High-quality eddy current probes: Beside robustness, high dynamics and high resolution the TX-Series also stands out with a wide temperature range from -60 °C up to 180 °C.

- High precision measurement
- High resolution (submicrometer)
- High dynamics (124 kSa/s)
- Minimal temperature coefficient
- High noise immunity
- Custom-made probes
For more than ten years we have been occupied with the development and production of high-quality eddy current probes for industry and research. With the new TX Series, eddylab is introducing a fully digital device – incorporating USB, CAN and a high-speed analogue interface.

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 a level of 50 nm 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 a DSP-driven 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 and fed towards further signal processing.

OUTSTANDING TEMPERATURE COEFFICIENT – ZERO TC

A remarkable feature is the TX-Serie’s temperature coefficient (TC). The temperature coefficient is optimized in a range between -60...+185 °C. For certain boundary conditions the position will be constant at ambient temperature and 150 °C. This matter of fact can interpreted as a Zero TC. Particularly when it comes to high-resolution measurements this effect is of seminal importance.

MINIMAL PROBE DRIFT

Every probe produced in eddylab’s facility line is treated with a thermal finishing procedure of 12-hours duration (burn-in). This procedure minimises aging and drift. The probe is then finally calibrated in our laboratory before delivery.

APPLICATIONS

High-resolution distance measurements on metallic objects regardless of non-conductive mediums in the measurement area. Examples are polymers, glass, oil, water, dirt. Measurement of thermal expansion with a maximum resolution of 50 nm.


Deformation and oscillation of gearwheels in operation. Axial thrust measurement of helical cut gears under load. Detection of tooth loss on gearwheels.


Thickness measurement of sheet material and foils. Two-sided measurement for thickness measurement. Controlling of machinery (feed-back, closed-loop).


Housing deformation of machines under load such as gearboxes, engines, turbo generators. Measurement of torsion on shafts and housing. Measurement of thermal expansion.

Distance-time diagram for measurement probes covered on the side. The measured object passes by the probe laterally. Measurement of object acceleration and deceleration.

Layer thickness of non-conductive material such as powder coatings and paint. Inspection of plastic injection-moulded parts at insert moulded metal parts.
EDDY CURRENT BASIC MODULE TX

The processor based design admits linearities less than 0.1 % - which is an exceptional feature for this sensor technology. Remarkable performance allows highly dynamic measurements with 124 kSa/s.

The TX-Driver is available as single- or dual-channel device. As standard, the device provides a USB and a CAN-bus Interface. The power supply is a galvanically isolated wide input from 10.5...36 (27) VDC.

All available sensor heads can be connected with the basic module TX (page 5-6).

- Probe and analogue output: Isolated output and high-speed signals via BNC connector. Selectable output signals 10 V, 5 V, ± 5 V, 0...20 mA, ± 20 mA.
- Benefit 2-channel unit: 2 different probes can be connected to one TX-driver.
- Benefit 1-channel unit: Highest dynamic performance. The output sampling rate is 124 kSa/s.

Illustration shows the 2-channel unit

Processor linearised signal conditioning
- linearisation and calibration with 50 points
- high dynamic performance with selectable digital filter
- high resolution and precision

CALIBRATION

The following variants of calibration are available:

- Factory calibration for one material including certificate.
- Factory calibration for three different materials. The materials are chosen with eddylab lite/standard/reference including three certificates.
- Factory calibration including certificate plus customer based linearisation on-site with a digital gauge and eddylab reference (requires REF option for the TX-driver). The accuracy behaviour of an eddy current sensor can be proved and improved on-site with a digital gauge as reference.

All of our probes are tested and calibrated before shipping. The calibration is based on 50 positions. Every probe has a unique setup - therefore the probes may not be interchanged among different drivers.

The certificate of calibration contains the measured and reference data, the sensitivity, the target material and the linearity as a chart.

The certificate of calibration is provided as standard – but it is also available subsequently.

TARGET-MATERIAL

Eddy current measurements depend on the target's conductivity and permittivity. The default material for factory calibration is steel of type 16MnCr5. Calibration is also possible with other conductive material such as aluminium, titanium, carbon fibre etc.

The following list shows available material for calibration. If you desire to use a different material we recommend to provide a probe (50x50 mm) for calibration.

<table>
<thead>
<tr>
<th>MATERIALS TO CHOOSE FROM FOR CALIBRATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>16MnCr5</td>
</tr>
<tr>
<td>42CrMo4</td>
</tr>
<tr>
<td>St52</td>
</tr>
<tr>
<td>C45E</td>
</tr>
</tbody>
</table>

Also eligible for calibration: zinc plate, titanium, carbon fiber
## TECHNICAL DATA – SENSORS

<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>range extended [mm]*</td>
<td>1</td>
<td>2.5</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>housing size</td>
<td>ø5</td>
<td>ø8</td>
<td>ø12</td>
<td>ø14</td>
<td>ø18</td>
<td>ø30</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>± 0.15 % of range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>resolution reg. corner frequency [% FS]**</td>
<td>dependent on the distance (see resolution diagram on page 15), valid for middle of range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Hz</td>
<td>0.006</td>
<td>0.01</td>
<td>0.006</td>
<td>0.007</td>
<td>0.007</td>
<td>0.006</td>
</tr>
<tr>
<td>100 Hz</td>
<td>0.008</td>
<td>0.015</td>
<td>0.008</td>
<td>0.008</td>
<td>0.007</td>
<td>0.007</td>
</tr>
<tr>
<td>1 kHz</td>
<td>0.021</td>
<td>0.035</td>
<td>0.021</td>
<td>0.014</td>
<td>0.014</td>
<td>0.015</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>35 kHz</td>
<td>0.101</td>
<td>0.088</td>
<td>0.078</td>
<td>0.064</td>
<td>0.075</td>
<td>0.078</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>dependent on distance (see temperature coefficient diagram on page 15)</td>
<td></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>standard length 3 m / 6 m / 9 m / 12 m / 15 m, customised length up to 20 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 SMB 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>

* linearity and resolution are not valid for extended measurement ranges

** 98.5% confidence interval (confidence limit), middle of range as % of range. Resolution dependent on the distance (see „Resolution and Temperature“ on page 15)

### CABLE CONFIGURATION

By default the probes have a BNC plug for the connection at the TX-Driver. Optionally the probes are equipped with a SMB connector. The SMB connection is either performed as BNC-SMB adapter (Version 1) or as a SMB-COAX cable extension (Version 2).

Please note:
The SMB connectors have beryllium copper contacts. The connector housing is gold plated and has an outer diameter of 6.5 mm. This facilitates the installation in particular with narrow conditions (Version 1). If the cable is durably affixed it might be desirable only to remove the probe from the entire cable (Version 2).

It is recommended to avoid unnecessary connections within the cable as it increases the probability of failure due to environmental influences such as wetness, dirt, aggressive media, massive vibration or shock.

### STANDARD VERSION
- probe with BNC connector
- cable length 3 m (standard)*

### VERSION 1
- probe with SMB connector
- cable length 3 m (standard)*
- BNC-SMB adapter for eddy current basic module

### VERSION 2
- probe with SMB connector
- cable length 3 m (standard)*
- additional extension cable SMB-KOAX with cable length 3 or 6 m*, SMB connector to BNC connector.

*customised cable length up to 20 m in total
TECHNICAL DRAWINGS – SENSORS

■ TYPE T05

The probe T05 is only available in a shielded version.

■ TYPE T2

T2-G-KA

T2-G-KA-VK23 (SHORT VERSION)

T2-G-KA-105
TECHNICAL DRAWINGS – SENSORS

■ TYPE T3

T3-S-KR

T3-G-KA

T3-G-KR

T3-FL-M1205-KR (FLANGE VERSION)

T3-G-KA-VL10

■ TYPE T4

T4-G-KA

■ TYPE T5

T5-G-KA

T5-DSC-KR

T5-G-KR

T5-S-KR

T5-G-KR-VL10

■ TYPE T10

T10-G-KA

T10-DSC-KR

T5-G-KR-VL10

T5-DSC-KR

T10-DSC-KR
### TECHNICAL DATA – EDDY CURRENT BASIC MODULE TX

<table>
<thead>
<tr>
<th>EDDY CURRENT–BASIC MODULE</th>
<th>TX1</th>
<th>TX2</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...+50 °C</td>
<td></td>
</tr>
<tr>
<td>storage temperature range</td>
<td>-40...+85 °C</td>
<td></td>
</tr>
<tr>
<td>humidity</td>
<td>95 % (no condensation)</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</td>
<td></td>
</tr>
<tr>
<td>housing</td>
<td>anodised aluminium and rubber feet, stackable</td>
<td></td>
</tr>
<tr>
<td>housing size L x W x H</td>
<td>195 x 116 x 29,5 mm</td>
<td></td>
</tr>
<tr>
<td>weight</td>
<td>665 g</td>
<td>694 g</td>
</tr>
</tbody>
</table>

**optional reference input**
- auxiliary voltage (for DK-gauges or encoder): 5 V maximum current 250 mA
- signal type: A / B pulses (RS422)

### Supply
- **Supply Voltage**: 10.5...36 VDC Wide Input; 10.5...27 VDC Ref\Version
- **current consumption**: 145 mA (24 V), 260 mA (12 V), 300 mA (10.5 V)  
  150 mA (24 V), 300 mA (12 V), 380 mA (10.5 V)
- **current consumption with DK-gauges**: 170 mA (24 V), 300 mA (12 V), 340 mA (10.5 V)  
  180 mA (24 V), 340 mA (12 V), 390 mA (10.5 V)
- **power on peek current**: 350 mA (24V), 470 mA (10.5V), < 30 ms
- **reverse polarity protection**: yes
- **protection circuit**: bipolar suppressor diode 36V / polyfuse 0.5A
- **isolation voltage**: min. 1 kV

### Analogue output
- **output signals**: 0...10 V / 0...5 V / ±5 V / 0...20 mA / 4...20 mA
- **dynamic / sampling rate**: 124 kSa/s  
  70 kSa/s
- **dyn. / samp. with simultaneous USB usage**: 76 kSa/s  
  45 kSa/s
- **filter corner frequency**: 10 Hz / 100 Hz / 1 kHz / 10 kHz / 35 kHz (-3 dB)
- **max. working resistance (current output)**: < 400 Ohm
- **temperature coefficient electronic**: -0.025 %/K
- **switching-on delay (boot-time)**: 3.1 s
- **switching-on drift**: < 1% (see diagram)
- **connection**: 1 x BNC female connector  
  2 x BNC female connector
- **output protection circuit**: polyfuse 50mA

### General data and industrial standards
- **electromagnetic compatibility**: EN 61326-1 / EN 55011
- **RoH5**: appropriate standard 2002/95/EG
- **MTBF**: EN 61709, > 360.000 h
**TECHNICAL DRAWINGS BASIC MODULE TX**

### FRONT OF UNIT

Output 2  
Sensor 2

Output 1  
Sensor 1

### REAR OF UNIT

Input REF  
CAN-Bus Opto-I/O

USB  
Supply

### CAN-BUS

The TX-Driver also provides a CAN-bus interface (controller area network). Wiring is achieved with a CAN-bus cable. The first and the last device on a CAN bus must be terminated.

- data transfer rate 1 MBit, standard-identifier
- triggers: internal timer, remote request, sync.
- networking of many devices with minimal wiring effort
- highly reliable data transfer over wide ranges, ideal for applications with many devices (consider dynamics)
- economisation of analogue measuring equipment (analogue-to-digital converter)

### USB

- The eddy current basic module provides a USB port (USB 2.0 High Speed).
- device configuration (filter, linearisation, CAN bus)
- data exchange with a PC or notebook via eddylab Windows software or via protocol

### REFERENCE INPUT

<table>
<thead>
<tr>
<th>PIN</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUNCTION</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>Z</td>
<td>Z</td>
<td>0V</td>
<td>Vcc</td>
<td>Vssns</td>
<td>n.c.</td>
</tr>
</tbody>
</table>

**SUPPLY VIA A 4-POLE M12 PLUG CONNECTOR (SOCKET)**

<table>
<thead>
<tr>
<th>PIN</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (brown)</td>
<td>+V (10.5...36 VDC)</td>
</tr>
<tr>
<td>3 (blue)</td>
<td>GND</td>
</tr>
</tbody>
</table>

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

**SAMPLING RATES**

<table>
<thead>
<tr>
<th>TX1</th>
<th>TX2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analogue, no USB</td>
<td>124 kSa/s</td>
</tr>
<tr>
<td>Analogue, with USB</td>
<td>76 kSa/s</td>
</tr>
<tr>
<td>USB</td>
<td>38 kSa/s</td>
</tr>
</tbody>
</table>

**CONNECTION**

- The eddy current basic module provides a USB port (USB 2.0 High Speed).
- device configuration (filter, linearisation, CAN bus)
- data exchange with a PC or notebook via eddylab Windows software or via protocol
ACCESSORIES

EDDYLAB

Powerful Windows software incorporating six major functions:

- Oscilloscope, FFT, Data logger, Waterfall, Waterfall-RPM and linearisation (details on pages 11-12).
- Delivery contents: software-CD, gold-plated USB cable, dual shields incl. 2 ferrites, length 1.8 m

DIGITAL GAUGES (DK-SERIES)

- Resolution: 0.1 μm
- Accuracy: 1 μm
- Output signal A/B reference point, TTL-linedriver according to EIA-422
- Displacement speed up to 250 m/min
- Working temperature 0...50 °C
- Protection class IP67

ADAPTER CABLE FOR DK-SERIES / REFERENCE INPUT

- Interface cable for the DK-Series on the TX-Driver
- Available lengths: 1 m, 3 m, 5 m

DIN RAIL CONNECTOR

- The DIN rail connector provides an easy and secure mounting of the TX electronics in a switch cabinet by simply snapping it onto a 35 mm DIN rail (DIN50022).
- Disassembling can be done by pulling the easy accessible latch.
- Stacking of several electronics can save lots of space in the switch cabinet. Therefore, please use the included housing connectors.

M12 CABLE FOR POWER SUPPLY

Cable with straight connector:

<table>
<thead>
<tr>
<th>Cable Code</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>K4P2M-S-M12</td>
<td>2 m</td>
</tr>
<tr>
<td>K4P5M-S-M12</td>
<td>5 m</td>
</tr>
<tr>
<td>K4P10M-S-M12</td>
<td>10 m</td>
</tr>
</tbody>
</table>

Cable with angled connector:

<table>
<thead>
<tr>
<th>Cable Code</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>K4P2M-SW-M12</td>
<td>2 m</td>
</tr>
<tr>
<td>K4P5M-SW-M12</td>
<td>5 m</td>
</tr>
<tr>
<td>K4P10M-SW-M12</td>
<td>10 m</td>
</tr>
</tbody>
</table>

BNC MEASUREMENT CABLE FOR THE ANALOGUE OUTPUT

XLSS-58

- Touch-safe coaxial measurement cable. BNC connectors on both ends. Connectors have nickel plated shields and gold plated pins.
- Length 2 m, temperature range -10...+70 °C
- Capacity 219 pF, inductance 680 nH, wave impedance 50 Ω

XLAM-446/SC

- Highly flexible, entirely shielded measurement cable. Touch-safe BNC connector on one end and two stackable Ø 4 mm connectors on the other end
- Length 1.6 m, temperature range -10...+70 °C
- Capacity 240 pF, inductance 1000 nH
ACCESSORIES

■ CABLE EXTENSION SMB-KOAX

- Additional extension accordingly to option 2 (see page 4 below). SMB connector to BNC connector.
- 3 m length: SMB-KOAX-3M
- 6 m length: SMB-KOAX-6M

Note: for probes with SMB connectors only. The probe is calibrated with an extension that can be ordered additionally.

■ WALL PLUG TRANSFORMER FOR THE TX-DRIVER

- nominal input voltage: 100-240 VAC, 50-60 Hz
- output voltage: 12 VDC ±5 %
- output current: 500 mA
- temperature range: 0...+40 °C
- protection class: IP40
- cable length: 2 m
- terminal: M12-plug, PIN 1 = +, PIN 3 = GND

■ RAIL-POWER SUPPLY 24 VDC PS-100-240AC/24DC/1.3

Extra slim power supply - only 22.5 mm wide. Reliable start-up of several eddy current basic devices is guaranteed by a 100% power boost. Reliability is also achieved on difficult global networks. The supply will remain stable even if transient or static voltage failure occurs. Well dimensioned capacitors bypass power failures of more than 150 ms.

- nominal input voltage: 100-240 VAC, 45-65 Hz
- output voltage: 24 VDC
- output current: 1.3 A (max. 1.6 A)
- temperature range: -25...+60 °C
- efficiency: > 85 %
- protection class: IP20

■ CALIBRATION RIG

Portable linear stage for the usage on-site

- Newport linear stage
- prism shaped socket for eddy current sensors
- 8 mm slot for linear encoders
- quick release socket for different targets (smallest dimension 50x50x5 mm, largest dimension 70x70x5 mm)
SOFTWARE EDDYLAB – OPTIONAL USE

EDDYLAB – WINDOWS ANALYSIS SOFTWARE VIA USB

eddylab 2.0 Standard is a powerful windows software which is available in three different versions: Lite, Standard and Reference. The Lite Version – delivered with every eddy current sensor system – offers an Oscilloscope function. The eddylab standard Version provides further features as FFT analyser, Waterfall and Data logger. The eddylab Reference Version enables the on-site linearisation of eddy current sensors with an active feedback system. The sampling rates are 38 kSa/s for a single-channel device and 22.5 kSa/s for a dual-channel device. Furthermore eddylab is used to configure the TX-Driver.

**OSCILLOSCOPE**

Sampled data is displayed with basic measurements in the style of a classical oscilloscope.

- single- and dual-channel oscilloscope. Samplingrates: 38 kSa/s (single); 22.5 kSa/s (dual)
- AC/DC-coupling
- variable time base 14 ms...5 sec
- scaleable Y-axis & autoscale function
- user-defined trigger level, hysteresis and pre-trigger, trigger source, falling and rising edge
- essential measurements on dynamic data can be taken: amplitude, frequency, max & min values
- data export as image (bmp) and text file

**FFT ANALYSER**


- visualisation of the frequency spectrum up to 19 kHz (single-channel); 1.25 kHz (dual-channel)
- threshold value for frequency detection can be selected
- detection of frequencies and amplitudes
- scalable frequency axis
- data export as image (bmp) and text file

**DATA LOGGER**

Record of measured data and storage on hard drive.

- user-defined sampling rate: 100 ms...10 s
- time base 1 min...60 min
- data export as image (bmp) and text file

**WATERFALL**

The FFT is expanded with a time axis. The 3D-plot provides a new view to your spectrum as it can be observed over time. The third axis emphasizes small peaks above the noise floor. In particular when these small peaks emerge and disappear over time.

- spectrum like the two-dimensional FFT expanded with a time axis
- scalable frequency axis
- 3D-view can be rotated
- movable analysis plane along the time axis
- detection of frequencies and amplitudes within the analysis plane
- export as image
SOFTWARE EDDYLAB 2.0 REFERENCE

EDDYLAB 2.0 reference is a powerful windows software with additional features. These are the linearisation and the rpm-based waterfall. eddylab reference requires a reference input on the TX-Driver.

CALIBRATION AND LINEARISATION

LINEARISATION

A well known issue when it comes to eddy current measurements is the strong sensitivity to varying target material and pre-attenuation. The maximum scaling error under varying material can be 20% or more. The linearity error can be 7% or more. Another severe error source affecting the accuracy is pre-attenuation. This effect has to be taken into account when the sensor is mounted in narrow gaps and holes. The error due to pre-attenuation is hard to predict - but in most cases higher than expected. The TX-Driver in conjunction with eddylab resolves the issues with an integrated linearisation procedure.

The backbone of the method is an interface to a linear encoder on the TX-Driver. The encoder is used as a reference signal. The reference can be used to either prove the accuracy of the sensor or to linearise the sensor. The linearisation is based on a user defined number of positions. The TX-Driver is capable of storing four user defined curves. In order to align the eddy current sensor with the linear encoder we provide a portable linear stage with a micrometer screw. This enables a linearisation on-site.

WATERFALL RPM

This function is only available in conjunction with a rotational incremental encoder. This admits the determination of the rotational speed of a rotating shaft. The FFT is expanded with a rpm axis. The correlation of rotational speed and FFT results in a characteristic 3D-plot. The plot may characterise the state of a rotating system depending on loads, oil-pressure, wear and similar aspects.

- spectrum like the two-dimensional FFT expanded with a rpm axis
- scalable frequency axis
- 3D-view can be rotated
- moveable analysis plane along the rpm axis
- detection of frequencies and amplitudes within the analysis plane
- export as image

<table>
<thead>
<tr>
<th>FUNCTION OVERVIEW</th>
<th>EDDYLAB LITE</th>
<th>EDDYLAB STANDARD</th>
<th>EDDYLAB REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oszilloscope</td>
<td>X</td>
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<td>FFT</td>
<td>X</td>
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<tr>
<td>Data logger</td>
<td>X</td>
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<td>Waterfall</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Linearisation</td>
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<td>X</td>
</tr>
<tr>
<td>Waterfall-RPM</td>
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<td>X</td>
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</tbody>
</table>
# INSTALLATION

- **ELECTRICAL INSTALLATION**

Choose a dry location, preferably with a stable temperature for the electrical installation (TX-Driver) 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 ground 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 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 electronics. Never shorten the probe cable!

Please note that the probe head must be kept free from surrounding conductive objects. In order to avoid pre-attenuation of the measuring system - stick to the following mounting guidelines. In the case of installation into non-metallic and non-conductive materials this is not necessary.

1. Installation with 45° countersinking. The diameter of the countersinking must be at least three times greater than the probes head diameter.
2. Installation with cylindrical countersinking. The diameter of the cylindrical countersinking must be at least 2-3 times greater than the probes head diameter. The projection of the probe and the cylindrical bottom must be at least three times the measuring range - however at least the length of the PEEK head.
3+4 Installation into plates or sheet metal with front or rear jam nut. Ideally, ensure there is an additional thread projection of approx. 3 mm to the board or the jam nut. Please note that thin-walled holders can oscillate or vibrate and the holder’s own frequency can interfere with the measurement result.

If these locations cannot be kept free of impairment as shown above it is recommended that a ferrite-shielded probe or a customer-specific linearisation is used. Ferrite-shielded probes are available on option.
INSTALLATION

■ OBJECT SIZE AND THE EDDY CURRENT MEASUREMENT FIELD

The sensing electromagnetic field (illustrated in red) is emitted elliptically from the probe and is greater than the probe head in terms of its spatial expansion. For standard-calibrated probes a surface with a target diameter 2-3 times greater than the probe head diameter 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 conductive objects collide with the sensing electromagnetic field the output signal is reduced due to pre-attenuation. The actual object appears to be closer to the probe. If this signal alteration is not desired, we provide a customer-specific linearisation for such applications. In this case, the probe is calibrated within the pre-attenuating environment. The measuring system will fulfill the standard specification. The object (shape, material) is documented in the calibration document.

The following pictures provides an overview of various geometrical arrangements:

■ 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. eddylab can perform a customer-specific linearisation in order to correct the measuring range and the linearity.

■ 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%. To correct this an optional customer-specific linearisation is available.

■ 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%. In this case we recommend a linearisation.

CONDUCTIVE OBJECTS IN THE SENSING FIELD

Please note that conductive objects such as screw heads, bolts, etc., located in the sensing field in both - radial and axial direction (or which cross the sensing field during rotation) can become disturbance variables in the signal.
RESOLUTION AND TEMPERATURE

■ RESOLUTION nm...µm

The probe’s resolution depends on the selected corner frequency and the actual position. The best resolution is achieved within the first 50% of the measuring range.

The following charts illustrate the resolution as a function of the position (normalized) and the corner frequency. Low corner frequencies and positions close to the target result in high resolutions.

■ TEMPERATURE COEFFICIENT TC

The temperature coefficient has a severe impact on the precision and in particular the repeatability of measurements when exposed to temperature variation. eddylab probes have a remarkable temperature characteristic - the temperature coefficient is almost zero over wide ranges of temperature. The following charts document the temperature coefficient as a function of the actual temperature and the position. The best temperature behaviour is achieved at 50% of the measuring range. The temperature coefficients refer to a cable length of approx. 50 cm.
PROPERTIES

■ DEVICE DRIFT AFTER POWER-ON
For highly precise measurements the device drift after power-on has to be consid-
ered. The entire device drift is <1 % of the measuring range.
- 0.1 % of MR at 30 min. warm up
- 0.2 % of MR at 20 min. warm up
- 0.4 % of MR at 10 min. warm up
- 0.8 % of MR without warm up

■ FREQUENCY RESPONSE
The TX Series contains a hardware filter with a corner frequency of 50 kHz in its
signal path. Additionally five user selectable software filters can be set. The chart
illustrates the respective characteristic. Lowering the corner frequency increases
the resolution. Note that higher frequencies will appear attenuated.

■ ZERO TC MEASUREMENTS – PROCEDURE:
The exceptional temperature behaviour of our probes allows zero TC measure-
ments. That means the position won’t be affected by temperature effects. Consider the
following five aspects:
- Only the probe is exposed to temperature.
- The probe cable must be located predominantly outside of the temperature
  influenced area and must not be laid on parts of machines, etc., subject to tem-
  perature fluctuations. Consider this for installation.
- The eddy current basic module must be placed outside any temperature influ-
  ence or variation. The device must be powered 60 min before measurements
  commences.
- The measurement has to be taken in middle of the entire measurement range.
- The zero TC effect is only valid for temperatures on the zero TC line with same
  positive and negative area (see chart).
**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 record 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.
- Avoid placing the cable under tensile or torsional stress. Never turn the probes in the holders inwards or outwards without first loosening the fastenings.
- 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 PROBE**

<table>
<thead>
<tr>
<th>Probe type</th>
<th>X X X</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) probe type</td>
<td></td>
</tr>
<tr>
<td>according to technical drawings, p. 5, p. 6 (e.g. T5-G-KA)</td>
<td></td>
</tr>
<tr>
<td>b) cable length</td>
<td></td>
</tr>
<tr>
<td>1 = 3M: 3 m (standard)</td>
<td></td>
</tr>
<tr>
<td>2 = 6M: 6 m</td>
<td></td>
</tr>
<tr>
<td>3 = 9M: 9 m</td>
<td></td>
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<tr>
<td>4 = 12M: 12 m</td>
<td></td>
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<tr>
<td>5 = 15M: 15 m</td>
<td></td>
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<tr>
<td>c) cable output</td>
<td></td>
</tr>
<tr>
<td>1 = BNC connector (standard)</td>
<td></td>
</tr>
<tr>
<td>2 = SMB connector</td>
<td></td>
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<tr>
<td>d) others</td>
<td></td>
</tr>
<tr>
<td>1 = - (standard)</td>
<td></td>
</tr>
<tr>
<td>2 = shielded version</td>
<td></td>
</tr>
</tbody>
</table>

**ORDER CODE BASIC MODULE**

- 1 channel
- 2 channel
- TX
- REF
- IO
- 10,5...36 (27) VDC
- 16 bit AD/DA
- 0..20 mA
- 0..10 V
- ± 5 V
- ± 5 V
## ACCESSORIES

| SMB-KOAX-3M          | extension cable for SMB connector 3 m |
| SMB-KOAX-6M          | extension cable for SMB connector 6 m |
| BNC/SMB              | adapter BNC/SMB for connection to TX module |

### Power supply cable with M12 mating connector

| K4P2M-S-M12         | 2 m, straight connector |
| K4P5M-S-M12         | 5 m, straight connector |
| K4P10M-S-M12        | 10 m, straight connector |
| K4P2M-SW-M12        | 2 m, angular connector  |
| K4P5M-SW-M12        | 5 m, angular connector  |
| K4P10M-SW-M12       | 10 m, angular connector |

### Digital gauge - accessories

| Sensor DK812SBR     | Resolution 0.1 µm, accuracy < 0.5 µm |
| Sensor DK812SBR5     | Resolution 0.5 µm, accuracy < 0.75 µm |

### Adapter cable DK-Series / Reference input

| CE22-01-TX-REF      | length 1 m |
| CE22-03-TX-REF      | length 3 m |
| CE22-05-TX-REF      | length 5 m |
| FGG.1B.310.CLADS2    | connector for reference input |

### BNC measurement cables for the analogue output

| XLSS-58             | BNC into BNC, 2 m |
| XLAM-446/SC         | BNC into ø4 mm banana plug, 1.6 m |

### Windows-software for USB

| eddylab 2.0 Lite    | software-CD |
| eddylab 2.0 Standard| software-CD, USB-cable 1.8 m |
| eddylab 2.0 Reference| software-CD, USB-cable 1.8 m |

### Power supply units

| PS-100-240AC/24DC/1.3| 24 VDC, 1.3 A / max. 1.6 A (DIN rail mounting) |
| PS-100-240AC/24DC/4  | 24 VDC, 4 A / max. 5 A (DIN rail mounting) |
| FW7662/12            | 12 VDC ±5%, 500 mA (wall plug transformer) |

### Micrometer calibration apparatus

| Micro-KALIB-V1       | Linear stage for the usage on-site |

### TX housing fixation

| DIN rail connector   | for TX housing |