Functional Safety

Solution for the position detection on rotary axes for safety-related systems can be offered with the absolute and incremental angle encoders by AMO.

These are scanning heads with an purely analogue output signal 1 Vpp signal period corresponding to a grating period. Corresponding angle encoders are marked with option „FA" in the order description. These angle encoders can be used for numerous safety functions of the complete system according to EN 61800-5-2.

AMO provides MTTF values for angle encoders and the annotated table D16 for motion and bearing sensors within the standard EN 61800-5-2 for the safety-related view of the complete system on demand.
In addition to the electrical interface, the mechanical connection of the measuring encoders to the drive is also relevant to safety.

In the standard for electrical drives EN 61800-5-2, Table D16, the loosening of the mechanical connection between the measuring encoder and the drive is listed as a fault.
The fault exclusion against loosening the mechanical connection is required in many cases, because the control can't detect such errors compellingly.

Fault exclusion against loosening of the mechanical connection

The machine manufacturer is responsible for the dimensioning of mechanical connections in a drive system. The OEM should ideally consider the application conditions for the mechanical design. Providing objective evidence of a safe connection is time-consuming, however.

For this reason, AMO has developed and confirmed by a type exermination a mechanical fault exclusion for the angle encoders.
The qualification of the mechanical fault exclusion was performed for a broad application range of the encoders.

This means that fault exclusion is ensured under the operating conditions listed below.

Fault exclusion against loosening of the mounting srews on the scanning head

	WMKA 2010	WMK 1105 WMK 1010	WMK 1105 WMK 110	WMK 2005 WMK 2010 WMK 2030	WMK 2110 WMK 2130
Design	20	10, 12		20, 21	
Mounting screws [1]					
Screws	M4 x 35 ISO 4762 8.8	M3 x 16 ISO 4762 8.8		M4 x 16 ISO 4762 12.9	
Torque Med [2]	2,0 ± 0,05Nm	1,0 ± 0,05Nm		2,0 ± 0,05 Nm	
Length of thread engagement	> 9mm	> 4mm		> 13,5mm [3]	
Mating stator					
Material	Steel				
Elastic limit $R_{e\,0,2}$	≥ 370 N/mm²				
Surface roughness	RZ 10 ÷ 40 µm				
Coefficient of thermal expansion α	(10 to 16) .10 $^{-6}$ K^{-1}				
Shock	6ms <1000 m/s² (EN 600068-2-27)				

[1] A compatible screw locking device must be used for the screw connections
[2] Tightening prozess: Torques monitored
Mounting at room temperature; Components must be balanced regarding temperature
[3] There must be anticipate a blind hole ø 4,3 x 3mm on the stator side at the mounting holes.See Figure.01

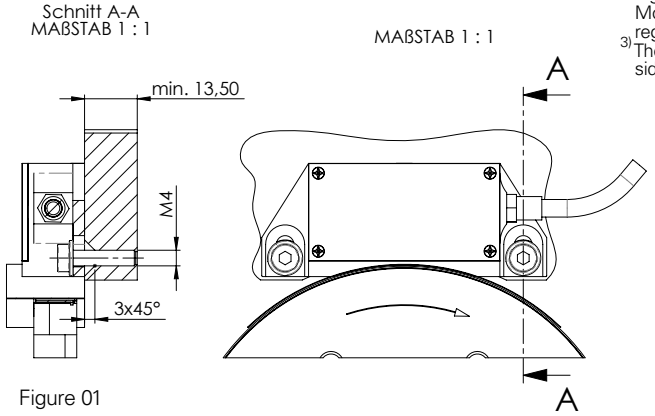


Figure 01

Fault exclusion against loosening of the mounting srews or of the measuring flange

The great range of temperatures in combination with the multitude of material characteristics, as well as the maximum permissible shaft speeds and accelerations require an interference fit of the Measuring flange. Because of the dimensioning of the interference fit and taking into account all safety factors, heating the measuring flange is neccessary and affect directly the required assembling temperatures.
See the mounting with the mechanical fault exclusion as an option.

If there is no need of the mechanical fault exclusion for the safety concept, the measuring flange can also fixed without the interference fit. (Look øW1 bzw. øW2 at the dimension of the respective measuring flange)

Measuring flange	
Mounting screws [1), 2)]	M6 x 25 ISO 4762 8.8; Md= 8,7 ± 0,1Nm M5 x 25 ISO 4762 12.9; Md= 5,2 ±0,1Nm
Free grip lengths M6 x 25	> 10mm
Length of thread engagement at M5 x 25	> 14mm
Mating shaft	
Material	Steel
Elastic limit $R_{p\ 0,2}$	≥ 370N/mm²
Surface roughness	Rz 10 ÷ 40 µm
Coefficient of thermal expansion α	(10 to 12) . 10^{-6} K^{-1}
Shock	6ms < 1000 m/s² (EN 600068-2-27)

[1)] A compatible screw locking device must be used for the screw connections
[2)] Tightening prozess: Torques monitored
Mounting at room temperature; Components must be balanced regarding temperature

Mounting temperature

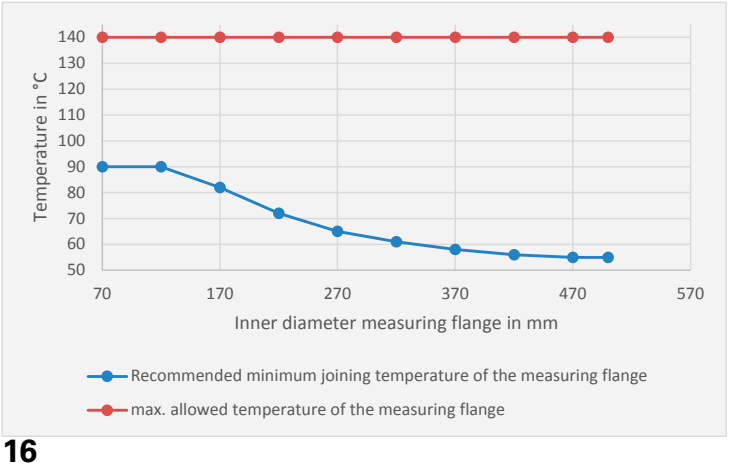
All information on screw connections is given with respect to a mounting temperature of 15 °C to 35 °C.

Assembling the measuring flange

An oversize of the shaft is required for fault exclusion. The measuring flange should preferably be shrunk thermally onto the mating shaft and additionally be fastened with screws. For this purpose, the measuring flange must be heated slowly before mounting. Use a heat chamber or a heat plate (but no induction heating sources). The diagram shows the recommended minimum temperatures for the different measuring flange diameters. The maximum temperature should not exceed 140 °C.

During shrink-fitting, make sure that the hole patterns of the scale drum and mating shaft are properly aligned. Appropriate positioning aids (setscrews) can facilitate mounting. When the scale drum has cooled down, all mounting screws have to be tightened again with the correct torque.

The mounting screws used for the assembly of the scanning head and measuring flange must be used only to secure the scanning head and the measurign flange. Do not additionally fasten any other components with these screws.



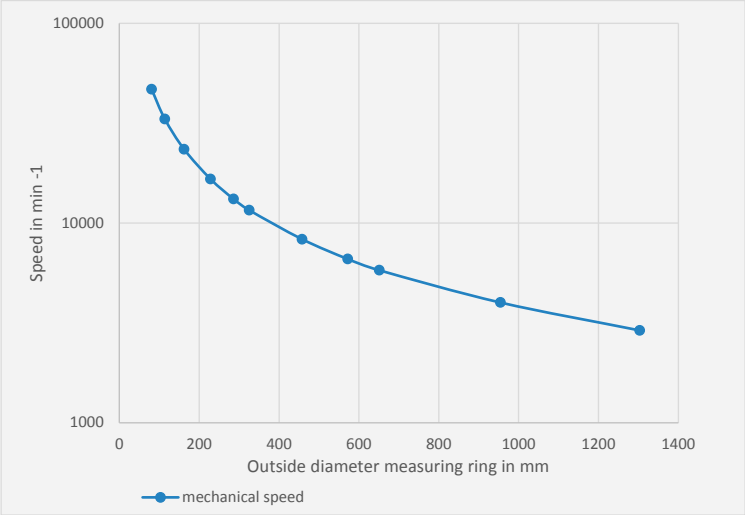
*The temperature specification refers to an ambient temperature of 22 ° C. If the ambient temperature is different, adjust the assembling temperature accordingly

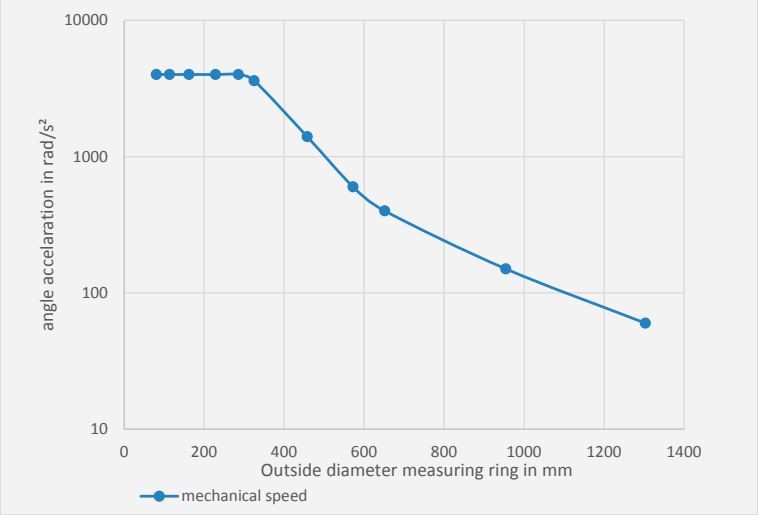
Fault exclusion against loosening the measuring ring from the carrier flange

A mechanical fault exclusion for the loosening of the measuring ring from the carrier flange is given, when the carrier flange is designed according to the mechanical requirements specified by AMO for the respective measuring ring type.

The maximum permissible speeds and accelerations for standard measuring ring sizes are listed in the technical parameters.

Carrirer Flange	
Material	Steel
Elastic limit $R_{\varrho\ 0,2}$	≥ 430N/mm²
Coefficient of thermal expansion α	(10 to 12). $10^{-6}\ K^{-1}$
Shock	6ms ≤ 1000 m/s² (EN 600068-2-27)





Mechanical design types and mounting

The inductive modular encoders consist of a measuring flange or a scale tape ring and the corresponding scanning head. The position of the scanning head and graduation relative to each other is determined solely via the machine bearing. However, the design features of the modular encoders assure comparably fast mounting and easy adjustment.
The stated values for graduation accuracy and the position error within one signal period can be attained in the application if the requirements are fulfilled (see Specifications).

Versions
There are various grating periods available for the modular encoders (500 µm, 1000 µm or 3000 µm). This results in different line counts for the same outside diameter. The graduation is available as a scale tape ring mounted on a flange or as very thin scale tape ring for mounting at customer site.

Scale tape ring on flange WMF or WMFA
For mounting, the measuring flanges are slid onto the mating shaft and fastened axially with screws.

Scale tape ring WMR or WMRA
The scale tape rings are designed for mounting on a prepared customer specific carrier at customer site. The mechanical requirements of the carrier for a proper mounting are shown in the technical specifications

Centering the measuring flange
Because the attainable total accuracy is dominated by mounting error (mainly through eccentricity), special attention must be placed on centering the measuring flange. Depending on the encoder and mounting method, various methods of centering the measuring flang are possible in order to minimize the eccentricity errors that occur in practice.

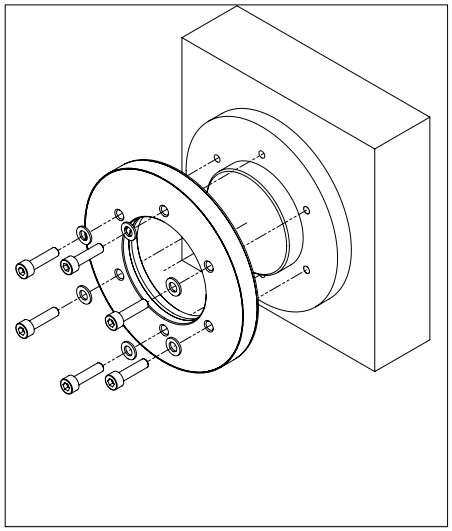
Centering by centering collar
The measuring flange is pushed or shrunk onto the shaft. This very simple method requires an exact shaft geometry and bearing quality to meet the corresponding accuracy requirements.
The measuring flange is centered via the centering collar on its inner circumference.

AMO recommends a slight oversize of the shaft on which the measuring flange WMF is to be mounted. For easier mounting, the measuring flange may be slowly warmed on a heating plate over a period of approx. 10 minutes to a temperature of at most 140 °C. In order to check the radial runout and assess the resulting deviations, testing of the shaft's rotational accuracy before mounting is recommended.
Back-off threads are used for dismounting the measuring flange.

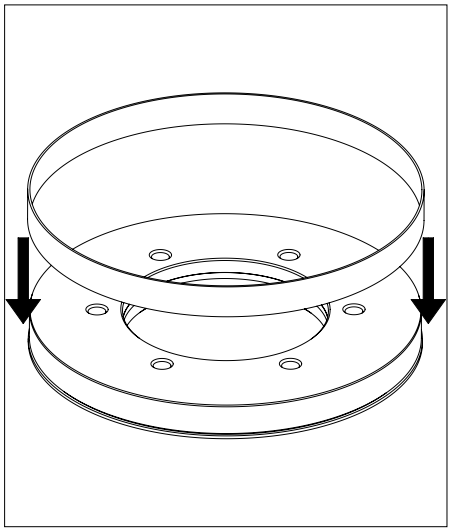
Mounting the scanning head
In order to mount the scanning head, the provided spacer foil is applied to the surface of the circumferential scale drum. The scanning head is pressed against the foil, fastened, and the foil is removed.

Mounting clearance
The mounting clearance (gap between scanning head and measuring flange) depends on the encoder's grating period. As a result, the spacer foils for mounting the scanning head are of varying thicknesses. Deviations of the scale-to-reticle gap from the ideal value negatively influence the functional reserve.

Mounting of the measuring flange WMF or WMFA



Mounting of the scale tape ring WMR or WMRA



Mounting of the scanning head WMK or WMKA