AX SERIES | EDDY CURRENT PROBES

eddy-current sensors with an waterproof and pressure-tight, high resolution analog electronics.

- 1 and 2 channel drivers
- Sensor protection class IP68
- Driver protection class IP40 or IP68
- Analog output
- Low current consumption
- High dynamics
- High electromagnetic immunity
INTRODUCTION

For more than fifteen years we have been occupied with the development and production of high-quality eddy current probes and drivers for industry and research. The AX driver series offers precise and high-resolution eddy current measurements with analogue output.

Eddy current probes are particularly suitable devices for non-contact measurements on metallic targets. Typical applications are measurements on rotating shafts for the detection of imbalance, vibration, out-of-roundness, air gap, radial/axial run-out, and much more besides. The extremely high resolution up to level of 20nm enables the smallest of amplitudes to be detected. eddylab probes are designed for temperatures up to 185 °C and are optimised for the entire temperature range with regard to temperature drift.

THE BASIC PRINCIPLE

The principle of measurement bases on an oscillating circuit made up of the probe (inductance) and a interconnect capacitance. This circuitry is attenuated in the presence of metallic objects. The oscillating circuit generates magnetic field lines - these induce eddy currents on the surface of conductive objects. The eddy currents counteract their cause and attenuate the amplitude of the oscillating circuit. This effect is decoupled from the oscillating circuit a fed towards further signal processing.

AX EDDY CURRENT PROBE DRIVER

Probe driver and sensor are matched pairs. Every sensor and probe driver will become a separate calibration certificate. A simple exchange of the sensor is not possible without prior adjustment and recalibration.

<table>
<thead>
<tr>
<th>PROBE</th>
<th>T05</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T10</th>
</tr>
</thead>
<tbody>
<tr>
<td>range [mm]</td>
<td>0...0,5</td>
<td>0...2</td>
<td>0...3</td>
<td>0...4</td>
<td>0...5</td>
<td>0...10</td>
</tr>
<tr>
<td>offset gap (blind range)</td>
<td>– 0.01 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>linearity</td>
<td>please refer to the technical data of the driver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>resolution reg. corner frequency [% FS]*</td>
<td>valid for middle of range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 kHz</td>
<td>0,075</td>
<td>0,061</td>
<td>0,040</td>
<td>0,033</td>
<td>0,047</td>
<td>0,045</td>
</tr>
<tr>
<td>temperature range sensor</td>
<td>-60...185 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>temperature coefficient sensor</td>
<td>0,2</td>
<td>0,05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sensor cable PTFE-COAX</td>
<td>Ø1,8 mm</td>
<td>Ø2,5 mm (max. 2,7 mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cable length</td>
<td>3 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>min. bend radius static/dynamic</td>
<td>10/25 mm</td>
<td>15/37 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>temperature range cable</td>
<td>-55...+200 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>connection</td>
<td>BNC connector / optional LEMO connector</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>protection class</td>
<td>IP68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vibration</td>
<td>20 g, DIN EN 60068-2-6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>shock</td>
<td>100 g / 6 ms, DIN EN 60068-2-27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>check resistance [Ω]</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>12</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>housing material</td>
<td>stainless steel 1.4305, sensor head PEEK (polyetheretherketon), FPM bend protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 98.5% confidence interval (confidence limit), middle of range as % of range. Resolution dependent on the distance.

CABLE CONFIGURATION

By default, the probes have a BNC plug for the connection at the eddy current basic module. Optionally the probes are equipped with a LEMO connector. This is necessary for connection to the probe driver with protection class of IP68.
## TECHNICAL DATA

<table>
<thead>
<tr>
<th>AX EDDY CURRENT PROBE DRIVER</th>
<th>AX1</th>
<th>AX2</th>
</tr>
</thead>
<tbody>
<tr>
<td>channels</td>
<td>1 channel</td>
<td>2 channel</td>
</tr>
<tr>
<td>operating temperature range</td>
<td>-40...+85 °C</td>
<td></td>
</tr>
<tr>
<td>storage temperature range</td>
<td>-50...+100 °C</td>
<td></td>
</tr>
<tr>
<td>humidity</td>
<td>100 %</td>
<td></td>
</tr>
<tr>
<td>vibration</td>
<td>5 g, DIN EN 60068-2-6</td>
<td></td>
</tr>
<tr>
<td>shock</td>
<td>15 g / 11 ms, DIN EN 60068-2-27</td>
<td></td>
</tr>
<tr>
<td>protection class</td>
<td>IP40, optional IP68 with LEMO connector</td>
<td></td>
</tr>
<tr>
<td>housing</td>
<td>anodised aluminium sealed with o-ring, mounting bores</td>
<td></td>
</tr>
<tr>
<td>housing size</td>
<td>134 x 65 x 30 mm (l x w x h)</td>
<td></td>
</tr>
<tr>
<td>weight</td>
<td>350 g</td>
<td>385 g</td>
</tr>
</tbody>
</table>

### Supply

- **Supply voltage**: 24 VDC ± 10 %
- **Current consumption**
  - AX1: 50 mA
  - AX2: 80 mA
- **Power on peak current**: n.s.
- **Reverse polarity protection**: yes
- **Protection circuit**: bipolar supressor diode 36 V
- **Isolation voltage**: mind. 1 kV

### Analog output

- **Output signal**: 0,5 ...10 V
- **Linearity***: ±2 % of full range
- **Filter corner frequency**: 10 kHz (-3 dB)
- **Calibration material**: 42CrMo4
- **Temperature coefficient electronic**: -0.06 % / K
- **Connection supply / output**: M12 connector 4 pole (IP68) for supply / output
- **Connection sensor**
  - AX1: 1 x BNC female connector / LEMO (IP68)
  - AX2: 2 x BNC female connector / LEMO (IP68)
- **Output protection circuit**: varistor

### General data and industrial standards

- **Electromagnetic compatibility**: EN 61326-1 / EN 55011
- **RoHS**: appropriate standard 2002/95/EG
- **MTBF**: EN 61709, > 360,000 h

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* * driver and sensor are matched and calibrated pairs
TECHNICAL DRAWINGS

■ TYPE T05

T05-G-KA

T05-G-KA-VK10

MATERIAL: 1.4404

■ TYPE T2

T2-G-KA

T2-G-KA-VK23 (SHORT VERSION)

T2-G-KA-VL20

M8 x 1

T2-S-KA

T2-S-KR

groove DIN471

groove DIN471

T2-G-KR

T2-G-KR-VK7 (SHORT VERSION)

M8 x 1

T2-G-M12-KA-105

M12 x 1

MATERIAL: 1.4404
TECHNICAL DRAWINGS

IP68 PROBE DRIVER WITH LEMO CONNECTOR

IP40 PROBE DRIVER WITH BNC CONNECTOR

CONNECTION

SUPPLY VIA 4-POLE M12 PLUG CONNECTOR (SOCKET)

View of the unit and the soldering side of the mating connector.

- Pin 1 (brown): V+
- Pin 2 (white): Signal channel 1
- Pin 3 (blue): GND
- Pin 4 (black): Signal channel 2

For connecting the power, shielded cables in various lengths are available (see accessories).

⚠️ Please use only shielded supply cables and set the screen on one side (to avoid earth loops)!

Note: Wrong connection of supply voltage at the output could damage the unit.

ACCESSORIES

Cable for power supply with mating connector M12 straight and angled - K4P

- Cable with straight connector:
  - K4P2M-S-M12 2 m
  - K4P5M-S-M12 5 m
  - K4P10M-S-M12 10 m

- Cable with angled connector:
  - K4P2M-SW-M12 2 m
  - K4P5M-SW-M12 5 m
  - K4P10M-SW-M12 10 m
**INSTALLATION**

**ELECTRICAL INSTALLATION**

Choose a dry location, preferably with a stable temperature for the electrical installation (eddy current basic module) such as electrical cabinets, terminal boxes, housing, etc.

Connect the supply line, probe lines and output lines. Please ensure that all supply and signal lines are laid separately from energy-carrying lines such as supply and discharge lines from converters and drives, lines from ovens and synchronised appliances or generator lines, etc., in order to avoid malfunctions in the signal behaviour. Please use shielded supply lines only and apply the shield to one side to avoid earth loops.

Please observe the correct assignment of the probes to the respective basic modules and channels. Each individual channel is aligned by the probe as a pair.

**PROBE INSTALLATION**

Firstly, install the probe at the relevant installation location and affix the probe using jam nuts or clamp mechanisms. After you have installed the probe, lay the cable. Ensure that the cable is laid without dents and it is not placed under stress. After you have laid the cable into place, do not turn the probe out of the thread, so as to prevent cable damage arising from stress. Secure excess probe cable as far away from temperature influences as possible, i.e. close to the electronics.

Never shorten the probe cable!

Please note that the probe head must be kept free from neighbouring metallic objects. In order to avoid attenuation of the measuring system, the following locations must not be impaired. In the case of installation into non-metallic and non-conductive materials, this is not necessary.

**OBJECT SIZE AND THE EDDY CURRENT MEASUREMENT FIELD**

The eddy current measurement field (illustrated in red) is emitted elliptically from the probe level, and is greater than the probe head in terms of its spatial expansion. Therefore, for standard-calibrated probes a two-dimensional object surface with a probe head diameter 2-3 times greater than this is necessary for measurement. If the object is too small, only a part of the measurement field enters the material, and the output signal becomes larger. If the diameter is too small, the object appears to be further away from the sensor. A similar effect takes place in the case of round objects.

However, if other metallic objects force their way into the measurement field (e.g. laterally), the output signal is reduced due to the additional object. The actual object appears to be closer to the probe.

The following provides an overview of various geometric object properties:

- **A** Optimum object surface preferably 2-3 times greater than the probe head diameter. The sensing field is captured by the object entirely.
- **B** Reduced object surface - a part of the sensing field remains outside the object. The probe displays a greater distance signal than the actual distance. The measurement area is reduced in size. Lateral object movements can influence the distance signal.
- **C** Large round objects (diameter > 8 x probe head diameter) such as cranks or shafts can be captured without significant signal alterations. The probe outputs the medium distance via the captured surface. The measuring range will be reduced by < 10%.
- **D** Small round objects such as shafts or wire (diameter < 2 x probe head diameter) can only be captured with a significantly smaller measuring range as long as customer-specific linearisation has not taken place. For example: shaft diameter < 2 x probe head diameter ➪ reduction in the measuring range of ~ 25%, linearity ~ 5%.
METALLIC OBJECTS IN THE MEASUREMENT FIELD

Please note that metallic objects such as screw heads, bolts, etc., located in the measurement field in both a radial and axial direction (or which cross the measurement field during rotation), can become disturbance variables in the signal.

PRECAUTIONS

- Never shorten the probe's coaxial cable. The probe, cable and electronic system form a coordinated oscillating circuit.
- Lay the cable so that it is protected and avoid running it along objects with sharp edges. A cable that has been squashed or damaged in another manner can tamper with the signal or render the probe unusable.
- Please note that the sensors have been aligned with the electronic system. The alignment can be found in the calibration certificate or on the label on the unit, identified by the serial number. Do not switch the channels.
- Avoid placing the cable under tensile or torsional stress. Never turn the probes in the holders inwards or outwards without first loosening the fastenings.
- Note the minimum bending radius for dynamic and static installation as specified in the datasheet. Avoid bending the cable.
- Protect the plug connections in the coaxial line against humidity and wetness.
- The sensors may not be used in strong radioactive environment (nuclear power plant).

ORDER CODE

SENSOR

- Sensor type
  - a
- Cable length
  - b 1 = 3M: 3 m
- Cable end
  - c 1 = BNC connector (standard)
  - 3 = LEMO connector
- Others
  - d 1 = - (standard)

AX BASIC MODULE

- AX basic module type
  - a
- Power supply
  - b 24 = 24 VDC
- Analogue output
  - c 10V = 0.5...10 V
- Protection class
  - d 1 = IP40
  - 2 = IP68 (LEMO connector)
- Sensor type
  - e A = T05
  - C = T2
  - D = T3
  - E = T4
  - F = T5
  - G = T10