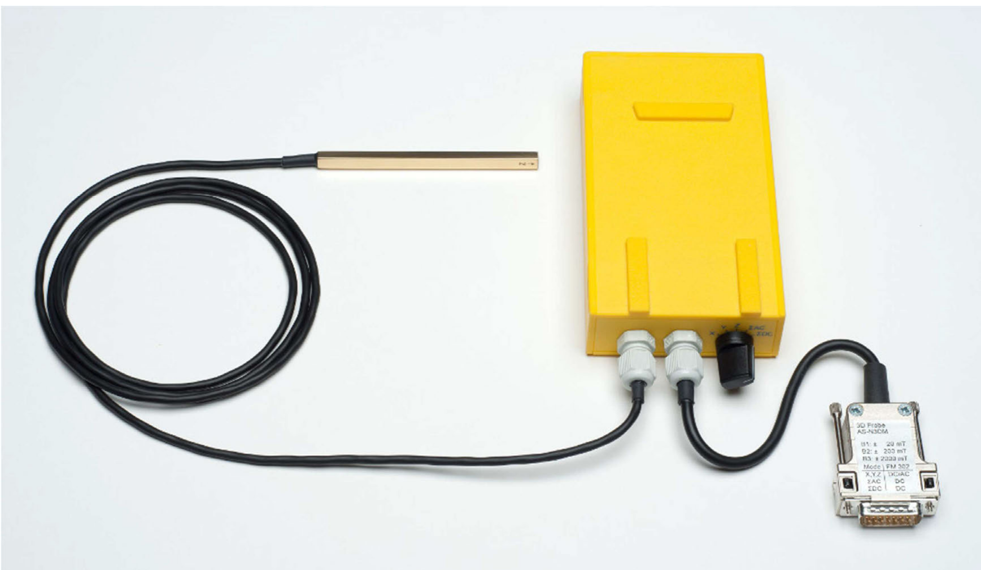
3D-magnetic field probes – single & total signal

AS-N3DM

AS-L3DM

- measurement of X, Y, Z or Σ
- measurement of steady (DC) and alternating (AC) fields
- measurement range
  AS-N3DM: ±2000 mT (20 kG)
  AS-L3DM: ±200 mT (2 kG)
- compact probe:
  6 x 6 x 100 mm³
- high bandwidth: DC – 10 kHz
- analog output
- linearity error X, Y, Z
  AS-N3DM: <0.5% ±0.2 mT
  AS-L3DM: <0.5% ±0.1 mT
- factory calibration certificate with traceability
- Made in Germany



The probes **AS-N3DM and AS-L3DM** are 3-axis measurement systems, which allow to measure the magnetic field independent of the orientation of the probe. With the maximum measurement ranges of ±2000 mT or ±200 mT respectively the probes are suitable for the measurement of strong as well as weaker magnetic fields.

The probes **AS-N3DM and AS-L3DM** are compatible with the other probes from our programm of AS-active-probes. Thereby it can be used with all devices which are intended to connect an AS-active-probe.
The probes can be used together with the Teslameter FM 302, the AS-probe adapter or the Interface IAS-4.

The AS-active-probes are active measuring-probes for measuring magnetic flux density. In contrast to most other available probes, the AS-probes contain an active electronic so that a calibrated analog signal is available at the plug. These probes are premium transducers for measuring steady and alternating fields.

The 3-axis probes **AS-N3DM and AS-L3DM** contain 3 sensors for the measurement of the 3 axis of the magnetic flux density within the probe head. With the dimension of merely 6 mm x 6 mm x 100 mm the probe head has a very compact size and is appropriate for the measurement even at small spaces.

There is an electronic box integrated in the probe cable near the probe plug. It contains the active electronic of the probe.

The electronic box is designed in a way that it can be attached underneath a Teslameter FM 205 or Teslameter FM 302 during the measurement. Shaped parts on the upper side of the electronic box fit into openings of the bottom of the Teslameter and ensure snug fit for both devices on each other. For fastening Velcro strips are used. They are drawn through two channels in the electronic box and tightened around the attached Teslameter. The Velcro strips are included in delivery.

With a switch at the electronic box different modes of measurement can be selected. Each of the signals of the single axis (X, Y, Z) or the total signal generated from the single axis (Σ) can be passed to the connected Teslameter FM 302. For the total signal again it can be selected between DC or constant component (ΣDC) and AC or alternating component (ΣAC).

In single axis measurement the probe behaves like a normal single axis probe. The full bandwidth of the probe is available. With the Teslameter FM 302 the constant component of the field (FM 302 – measurement mode DC) as well as the RMS-value of the alternating component (FM 302 – measurement mode AC) can be determined.

With the switch it can be selected if the signal of the X-, Y- or Z-axis is passed to the connected Teslameter FM 302. If all three single axis shall be measured that way, the switch has to be operated accordingly between measurements. A simultaneous measurement of all three single axis is not possible.

In mode ΣDC the absolute value of the total field is determined from the three single axis and passed to the connected Teslameter FM 302. This mode is used for the measurement of the constant component. Thereby the bandwidth is 3.6 Hz. For this the Teslameter FM 302 is operated in measurement mode DC.

In mode ΣAC only the alternating component of the total field is determined. The bandwidth of the measurement is 5 Hz to 10 kHz. A direct voltage is generated whose level corresponds to the effective value (RMS) of the total alternating field. This signal is passed to the connected Teslameter FM 302.

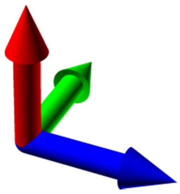
Therefore also in mode ΣAC the Teslameter FM 302 has to be operated in measurement mode DC to achieve a correct display of the measured value.

Functional Principle

Most available magnetic field probes are single axis probes. That means that they can only detect fields in parallel to their particular measurement direction. If the AS-probe is positioned with an angular to the field, the displayed value is lower than the actual field. The display value results from the following relation.

$$B_{display} = B_{real} \cdot \cos\alpha$$

To avoid this problem the **AS-N3DM and AS-L3DM** are designed as 3D probes. There are three sensors mounted in the probe head which are aligned perpendicular to each other. These three sensors measure the three axis of the magnetic flux density.



Technical data are subject to change without prior notice!

From the signals of the single axis the absolute value of the total signal can be calculated. The calculation is carried out according to the following formula.

$$B = \sqrt{{B_x}^2 + {B_y}^2 + {B_z}^2}$$

This principle works for all orientations between probe and magnetic field. Required is the perpendicularity of the single sensors.

In the probes **AS-N3DM and AS-L3DM** this calculation is implemented by an efficient technology. Thus even fast signals from 0 Hz to 10 kHz can be processed without problems.

Sign and Directional Information

It will always be calculated just the magnitude of the field. Furthermore it can be seen from the formula, that the value of the total field is always positive. The absolute value arises from the squaring of the three single signals.

The information about the direction of the magnetic field is not kept by the calculation of the total field. Therefore the measured value of the total field is always positive.

In addition see also Measurement Direction and Polarity at page 8.

Constant Field Measurement with Overlaying Alternating Fields

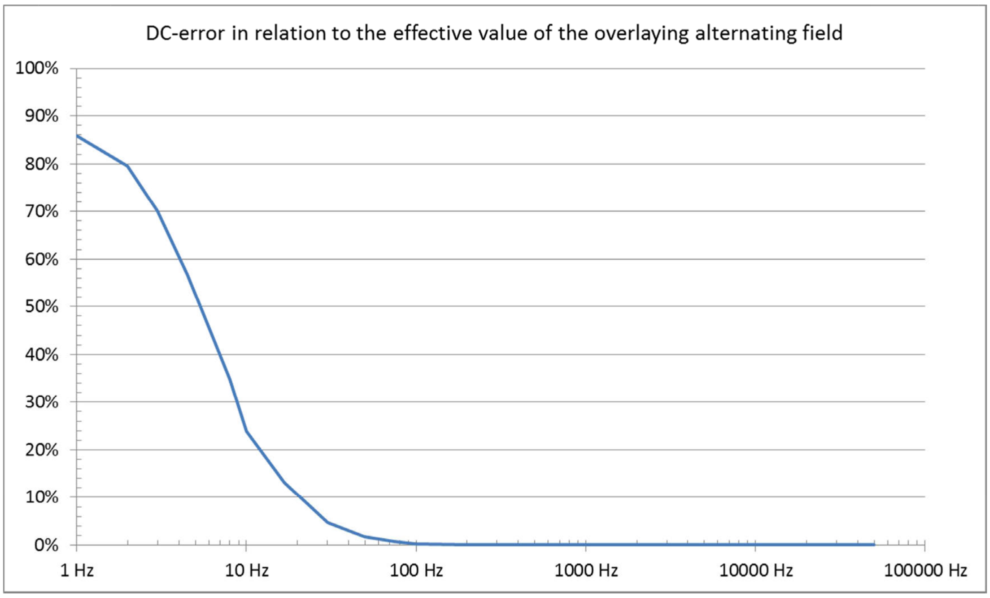
The squaring of the values causes a rectifier effect. This rectification especially affects the measurement of alternating fields. Their rectified signal generates an additional constant component in the measurement signal. This problem is caused by the principle of measurement and affects all measurement systems which derive the total signal from the single axis. It is essentially to observe the consequences at all 3-axis measurements.

At 3-axis measurements overlaying alternating fields generate an error in the measurement of constant fields. Therefore the presence of alternating fields should always be checked before doing constant field measurements.

For constant field measurement the probes **AS-N3DM and AS-L3DM** include additional low-pass filters with a cut-off frequency of 3.6 Hz. These will be activated automatically in the measurement mode ΣDC. These filters attenuate the influence of alternating fields to the measurement. However, a total suppression of the alternating components is not possible. Especially the influence of low frequency alternating components is reduced but still existing.

The following graphic shows the error caused by overlaying alternating fields in dependence of the frequency. The indication is made in relation to the effective value of the overlaying alternating field. E.g. for 20 Hz a value of 10 % can be read. This means, that an overlaying alternating field with an effective value of 15 mT would cause an error of 10 % of this effective value. In this example this would be 1.5 mT.

生意科技有限公司
Tel:0954-035698
e-mail: gm@tw.aiipq.com
http://www.aiipq.com



By the low-pass filter alternating fields with frequencies of the mains frequency (50 Hz) and above will be suppressed sufficiently. For common fields occurring in the technical area e.g. transformers the interference is minimal. Closer attention must be paid at facilities with traction power as these often work with just 16.7 Hz.

In case of doubt e.g. with unknown strong alternating fields the signals of the single axis should be checked with an oscilloscope at the analog output of the Teslameter FM 302. Thereby especially the frequency should be verified.

Influence of the Low-Pass Filters to Rotation of the Probe in Constant Field

The low-pass filters affect also changes of the signals which arise from the rotation of the probe. Indeed the total field remains unchanged but the components of the field measured by the three sensors change. Here the necessary low bandwidth of the filters prevents a fast reaction to the change of the measurement signals.

During fast rotation of the probe temporary a deviating measured value is displayed due to the integrated filters. Therefore the probe should be turned only slow to allow the filters to follow the measurement signal.

Measurement of Alternating Fields

At the measurement of alternating fields in position ΣAC the constant component of every sensor axis is separated by a high-pass filter. The cut-off frequency of these filters is 5 Hz. Afterwards the calculation of the total field is performed. Thus only the alternating components contribute to the measurement result.

Here the rectifying effect of the total field calculation has to be observed, too. To gather the effective value of the signal the processing has to be done from DC on. As the Teslameter FM 302 in alternating field measurement measures only above a low cut-off frequency of 5 Hz the signal cannot be evaluated directly by the Teslameter FM 302. Therefore the electronic of the probes **AS-N3DM and AS-L3DM** contains an additional RMS converter for alternating field measurement. In addition see also the chapter Functional Scheme at page 7.

This module carries out the correct effective value generation. It generates a voltage signal proportional to the effective value.

Therefore the FM 302 has to be operated in measurement mode DC even in mode ΣAC to achieve a correct display.

Influence of the High-Pass Filters to Rotation of the Probe in Constant Field

The high-pass filters in the probes **AS-N3DM and AS-L3DM** are intentionally designed with a very low cut-off frequency of 5 Hz. This allows even the measurement of very low alternating fields. But if the probe is rotated in an overlaying constant field (e.g. the earth magnetic field) during alternating field measurement a changing measurement signal appears at the sensors. During faster rotation of the probe these changes cannot be suppressed completely by the high-pass filter.

During fast rotation of the probe temporary a deviating measured value is displayed due to the integrated filters. Therefore the probe should be turned only slow to allow the filters to follow the measurement signal.

Minimum Required Field

The calculation of the total field works within a very broad range of field. But with very small fields it becomes substantially non-linear.

Thus for a reliable total field measurement a certain minimum flux density is necessary.
That value is stated in the technical data of the respective probe.

In single axis measurement even smaller fields can be measured. Here the non-linearity, zero drift, and noise limit the lower end of the usable range.

Overload

The used sensors have a limited measurement range. Signals with more than ±2500 mT at an AS-N3DM or more than ±250 mT at an AS-L3DM will result in an overload of the single sensors. The integrated filters are located after the sensors. Thus the entire field of alternating field and constant field has to be considered.

Constant field and alternating field may not overload the sensors. This would result in distort measurement results.

A damage of the sensors does not occur by the overload.

In case of doubt e.g. with complex alternating fields the signal should be checked with an oscilloscope at the analog output of the Teslameter FM 302.

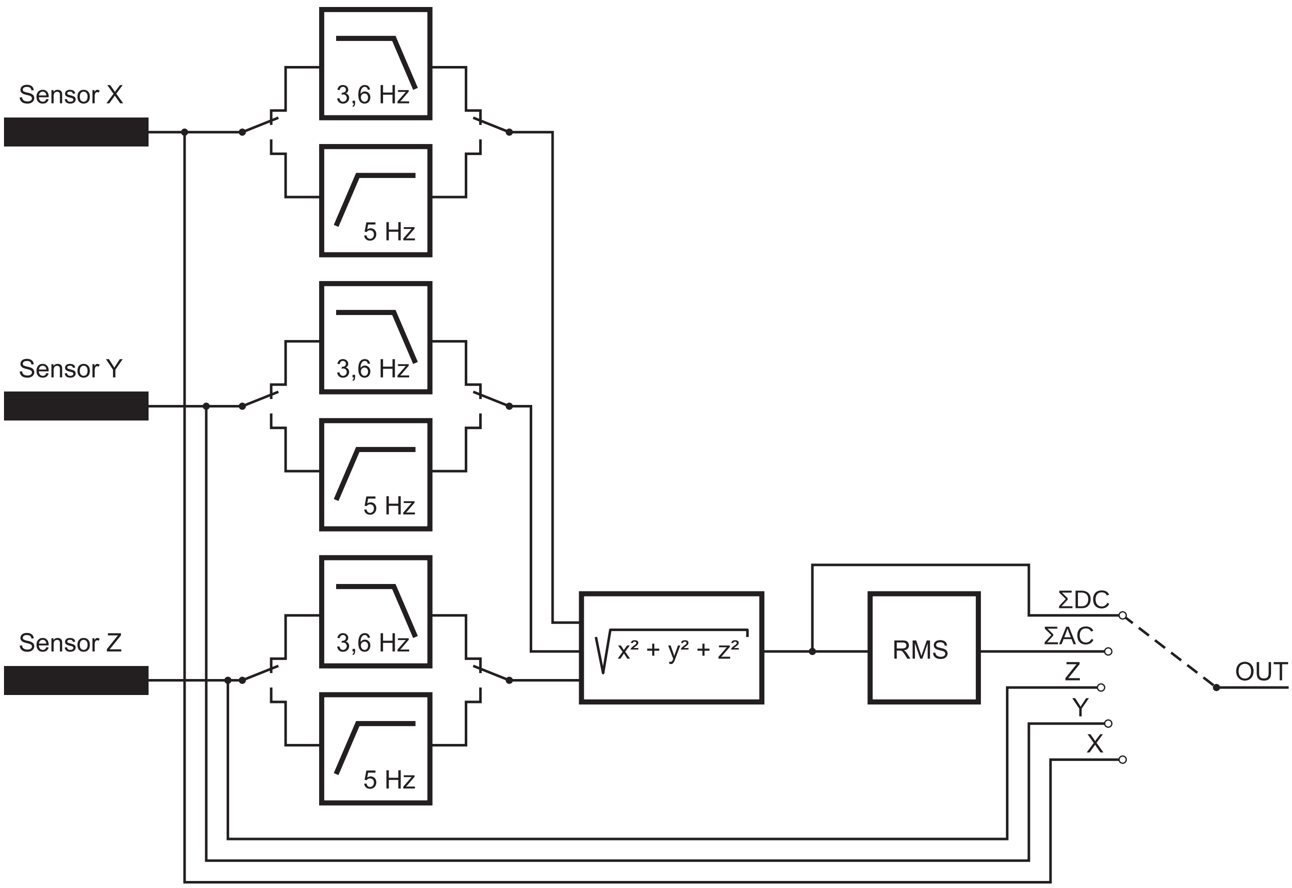
生意科技有限公司
Tel:0954-035698
e-mail: gm@tw.aiipq.com
http://www.aiipq.com

Functional Scheme

The following graphic shows again the functional scheme of the probe with the three sensors, the high-pass and low-pass filters, the total field calculation and the RMS converter for alternating fields.

The switching of the filters is done automatically in correspondence with the selected measurement mode.

To save energy the part of the circuit for the calculation of the total field is only activated while the total field is measured. During single axis measurement this part is deactivated. Similar applies to the RMS converter. It is only active in ΣAC and deactivated in all other measurement modes.



Measurement Direction and Polarity

If as measurement mode one of the single axis is selected, the **AS-N3DM and AS-L3DM** behave like a normal single axis probe. If in single axis measurement the probe is positioned with an angular to the field, the displayed value is lower than the actual field. Additionally in single axis measurement the direction of the field is displayed by the sign of the measured value. The direction for a positive display value is indicated by the arrows of the axis at the probe head.

In 3-axis measurement the absolute value of the total field resulting from the three single axis is determined. Thereby ideally the measured value is independent of the angular between probe and magnetic field.

In 3-axis measurement only the magnitude of the total field is displayed. Directional information is not shown. Therefore the displayed value is always positive.

For this see also the information to the functional principle of the probe at page 3.

For determination of the polarity of magnets the probe has to be operated in single axis measurement as polarity cannot be displayed in 3-axis measurement.

Mounting of the Probe Head

The body of the probe head consists of a square brass profile of 6 mm x 6 mm. For mounting the probe head can e.g. clamped in an appropriate mounting hole.

The sensors are located at the front end of the probe head. Therefore there should be applied no pressure at this area of the probe head.

The probe head must not be clamped at the first 20 mm.

生意科技有限公司
Tel:0954-035698
e-mail: gm@tw.aiipq.com
http://www.aiipq.com

Heating due to Eddy Currents

When measuring fields of B > 20 mT and f > 10 kHz, the brass probe should not be operated for more than 1 minute in order to prevent excessive heating of the brass tube with the Hall elements inside!

Minimum Operation Conditions (EMC)

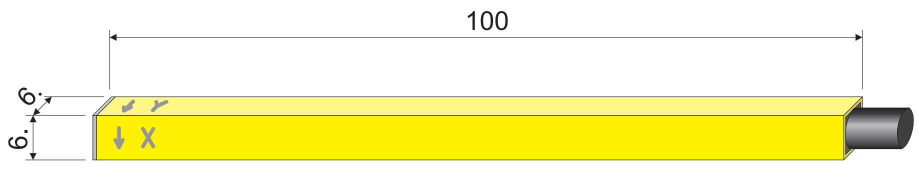
The presence of strong HF fields can result in distorted measurement results. Below 800 MHz a field strength of 3 V/m and above 800 MHz a field strength of 1 V/m should not be exceeded.

Ground Connection / Earthing

Attention should be paid that in the probe there is a connection between GND, probe head, connector shield, connector housing and cable. Possibly an isolated installation of the probe and/or the probe connector is necessary to prevent an unintended connection between measuring GND and protective earth.

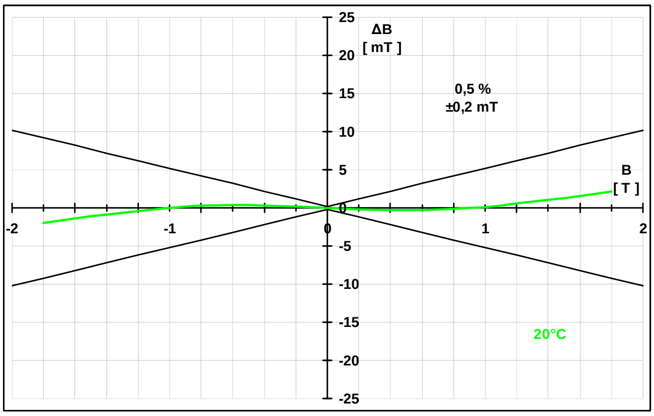
生意科技有限公司
Tel:0954-035698
e-mail: gm@tw.aiipq.com
http://www.aiipq.com

Technical Data – 3-axis Probe 2000 mT (AS-N3DM)



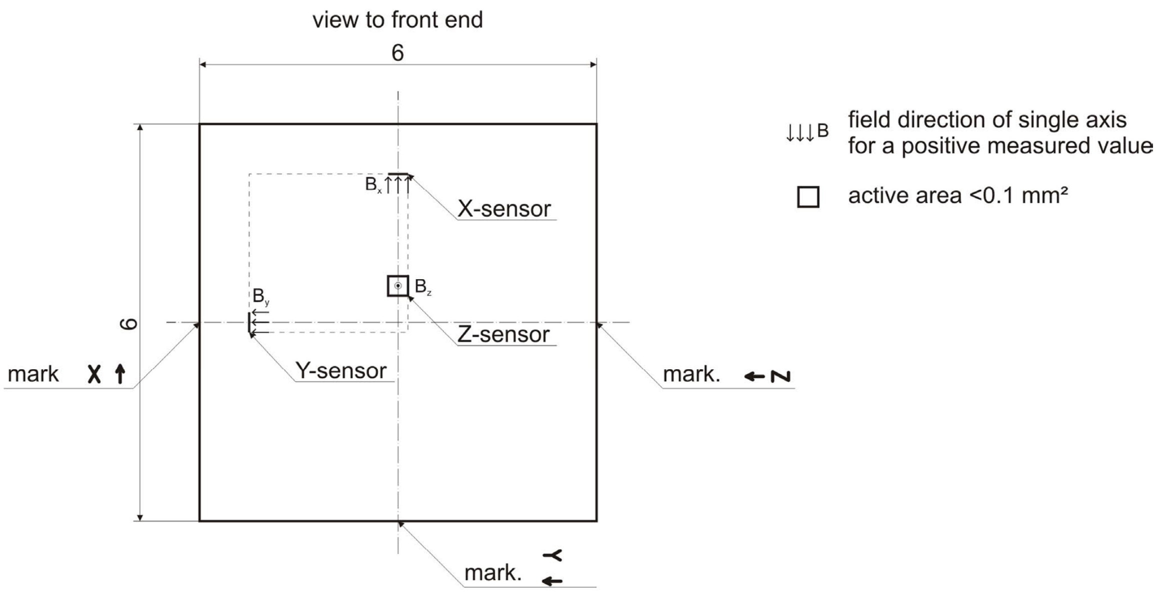
Ranges (with FM 302)	±20 mT; ±200 mT; ±2000 mT	
Measurement settings	5 different; selectable by rotary switch	
	X:	single axis X-axis
	Y:	single axis Y-axis
	Z:	single axis Z-axis
	ΣDC:	total signal DC (average)
	ΣAC:	total signal AC (effective value)
Sensor volume	see drawing page 12	
Effective sensor area	<0.1 mm² per axis	
Perpendicularity of the sensors	±2°	
Transfer factor	1 V/T	
Bandwidth (-3 dB)	single axis:	DC – 10 kHz
	ΣDC:	DC – 3.6 Hz
	ΣAC:	5 Hz – 10 kHz
Rise time (X, Y, Z)	<30 µs	
Rise time (ΣAC)	typ. 0.3 s	
Linearity error (X, Y, Z)	<0.5 % ±0.2 mT (at 23 °C ±1 °C)	
Temperature coefficient (X, Y, Z)	max. 0.05 %/K, typ. 0.03 %/K (0 to 50 °C)	
Zero drift (X, Y, Z)	max. 0.020 mT/K, typ. 0.010 mT/K (DC)	
Noise (X, Y, Z)	typ. 64 μT_{RMS} (10 Hz – 10 kHz)	
	typ. 24 μT_{PP} (DC – 10 Hz, 50 s)	
Error of vector calculation	max. 0.2 % ±1.0 mT	
Validity of vector calculation	for fields ≥1.0 mT	
Probe head	brass 6 mm x 6 mm x 100 mm without cable	
Length of cable	1.5 m	
Electronic box	110 mm x 75 mm x 25 mm	
Operation temperature	+5 °C to +50 °C	
Storage temperature	-10 °C to +60 °C	
Max. relative humidity	70 % at +35 °C	
Power	±3 V through FM 302, AS-probe adapter, Interface IAS-4 or SPS	
Connector	15 pol. SubD	
Output impedance	<1 Ω	

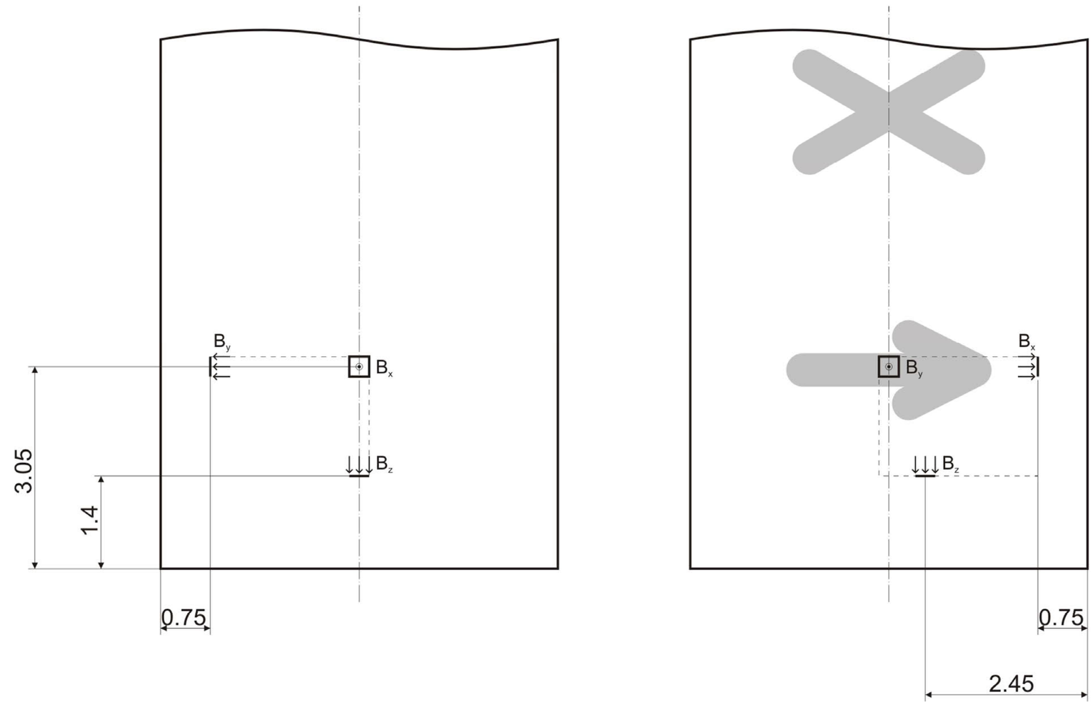
typical linearity curves of the single axis



生意科技有限公司
Tel:0954-035698
e-mail: gm@tw.aiipq.com
http://www.aiipq.com

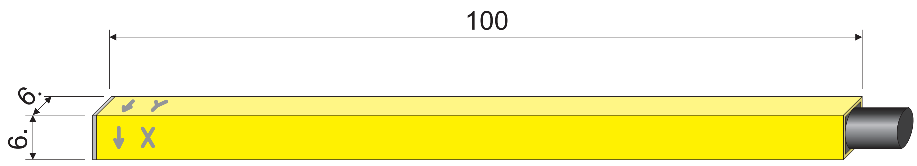
Position of the Active Areas AS-N3DM





生意科技有限公司
Tel:0954-035698
e-mail: gm@tw.aiipq.com
http://www.aiipq.com

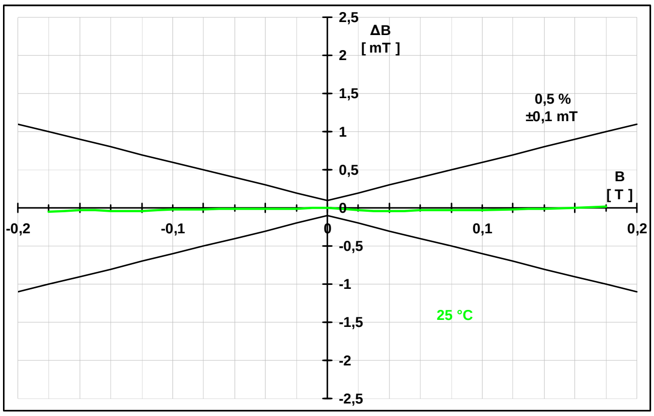
Technical Data – 3-axis probe 200 mT (AS-L3DM)



Ranges (with FM 302)	±2 mT; ±20 mT; ±200 mT	
Measurement settings	5 different; selectable by rotary switch	
	X:	single axis X-axis
	Y:	single axis Y-axis
	Z:	single axis Z-axis
	ΣDC:	total signal DC (average)
	ΣAC:	total signal AC (effective value)
Sensor volume	see drawing page 15	
Effective sensor area	<0.1 mm² per axis	
Perpendicularity of the sensors	±2°	
Transfer factor	1 V / 100 mT	
Bandwidth (-3 dB)	single axis:	DC – 10 kHz
	ΣDC:	DC – 3.6 Hz
	ΣAC:	5 Hz – 10 kHz
Rise time (X, Y, Z)	<30 µs	
Rise time (ΣAC)	typ. 0.3 s	
Linearity error (X, Y, Z)	<0.5 % ±0.1 mT (at 23 °C ±1 °C)	
Temperature coefficient (X, Y, Z)	max. 0.05 %/K, typ. 0.03 %/K (0 to 50 °C)	
Zero drift (X, Y, Z)	max. 0.010 mT/K, typ. 0.005 mT/K (DC)	
Noise (X, Y, Z)	typ. 9.5 µT_{RMS} (10 Hz – 10 kHz)	
	typ. 26 µT_{PP} (DC – 10 Hz, 50 s)	
Error of vector calculation	max. 0.2 % ±0.1 mT	
Validity of vector calculation	for fields ≥0.1 mT	
Probe head	brass 6 mm x 6 mm x 100 mm without cable	
Length of cable	1.5 m	
Electronic box	110 mm x 75 mm x 25 mm	
Operation temperature	+5 °C to +50 °C	
Storage temperature	-10 °C to +60 °C	
Max. relative humidity	70 % at +35 °C	
Power	±3 V through FM 302, AS-probe adapter, Interface IAS-4 or SPS	
Connector	15 pol. SubD	
Output impedance	<1 Ω	

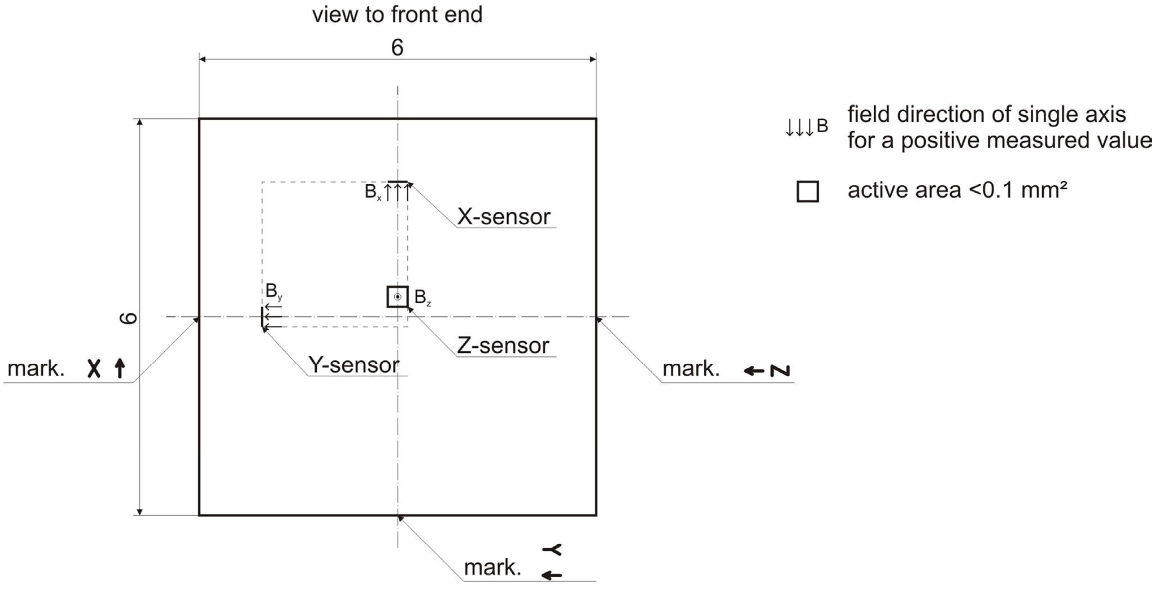
生意科技有限公司
Tel:0954-035698
e-mail: gm@tw.aiipq.com
http://www.aiipq.com

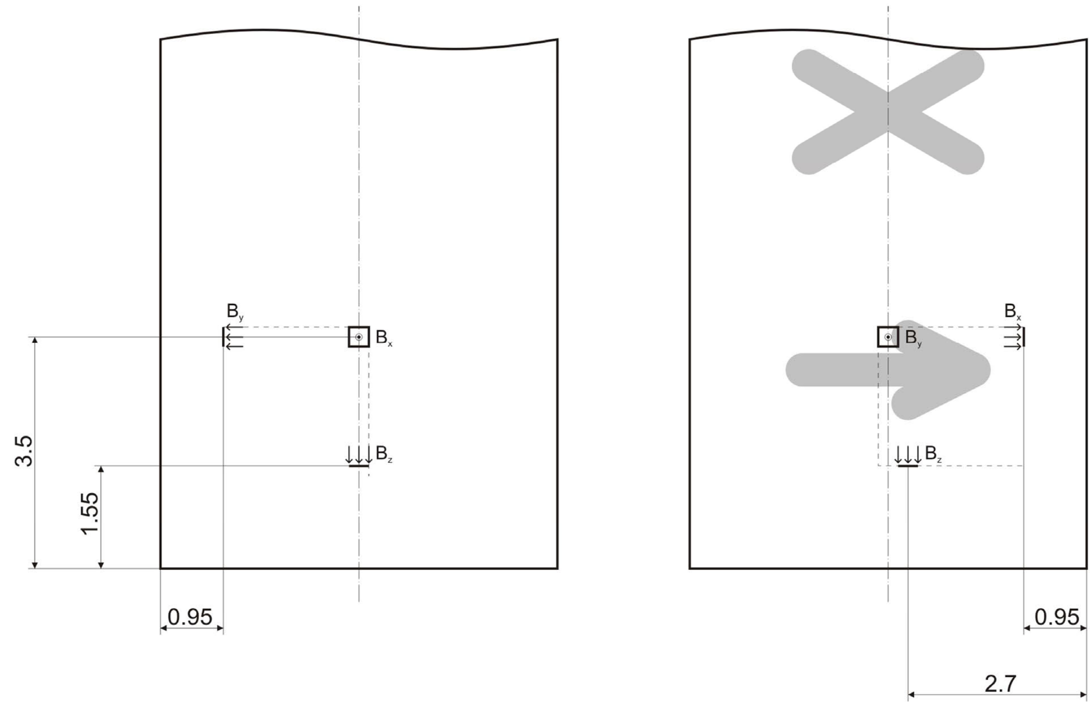
typical linearity curves of the single axis



生意科技有限公司
Tel:0954-035698
e-mail: gm@tw.aiipq.com
http://www.aiipq.com

Position of the Active Areas AS-L3DM





Items Supplied:

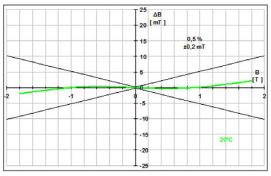
- AS-active-probe AS-N3DM or AS-L3DM
- Velcro straps to fix the electronic box underneath a Teslameter FM 205 or Teslameter FM 302
- operating manual
- factory calibration certificate with traceability to national standards (PTB)
- case for AS-active-probe AS-N3DM or AS-AS-L3DM, Teslameter FM 302 and accessories

Options:

- **probe extension cord**
  2 m, 5 m or 10 m
  without influence on measurement result

- **zero chamber**
  for shielding external fields and for exact offset adjustment
  see Application Note PE012 – Zero Chamber – Zero Point Adjustment

- **linearity curve**
  test curve for every of the three single axis, each with 19 test points
  see Application Note PE003 – Linearity Curves
  for typical curves see the technical data of the probes



- **Top Hat Rail Adapter**
  In addition the electronic box of the probe can be equipped with a fix mounted top hat rail adapter for control cabinet mounting. For release the locking bar has to be pulled upward with a hooked screw driver.

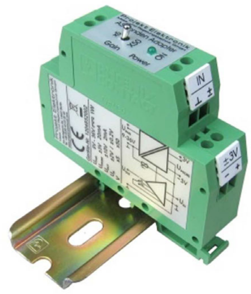
  The top hat rail adapter will be permanently screwed to the bottom side of the electronic box. A Teslameter FM 302 can still be fixed to the top side.

生意科技有限公司
Tel:0954-035698
e-mail: gm@tw.aiipq.com
http://www.aiipq.com

Devices to use with AS-active-probes

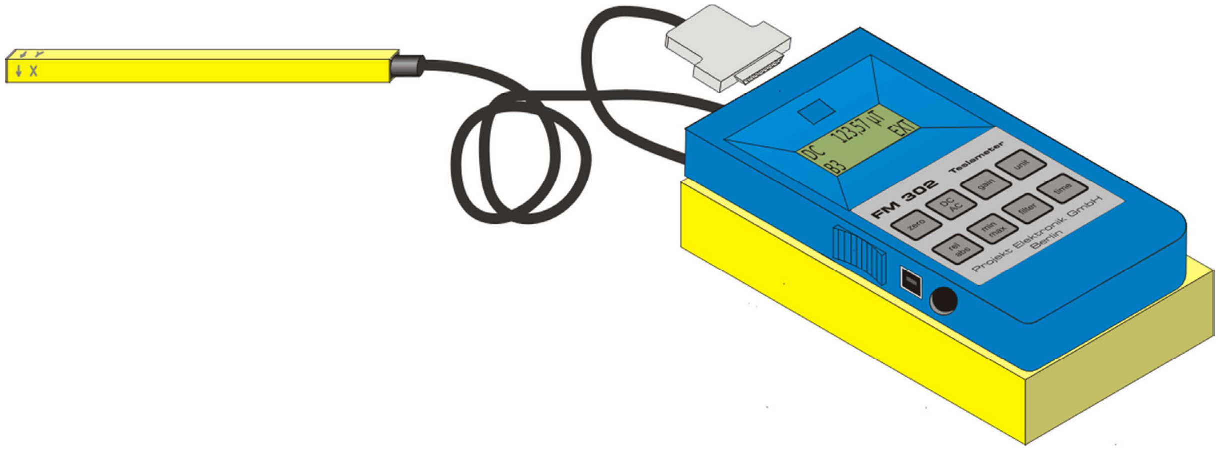
- **Teslameter FM 302**
  device to use with one AS-active-probe
  for further information see separate data sheet

- **AS-probe adapter**
  for usage and supply of one AS-active-probe e.g. at PLC
  for further information see separate data sheet



- **Interface IAS-4**
  for simultaneous usage and supply of up to 4 AS-active-probes
  for further information see separate data sheet

Usage of the 3-axis AS-active-probes with the Teslameter FM 302:



In normal case the plug of the probe electronic is simply connected to the Teslameter. The electronic box is fixed with Velcro straps underneath the Teslameter FM 302. The measurement can be started immediately.

The desired measurement mode has to be selected with the switch at the electronic box.

生意科技有限公司
Tel:0954-035698
e-mail: gm@tw.aiipq.com
http://www.aiipq.com

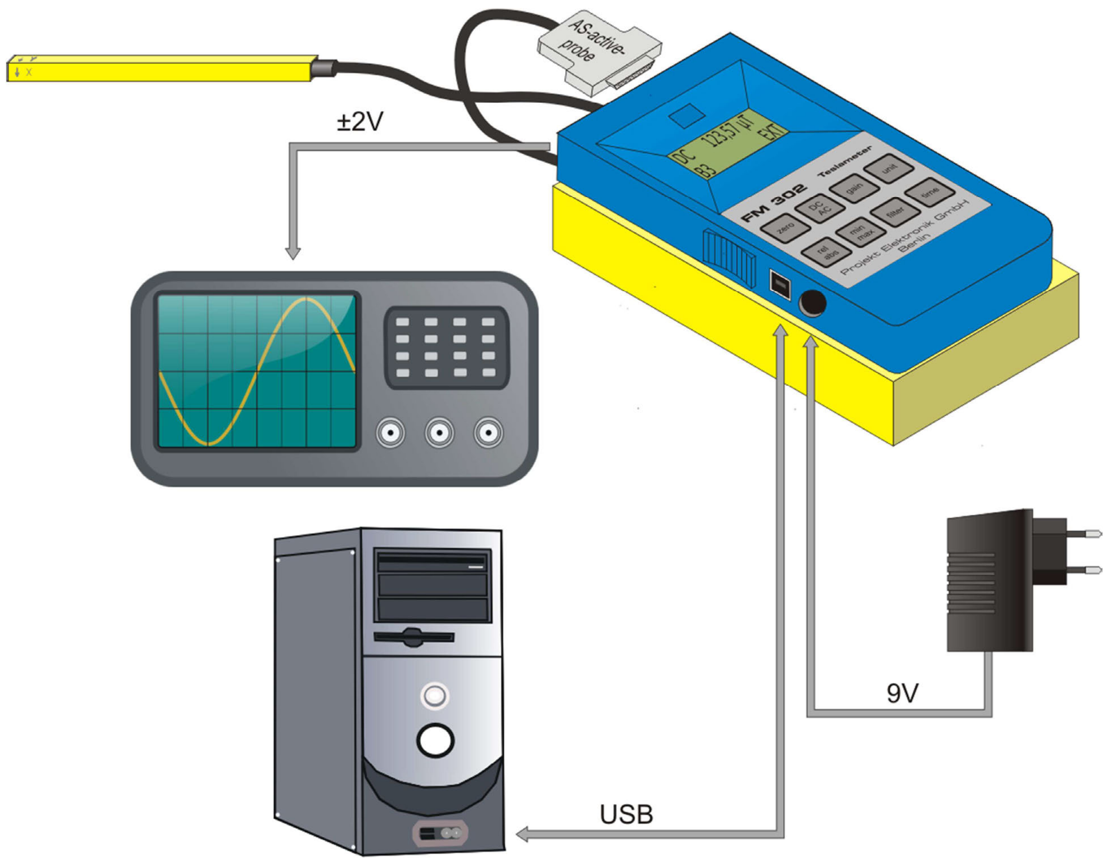
Also all extended possibilities of the Teslameter FM 302 like calibrated analog output, control via USB interface or power supply with power adapter are usable in that way.

The Teslameter FM 302 offers the opportunity to switch the sensitivity between x1, x10 and x100. Thus with every probe a wide measuring range can be covered. Furthermore the Teslameter FM 302 offers switching of the display unit.

Also see our webpage about sensitivity classes

http://www.projekt-elektronik.de/teslameter-gaussmeter/magnetfeldsonden-as-aktivsonden/empfindlichkeitsklassen/

Further details can be found in the data sheet of the Teslameter FM 302.



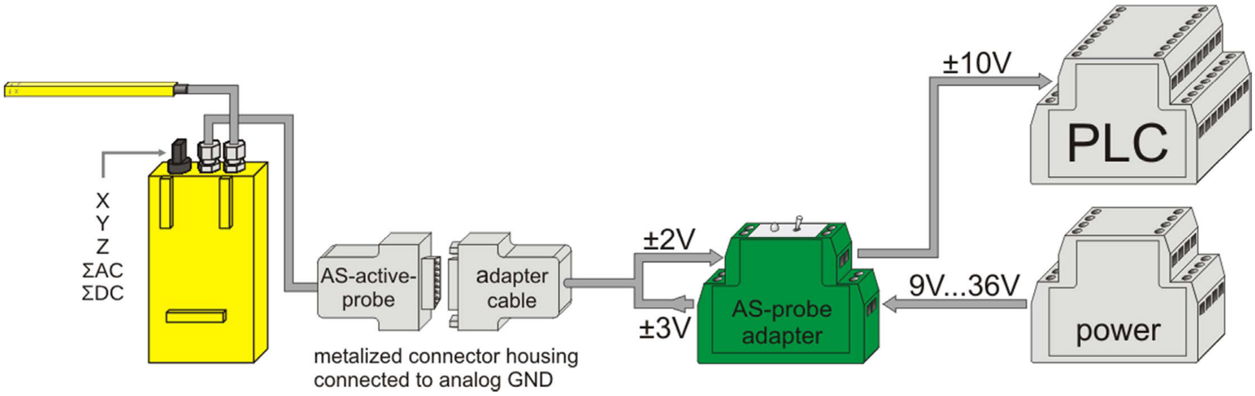
Usage of the 3-axis AS-active-probes with the AS-probe adapter:

The AS-probe adapter amplifies the analog output signal of the yellow electronic box of the probes to ±10 V (gain x5) which is the typical input range of analog inputs of a PLC.

With the switch at the AS-probe adapter a 10-times higher gain (x50) can be selected. This way, even small fields can be measured in this configuration.

To be usable all-purpose the AS-probe adapter has a wide supply voltage range from 9 V to 36 V and provides high-stable ±3 V necessary to supply the AS-active-probes. Additionally the measurement signal is galvanically isolated from the power supply.

Further details can be found in the data sheet of the AS-probe adapter.



Usage of the 3-axis AS-active-probes with the Interface IAS-4:

Up to four AS-active probes can be simultaneously operated with the Interface IAS-4. The IAS-4 supplies all connected probes.

The analog output signals of all connected AS-active probes is available at the same time, in parallel and with full frequency range both at the BNC connectors at the front and the SubD connector at the rear.

As additional control instrument a Teslameter FM 302 can be connected at the front. With a switch it can be linked to any of the connected probes without interfering the analog outputs. The full range of functions of the FM 302 may be used with the selected probe.

Further details can be found in the data sheet of the Interface IAS-4.