

Datasheet:

3MH4 DIGITAL 3D TESLAMETER

High-quality 3-axis digital teslameter

DESCRIPTION:

SENIS 3D Digital Teslameter 3MH4 redefines magnetic field measurement with unmatched precision, stability, and adaptability. With its absolute accuracy of below 0.1% (1'000ppm), it sets the wide standards in magnetic field measurement. Stability is key, and this device maintains rock-solid digital readings, ensuring consistent and reliable measurement data.

Unparalleled spatial resolution at $0.10 \times 0.01 \times 0.10 \text{ mm}^3$ of the 3-axis Hall probe empowers detailed exploration of magnetic fields. Probe interchangeability simplifies switching probes without sacrificing accuracy, while $<100\text{ppm}/^\circ\text{C}$ temperature stability guarantees reliable measurements across various conditions.

With very high magnetic DC resolution better than 1ppm RMS @ $\pm 2 \text{ T}$, up to 4 (four) selectable field ranges ($\pm 0.1 \text{ T}$ to $\pm 20 \text{ T}$), and seamless connectivity through USB2.0 and LAN, it's a versatile tool for diverse applications.

This teslameter is invaluable for mapping magnetic fields, characterizing systems, current sensing, and quality control in laboratories, production lines, and magnet systems. It's the ultimate tool for precision in magnetic field measurement, offering the future of magnetic field analysis.



Figure 1: 3-channel digital teslameter 3MH4: front panel (left); rear panel (right)

KEY FEATURES:

- Digital teslameter with integrated 3-axis Hall Probe (Bx, By, Bz) and temperature sensor.
- High measurement DC accuracy @ Sampling rate 10 SPS (SPS - samples per second):
 - < 0.1% (1'000 ppm FS) @ ± 0.1 T, ± 0.5 T and ± 2 T ranges, and
 - determined upon a High-Field DC Calibration Table for higher field ranges @ $B > \pm 2$ T.
- Very good stability of the digital readings.
- Very high spatial resolution: overall FSV of the applied 3D Hall IC in the probe is only $0.10 \times 0.01 \times 0.10 \text{ mm}^3$.
- Detachable Hall probes: DC calibration data of each Hall probe are stored in an integrated EEPROM.
- High temperature stability: $< \pm 100 \text{ ppm}/^\circ\text{C}$ ($\pm 0.01 \text{ } \%/^\circ\text{C}$).
- 4 (four) selectable magnetic field ranges: ± 0.1 T, ± 0.5 T, ± 2 T, and up to ± 20 T *
(* the last is in-factory calibrated up to ± 2 T; optionally: calibration up to maximum field ± 9 T).
- Selectable Sampling rate: (10 - 7'500) SPS.
- Very high magnetic DC resolution @ Sampling rate 10 SPS: < 1 ppm RMS @ ± 2 T range: 1 μT_{rms} for perpendicular (By) and 2 μT_{rms} for planar components (Bx & Bz) of a measured magnetic field.
- Measurement of DC & AC magnetic fields.
- Frequency Bandwidth: DC - 2.5 kHz (-3 dB).
- AC Accuracy: see the Table 1 below.
- Analog outputs: uncalibrated.
- 24-bit A/D Convertor.
- Triggers Internal and external - Single shot, Manual and Continuous.
- TFT LCD graphic display (108 x 65mm) for Bx, By, Bz, Btot, and the Th (probe) and Te (box) temperatures.
- Data acquisition & visualization PC Software running on Windows 11 / 10 OS via USB2.0 and Ethernet (LAN) interface.

TYPICAL APPLICATIONS:

- Mapping magnetic fields.
- Characterization of the undulator systems.
- Current sensing applications.
- Application in laboratories and in production lines.
- Quality control and monitoring of magnet systems (generators, motors), etc.

H-MODULE (3-AXIS HALL PROBE & CABLE):



Figure 2: Photo of a 3-axis Hall probe for the 3MH4 digital teslameters

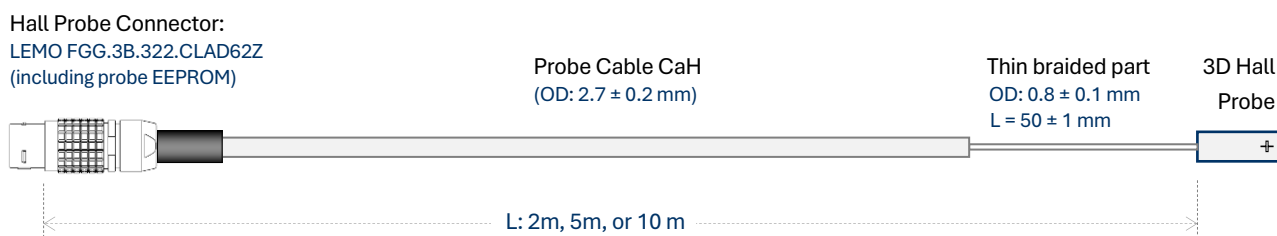




Figure 3: Structure of the standard H-module (3D Hall probe and cable) for the 3MH4 digital teslameters

The 3MH4 digital teslameters apply a number of different geometries/dimensions of Hall probes that fulfil a wide range of application requirements:

| Hall Probe Type: | External Dimensions: L x W x H (mm) | Magnetic Field Sensitive Volume FSV (μm^3) |
|---|---|--|
| Type C ¹⁾  | C: 8.0 x 4.0 x 0.9 | B_x, B_z: 100 x 10 x 100 B_y: 30 x 5 x 30 |
| Type H ²⁾  | HL: 71.0 x 2.0 x 0.75 | |
| | HM: 47.0 x 2.0 x 0.75 HS: 8.0 x 2.0 x 0.75 | |

REMARKS:

- Standard, robust respective to its small size and very compact probe package. Please see more details at:
https://www.senis.swiss/wp-content/uploads/2023/04/Hall-probe-type-C-for-3MH6-3MH4-digital-teslameters-and-I3D-low-noise-magnetic-field-transducers_rev.1.1.pdf.
- Narrow and thin package with mechanically protected chip. It is available in 3 (three) lengths: long (L), medium (M) and short (S). For more details please see:
https://www.senis.swiss/wp-content/uploads/2023/10/3-axis-Hall-probe-type-H-for-3MH4-3MH2-digital-teslameters-and-I3D-low-noise-analog-magnetic-field-transducers_rev.1.1.pdf.

PRELIMINARY SPEC'S: FREQUENCY BANDWIDTH VS. RESOLUTION:

Conditions:

- Measurement Range: ± 2 T;
- Probe cable length: 2 m
- Internal Sampling rate: 30 kS/s
- Frequency Bandwidth: DC to $f_c(-x)$, where $f_c(-x)$ is the B signal frequency at which the measurement error with respect to DC reaches x .

| Sampling rate [SPS] | 10 | 30 | 50 | 60 | 100 | 500 | 1'000 | 2'000 | 3'750 | 7'500 |
|------------------------------|------|--------|------|--------|------|------|-------|-------|-------|-------|
| Averaging time [ms] | 100 | 33.333 | 20 | 16.667 | 10 | 2 | 1 | 0.5 | 0.267 | 0.133 |
| Resolution [μT_{RMS}] | 0.8 | 0.9 | 1 | 1.1 | 1.2 | 2 | 2.5 | 3 | 4 | 5 |
| f(-10 ppm) [Hz] | 0.03 | 0.08 | 0.13 | 0.15 | 0.27 | 1.4 | 2.6 | 5 | 9 | 10 |
| f(-100 ppm) [Hz] | 0.08 | 0.24 | 0.39 | 0.47 | 0.8 | 4 | 8 | 18 | 25 | 30 |
| f(-0.1%) [Hz] | 0.25 | 0.74 | 1.23 | 1.48 | 2.5 | 12.5 | 24 | 50 | 75 | 90 |
| f(-1%) [Hz] | 0.78 | 2.34 | 3.9 | 4.69 | 7.8 | 39 | 77 | 155 | 230 | 300 |
| $f_c(-3 \text{ dB})$ [Hz] | 4.4 | 13.3 | 22.2 | 26.5 | 44 | 220 | 434 | 880 | 1340 | 2500 |

Table 1: The table shows the combinations of the magnetic signal frequencies, measurement resolutions and bandwidths that are achievable with the 3MH4 teslameter. Displayed values apply to each measurement axis Bx, By & Bz.

Notations:

- **Data rate [SPS, samples per second]:**

The rate with which the measurement data appear at the 3MH4 teslameter digital output. In the teslameter specifications it is called the “**Selectable sampling rate**” and it goes from 10 SPS up to 7.5 kSPS.

This is one of the main parameters that a user should select on the front panel of the 3MH4 digital teslameter. Once a data rate is chosen, this will define the Data **Averaging time [ms]** as the inverse of the data rate.

For example, if the data rate of 10 samples per second is chosen, then the teslameter will spend 100 milliseconds with averaging the raw measurement results.

- **Resolution [μT_{RMS}]:**

The minimal magnetic flux density change that can be detected by 3MH4 teslameter.

For example, if the data rate of 100 SPS is chosen, then the measurement resolution will be about $1.2 \mu T_{RMS}$.

- **Bandwidth f(-“x”):**

These are the frequencies at which the measured signal attenuation with respect to the DC value reach a given value (this, due to various low-pass filtering effects within the Teslameter).

For instance, the line “f(-100 ppm)” shows that if the data rate is 3.75 kS/s, at the signal frequency of 25 Hz, the measured B-field amplitude will appear 100 ppm lower than its true value.