Data-sheet:

3-axis Hall probe type LSs, LMs and LLs for the SENIS F3A analog magnetic field transducers and 3MH3A digital teslameters

Very thin fully integrated 3-axis Hall Probe with a naked Hall sensor and high spatial resolution

DESCRIPTION:

The new developed Hall probe type LXs for SENIS F3A analog magnetic field transducers and 3MH3A digital teslameters has a very thin probe tip with a naked Si-chip.

Dimensions of the naked Si-chip (L x W x H) are: 1.85 x 0.66 x 0.10 mm. The thickness of the probe body is 0.5 mm.

The probe provides simultaneous analogue voltage outputs for all three components (Bx, By and Bz) of a measured magnetic flux density and for the probe temperature.

The LXs probes are available in 3 (three) different lengths (see Figure 1):

1. LLs (long): 71 mm,
2. LMs (medium): 47 mm,
3. LSs (small): 8 mm.

Figure 1: Photos of the 3-axis Hall probes type KSs, KMs and KLs.

The LXs probe is designed with the goal to enable measurements where the magnetic field sensitive volume (hereinafter: FSV) of the Hall sensor needs to be placed very close to the object under test, or to allow measurements of the magnetic field in the object cavities or in the small air gaps.

For such applications, the LXs probe is designed in the way that the FSV is located at the distance of (150 - 200) µm from the probe front edge, and 10 µm in depth from the top surface of the silicon Hall sensor.

The probe contains a CMOS integrated circuit, which incorporates a group of 3 (three) mutually orthogonal Hall elements, biasing circuits, amplifiers and a temperature sensor.

The integrated Hall elements occupy very small area (0.15 x 0.15 mm^2), which provides very high spatial resolution of the probe, see Figure 2:

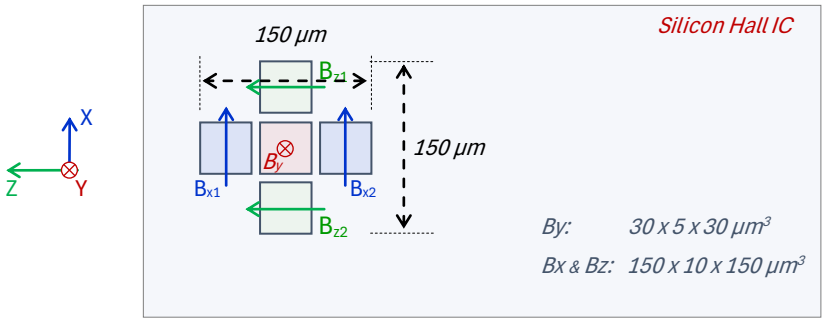


Figure 2: Magnetic field sensitive volume (FSV) of the applied fully integrated 3D Hall sensor.

The CMOS IC technology enables very high precision in the fabrication of the vertical and horizontal Hall elements, which gives high angular accuracy between the three measurement axes of the probe (mutual orthogonality error is < 1°, which can be determined with an accuracy of better than 0.1° by the utilization of an improved calibration method).

The on-chip application of the spinning-current technique in the biasing of the Hall elements suppresses the planar Hall effect.

The signal pre-processing on the chip enables a very high frequency bandwidth of the probe (DC - 25 kHz (-3dB)), and on-chip signal amplification provides high output signals of the Hall probe.

The sensor chip is embedded in the probe package made of thin flex-printed substrate and alumina-ceramics (Al_2O_3) and it is connected to the flexible shielded cable.

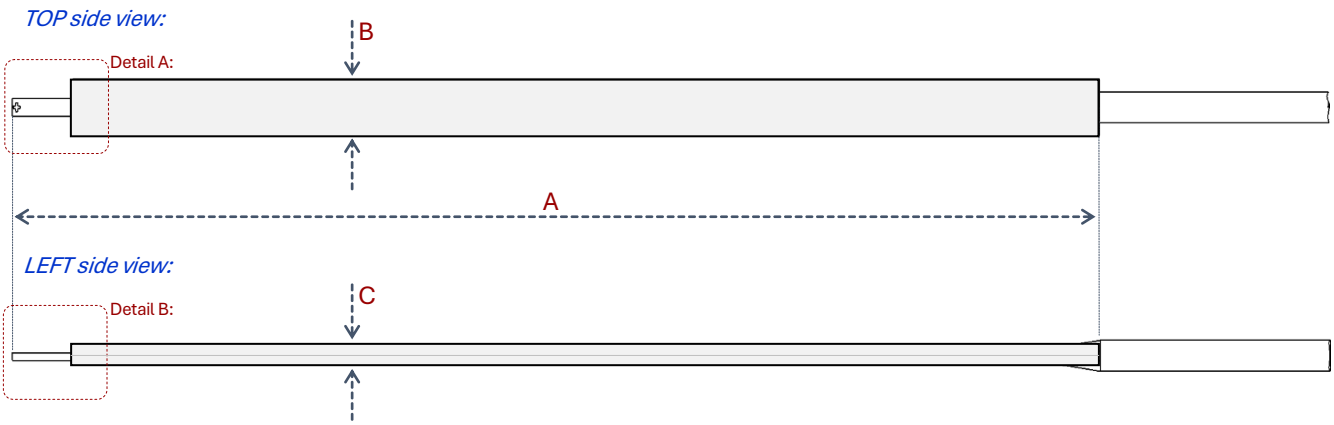
The outputs of the probe are:

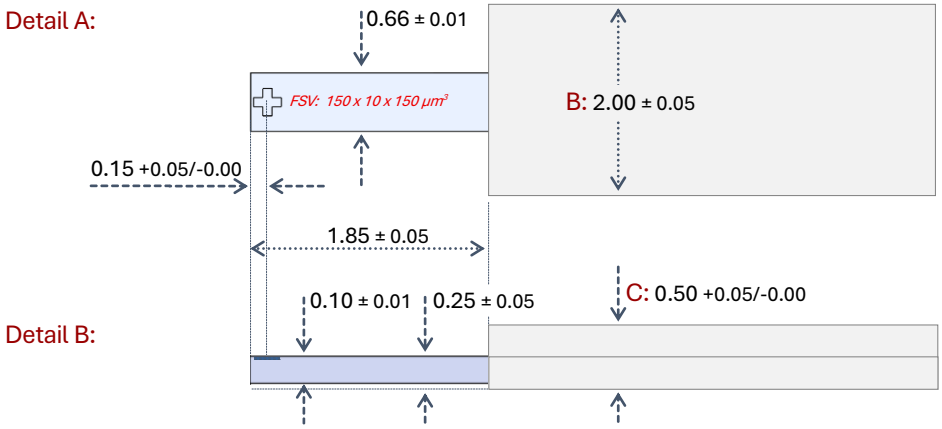
- high-level voltages proportional to the measured magnetic field components Bx, By and Bz, and
- voltage proportional to the actual local temperature of the Hall chip.

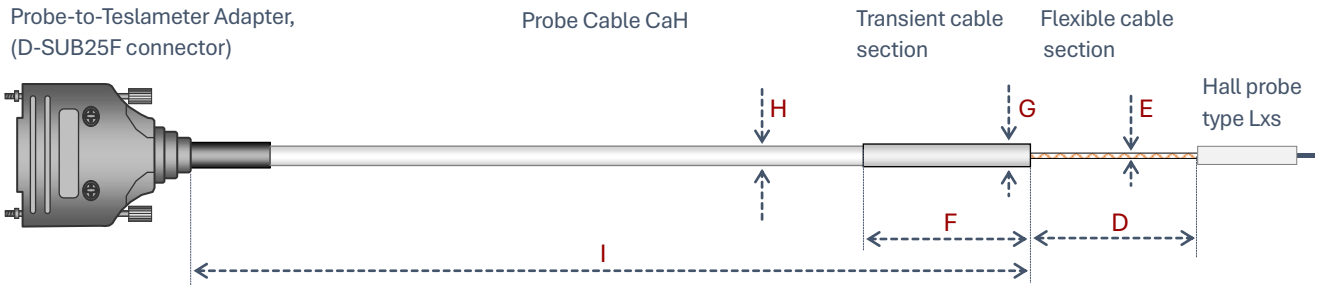
Key features of the Hall probe type LXs:

- Hall probe type L**X**s has an ultra-thin probe tip (0.1 mm) with a naked single Si-chip going out from the ceramic substrate. The thickness of the probe body is 0.5 mm.
- Probe package is particularly suitable for very small distances (narrow gaps) between the probe's field sensitive spot (FSV) and the surface of magnetic materials. Probe's FSV is located at the distance of (0.15 - 0.20) mm from the front edge of the exposed Hall IC.
- L**x**s Hall probe is available in 3 (three) different lengths (**x**): 71 mm (L**L**s - long), 47 mm (L**M**s - medium), and 8 mm (L**S**s - small probe).
- Probe package is made fully of Al_2O_3 (alumina-ceramics), with the chip and cable connecting pads directly printed on the ceramic substrate.
- Fully integrated CMOS 3-axis (Bx, By, Bz) Hall Probe, of which one, two, or three channels are used.
- Very high spatial resolution: By: 30 x 5 x 30 μm^3 ; Bx & Bz: 150 x 10 x 150 μm^3.
- High angular accuracy of the measurement axes: mutual orthogonality between the three measurement axes of the probe is < ±1°, determined with accuracy better than 0.1° by the application of an improved method.
- High frequency bandwidth: DC - 25 kHz (-3 dB point of sensitivity attenuation).
- Virtually no planar Hall Effect.
- Negligible inductive loops on the Probe.
- Integrated temperature sensor on the probe for temperature compensation, etc.

Hall probe and Cable - Mechanical specifications:







Part		Dimension (mm)	Part	Dimension (mm)
A	LSs	8.0 ± 0.2	F	25 ± 2
	LMs	47.0 ± 0.5	G	Ø 2.2 ± 0.1
	LLs	71.0 ± 0.5	H	Ø 1.7 ± 0.1
B		2.00 ± 0.05	I	Standard cable lengths: 2'000 ± 1% 5'000 ± 1% 10'000 ± 1%
C		0.50 +0.05/-0.00		
D		50 ± 1		
E		Ø 0.8 ± 0.1		

Figure 3: Dimensions and tolerances of the H-module type F3A-03L**x**s0**l**C (here "**x**" denotes probe length: L, M or S, and "**l**" denotes the length of the probe cable). All measures are in millimeters (mm).

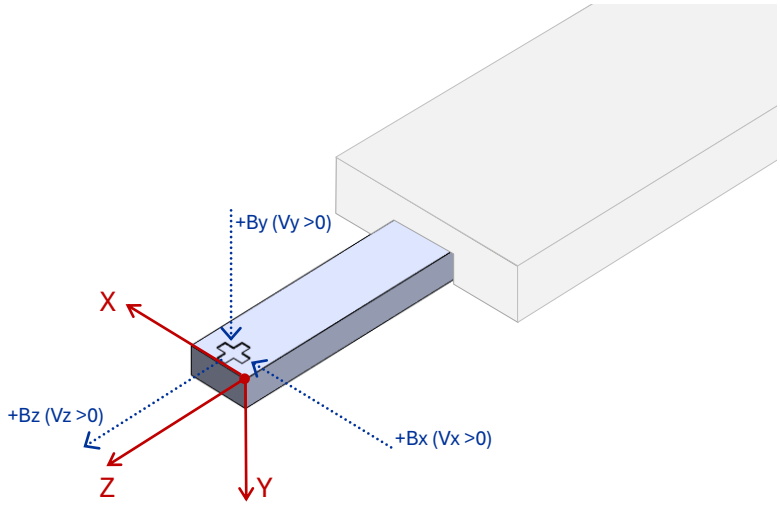


Figure 4: Reference Cartesian coordinate system (X, Y, Z) of the 3-axis Hall probes type LSs, LMs and LLs.

Parameter				
Dimensions		**X (mm)**	**Y (mm)**	**Z (mm)**
Magnetic field sensitive volume (FSV)		0.15	0.01	0.15
Position of the FSV centre (Figures 3 and 4)		0.33 ± 0.05	-0.01	-0.20 +0.05/-0.00
External dimensions of the probe	LSs	**Probe body:** 2.00 ± 0.05	**Probe body:** 0.50 +0.05/-0.00	8.0 ± 0.2 *
	LMs			47.0 ± 0.5 *
	LLs	**Sensitive probe tip:** 0.66 ±0.01	**Sensitive probe tip:** 0.10 ±0.01	71.0 ± 0.5 *
		* Including naked silicon Hall sensor tip: 1.85 ± 0.05 mm.		
Positioning accuracy				
Angular accuracy of the measurement axes		▪ < ±1° with respect to the reference surface ▪ Mutual orthogonality between the meas. axes: < ±1° (determined with an accuracy of better than 0.1° by the application of a well-improved measurement method)		
Cable properties				
Conductor:		Silver plated soft copper core, 7 x 44 AWG		
Insulation:		PFA (Perfluoro Alkoxy), diameter 0.30 mm		
Minimum bending radius:		10 x OD in static applications 15 x OD in dynamic applications		
Shield:		Silver plated soft copper braid		
Jacket:		PFA (Perfluoroalkoxy)		
Service temperature:		-196 / +200 °C		
Linear resistance:		1.4 Ω/m		
Rated voltage:		150 Vac		
RoHS compliance:		Yes		
Cable length: NOTE: Various cable lengths are available upon request.		Standard: 2 m Notation: F3A-03Lxs02C Optional: X m Notation: F3A-03Lxs0XC		

Installation Manual for the Lxs probe:

NOTE: The Lxs probes are fragile! Please handle it with a special care.

In order to achieve the small thickness of the probe, a part of the sensor chip is left non-encapsulated. The Hall sensor chip is a 0.1mm thick bar of mono-crystalline silicon, and can be easily broken.

Therefore, avoid any mechanical contact of the probe tip with other objects! Moreover, avoid the immersion of the probe in any liquid, as well its exposure to moisture and aggressive gasses.

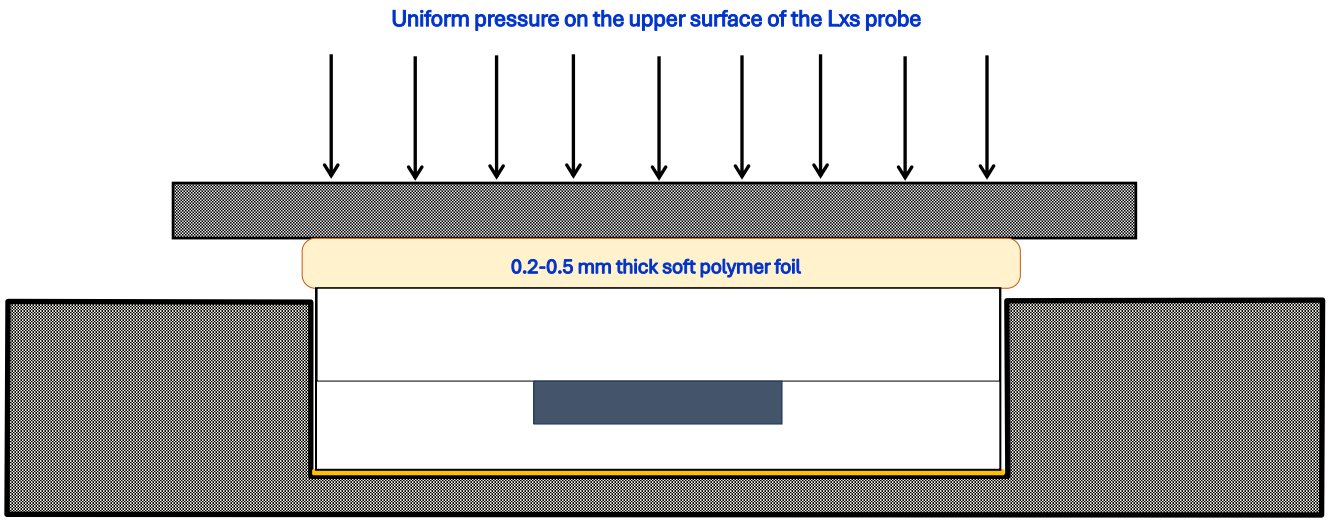
Considering that we deal with a high-precision device of very small dimensions, following precautions should help to avoid damage to the probe during installation and handling, and ensure that the accurate calibration of the device remains preserved:

- Always disconnect powering of the instrument before plugging/unplugging the Hall probe!

  If so, carefully plug the probe connector (female SUB-D/25-pins connector) to the corresponding male SUB-D/25-pins connector on the electronic box. After ensuring that its pins engage correctly, tighten the metal screws of the probe connector. Do not leave these loose since they are the component part of the shielding system of the magnetometer.

- Applied CMOS Hall sensor can be damaged by ESD. We strongly recommend that the probe be handled with appropriate ESD preventive precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure.
- Mounting of the Probe should be carried out by application of very low pressure to its head and the thin red cable.
- Do not apply more force than required to hold the probe in its place. Damage to either the ceramics package of the Hall sensor or thin wiring could destroy the Probe.
- If the probe head is clamped, the user needs to make sure that the environment surface in contact with the reference plane of the probe is flat and covers as much of the probe reference surface as possible.
- Do not apply more force than required to hold the probe in its mounting. Also, do not press the probe just in a single spot. Pressure on the probe should be uniformly distributed over its upper ceramics surface.

  To relax a stress while mounting or gluing the probe in a groove, it is recommended to press the probe by application of a flat 0.2-0.5 mm thick soft polymer or a rubber foil over the upper ceramics surface of the probe:

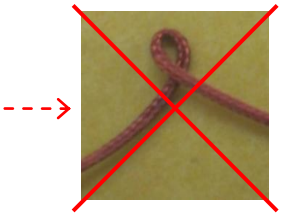


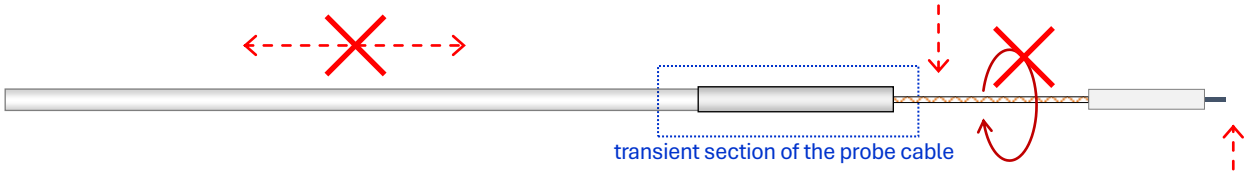
- In order to prevent rupture of the thin probe wiring, the user should fix and secure the probe cable in the proximity of the head. The thin black wire from the probe can be folded only with a special care. Strongly avoid loops or twisting of this section.

Do not push / pull the probe cable if the probe head is fixed !

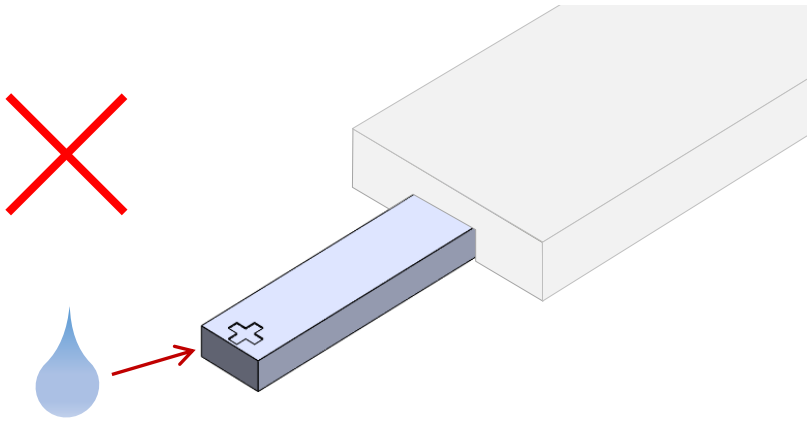
The following actions must be strictly avoided:

- pressing the thin red cable;
- contacts to any sharp edges;
- loops or twisting of the thin red part !





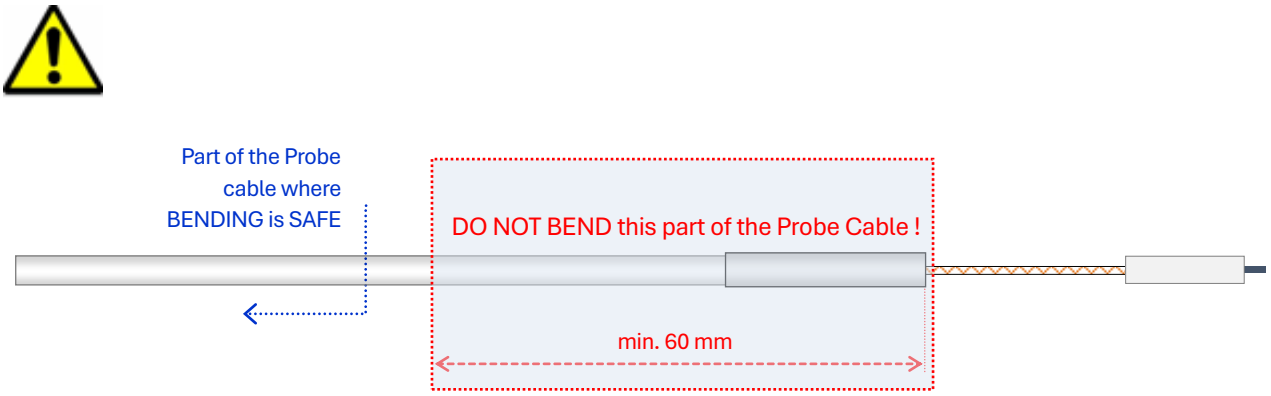
Do not expose the front side of the probe to any liquid or gas !



Strongly avoid contact of the naked silicon Hall sensor on the probe tip to any liquid or a grain mass (such as glue). Due to capillary effect, such matter could enter the conductive sensor surface and deteriorate or even destroy the characteristics of the CMOS Hall sensor !

- Do not expose the thin red cable to the external sharp edges.
- Do not expose the probe to moisture and aggressive gasses.
- Avoid immersion of the probe in any liquid.
- Strongly avoid any high pressure, tightening and/or bending of the rigid (non-flexible) transient section between the thin (black) and thick (grey) probe cables.

- Safe area for bending the thick (white) probe cable is illustrated on the following drawing:



- Keep the cable out of the way of foot traffic. Do not pinch the cable, or drop sharp or heavy objects on it. A severed cable cannot be re-joined without altering the probe performance, and requires factory repair and full re-calibration of the device.

- Example / proposal for a safe fixation of the Lxs probe on a probe holder: