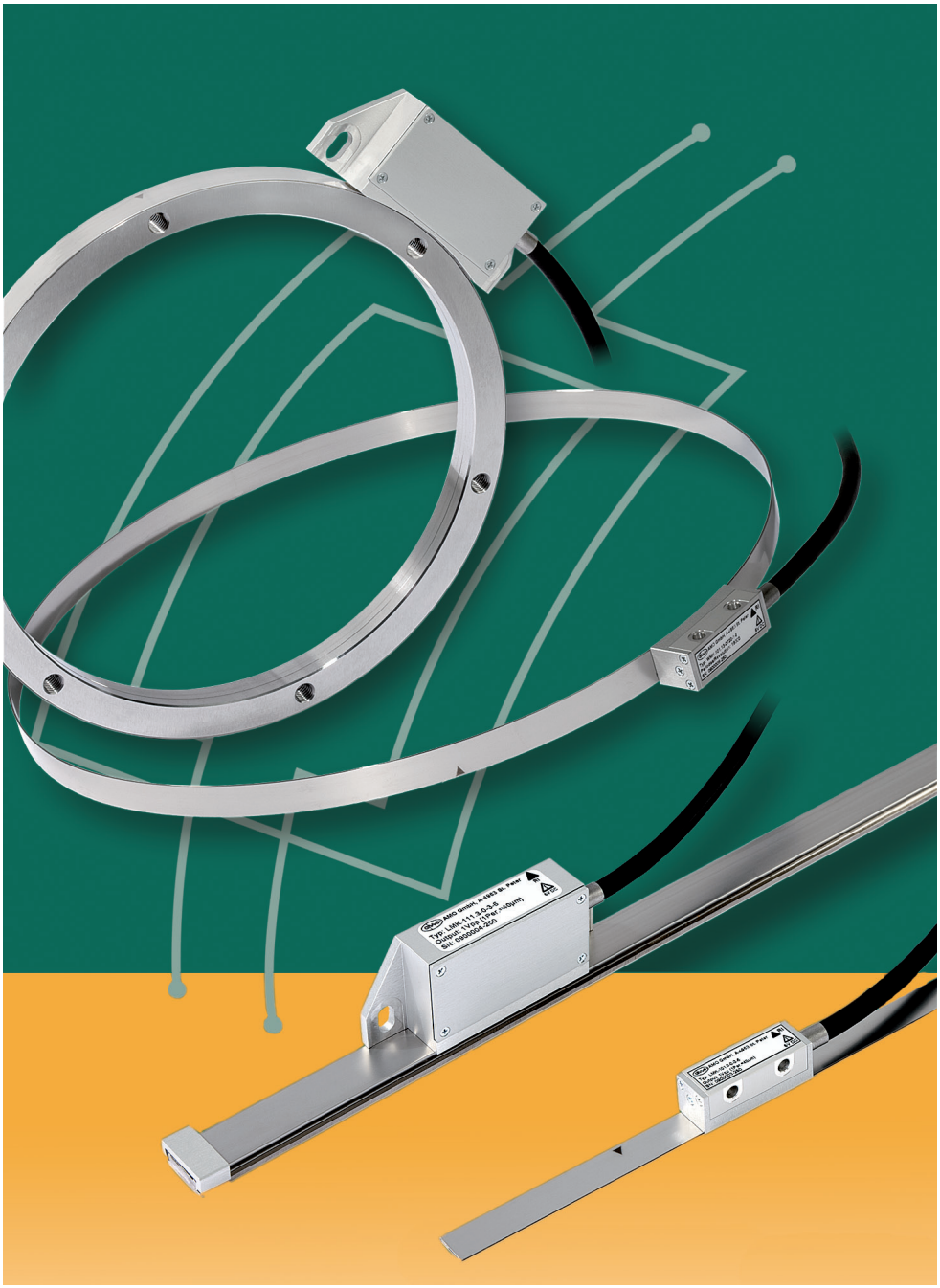
AMO GmbH

# *Design Guide for unguided AMO measurement systems*



*This document was created very carefully. If there are any technical changes, they will promptly updated in the documents on our website www.amo-gmbh.com*

*With the publication of this brochure all previous editions become invalid.*

SN: 20120418

# Inhaltsübersicht
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# Introduction

The document serves as a design support for AMOSIN® length and angle measuring systems, and is only an additional help.

High-precision measurement systems provide the best measurement results, when the scanning distance between the measuring scale and scanning head is kept as accurately and consistently. The open (non-guided) measuring systems work contactless. The relative position between the 2 measuring components (scanning head and measuring tape) should be guaranteed by the machine-management and assembly. For measuring systems with its own Guide, this is given by the construction. However, such measuring systems don‘t work wear-free, are relatively expensive and the Guide generates unwanted friction and abrasion.

To avoid over certain assembly, possibly be used in guided systems (type LMI-310,LMIA...), an elastic coupling element, which brings more disadvantages (Measurement errors due to elasticity, dynamic behavior, tendency to vibrate, break of the coupling element). Optical systems have to be encapsulated for a satisfactory protection, and for this reason they are usually available only in guided design. For direct drive axes (linear motor, torque motor) do not use a spring element.

AMOSIN measurement systems have due to the inductive scanning principle, even without encapsulation as standard IP67 protection. Therefore, they are usually used WITHOUT own guidance system. So that all the above-described disadvantages are avoided.

For the mechanical engineer, this means with unguided measuring systems he has to care on his own for compliance to the position between the scale and scanning head. Therefore must some special rules be considered in designs with unguided systems. However, this is quite easy if you know this.

This design guide will help you to get with little effort, the most of your unguided AMO length and angle measuring systems and to avoid errors if you use the first time unguided measurement systems.

# *General design guidelines for linear and rotary, unguided AMO measuring systems*

## 1. Installation place of the measuring system

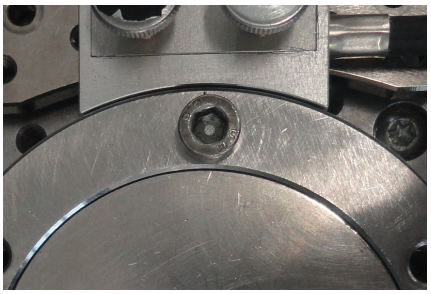
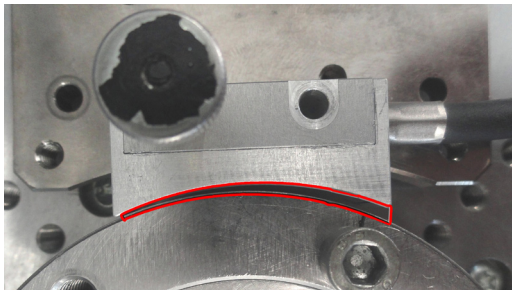
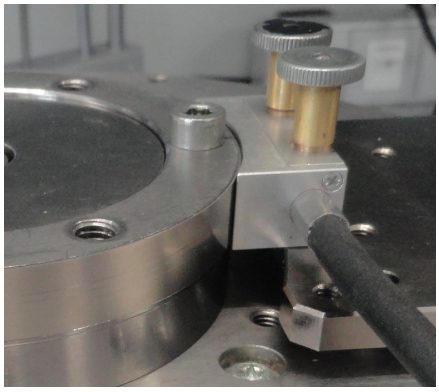
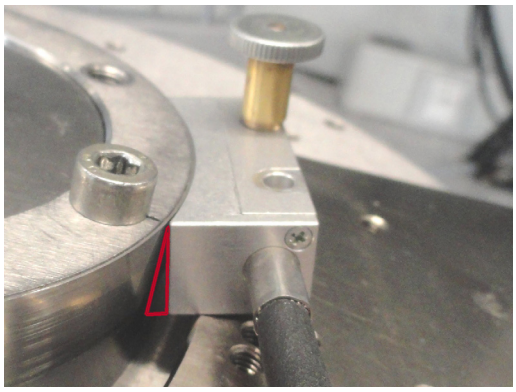
The installation of the measuring system significantly affected the performance of the entire axis. Please consult the installation position with your drive supplier, or a specialist for dynamic vibration effects, especially in highly dynamic direct drives. As a general guideline:

1) Measurement system should be installed as near as possible to the camp respectively the linear guide.
2) Mount near as possibly to the object which should be measured. (Abbé critereon, cosine error-minimizing)
3) Mount in a safe distance to strong EMV disorders.
4) Avoid temperature fluctuations.

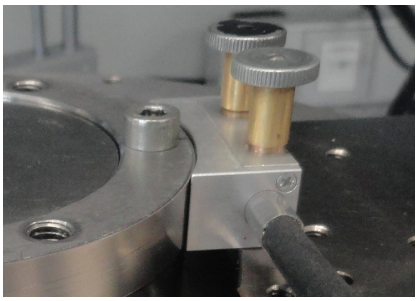
## 2. Angularity and position of the scanning head must be fixed

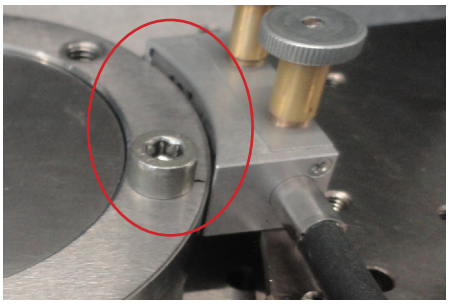
The support (Mounting bracket or -block) for the scanning head has to be designed with help of stop edges and smooth angle surfaces, therewith the perpendicularity and axial position to the measuring rod is given.The only adjustable degree of freedom may be the distance between the scanning head and the scale. Thats the only way for a quick and processsafe adjustment.

All errors in the images shown here are extremely exaggerated to make them visible. In reality a few µm deviation can cause to an error.

| | correct | wrong |
|---|---|---|
| a) air gape not evenly |  |  |
| b) parallelism does not exist |  |  |

c) Axial displacement (positive)





## 3. Stability of the sensor head mounting

Any unwanted movement between the scanning head and measuring tape - even in the micron range - is interpreted due to the high resolution from the measurement system as a position change and thus acts directly on the position control. The support (bracket or block) can be considered for the propulsion system as a flexible »member« in the »feedback loop« that, if it is too elastic, could limit the system bandwidth. The support for the scanning head must therefore be so stiff that may occur during operation, no vibrations or resonances. It‘s the best, you use milling, and no bending parts.

## 4. Axial position of the scanning head to the measuring tape or ring

The axial position of the scanning head to the measuring scale is formally specified by the design and not adjustable. The allowable tolerance of this position is relatively large (see catalog or mounting instructions), therefore it is easy to observe it with a fixed construction.

Attention! Especially for prototypes, we recommend you to give a spacer plate between scanning head and machine bed . This is the only way to correct the position with reasonable effort on both sides, in case the position of the scanning head in the assembly is out of range. Spacers must be completely flat, flat and free of burrs. Washers, etc. are unsuitable.

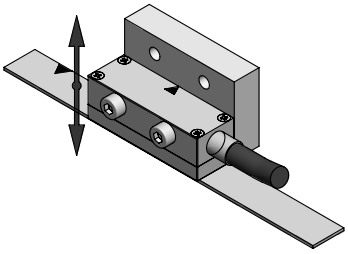
## 5. Adjustment mechanism for the air gap of the scanning head

The distance between the scanning head and measuring scale has to be set exclusively with the supplied spacer film. This is best done directly with the fastening screws of the scanning head. The clearance in the holes should suffice. If this is not possible (for example the type LMKF), the scanning head must be screwed to a few inches wide, lightweight support (e.g. alumium) which allows the adjusting of the scanning distance becauce of the clearance in the mounting holes. Adjustment mechanisms with adjusting screws, etc. are unnecessary and unworkable.

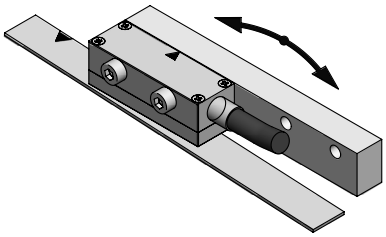
Attention! Only use given M3 or M4 fixing screws with corresponding burr free  washers of electrically conductive material (see also EMC). With larger screws the adjustment would go wrong because of the larger frictional torque of the screw heads. (observe screw mounting torque)

The mounting screws for setting the scanning distance possible should be in the center of the scanning head, or it will tilt while adjusting the scanning distance (No L-shaped mounting bracket).

*correct*

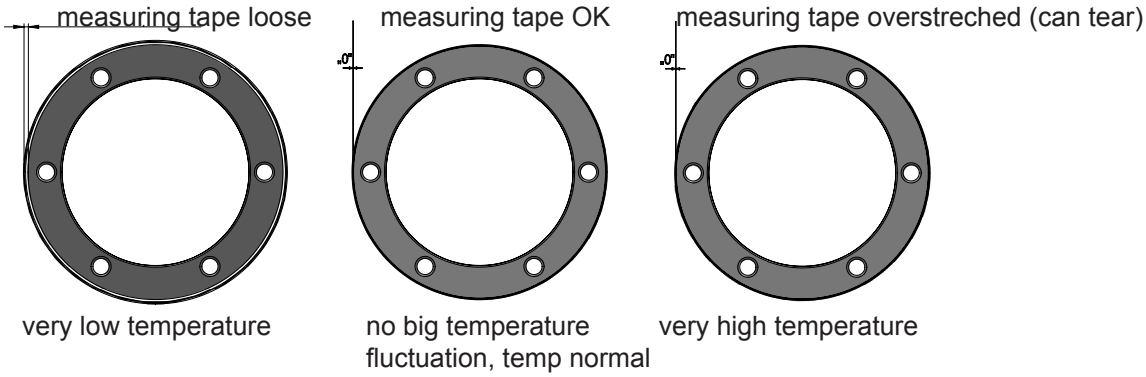


*wrong*



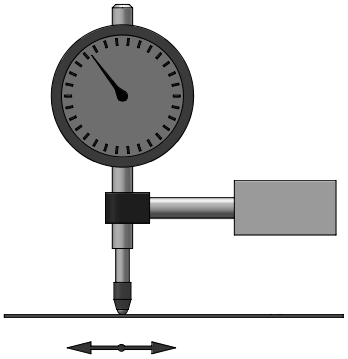
## 6. Termal expansinon

Please calculate for applications with large working temperature range the influence of thermal expansion on the sampling tolerances. Pay attention to material combinations, e.g. Aluminum ~23ppm/°C - steel ~13ppm/°C ! Measuring tape rings WMR and WMB can in principle also be mounted on round flanges, which are not made of steel. Attention! With a large operating temperature range is such a pairing because of the different thermal expansion not permitted, the measuring tape can become loose, or otherwise be overstretched. (see sketches)

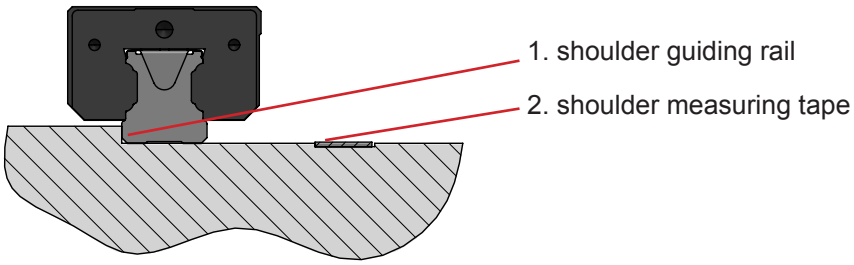



## 7. Accessibility of the scanning head

The space around the sensor head must be easily accessible. In order to insert the spacer foil and then pull out again in order to set the scanning distance. There must be enough space left to push the scanning head and its support with a finger against the film and coincident with the other hand to tighten the mounting screws.



For linear systems: The setting of the scanning distance should ideally be possible over the entire measuring length, so that it may be in the middle of the tolerance zone. The passage in question is determined by a dial gauge that you put on the slide and drive the tape along the entire length.(1. shoulder guide rail, 2. shoulder measuring tape) If possible, provide to the trolley a mounting option for a dial-gauge holder (magnetic material).
parallelism ==> mounting surface, measuring tape in an editing process to check with stopp guide rail.




## 8. Choice of connectors

The customer‘s cable assembly is not recommended.
The strands of the cable having an extremely small cross-section and can therefore be very difficult to solder or crimp. We therefore recommend strongly to order a factory-assembled connector, even if the systems can be supplied without a plug. For cable penetrations, we can offer on request, connector solutions, which are not listed in the catalog. Caution on protection for Sub-D connectors, these can NOT be used for dirt-producing processes, just outside the machining area of the machine.

## 9. Cabling / Serviceability

Choose cable length and connector position so that the scanning head in case of service can be easily replaced. It may be advisable not to go with the cable of the scanning head, but with an extension cord through an often turbulent trailing cable, so that the scanning head does not become an »expendable«.

## 10. Cable length / voltage drop on the 5V power supply

Inductive measuring systems have a relatively high power consumption. In the design phase the power supply capacity of the drive controller should be checked. See catalog. For cable lengths> 3 m, the voltage drop is observed. If present, the sense-function of the sense-5V supply must be used. Otherwise provide with an extension cord and / or parallel connection of power supply to the sense lines for sufficient cross-sections.

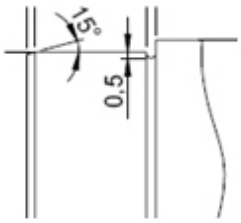
## 11. EMC-Protection

The scanning head is connected over the mounting bolts to the machine ground. Do not use burnished or other isolated screws. The sensor extension cable must be twisted pair, shielded and the shield must be implemented on all connections. Sensor and power cables are not laid in the same channel or towing. Between sensor and power cables must be a minimum distance of 10 cm. The cable length between the miniature scanning heads and the external connector and the evaluation electronics MHS or CHS is too short as possible.

# Special features for rotative measuring systems

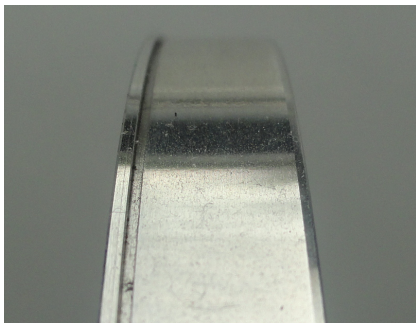
## 1. Stop edge or bed for measuring ring WMR/WMB

For using the measuring ring the holding cylinder for the measuring ring must be exactly as shown in the drawing in the catalog.Attention! The scanning head is wider than the measuring tape. The bottom edge (or the bed with interior scanning) must therefore be less deep than the thickness of the tape measure to avoid a collision with the scanning head. Measurings you can see in the catalog or mounting instruction. Attention! Not all measuring tapes are equally thick!

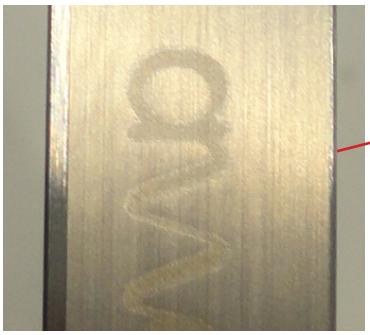



## 2. Save flanges from damage during

Lying outside rings or measuring ring flanges are very exposed and can be damaged during installation by unintended touches. Please design the flange so that measuring tape is not entirely outside. You can protect the ring, for example, by a projecting edge. Or use a centering ring which is inserted in the mounting direction in front of the measuring ring ring in the surrounding component. Thus, the measuring ring can not touch the outer ring while assembly.



measuring flange without measuring ring



The measuring ring is not very outside, and is thus protected from damage at the edges

measuring flange with measuring ring

## 3. Accuracy: influenced by storage, eccentricity and runout

Angle measuring systems can not be more accurate for geometrical reasons as the used bearing. It is therefore high, backlash-free bearings to be used.

The eccentricity of the measuring ring must be kept low. Just a few microns eccentricity can cause to a systematic measurement error, which can exceed the grating accuracy of the measurement system far over!

The eccentricity e, the measured ring diameter A and the resulting angular error Δ φ are related as follows:

$$\Delta \varphi \, [\mu m] = \pm 412 * e/A$$

Example of a measurement ring diameter of 163 mm and an eccentricity of 5 microns:

412* 5/163 = ± 12,6“ angle error

## 3.1 Directed flange around instead od expensive µm tolerances?

Please also take into consideration you to mount the flange without centering and then judge with the dial gauge round. This saves expensive components with micron tolerance. An experienced mechanic caused so a flange in a few minutes to a few microns exactly round. In our experience this is more cost effective. Machined parts with roundness and concentricity of <5 microns are desirable, but very expensive to produce. Very few turned parts manufacturers are willing and able to produce such parts.

## 3.2 Compensate for the eccentricity error in the control

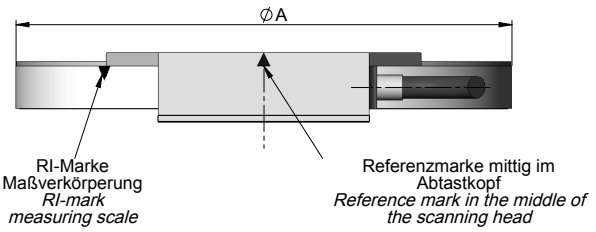
If you measure your rotary axes with the autocollimator and compensate in the control, the axis after the compensation will be much more accurate than the calculated value of pitch accuracy of the measuring ring and eccentricity. Mayby in this case you can save some money due to use larger tolerances on machined parts and due to use of a measuring ring with lower grating accuracy.

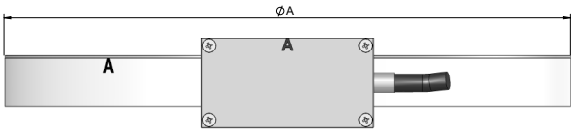
## 3.3 More head-measuring systems automatically compensate for eccentricity

Multi-head measuring systems of the type MHS or CHS are able to compensate for the eccentricity automatically. Perhaps such a solution is less expensive than the mechanical tolerance of the rotating parts in the micron range. We can help you with the technical / commercial comparison of different systems.

## 4. Marking of the installation position measuring ring to scanning head

The measuring ring and the sensor head are internally asymmetric constructed. Both are, therefore, with an arrow (incremental) or with an »A« (absolute) marked. Attention to the mounting position of these markers eighth and draw them into the assembly drawing clearly visible. See installation instructions or drawings in the catalog. If the rotational position of the zero point plays a role on the axis, this is also inscribe.



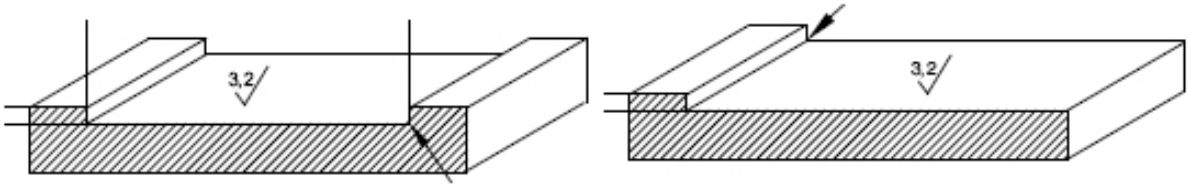

## 5. Position of the zero position for rotary axis < 360°

For axes which rotate less than 360 °, the Rotary position of the zero position has to be set strictly. In an incremental system the zero mark has to be set in the pivoting range, so it can be run over.
In an absolut system the zero mark has to be set outside of the pivoting range, because when the zero mark is run over, the value jumps from 0° to 360° (or in the other way).

# Special features for linear measuring systems

## 1. Guide bed or stop edge for the measuring tape

For the assembly of the scale is a deeper bed, or at least a stop edge nessecary to fix the lateral position. Attention! The scanning head is wider than the measuring tape. The bed and the bottom edge must therefore be less deep than the thickness of the measuring tape to avoid a collision with the scanning head. Dimensions see catalog / assembly instructions. Attention! Not all measuring tapes are equally thick!




## 2. Parallelism Guide / measuring tape

The scale must be mounted on the same, stable profile respectively machine bed as the linear guide. The beds for the scale and the linear guide must be made in the same operation, to ensure parallelism and thus a constant distance between the scanning head across the entire length. The parallelism between the scale and the leadership must be <½ of the allowable tolerance distance, so there is still reserve for assembly tolerance. (see catalog / assembly instructions)

## 3. Zero mark position

The measuring ring and the sensor head are internally asymmetric constructed. Both are, therefore, with an arrow (incremental) or with an »A« (absolute) marked. Attention to the mounting position of these markers eighth and draw them into the assembly drawing clearly visible. See installation instructions or drawings in the catalog (Picture page 10 point 4)

Attention! AMO does not define the physical location of the zero mark on the measuring tape, but the position of the scanning head on the measuring tape when crossing the zero mark. Assembly drawings of the corresponding measuring system are in the catalog. Right means the right of the assembly drawing in the catalog. It is also the right side of the cable outlet on the scanning head according to drawing.

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## 3.1 Zero mark positions from the right, example

If the scanning head is flush with the right end of the tape measure, it means zero mark position 0 mm from the right. When he moved from that position by 10 mm to the left, is the zero mark position 10 mm from the right.

## 3.2 Nullmarkenposition von links, Beispiel

If the scanning head is flush with the left end of the tape measure, it means zero mark position 0 mm from the left. When he moved from that position by 10 mm to the right, is the zero mark position 10 mm from the left.

## 3.3 Special case of the measuring tape system LMB-4xxxx with steel and snap cover

In this type of measuring tape right and left may be a supplied bracket is mounted to keep measuring tape from accidental detach the snap cover.

In this type of measuring tape right and left may be a supplied bracket is mounted to keep measuring tape from accidental detach the snap cover. Thus, the measurement range is limited on both sides by 10 mm. Again, the drawing in question is relevant.

# Notice

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