

**DESCRIPTION:**

The Hall Probe 03U for the OEM applications is an ultra-thin (0.25mm) and robust, single-chip fully integrated 3-axis Hall-Probe system.

The Probe contains a CMOS integrated circuit, which incorporates three groups of Hall elements, biasing circuits, amplifiers, and a temperature sensor. The integrated Hall elements occupy very small area (150 x 150  $\mu\text{m}$ ), which provides very high spatial resolution of the probe.

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 (DC to 25 kHz) of the probe; and on-chip signal amplification provides high output signals of the Hall probe.

The sensor chip is embedded in the probe package and connected to the CaH cable, which makes this probe both mechanically and electrically very robust. The chip is glued onto a reference ceramic plate suitable for an appropriate fixing of the probe.

The outputs of the Hall Probe are high-level analog voltages proportional to each of the three measured components of a magnetic flux density and a voltage proportional with the probe temperature.

To achieve it's fully specifications, 03U Hall probe needs to be connected with an appropriate signal conditioning Electronics module providing biasing for the Hall probe and additional conditioning of the Hall probe output signals: amplification, linearization, cancelling offsets, compensation of the temperature variations, and limitation of the frequency bandwidth.

**KEY FEATURES:**

- **Fully integrated CMOS 3-axis (Bx, By, Bz) Hall Probe, of which one, two, or three channels are used**
- **Very high spatial resolution:**  
**By: 0.03 x 0.005 x 0.03mm**  
**Bx and Bz: 0.15 x 0.01 x 0.15 mm<sup>3</sup>**
- **High angular accuracy (orthogonality error less than 0.1°)**
- **4 selectable measurement ranges of the Probe: 0.1T, 0.5T, 3T, and 20T**
- **Very good linearity (better than 1% of full scale at 0.1T, 0.5T and 3T ranges)**
- **Virtually no planar Hall Effect**
- **High frequency bandwidth (from DC up to 25kHz)**
- **High disturbance immunity**
- **Negligible inductive loops on the Probe**
- **Integrated temperature sensor on the probe for temperature compensation**

**TYPICAL APPLICATIONS:**

- Characterization and quality control of permanent magnets
- Development of magnet systems
- Mapping magnetic field
- Quality control and monitoring of magnet systems (generators, motors, etc.)
- Application in laboratories and in production lines

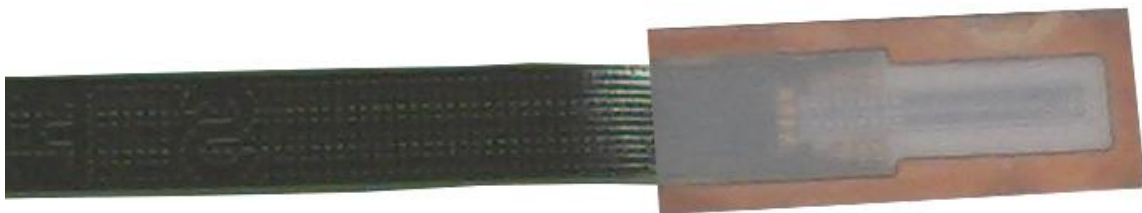


Figure 1. SENIS fully integrated 3-Axis Hall probe 03U

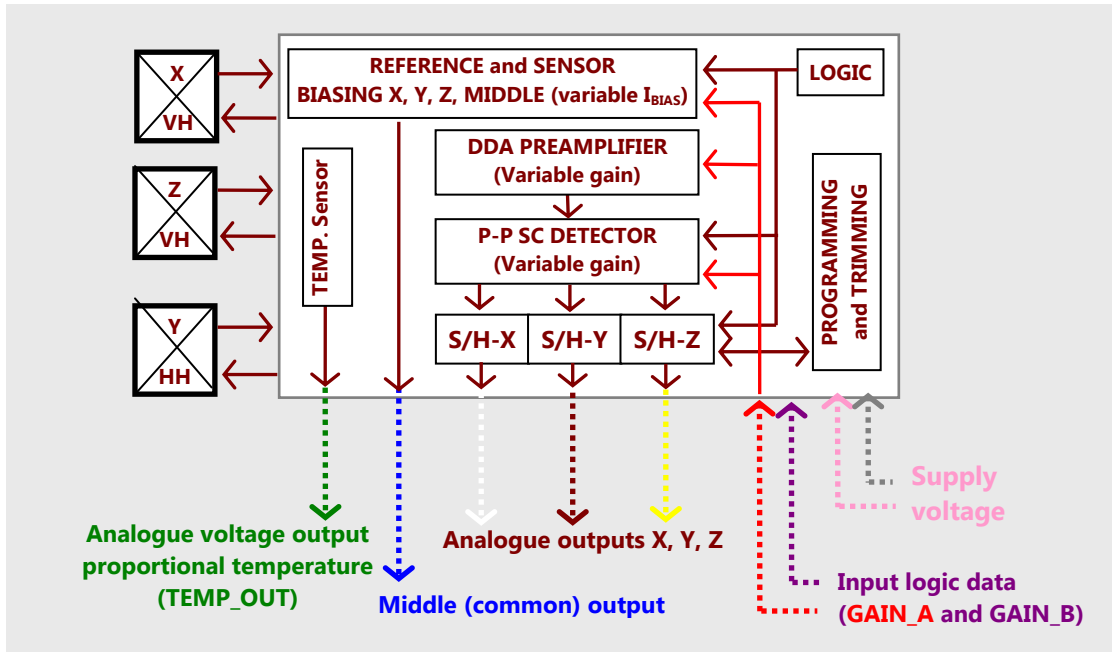
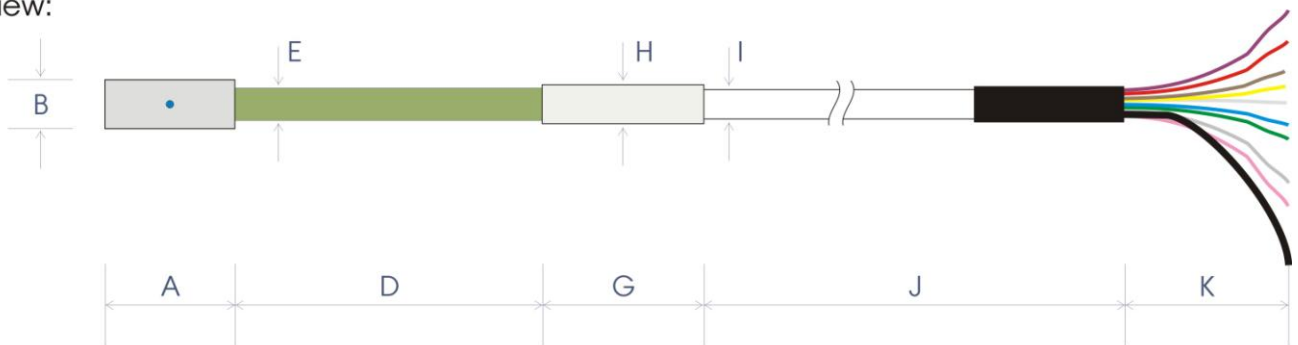


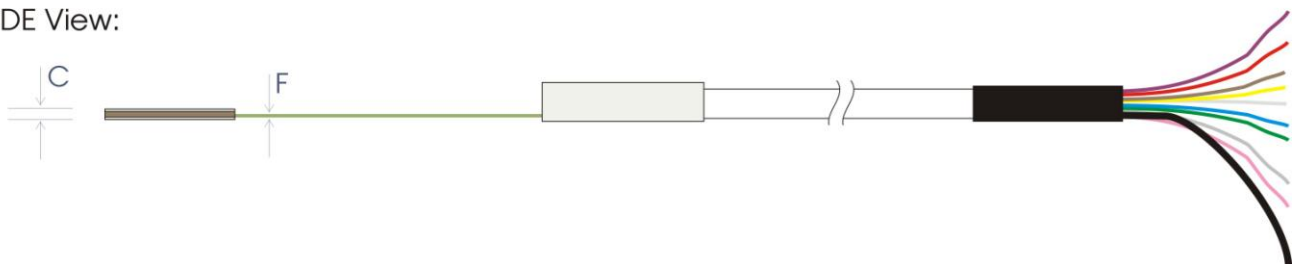
Figure 2. Functional block-diagram of the SENIS fully integrated 3-axis Hall sensor

PROBE and CABLE-MECHANICAL SPECIFICATIONS:

TOP View:



LEFT SIDE View:



Dimension	mm	Dimension	mm
A	8.0 ± 0.1	G	22 ± 2
B	3.0 ± 0.1	H	∅ 2.2 ± 0.2
C	0.25 ± 0.02	I	∅ 1.7 ± 0.2
D	34 ± 2	J	2'000 ± 20
E	2.0 ± 0.1	K	30 ± 5
F	0.05		

Figure 3. Dimensions and tolerances of the 03U Hall probe and CaH cable

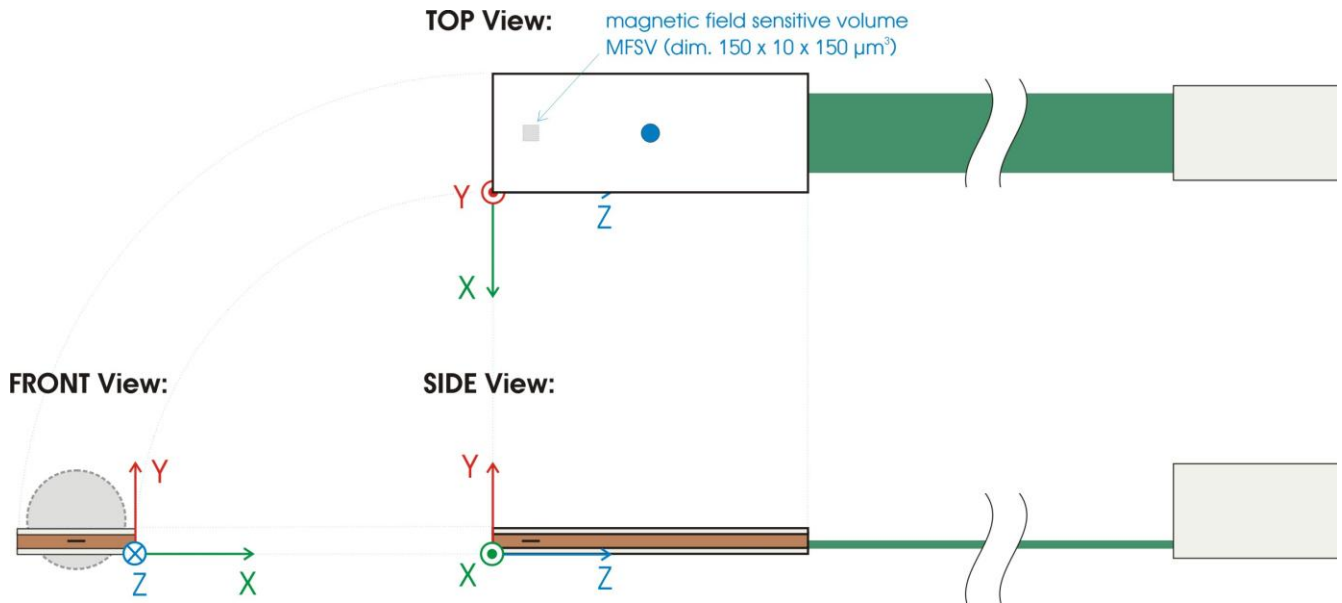


Figure 4. The reference Cartesian coordinate system of the 03U Hall probe: the GREEN, RED and BLUE arrows denote POSITIVE sensing directions of each measurement axis X, Y, and Z, respectively.

Dimension	X [mm]	Y [mm]	Z [mm]
Magnetic field sensitive volume (MFSV)	0.15	0.01	0.15
Position of the centre of MFSV (Figure 4)	-1.50 ± 0.1	+0.10 ± 0.02	+1.0 ± 0.1
Total Probe external dimensions	3.0 ± 0.1	0.25 ± 0.02	8.0 ± 0.1
Angular accuracy of the axes	±1° with respect to the reference surface		
CaH Cable (construction and characteristics)	Conductor: Silver plated soft copper core, 7 x 44 AWG Insulation: PFA (Perfluoro Alkoxy), diameter 0.30 mm Twisting: 15 x Diameter Shield: Silver plated soft copper braid Jacket: PFA (Perfluoro Alkoxy) Service temperature: -196 / +200 °C Linear resistance: 1.4 Ω/m Rated voltage: 150 Vac RoHS compliance: Yes		
Total length of the CaH cable:	<ul style="list-style-type: none"> <li>Standard: 2 m (Probe notation: <b>F3A-03U02</b>)</li> <li>Optional: XX m (Probe notation: <b>F3A-03UXX</b>)</li> </ul> NOTE: Various cable lengths are available upon request.		

**APPLICATIONS INFORMATION:**

For a reliable operation within the specifications, the Hall probe needs to be powered as follows:

1. POWER SUPPLY range:
  - Single supply:  $V_{DD}=5V$ ,  $V_{SS}=GND$  (0V); max voltage tolerance:  $\pm 5\%$ ; Supply current: 8-9 mA;
  - Dual supply:  $V_{DD}=+2.5V$ ,  $V_{SS}=-2.5V$ ; max voltage tolerance:  $\pm 5\%$ ; Supply current: 8-9 mA.
2. It is recommendable to put in parallel a 100nF and tantalum 10 $\mu$ F capacitors between inputs ( $V_{DD}$ ) and ( $V_{SS}$ ).
3. Measurement range selection: Control inputs GAIN\_A and GAIN\_B to be used to select a desired measurement range.

GAIN_A level	GAIN_B level	MEAS. RANGE
logic_0	logic_0	0.1 T
logic_0	logic_1	0.5 T
logic_1	logic_0	3 T
logic_1	logic_1	20 T
NOTE: logic_0 = $V_{SS}$ (0V or -2.5V) logic_1 = $V_{DD}$ (+5V or +2.5V)		

4. Probe signals and corresponding cable wires are given in the following table:

HALL Probe signal	WIRE Color (see Fig. 2)	NOTE	
VDD (logic 1)	ROSE	<b>+5V (single supply)</b>	<b>+2.5V (dual supply)</b>
VSS (logic 0)	GREY	<b>0V (GND, single supply)</b>	<b>-2.5V (dual supply)</b>
GAIN_A	RED	<b>Measurement range selection</b>  <b>differential output voltages, referenced to MIDDLE_OUT</b>	
GAIN_B	VIOLET		
X_OUT	WHITE		
Y_OUT	BROWN		
Z_OUT	YELLOW	$\approx (V_{DD}-V_{SS})/2$	
MIDDLE_OUT	BLUE	$\approx +2V \pm 0.3V$ (single supply)	$\approx -0.5 \pm 0.3V$ (dual supply)
TEMP_OUT	GREEN	<b>to be connected to power grounding</b>	
CABLE SHIELD	BLACK		

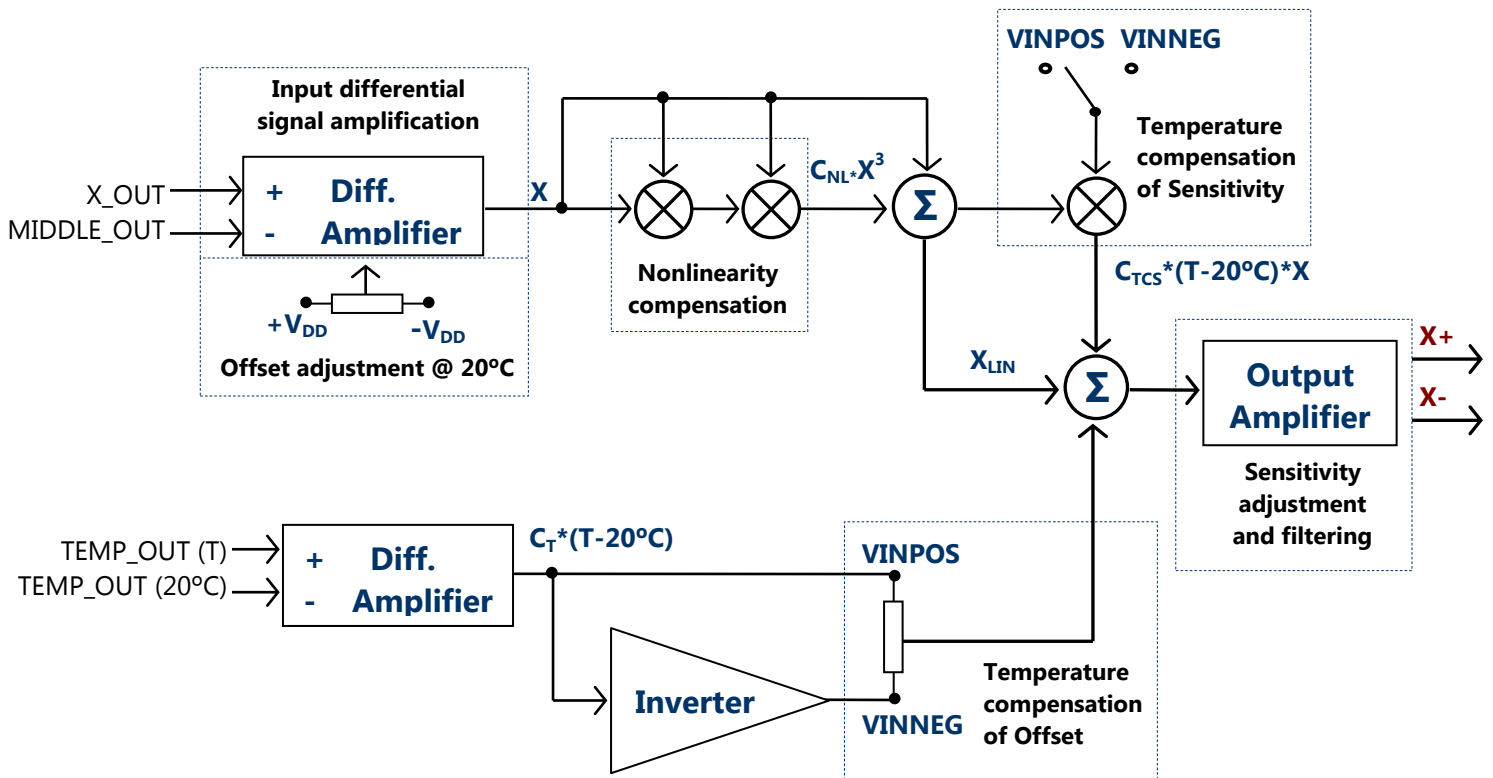


Figure 5. Typical block-diagram for conditioning the raw output signals from the 03A Hall probe (applied to X\_OUT, Y\_OUT and Z\_OUT, respectively)

**MAGNETIC and ELECTRICAL SPECIFICATIONS:**

If not noted otherwise, specifications apply for all three B-measurement channels X, Y, Z at the following conditions:

- Ambience temperature ( $23 \pm 5^\circ\text{C}$ )
- Voltage supply:  $V_{DD} - V_{SS} = 5\text{V}$ , Supply current: 8-9 mA
- Warm-up time: at least 10 minutes
- The specifications below are given for the **differential** output voltages (X\_OUT, Y\_OUT, and Z\_OUT) from the Hall probe (i.e. these are referenced to the MIDDLE\_OUT, which is approx. equal to  $(V_{DD} - V_{SS})/2$ )

Parameter	Value			Unit	
	Min.	Typ.	Max.		
Maximum (full scale) magnetic flux density	$\pm 0.1$			T (tesla)	
Linear range of magnetic flux density	$\pm 0.1$			T (tesla)	
Output voltages (X_OUT, Y_OUT, Z_OUT) referenced to the MIDDLE_OUT from the Probe	Differential				
Sensitivity to DC magnetic field	18	20	22	V/T	
Nonlinearity	0.1	---	0.5	% (of full scale)	
Planar Hall voltage	< 0.01% of $V_{\text{NORMAL}}$				
Temperature Coeff. of Sensitivity @ Temperature range $23 \pm 10^\circ\text{C}$	X & Z axes	-1200	-1500	-1800	ppm/ $^\circ\text{C}$
	Y axis	-450	-600	-800	
Offset (@B = 0T, @ Temp. range $23 \pm 5^\circ\text{C}$ )		-80	---	+80	mV
Offset fluctuation & drift (peak-to-peak value) ( $\Delta t = 0.05\text{s}$ , $t = 100\text{s}$ )	X & Z axes	20	25	35	$\mu\text{T}$ (microtesla)
	Y axis	12	15	20	
<b>Output noise</b>					
Noise Spectral Density (NSD <sub>w</sub> ) @ f > 10 Hz (white noise)	X & Z axes	0.70	1.00	1.25	$\mu\text{T}/\sqrt{\text{Hz}}$
	Y axis	0.50	0.70	1.00	
<b>Typical frequency response</b>					
Frequency Bandwidth	DC to 25 kHz				
<b>Temperature output (TEMP_OUT, ground-referred voltage)</b>					
- for Single-supply ( $V_{DD} = +5\text{V}$ , $V_{SS} = \text{GND}$ ):	1.8	2.0	2.3	V	
- for Dual-supply ( $V_{DD} = +2.5\text{V}$ , $V_{SS} = -2.5\text{V}$ ):	-0.7	-0.5	-0.2		
Sensitivity of TEMP_OUT	8.0	8.5	9.0	mV/ $^\circ\text{C}$	
Operating temperature range	+5	---	+45	$^\circ\text{C}$	
Storage temperature	-20	---	+80	$^\circ\text{C}$	

Parameter	Value			Unit	
	Min.	Typ.	Max.		
Maximum (full scale) magnetic flux density	±0.5			T (tesla)	
Linear range of magnetic flux density	±0.5			T (tesla)	
Output voltages (X_OUT, Y_OUT, Z_OUT) referenced to the MIDDLE_OUT from the Probe	Differential				
Sensitivity to DC magnetic field	3.9	4.3	4.7	V/T	
Nonlinearity	0.1	---	0.5	% (of full scale)	
Planar Hall voltage	< 0.01% of V <sub>NORMAL</sub>				
Temperature Coeff. of Sensitivity @ Temperature range 23±10°C	X & Z axes	-1200	-1500	-1800	ppm/°C
	Y axis	-450	-600	-800	
Offset (@B = 0T, @ Temp. range 23±5°C)		-30	---	+30	mV
Offset fluctuation & drift (peak-to-peak value) (Δt = 0.05s, t = 100s)	X & Z axes	30	35	40	μT (microtesla)
	Y axis	25	30	35	
<b>Output noise</b>					
Noise Spectral Density (NSD <sub>w</sub> ) @ f > 10 Hz (white noise)	X & Z axes	0.7	1.0	1.4	μT/√Hz
	Y axis	0.6	0.8	1.1	
<b>Typical frequency response</b>					
Frequency Bandwidth	DC to 25 kHz				
<b>Temperature output (TEMP_OUT, ground-referred voltage)</b>					
- for Single-supply (V <sub>DD</sub> =+5V, V <sub>SS</sub> =GND):	1.8	2.0	2.3	V	
- for Dual-supply (V <sub>DD</sub> =+2.5V, V <sub>SS</sub> =-2.5V):	-0.7	-0.5	-0.2		
Sensitivity of TEMP_OUT	8.0	8.5	9.0	mV/°C	
Operating temperature range	+5	---	+45	°C	
Storage temperature	-20	---	+80	°C	

Parameter	Value			Unit	
	Min.	Typ.	Max.		
Maximum (full scale) magnetic flux density	±3			T (tesla)	
Linear range of magnetic flux density	±2			T (tesla)	
Output voltages (X_OUT, Y_OUT, Z_OUT) referenced to the MIDDLE_OUT from the Probe	Differential				
Sensitivity to DC magnetic field	0.65	0.71	0.78	V/T	
Nonlinearity	0.5	---	1.5	% (of full scale)	
Planar Hall voltage	< 0.01% of V <sub>NORMAL</sub>				
Temperature Coeff. of Sensitivity @ Temperature range 23±10°C	X & Z axes	-1200	-1500	-1800	ppm/°C
	Y axis	-450	-600	-800	
Offset (@B = 0T, @ Temp. range 23±5°C)	-30	---	+30	mV	
Offset fluctuation & drift (peak-to-peak value) (Δt = 0.05s, t = 100s)	all 3 axes	70	80	85	μT (microtesla)
<b>Output noise</b>					
Noise Spectral Density (NSD <sub>w</sub> ) @ f > 10 Hz (white noise)	all 3 axes	0.8	0.8	0.9	μT/√Hz
<b>Typical frequency response</b>					
Frequency Bandwidth	DC to 25 kHz				
<b>Temperature output (TEMP_OUT, ground-referred voltage)</b>					
- for Single-supply (V <sub>DD</sub> =+5V, V <sub>SS</sub> =GND):	1.8	2.0	2.3	V	
- for Dual-supply (V <sub>DD</sub> =+2.5V, V <sub>SS</sub> =-2.5V):	-0.7	-0.5	-0.2		
Sensitivity of TEMP_OUT	8.0	8.5	9.0	mV/°C	
Operating temperature range	+5	---	+45	°C	
Storage temperature	-20	---	+80	°C	



Parameter	Value			Unit	
	Min.	Typ.	Max.		
Maximum (full scale) magnetic flux density	±20			T (tesla)	
Linear range of magnetic flux density	±2			T (tesla)	
Output voltages (X_OUT, Y_OUT, Z_OUT) referenced to the MIDDLE_OUT from the Probe	Differential				
Sensitivity to DC magnetic field	0.10	0.12	0.15	V/T	
Nonlinearity	3	5	10	% (of full scale)	
Planar Hall voltage	< 0.01% of V <sub>NORMAL</sub>				
Temperature Coeff. of Sensitivity @ Temperature range 23±10°C	all 3 axes	≤±500	≤±400	≤±300	ppm/°C
Offset (@B = 0T, @ Temp. range 23±5°C)		-20	---	+20	mV
Offset fluctuation & drift (peak-to-peak value) (Δt = 0.05s, t = 100s)	all 3 axes	0.65	0.70	0.75	mT (millitesla)
<b>Output noise</b>					
Noise Spectral Density (NSD <sub>w</sub> ) @ f > 10 Hz (white noise)	all 3 axes	14	15	17	μT/√Hz
<b>Typical frequency response</b>					
Frequency Bandwidth	DC to 25 kHz				
<b>Temperature output (TEMP_OUT, ground-referred voltage)</b>					
- for Single-supply (V <sub>DD</sub> =+5V, V <sub>SS</sub> =GND):	1.8	2.0	2.3	V	
- for Dual-supply (V <sub>DD</sub> =+2.5V, V <sub>SS</sub> =-2.5V):	-0.7	-0.5	-0.2		
Sensitivity of TEMP_OUT	8.0	8.5	9.0	mV/°C	
Operating temperature range	+5	---	+45	°C	
Storage temperature	-20	---	+80	°C	

## INSTALLATION MANUAL FOR THE 03U HALL PROBE

### MECHANICAL PRECAUTIONS:

Although the 03U probe is very robust with respect to its size, it should be handled with a special care. 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 device's accurate calibration remains preserved:

- The Hall Probe is sensitive to Electrostatic Discharge (ESD). Be sure to ground yourself and follow proper procedure when handling the Hall probe.
- The mounting of the Probe should be carried out by application of very low pressure to its head and particularly on the thin flexible PCB.
- 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 flexible PCB will destroy the Probe. We strongly suggest storing the probe in its protective case when not in use.



- 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 (see image below). Do not apply more force than required to hold the probe in its mounting.



- In order to prevent rupture of the flexible PCB wires from the probe head, the user should fix and secure the probe cable in the proximity of the head. The thin wires of the **flexible section** of the probe need to be folded with care; repeated sharp bending should be strongly avoided.
- Avoid any high pressure and bending of the **transient section** between the flexible PCB and the Probe cable.
- Avoid the immersion of the probe of any liquid, and its exposure to moisture and aggressive gasses.

Although the Hall probe is operable even on the higher temperatures (almost up to +160°C) it is strongly recommendable to avoid its exposing to rapid temperature changes!

### Appendix: Electrostatic discharge and antenna effect

Electrostatic discharge (ESD) damage is usually caused by one of three events: direct electrostatic discharge to the device, electrostatic discharge from the device or field-induced discharges. Damage to an ESD-sensitive device by the ESD event is determined by the device's ability to dissipate the energy of the discharge or withstand the voltage levels involved. This is known as the device's "ESD sensitivity".

We suggest the following:

- Identify and define the electrostatic protected areas (EPA) in which you will be handling sensitive parts.
- Eliminate and reduce generation by reducing and eliminating static generating processes, keeping processes and materials at the same electrostatic potential, and by providing appropriate ground paths to reduce charge generation and accumulation.
- Dissipate and neutralize by grounding, ionization, and the use of conductive and dissipative static control materials.
- Protect products from ESD with proper grounding or shunting and the use of static control packaging and materials handling products.

An ESD protective workstation refers to the work area of a single individual that is constructed and equipped with materials and equipment to limit damage to ESD sensitive items.

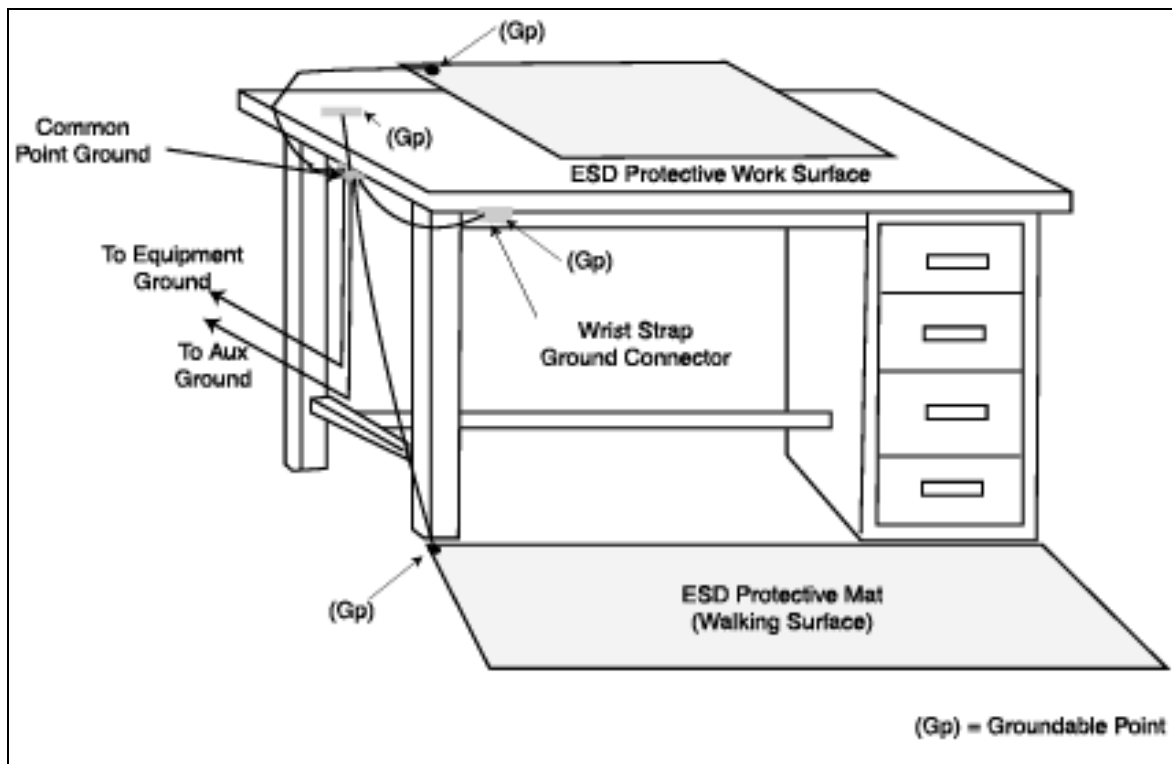


Figure 6. Typical ESD Workstation

The key ESD control elements comprising most workstations are a static dissipative work surface, a means of grounding personnel (usually a wrist strap), a common grounding connection, and appropriate signage and labelling. A typical workstation is shown in Fig. 6.

The workstation provides a means for connecting all work surfaces, fixtures, handling equipment, and grounding devices to a common point ground. In addition, there may be provision for connecting additional personal grounding devices, equipment, and accessories such as constant ground monitors and ionizers.

Grounding is the primary means of controlling static charge on equipment and many production aids. Shielded cable minimizes the antenna effect that occurs with cable of any significant length. This antenna effect will produce low-voltage interference that can affect sensitive devices and cause erratic operation. Use shielded cable for communication between devices, sensitive analogue sensors (e.g. temperature), or if the wire has to be run close to the 220V/110V AC wire. If in doubt, use shielded. Ground wire acts as an extra conductor.