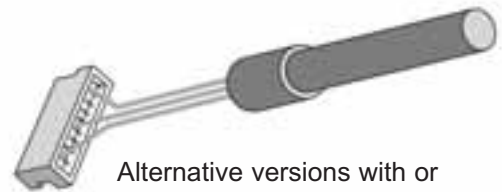


Vertical input connector for measuring module; horizontal connector for connecting cable

On the connector board are located:

- The connectors for measuring module and connecting cable
- Line filters
- Diagnostic and setup connector pins for signal adjustment
- Optionally signal interpolation electronics and RS 422 line driver

### Connecting cable to evaluation electronics



Alternative versions with or without connector to evaluation electronics

### Scale tapes

The maximum total length is 400 mm with a reference mark on a user-defined position.

#### DOUBLEFLEX scale tape

Mechanical isolation of the scale tape from the scale tape carrier; this results in defined thermal behavior

Preferentially used for:

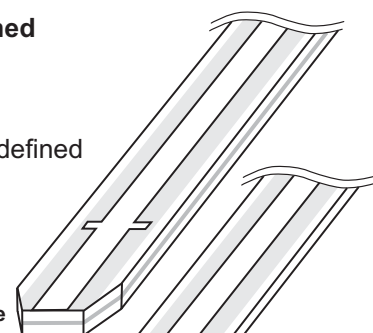
- Carrier materials with thermal expansion behavior different from steel
- Measuring length longer than 100 mm
- High accuracy requirements

#### SINGLEFLEX scale tape

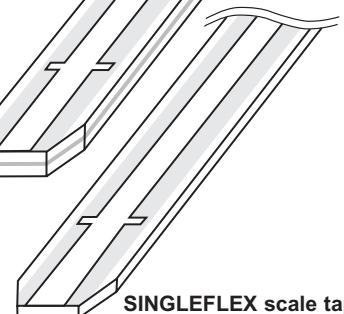
Preferentially used for:

- Scale tape carrier with thermal expansion behavior same as steel
- Low accuracy requirements

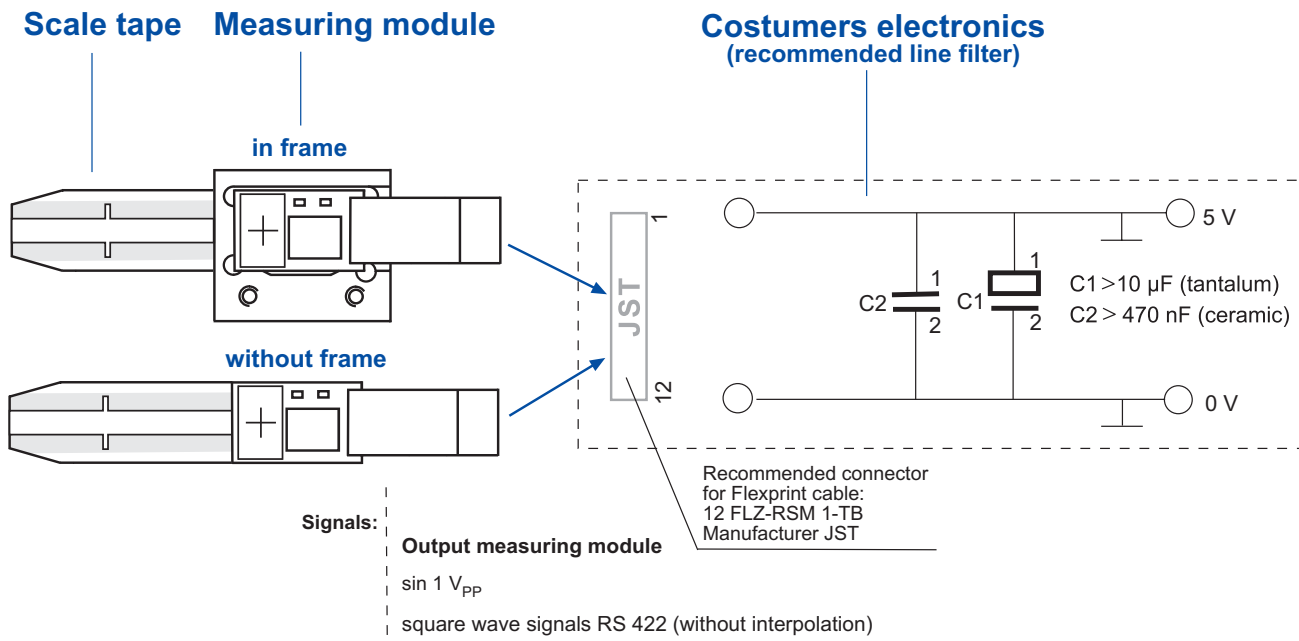
DOUBLEFLEX scale tape



SINGLEFLEX scale tape



## Modular design - without signal processing



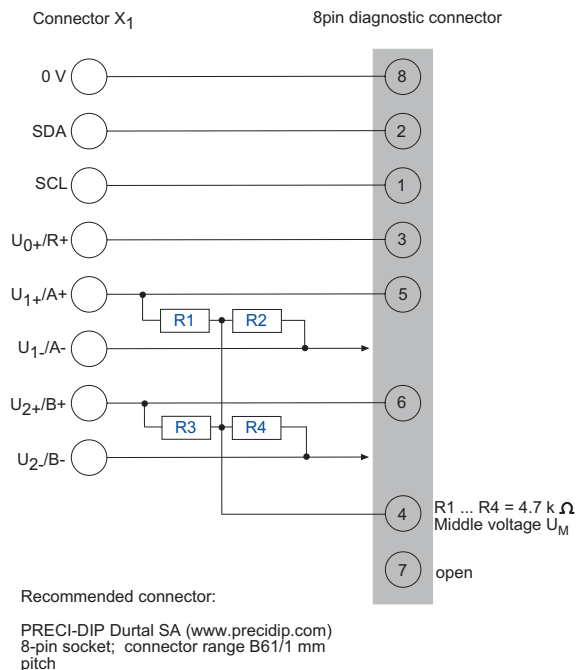
PIN assignment and installation dimensions on pages 11-14

### Driven square wave signals

The sensor module is pre-adjusted. Using this interface, note that the reference pulse is not linked with the counting pulses. When approached from different directions, the hysteresis of the reference pulse can reach approximately one signal period.

### Electronic adjustment is recommended (requires adjustment kit or signal monitor).

**Note:** To adjust the Encoder Kit L4 electronically it is necessary to integrate the adjacent circuitry. The connection between the adjusting device and the PCB is done with an 8pin plug connector, which is included with the adjusting device.

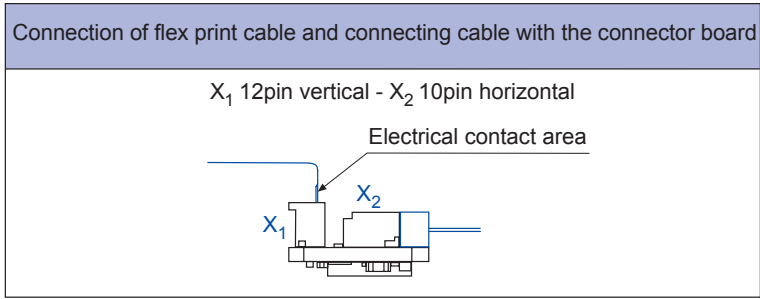
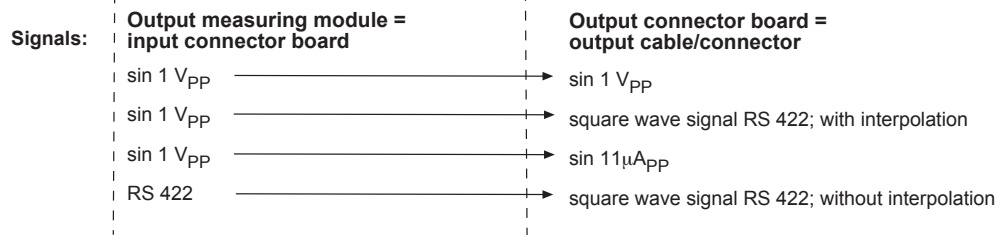
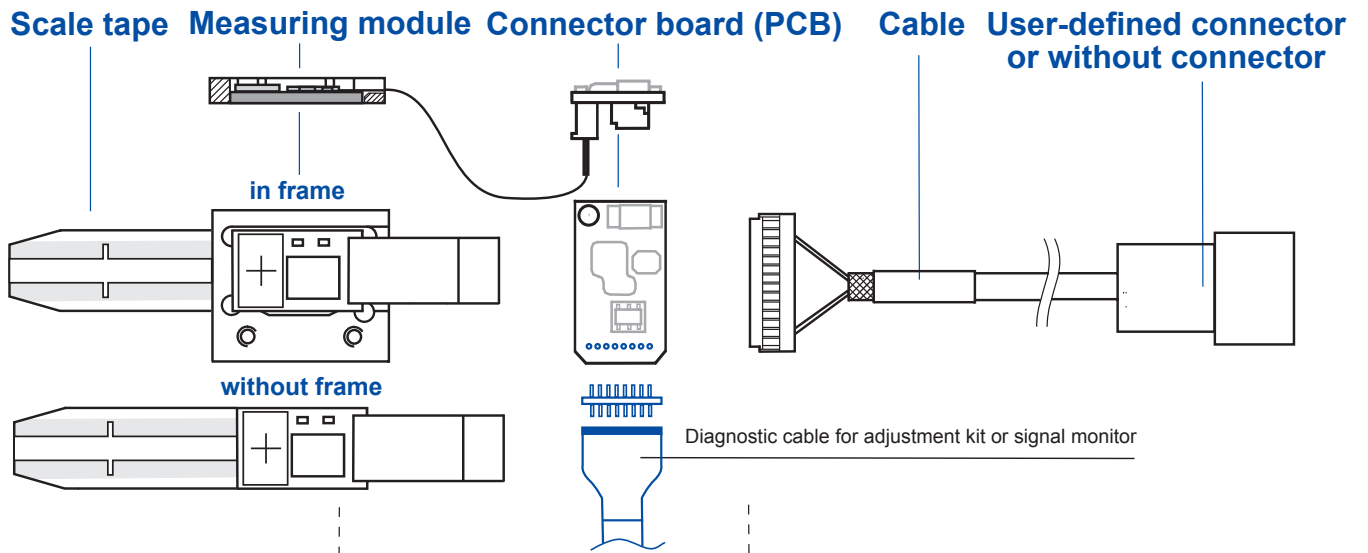


### Designation example:

### EML 4 3 - C0 B2 A

EML	system version without electronics
4	single field sensor
3	length of flex print cable at the sensor 25 mm, 90° offset
-	grating period 20 µm
C0	signal output 1V <sub>PP</sub>
B2	frame: fastening angle with holes Ø 2,3
A	frame consting of aluminium

# Modular design - signal processing on the connector board

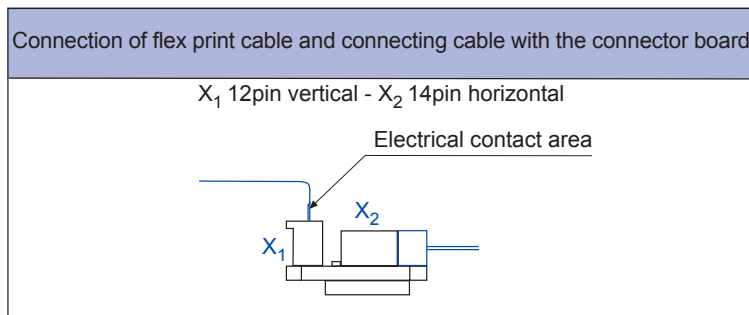
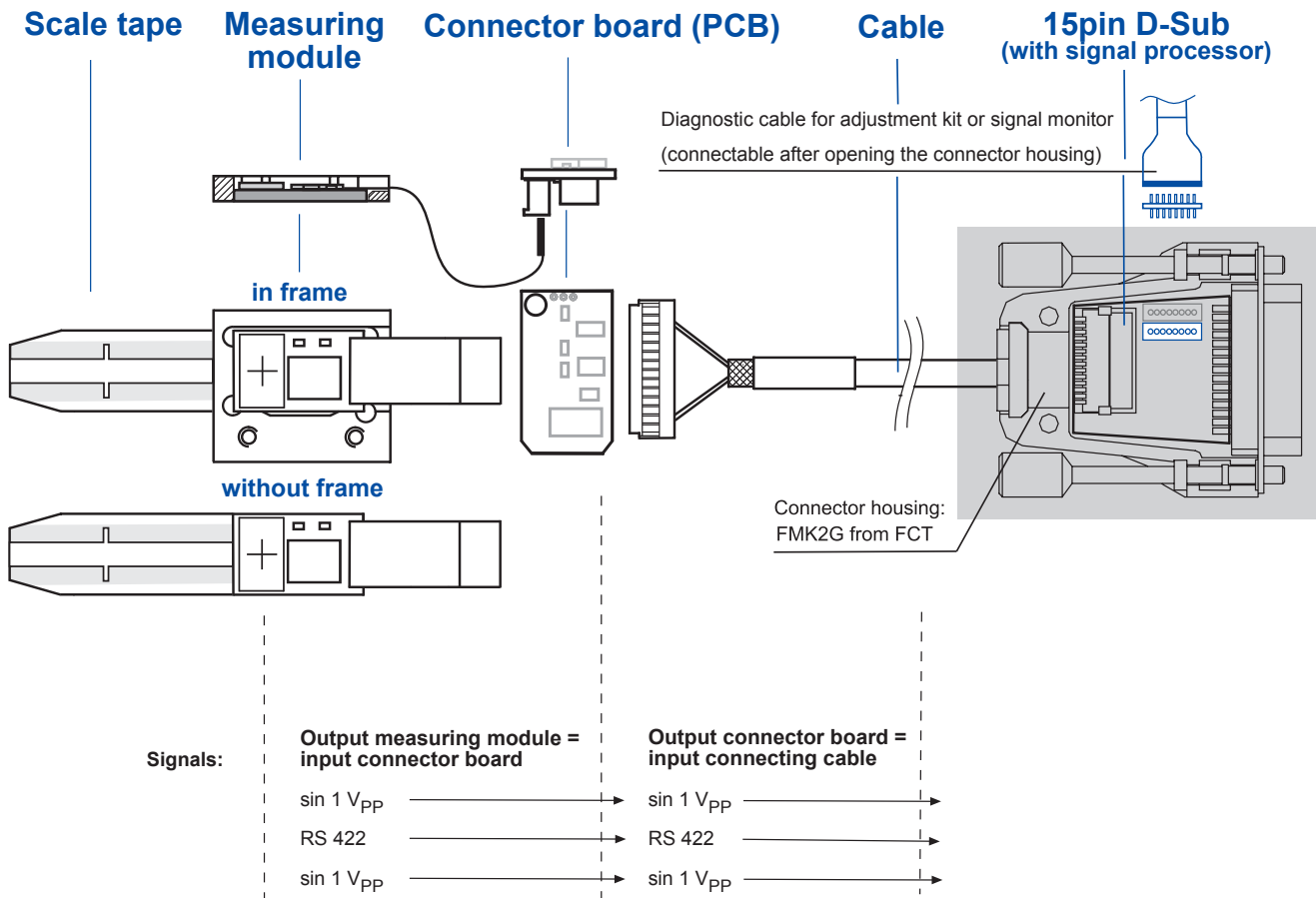


PIN assignment and installation dimensions on pages 11-14

**Measuring module, connector board and cable (with connector) are interfaced and electronically adjusted.**

<b>Designation example:</b>	<b>Kit L 4 3 - L5 B2 A - T A</b>
Kit L	system version with electronics
4	single field sensor
3	length of flex print cable at the sensor 25 mm, 90° offset
-	grating period 20 μm
L	signal output RS 422, interpolation 5x
5	speed factor
B2	frame: fastening angle with holes Ø 2,3
A	frame consting of aluminium
-	standard device
T	1 m cable Ø 3,7
A	without connector

# Modular design - signal processing inside the connector



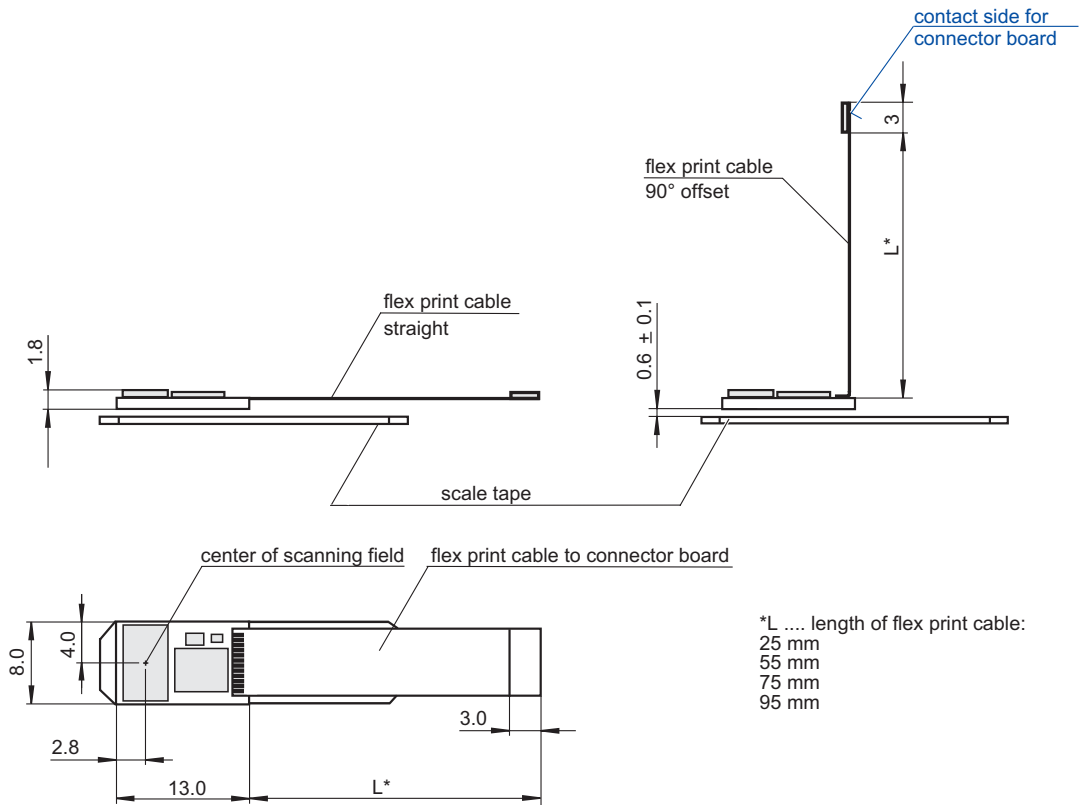
PIN assignment and installation dimensions on pages 11-14

Measuring module, connector board and cable with connector are interfaced and electronically adjusted.

## Designation example: Kit L 4 3 - L5 B2 A - T Z

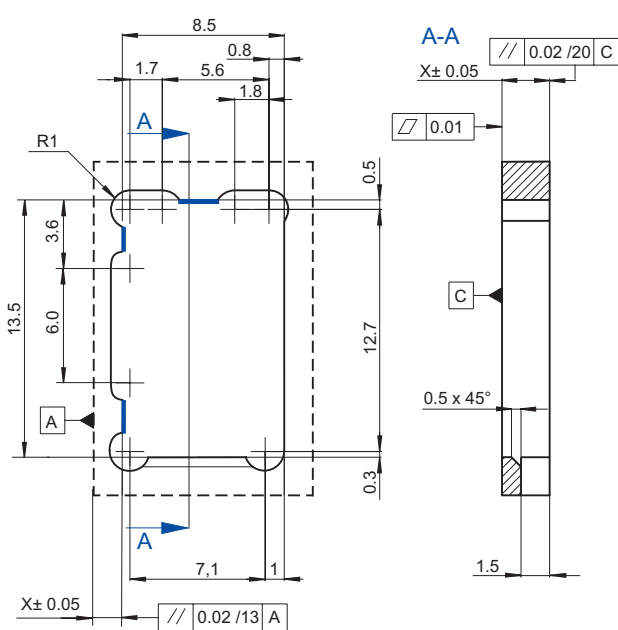
Kit L	system version with electronics
4	single field sensor
3	length of flex print cable at the sensor 25 mm, 90° offset
-	grating period 20 µm
L	signal output RS 422, interpolation 5x
5	speed factor
B2	frame: fastening angle with holes Ø 2,3
A	frame consting of aluminium
-	standard device
T	1 m cable Ø 3,7
Z	15pin D Sub, signal processing inside the connector

## Dimensions of EPIFLEX-measuring module



## Minimal dimensions — Mounting tolerances

for frame of measuring module  
 (versions without frame)

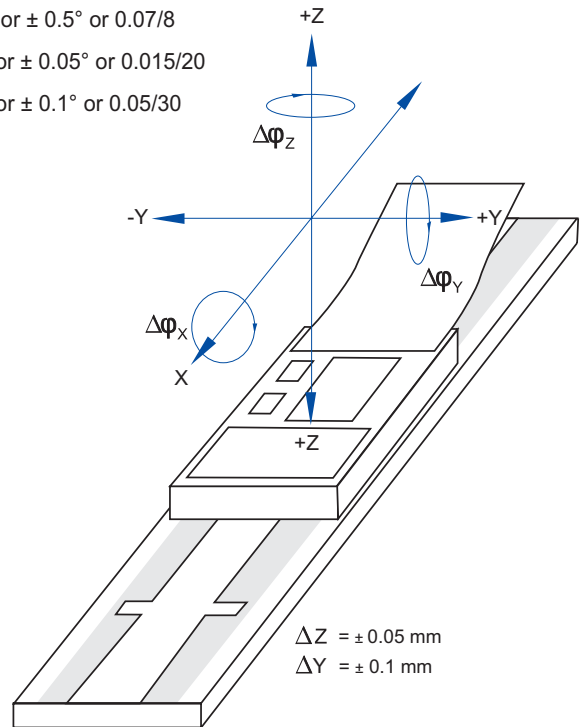


— Lay-on edge for measuring module  
 Datum face C contact surface of measuring modul  
 Datum face A contact surface for system mounting

$$\Delta\varphi_X = \pm 30' \text{ or } \pm 0.5^\circ \text{ or } 0.07/8$$

$$\Delta\varphi_Y = \pm 3' \text{ or } \pm 0.05^\circ \text{ or } 0.015/20$$

$$\Delta\varphi_Z = \pm 6' \text{ or } \pm 0.1^\circ \text{ or } 0.05/30$$



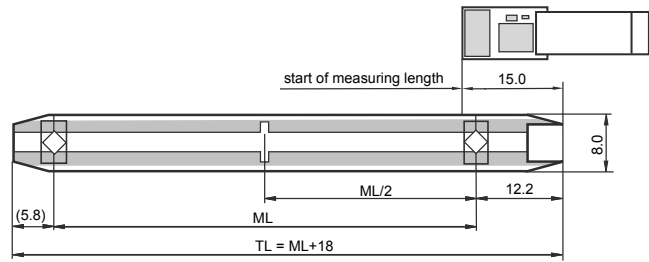
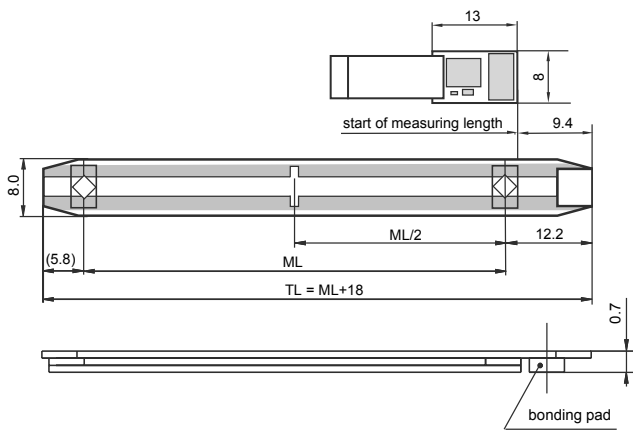


# Allocation of scanning head, scale and measuring length

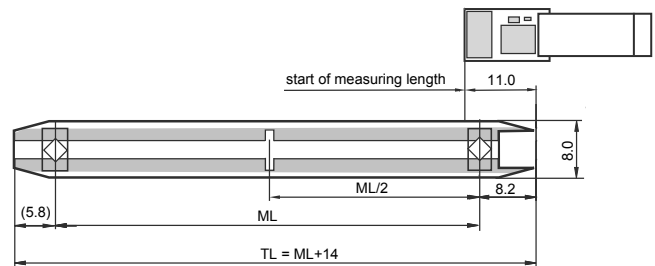
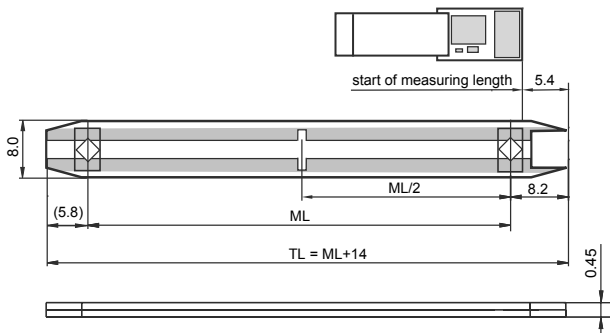
flex print cable to the left

flex print cable rightwards

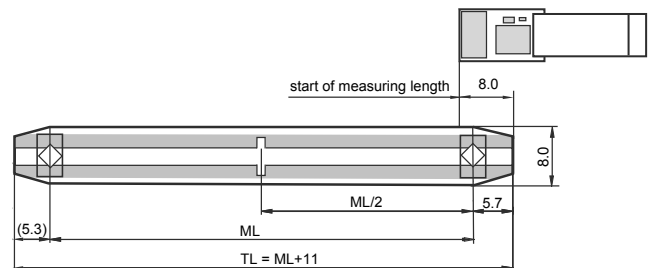
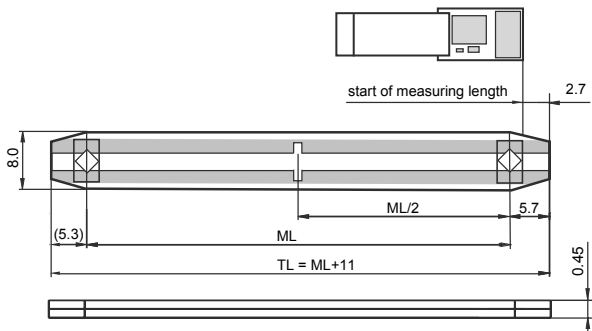
DOUBLEFLEX scale tape with label (MT 10)



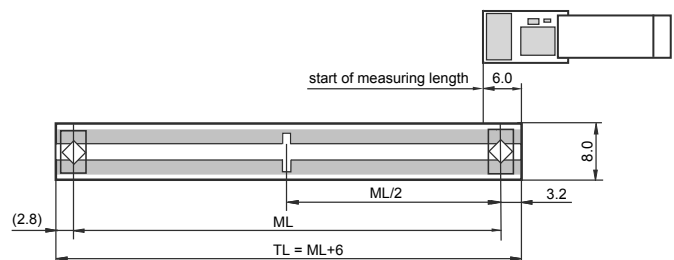
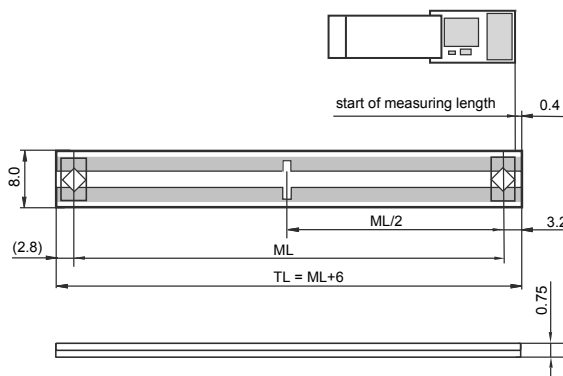
SINGLEFLEX scale tape with label (MT 11)



SINGLEFLEX scale tape without label (MT 15)



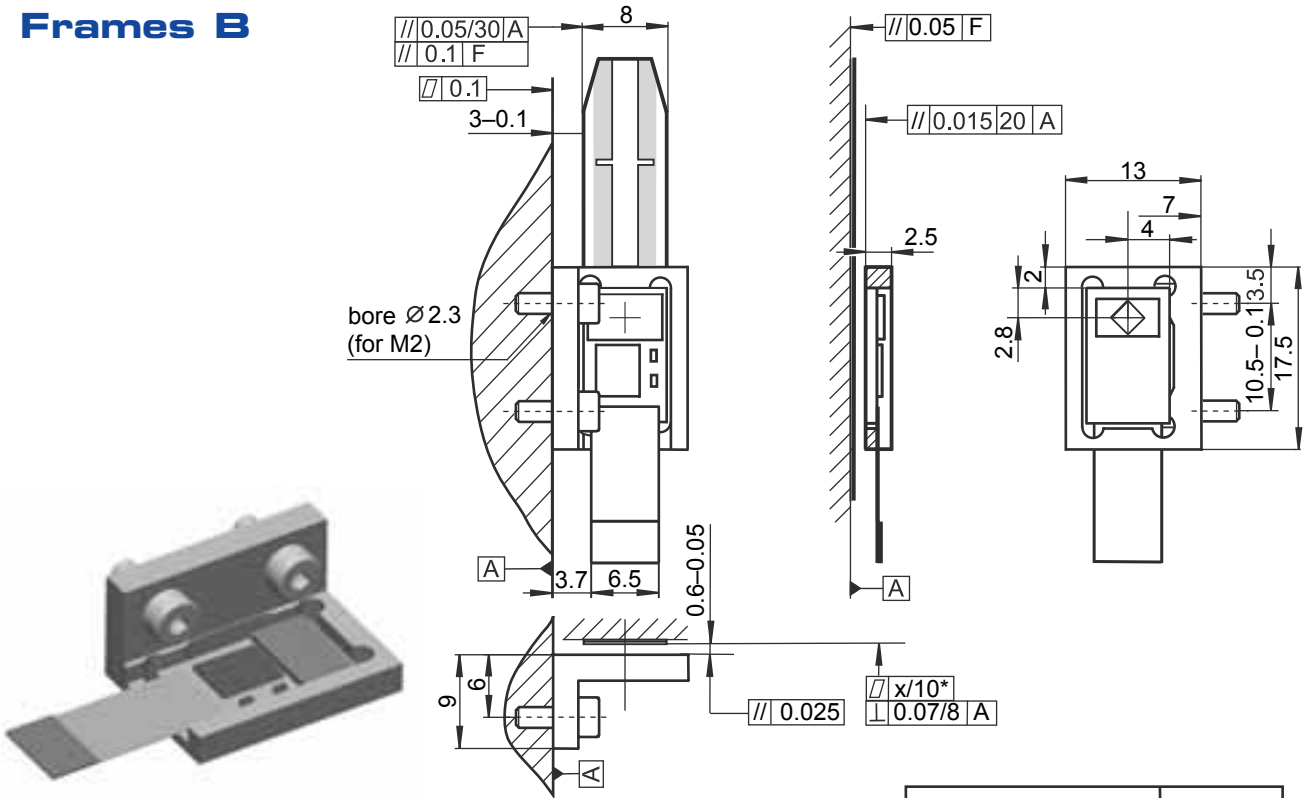
Glass scale (MT 26)



ML ... Measuring length  
TL ... Total length

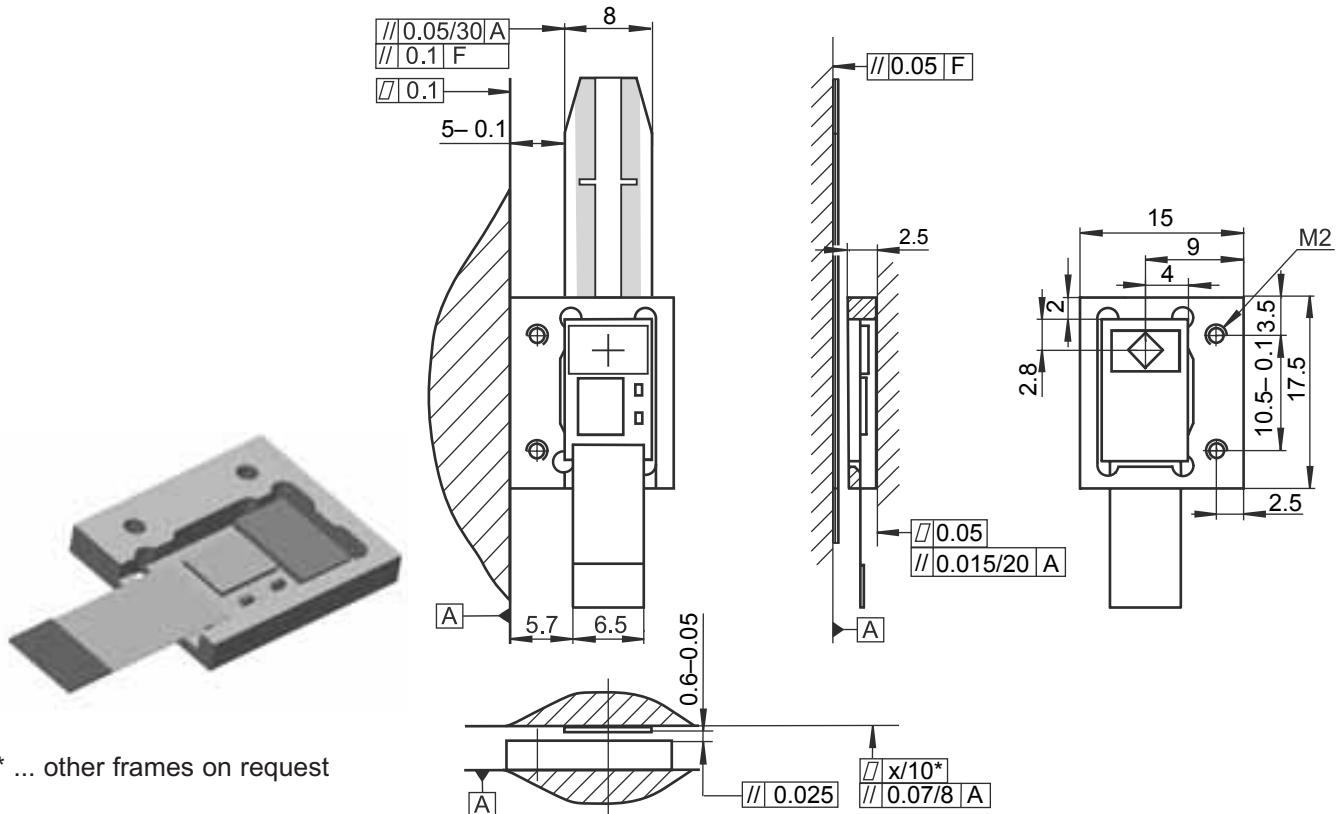
# Standard sensor frames\*

## Frames B



accuracy class scale tape	x
- 1 $\mu$ m	0.003
- 2 $\mu$ m	0.006
- 3 $\mu$ m	0.009
- 5 $\mu$ m	0.009

## Frames C

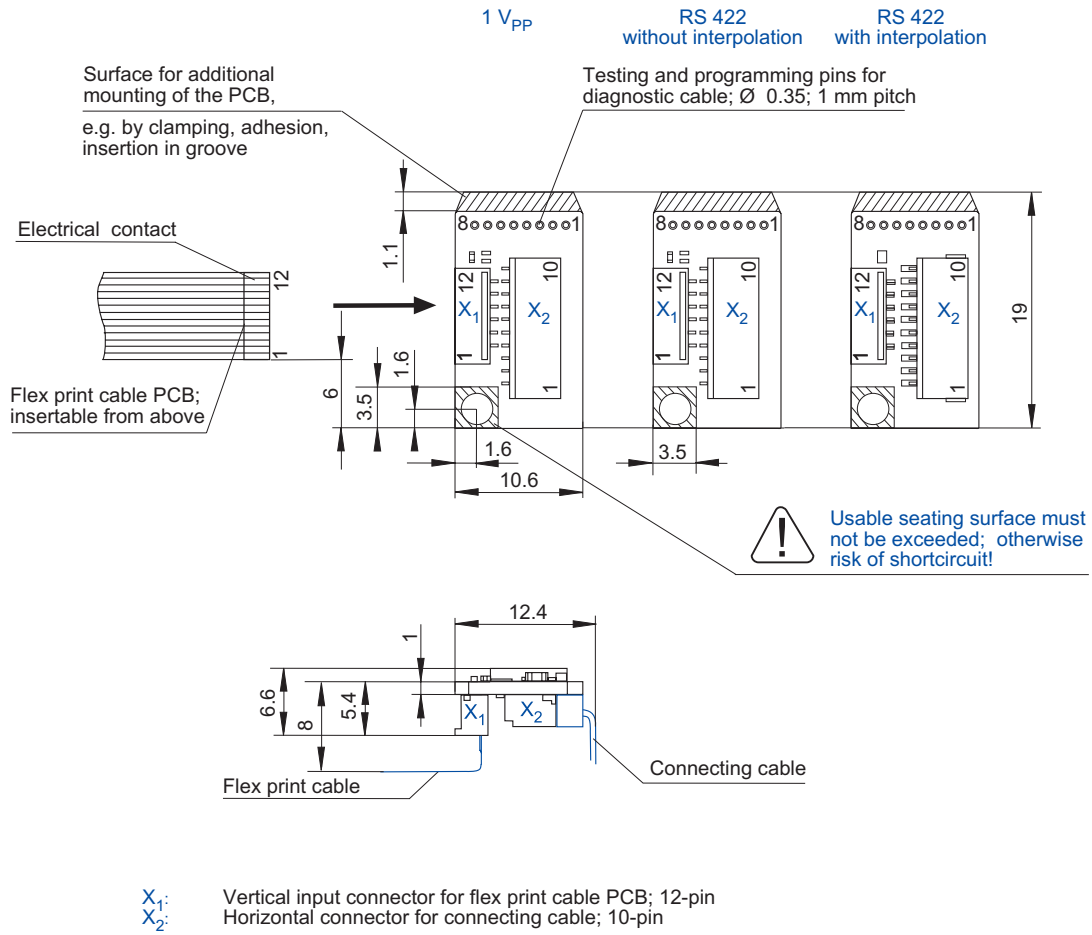


\* ... other frames on request

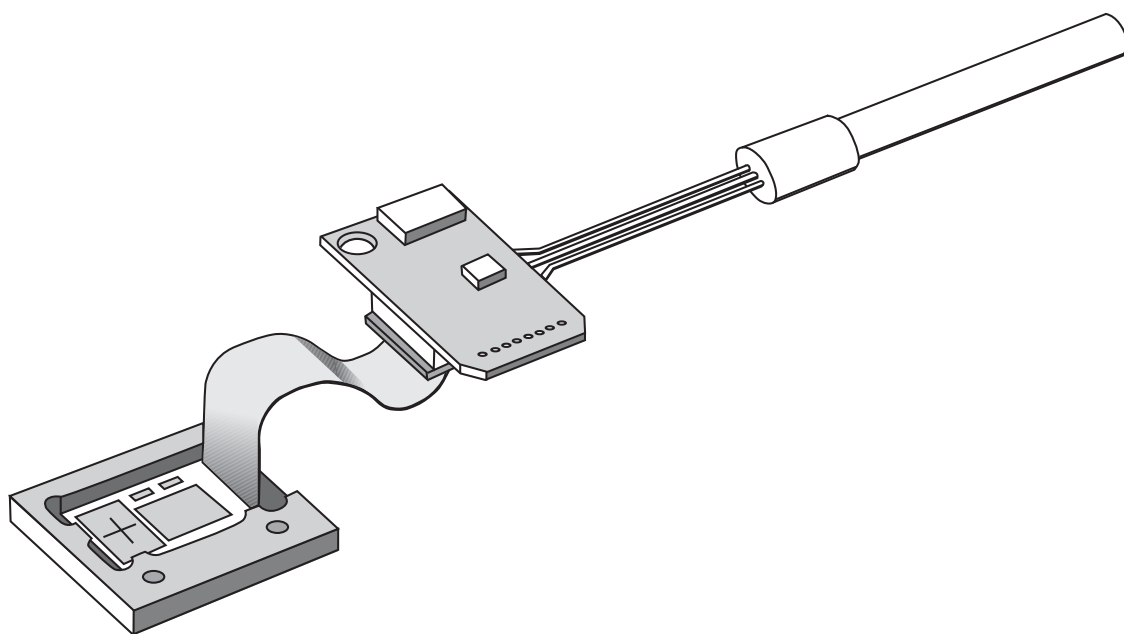
F ... guideway

# Installation dimensions - connector board

for signal processing on the connector board

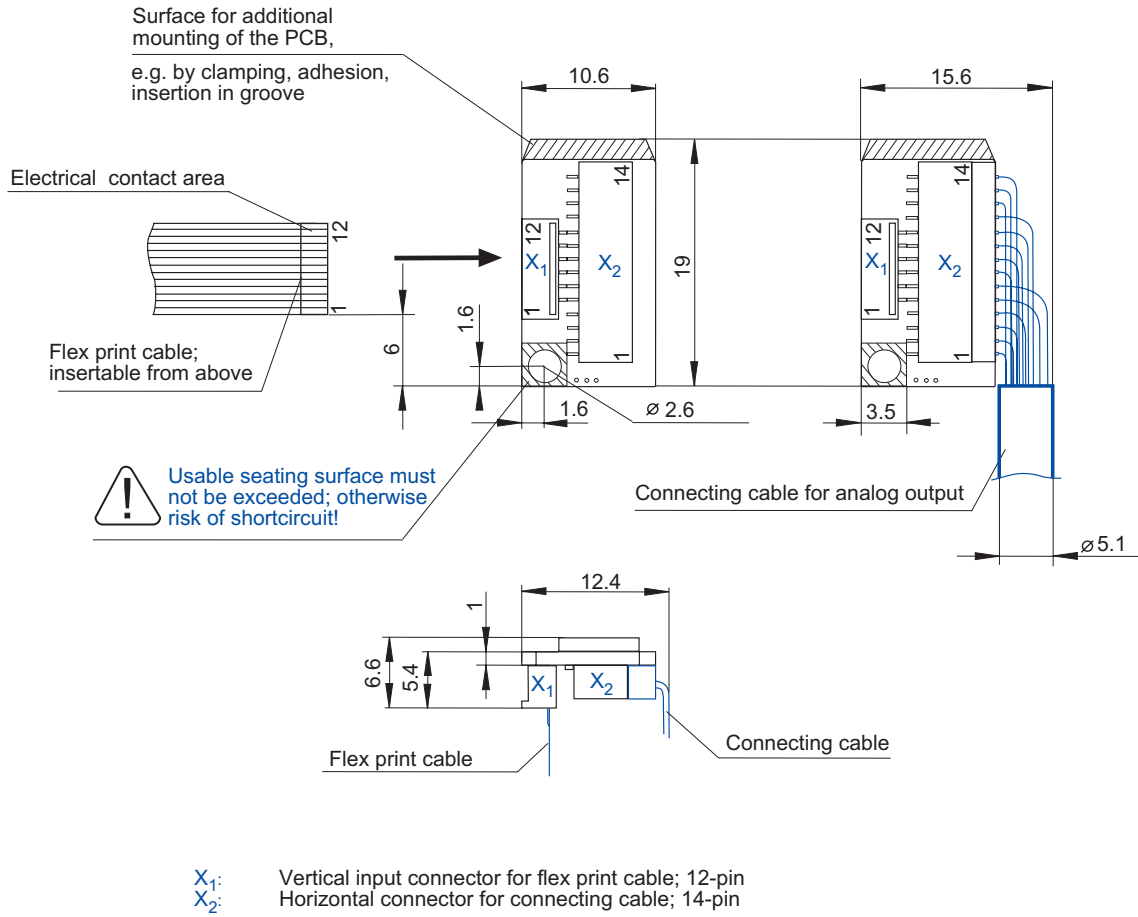


## System illustration with connector board

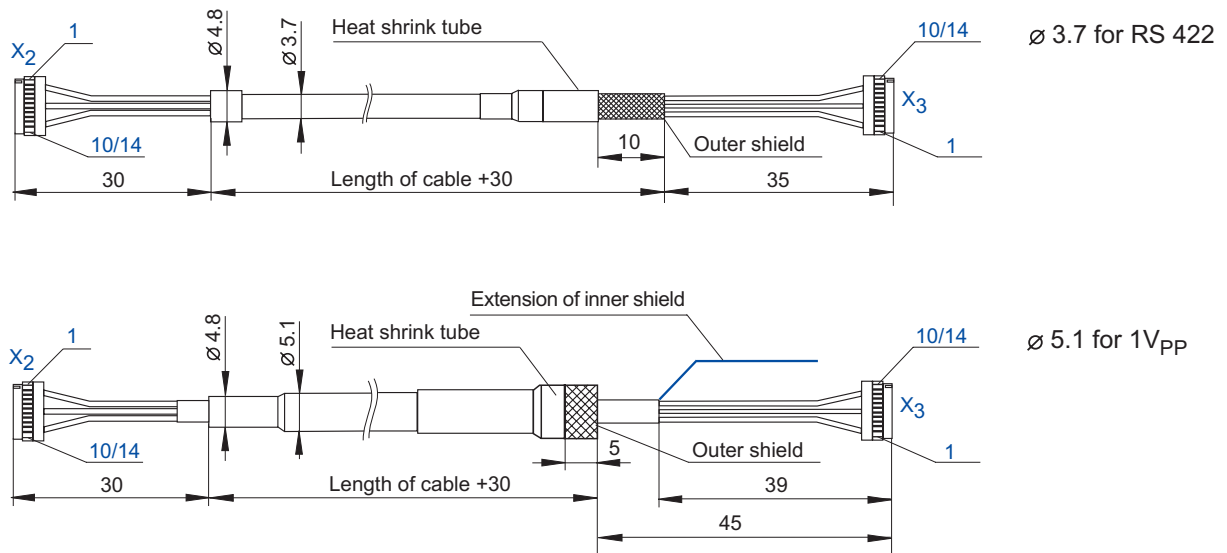


# Installation dimensions - connector boards

## Vertical input connector; for signal processing in the connector



## Installation dimensions - cable with open output



## Connectors and PIN assignment

### Legend

U <sub>1+</sub>	sin-signal; counting track	Sine-signals	A+	Counting signal 0°	Square wave-signals	U <sub>B</sub>	Operating voltage (5 V)
U <sub>2+</sub>	cos-signal; counting track		B+	Counting signal 90°		GND	Ground (0 V)
U <sub>1-</sub>	- sin-signal; counting track		A-	Inverse counting signal 0°(180°)		SCL SDA	Programming wires for electronic signal adjustment
U <sub>2-</sub>	- cos-signal; counting track		B-	Inverse counting signal 90°(270°)			
U <sub>0+</sub>	Reference signal		R+	Reference signal			
U <sub>0-</sub>	- Reference signal		R-	Inverse reference signal			

AS	Monitoring signal	AS low/NAS high: Sensor signal is within the tolerance range; encoder functioning properly.
NAS	Inverse monitoring signal	AS high/NAS low: Sensor signal is out of tolerance range; check the encoder!

### PIN assignment for X1 on the connector board

PIN	1	2	3	4	5	6	7	8	9	10	11	12
1 V <sub>PP</sub>	SCL	SDA	GND	-	U <sub>1-</sub>	U <sub>1+</sub>	NAS	U <sub>0+</sub>	U <sub>0-</sub>	U <sub>2-</sub>	U <sub>2+</sub>	5 V
RS 422	SCL	SDA	GND	-	A-	A+	NAS	R+	R-	B-	B+	5 V

### 10pin JST miniature connector X2 and X3 (only for open output and signal processing on the connector board)

PIN	1	2	3	4	5	6	7	8	9	10	
1 V <sub>PP</sub>	U <sub>2-</sub>	0 V	-	U <sub>2+</sub>	U <sub>0-</sub>	-	U <sub>1-</sub>	U <sub>0+</sub>	U <sub>1+</sub>	5 V	Inner shield
RS 422	B-	0 V	NAS	B+	R-	AS	A-	R+	A+	5 V	-
Cable Ø 5.1 mm double shielded	RD	WH	VT	BU	PK	BK	YE	GY	GN	BN	WH/GN
Cable Ø 3.7 mm single shielded	RD	WH	VT	BK	PK	YE	BN	GY	GN	BU	-

### 14pin JST miniature connector X2 and X3 (only for open output and signal processing in the connector respectively)

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1 V <sub>PP</sub>	0 V	U <sub>1-</sub>	-	SCL	SDA	-	U <sub>1+</sub>	U <sub>0+</sub>	U <sub>2-</sub>	5 V	U <sub>2+</sub>	U <sub>0-</sub>	-	-	Inner shield
RS 422	0 V	A-	NAS	SCL	SDA	-	A+	R+	B-	5 V	B+	R-	-	-	-
Cable Ø 5.1 mm double shielded	WH	YE	VT	BK	BN/GN	WH/GN	GN	GY	RD	BN	BU	PK	-	-	WH/GN (0.14 mm <sup>2</sup> )

SCL programming wire for clock  
SDA programming wire for data

## Connectors and PIN assignment

### 9pin D-sub connector

PIN	1	2	3	4	5	6	7	8	9	Housing
1 V <sub>PP</sub>	U <sub>1-</sub>	0 V	U <sub>2-</sub>	Inner shield	U <sub>0-</sub>	U <sub>1+</sub>	5 V	U <sub>2+</sub>	U <sub>0+</sub>	Outer shield
11 μA <sub>PP</sub>	I <sub>1-</sub>	0 V	I <sub>2-</sub>	Inner shield	I <sub>0-</sub>	I <sub>1+</sub>	5 V	I <sub>2+</sub>	I <sub>0+</sub>	Outer shield
Cable Ø 5.1 mm double shielded	YE	WH	RD	WH/GN (0.14 mm <sup>2</sup> )	PK	GN	BN	BU	GY	-
RS 422	A-	0 V	B-	NAS	R-	A+	5 V	B+	R+	Outer shield
Cable Ø 3.7 mm single shielded	BN	WH	RD	VT	PK	GN	BU	BK	GY	-

### 12pin circular connector (Ø 28; M 23 x 1)

PIN	1	2	3	4	5	6	7	8	9	10	11	12	Housing
1 V <sub>PP</sub>	U <sub>2-</sub>	5 V	U <sub>0+</sub>	U <sub>0-</sub>	U <sub>1+</sub>	U <sub>1-</sub>	-	U <sub>2+</sub>	Inner shield	0 V	0 V	5 V	Outer shield
Cable Ø 5.1 mm double shielded	RD	BN	GY	PK	GN	YE	VT	BU	WH/GN (0.14 mm <sup>2</sup> )	WH	WH	BN	-
RS 422	B-	5 V	R+	R-	A+	A-	NAS	B+	-	0 V	0 V	5 V	Outer shield
Cable Ø 3.7 mm single shielded	RD	BU	GY	PK	GN	BN	VT	BK	-	WH	WH	BU	-

Pins 2 and 12 bridged, pins 10 and 11 bridged

### 15pin D-sub connector

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>	Inner shield	Outer shield
Cable Ø 5.1 mm double shielded	-	-	VT	PK	RD	YE	-	BN	WH	-	BK	GY	BU	GN	WH/GN (0.14 mm <sup>2</sup> )	-
RS 422	-	-	NAS	R-	B-	A-	-	5 V	0 V	-	AS	R+	B+	A+	Inner shield*	Outer shield
Cable Ø 3.7 mm single shielded	-	-	VT	PK	RD	BN	-	BU	WH	-	YE	GY	BK	GN	-	-

\*) for signal processing inside the 15-pin D-sub connector

## Ordering key for scanning head

Designation example  
scanning head:

**Kit L 4 1 0 - P 4 2 B1 A - T Z**

Version - measuring head

Kit L	with signal processing
EML	without signal processing

Type of sensor

4	sensor with one scanning field; SV3-R
---	---------------------------------------

Flexible tape-length L

1	25 mm, straight output
2	55 mm, straight output
3	25 mm, 90° offset
4	55 mm, 90° offset
5	75 mm, straight output
6	75 mm, 90° offset
7	95 mm, straight output
8	95 mm, 90° offset

Grating period

-	20 µm
---	-------

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	RS 422 square wave with interpolation 25x
N	RS 422 square wave with interpolation 50x
P	RS 422 square wave with interpolation 100x

Speed factor

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

Type of connector

A	without connector (10pin.-JST)
Z	15pin D-Sub; elektronik in the connector
D	9pin D-Sub; PIN
O	15pin D-Sub; PIN
H	12pin; circular; plastic coated

Cable-length; 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<sup>2\*</sup>

-	standard
---	----------

Material of frame<sup>3</sup>

A	aluminium; conversion coated
---	---------------------------------

Type of frame<sup>4</sup>

A <sup>6</sup>	without frame
B <sup>17</sup>	fastening angle with thread M2
B <sup>27</sup>	fastening angle with hole Ø 2,3
C <sup>17</sup>	fastening plate with thread M2
C <sup>27</sup>	fastening plate with hole Ø 2,3

Type of connector board

2	vertical input connector
---	--------------------------

- 1 ... no standard, supplied for a surcharge
- 2 ... version for a vacuum application up to 10<sup>-6</sup> mbar possible
- 3 ... other materials on request
- 4 ... other frames on request
- 6 ... the system is electronically pre-adjusted. Measuring module is not interfaced with the connector board.
- 7 ... measuring module and connector board are interfaced and electronically adjusted.

\* The Encoder Kit L4 is also available as vacuum version for pressure ranges up to 10<sup>-6</sup> mbar. The according datasheet can be downloaded at [www.numerikjena.de](http://www.numerikjena.de).

## Ordering key for the scale

Designation example scale:

**MT 1 0 - 1 1 B P 00270**

Material

1	steel, max. 400 mm total length
2	glass, max. 100 mm total length

Design type

0 <sup>3</sup>	DOUBLEFLEX, standard (ML+18 mm)
1	SINGLEFLEX, standard (ML+14 mm)
5 <sup>1</sup>	reduced scale tape length (steel) (ML+11mm)
6 <sup>1</sup>	reduced scale length (glass) (ML+6 mm)

Accuracy class

1	± 1 µm
2	± 2 µm
3	± 3 µm
4	± 5 µm

measuring length (ML) [mm]

Grating period GP

P 20 µm

Position of reference mark

O	without reference mark
B	in the center of measuring length
E <sup>4</sup>	customized version*

Fixing\*\*

0 <sup>1</sup>	without bonding pad
1 <sup>2</sup>	bonding pad at start of measuring length
3	without adhesive tape
5 <sup>2</sup>	bonding pad at end of measuring length*

- 1 ... only for SINGLEFLEX-scale tapes and glass scales
- 2 ... only for DOUBLEFLEX-scale tapes
- 3 ... min. ML DOUBLEFLEX-scale tapes = 100 mm
- 4 ... indication in XXXXX mm after beginning of ML

\* ... supplied for a surcharge

\*\*... standard with adhesive tape 0.2 mm



## Technical specification

Mechanical data		Electrical data	
Mass of EPIFLEX measuring module	1.0 g	Scanning frequency	max. 500 kHz
Recommended resolution	0.05 µm; 0.1 µm; 0.2 µm; 0.5 µm; 1.0 µm; 5.0 µm	Output interfaces - Voltage output - Square wave output	1 V <sub>PP</sub> RS 422 with interpolation up to 100x
Travel speed - without interpolation (maximum) - with 50x interpolation (maximum)	600 m/min resp. 10 m/s 96 m/min resp. 1.6 m/s	Supply voltage	5 V DC ± 10%
Scale Total length	up to 400 mm for steel up to 100 mm for glass	Power consumption - Voltage output - Square wave output	50 mA ±10 mA 150 mA ±10 mA
- Material - Grating period (GP) - Reference marks	steel or glass 20 µm standard at the center of the measuring length; others on request	Cable lengths - Flex print cable connected to the scanning head  - Permissible total cable length	25 mm; 55 mm; 75 mm; 85 mm  for 1 V <sub>PP</sub> max. 100 m for RS 422 max. 30 m with extension cable (on request)
Linear expansion coefficient - DOUBLEFLEX scale tape - SINGLEFLEX scale tape	10,5 x 10 <sup>-6</sup> grd <sup>-1</sup> as function of material of the mounting surface	<b>Ambient conditions</b>	
- glass scale	8,5 x 10 <sup>-6</sup> grd <sup>-1</sup>	Operating temperature range	0°C ... +55°C
Accuracy classes - DOUBLEFLEX scale tape	±1 µm; ±2 µm; ±3 µm; ±5 µm	Storage temperature range	-20°C ... +70°C
- SINGLEFLEX scale tape	±5 µm; others on request	Vibration (50 Hz ... 2,000 Hz)	≤ 200 ms <sup>-2</sup>
- glass scale	±1 µm	Shock (11 ms)	≤ 400 ms <sup>-2</sup>
		Humidity	93% RH (no condensing)



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