Combination Thrust and Radial Bearings with Integrated Measuring System
Series YRTM/MEKO

Features

The measuring system integrated in series YRT combination thrust and radial bearings allows the non-contact, magnetoresistive recording of angles within the range of a few angular seconds.

It consists of:

- an INA combination thrust and radial bearing, series YRTM with a dimensional scale
  - the dimensional scale consists of several metallic layers. The layers are electro-plated onto the YRT-bearing shaft washer.
- the MEKO electronic measuring system, consisting of two measuring heads and an electronic evaluation device
  - the measuring heads have magnetoresistive sensors and are diametrically integrated into the mounting structure
  - the electronic evaluation device uses vector addition to calculate the value of the effective angle from the two sensor signals and then converts this value to a 1 Vpp value

Advantages of the INA Angle Measuring System

The measuring system offers the following advantages:

- Non-contact operation and thus wear-free
- Measurements not dependent on tilting or position
- Self-adjusting electronics
- Self-centering
- Not affected by vibration
- Not affected by lubricants
- Easy to install; measuring heads are easy to adjust
  - no alignment of bearings or separate measuring system necessary
- Compatible with conventional angle measuring systems available on the market
- Requires no additional components
  - the dimensional scale and measuring heads are integrated in the bearing and the mounting structure
  - the design space saved can be used for the machine work area
- Supply leads pose no problems
  - leads can be placed inside the mounting structure, through the bearing bore
- Requires fewer components
- Compact, integral design with fewer components is cost effective and allows overall design space savings

Please refer to INA brochure GKL for relevant technical data on YRT combination thrust and radial bearings.

Thrust/Radial Bearings w/ Measuring System

for bearings with bore diameters of 180 mm, 200 mm, 260 mm, 325 mm and 395 mm
suitable for temperatures from 0 °C to +70 °C

System Measuring Principle

- magnetic scale
- magnetic flux lines
- measuring head with magnetoresistive sensor
- electronic evaluation device
- analog signals at output

Please refer to INA brochure GKL for relevant technical data on YRT combination thrust and radial bearings.
**Dimensional Scale**
Magnets with high-precision encoders are positioned 250 μm apart on the magnetizable electro-plated coating and serve as angle references (Figure 1). A sharply defined magnetic field is measured between the poles of the magnets.

**Reference Marks**
The magnetoresistive dimensional scale allows incremental angle measurement. However, since an absolute reference is needed to determine the positions, another track is furnished in addition to the incremental track. This track has reference marks. These reference marks must be passed to produce an absolute reference. The INA angle measuring system has distance-coded reference marks every 15° so the system can easily move to the reference (Figure 1). The absolute reference is present as soon as two adjacent reference marks are passed.

**Measuring Heads with Magnetoresistive Sensors**
Both measuring heads are optimized in terms of design space (Figure 2). They are secured in a slot in the mounting structure by a mounting screw.

The magnetoresistive (MR) effect allows the small magnetic fields to be detected. Unlike magnetic heads, the MR sensors perform static measurements on magnetic fields, i.e. electrical signals are derived without motion.

The resistive coating of the MR sensors is designed so that the resistance changes when a magnetic field is applied perpendicular to the current flow. The magneto-sensitive coatings are specially arranged to ensure that:
- external influences – e.g. temperature fluctuations – are almost completely compensated
- two optimum electrical signals are always available at the same time

Two sinusoidal signals with a phase shift of 90° and a cycle length of 500 μm are generated when the magnetic scale moves past the MR sensor. This coupling is used to measure the angle.
Electronic Evaluation Device

The electronic evaluation device (Figure 3) operates with the aid of a digital signal processor (DSP):

- the MR sensor input signals are digitized by an analog-to-digital converter
- the high-performance processor (DSP) automatically adjusts the sensor signals and uses vector addition to calculate the effective angle value from the sensor signals – factors such as the analog-signal offset are corrected
- a digital-to-analog converter generates synthetic analog signals as a 1 Vpp value

The electronic evaluation system can be placed anywhere on or inside the mounting structure. It is connected to the control system by a conventional 12-pin extension cable.

Output Signals

Incremental signals A and B are phase-offset by 90° and have an output level of approx. 1 Vpp. The reference mark signals, applied at 15° intervals, have an effective value of around 0.5 V. Leads of up to 100 m in length can be used to transmit the voltage signals from the electronic evaluation device to the downstream electronic system.

The supply voltage is 5 V ±10%.

Signal Transmission Cables

The measuring system components have polyurethane (PUR) cables that are resistant to oils, hydrolysis and microbes in accordance with VDO 0672.

The bending radii R will vary depending on the cable diameter (Table 1).

<table>
<thead>
<tr>
<th>Table 1 - Bending Radii R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable</td>
</tr>
<tr>
<td>Measuring head</td>
</tr>
<tr>
<td>Lead</td>
</tr>
</tbody>
</table>

Plug Connections

INA plug connections are robust and designed for use in an industrial environment. When plugged in, they comply with protection class IP 65 (EN 60 529). The large sheathed areas in the plugs reliably shield the cable connection between the measuring system and the downstream electronic system.
Combination Thrust and Radial Bearings with Integrated Measuring System

Product Description

Measuring Accuracy
The more accurate the angle measurement, the more accurately a shaft can be positioned. The accuracy of angle measurement is mainly determined by the following:

- Quality of ruled grid distribution
- Scanning quality
- Quality of the electronics for signal processing
- Pitch eccentricity with respect to the bearing arrangement
- Radial runout deviation of the bearing arrangement
- Elasticity of the measuring system shaft and its coupling to the shaft to be measured
- Elasticity of the stator shaft or shaft coupling

Only 1 to 4 are relevant for the INA YRTM measuring system. The eccentricity in 5 is completely eliminated by the diametric arrangement of the MR sensors. 5 to 7 above play only a minor role in the measuring system.

Accuracy deviations
The measuring system can detect two types of deviations:

- Positional deviations during a rotation
  - these deviations are the absolute measurement errors in one system rotation. They apply at an ambient temperature of +20 °C and a rotation speed of 5 rpm.
  
  Deviations:
  YRTM 180 ≤±5°
  YRTM 200, YRTM 260, YRTM 325, YRTM 395 ≤±3°

- Positional deviation during a signal cycle
  - this deviation is less than 1%.
  - This is equivalent to a positioning deviation of ≤±3°

Because the system’s dimensional scale is linked to the rolling bearing directly – without any compensating elements – bearing displacements and eccentricities can affect the measuring results. However, this effect does not occur here because of the diametric sensor arrangement. The electronic evaluation device always uses vector addition to obtain the effective measurement value from both signals.

Measurement record
An accuracy record is included with each INA measuring system (Figure 4). Accuracy is measured and recorded on the coded washer of the YRT bearing when the coding is applied. The measurement record indicates the coding pitch error.

![Sample measurement record for an INA angle measuring system](image-url)
Possible Sources of Electrical Interference during Signal Transmission

Interference voltages are mainly generated and transmitted by capacitive or inductive interference. Interference can occur through lines as well as from equipment inputs and outputs. Sources of interference include:

- Strong magnetic fields from transformers and electric motors
- Relays, contactors and solenoid valves
- High-frequency equipment, pulse equipment and magnetic stray fields from switched-mode power supply units
- Supply mains and leads to the equipment mentioned above

Safety Information

❗ Never use YRTM bearings to locate dial gages etc. Magnetic fields will damage or erase the dimensional scale. This will result in incorrect system measurements that are displayed as an error message in the control. The measuring system should be designed so that operation is not affected by electrical or mechanical sources of interference.

INA cables or suitable, commercially available cables should be used as signal lines.

Angle Measuring Device – Technical Data

Technical data for the angle measuring device are provided in Table 2.

Table 2 - Technical Data

<table>
<thead>
<tr>
<th>Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage supply</td>
<td>5 V ±10%/max. 200 mA (zero load)</td>
</tr>
<tr>
<td>Scale</td>
<td>magnetically hard electro-plated coating with periodic North-South pitch</td>
</tr>
<tr>
<td>Incremental signals</td>
<td></td>
</tr>
<tr>
<td>Line count/accuracy (at +20 °C)</td>
<td>≈1 Vpp</td>
</tr>
<tr>
<td>YRTM 180 3 072/±5°</td>
<td>YRTM 200 3 408/±3°</td>
</tr>
<tr>
<td>YRTM 260 4 320/±3°</td>
<td>YRTM 325 5 184/±3°</td>
</tr>
<tr>
<td>YRTM 395 6 096/±3°</td>
<td>distance-coded every 15° ≈180 kHz</td>
</tr>
<tr>
<td>Reference marks</td>
<td></td>
</tr>
<tr>
<td>Limit frequency (~3 dB)</td>
<td></td>
</tr>
<tr>
<td>YRTM 180 3 072/±5°</td>
<td></td>
</tr>
<tr>
<td>YRTM 200 3 408/±3°</td>
<td></td>
</tr>
<tr>
<td>YRTM 260 4 320/±3°</td>
<td></td>
</tr>
<tr>
<td>YRTM 325 5 184/±3°</td>
<td></td>
</tr>
<tr>
<td>YRTM 395 6 096/±3°</td>
<td></td>
</tr>
<tr>
<td>Distance-coded every 15°</td>
<td></td>
</tr>
<tr>
<td>≈180 kHz</td>
<td></td>
</tr>
<tr>
<td>Data interface</td>
<td></td>
</tr>
<tr>
<td>Recommended measurement step</td>
<td>0.0001°</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>from −0 °C to +70 °C</td>
</tr>
<tr>
<td>Protection class (EN 60 529)</td>
<td>IP65</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
</tr>
<tr>
<td>Measuring heads</td>
<td>130 g each</td>
</tr>
<tr>
<td>Electronic evaluation device</td>
<td>520 g</td>
</tr>
<tr>
<td>Electrical connections</td>
<td></td>
</tr>
<tr>
<td>Measuring heads</td>
<td></td>
</tr>
<tr>
<td>Downstream electronic system (not included)</td>
<td></td>
</tr>
<tr>
<td>with: 2 m PUR cable Ø 5.5 mm with plug Ø 12 mm with: 12-pin flanged plug, Ø 28 mm</td>
<td></td>
</tr>
<tr>
<td>Permissible length of cable to downstream electronic system</td>
<td>max. 100 m</td>
</tr>
</tbody>
</table>

Sample Order and Order Code Designation

A unit always consists of:

- **Series YRTM combination thrust and radial bearing with dimensional scale**
- **MEKO electronic measuring system The electronic measuring system includes two measuring heads and an electronic evaluation device.**

Example

One unit comprising:

- a **series YRTM combination thrust and radial bearing for a bore diameter of 260 mm**
- a **MEKO electronic evaluation system 260**

Order code designation: 1 pc. YRTM 260
1 pc. MEKO 260
The complete angle measuring system is very easy to install, because the arrangement of the dimensional scale is compact, and the measuring heads are small and designed for optimum design space.

Checking the Mounting Structure

⚠️ Always ensure that:
- the slots for the measuring heads are made within the specified dimensions (Table, Page 11)
- the recess $D_{A\min}$ (Figure 5, Table 3) is integrated in the mounting structure for bearing installation and reliable measuring system operation
- distance $F$ (Figure 6, Table 3) is observed after measuring head installation. When installed, the measuring heads must be centered with respect to the shaft-washer height

Installing Combination Thrust and Radial Bearings

During installation, the high-precision shaft journal centers the coded shaft washer over the entire bearing height. If holes in the shaft washer are offset with respect to the bearing inner ring, loosen the retention screws and manually rotate the shaft washer to the correct position.

⚠️ Metal tools or magnetized tools must not be used.

The installation instructions for series YRT combination thrust and radial bearings given in the INA publication TPI 103 should also be followed.

Table 3 - Recess diameter $D_{A\min}$ and Distance $F$

<table>
<thead>
<tr>
<th>Combination Thrust and Radial Bearings Designation</th>
<th>Recess Diameter $D_{A\min}$ mm</th>
<th>Distance $F$ mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>YRTM 180</td>
<td>245.5</td>
<td>10</td>
</tr>
<tr>
<td>YRTM 200</td>
<td>272</td>
<td>10</td>
</tr>
<tr>
<td>YRTM 260</td>
<td>345</td>
<td>11.8</td>
</tr>
<tr>
<td>YRTM 325</td>
<td>416</td>
<td>12.5</td>
</tr>
<tr>
<td>YRTM 395</td>
<td>486.5</td>
<td>13.8</td>
</tr>
</tbody>
</table>
Installing Measuring Heads

The installation position for the measuring heads is identified with an arrow (see top figure on page 1). The heads should always be installed with the arrow tip pointing to the mounting face of the bearing outer ring.

Set measuring heads between 0.02 mm and 0.1 mm from the shaft washer outside diameter (Figure 7) using the adjusting foils provided.

⚠️ The diametrical arrangement of the measuring heads must not vary by more than 180° ± 1°.
Use only demagnetized tools to make adjustments.
Secure the measuring-head mounting screws using Loctite.

The measuring heads have been factory-adjusted to the electronic evaluation device. Further adjustment is not necessary during mounting. Care has also been taken to ensure that the permissible positional deviation is not exceeded during a signal cycle.

A seal can be integrated in the mounting structure (Figure 7).

Setting and Diagnostics Program

An optional evaluation program can be used to facilitate the adjustment of the measuring heads. This program can be used both for mounting and the functional diagnosis of the installed measuring system.

Connecting Signal-Transmission Cables and Plugs

A 2-meter cable with plug is attached to each measuring head. The cables can be routed through the mounting structure through a 13-mm-diameter hole.

⚠️ Measuring heads, plugs and cables should be protected from mechanical damage.

The measuring system should be grounded with a short cable to prevent interference.

Input-signal plugs for the electronic evaluation system are equipped with 7 or 8 pins and are color-coded.
Connect the 7-pin and 8-pin plugs to the appropriate jacks on the MEKO box.
Combination Thrust and Radial Bearings
double direction
Series YRTM

Dimension Table - Dimensions in mm

<table>
<thead>
<tr>
<th>Bearing bore diameter</th>
<th>Designation</th>
<th>Weight</th>
<th>Dimensions</th>
<th>Locating holes</th>
<th>Retention screws</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>kg</td>
<td>d</td>
<td>D</td>
<td>H</td>
</tr>
<tr>
<td>180</td>
<td>YRTM 180(5)</td>
<td>7.7</td>
<td>180</td>
<td>280</td>
<td>44</td>
</tr>
<tr>
<td>200</td>
<td>YRTM 200(5)</td>
<td>9.7</td>
<td>200</td>
<td>300</td>
<td>45</td>
</tr>
<tr>
<td>260</td>
<td>YRTM 260</td>
<td>18.3</td>
<td>260</td>
<td>385</td>
<td>55</td>
</tr>
<tr>
<td>325</td>
<td>YRTM 325</td>
<td>25</td>
<td>325</td>
<td>450</td>
<td>60</td>
</tr>
<tr>
<td>395</td>
<td>YRTM 395</td>
<td>33</td>
<td>395</td>
<td>525</td>
<td>65</td>
</tr>
</tbody>
</table>

1) Including retention screws or threaded extraction holes.
2) Tightening torque for screws to DIN 912, quality class 10.9.
3) \( M_{RL} \) at \( n_{const} = 5 \) rpm.
When designing the drive, a starting torque between 2 and 2.5 times \( M_{RL} \) must be taken into consideration.
4) Rigidty values take rolling element set, bearing ring deformation and the screw connection into account.
5) The read head cannot be mounted between the fixing holes or the mounting screw heads.
This leaves two unused holes for the mounting screws in the bearing outer ring.
6) Note: \( H \) is 1 mm higher than standard series YRT bearings.
### Hole pattern

### Retention screws

### Mounting structure requirements

<table>
<thead>
<tr>
<th>Threaded extraction holes</th>
<th>Pitch $^{(1)}$</th>
<th>Screw tightening torque</th>
<th>Load ratings</th>
<th>Fatigue limiting load</th>
<th>Limiting speed</th>
<th>Bearing frictional torque $^{(3)}$</th>
<th>Axial rigidity $^{(4)}$</th>
<th>Radial rigidity $^{(4)}$</th>
<th>Tilting rigidity $^{(4)}$</th>
<th>Bearing bore diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>G</strong></td>
<td>Number</td>
<td>Number × 1</td>
<td>$M_{x}^{(2)}$ Nm</td>
<td>dyn. axial kN</td>
<td>stat. axial kN</td>
<td>dyn. radial kN</td>
<td>stat. radial kN</td>
<td>$f_{G}$ rpm</td>
<td>$M_{el}$ Nm</td>
<td>$C_{el}$ kN/μm</td>
</tr>
<tr>
<td>M8</td>
<td>3</td>
<td>48 × 7.5°</td>
<td>14</td>
<td>92</td>
<td>580</td>
<td>83</td>
<td>209</td>
<td>56</td>
<td>23.3</td>
<td>190</td>
</tr>
<tr>
<td>M8</td>
<td>3</td>
<td>48 × 7.5°</td>
<td>14</td>
<td>98</td>
<td>650</td>
<td>89</td>
<td>236</td>
<td>61</td>
<td>25.5</td>
<td>170</td>
</tr>
<tr>
<td>M12</td>
<td>3</td>
<td>36 × 10°</td>
<td>34</td>
<td>109</td>
<td>810</td>
<td>102</td>
<td>310</td>
<td>71</td>
<td>31</td>
<td>130</td>
</tr>
<tr>
<td>M12</td>
<td>3</td>
<td>36 × 10°</td>
<td>34</td>
<td>186</td>
<td>1710</td>
<td>134</td>
<td>415</td>
<td>131</td>
<td>38.5</td>
<td>110</td>
</tr>
<tr>
<td>M12</td>
<td>3</td>
<td>48 × 7.5°</td>
<td>34</td>
<td>202</td>
<td>2010</td>
<td>133</td>
<td>435</td>
<td>146</td>
<td>43.5</td>
<td>90</td>
</tr>
</tbody>
</table>

### Diagram

Mounting structure requirements
MEKO
Electronic Measuring Device

Electronic Components

Plug Configuration of 12-pin Flanged Plug

<p>| | | | | | | | | | | | |</p>
<table>
<thead>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>6</td>
<td>8</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>12</td>
<td>10</td>
<td>2</td>
<td>11</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>A</td>
<td>B</td>
<td>R</td>
<td>5 V (Up)</td>
<td>0 V (Un)</td>
<td>5 V (sensor)</td>
<td>0 V (sensor)</td>
<td>not assigned</td>
<td>/</td>
<td>not assigned</td>
<td>/</td>
<td>not assigned</td>
</tr>
<tr>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>IEC 747 EN 50 178</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The sensor cables are connected internally with the supply cables. The housing is shielded.

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Plug configuration of 12-pin flanged plug

Bending radius

Protection class IP65

Design type | B
---|---
MEKO 200 | 20
MEKO 260/395 | 25
MEKO 180/325 | 22.5
Mounting structure © with cable opening
© without cable opening

Electronic evaluation system

Protection class IP65

Ground terminal M4

Hole for 2× mounting screw
DIN 912-M4×20