

DESCRIPTION:

The 03A is a single-chip integrated 3-axis Hall probe system for OEM applications.

The Hall Probe contains a CMOS integrated circuit, which incorporates three groups of mutually orthogonal Hall elements, biasing circuits, amplifiers, and a temperature sensor. The integrated Hall elements occupy very small area ($150\mu\text{m} \times 150\mu\text{m}$), which provides very high spatial resolution of the probe. The CMOS IC technology enables very high precision in the fabrication of the vertical and horizontal Hall elements, which gives high angular accuracy (orthogonality error $< 0.1^\circ$) of the three measurement axes of the probe. The application of the spinning-current technique in the biasing of the Hall elements suppresses the planar Hall effect. The on-chip signal pre-processing 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, which makes it immune to electromagnetic disturbances.

The sensor chip is embedded in the probe package and connected to the CaH cable, which makes the 03A Probe mechanically and electrically robust. The voltage outputs of the 03A probe are available at the free ends of the CaH cable (Fig. 2): these are high-level voltages proportional with each of the measured components of a magnetic flux density; and a ground-referred voltage proportional with the probe temperature.

To achieve its fully specifications, 03A 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 (B_x, B_y, B_z) Hall Probe, of which one, two, or three channels are used**
- **Very high spatial resolution (B_y: $0.03 \times 0.005 \times 0.03\text{mm}^3$; B_x and B_z: $0.15 \times 0.01 \times 0.15 \text{ mm}^3$)**
- **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

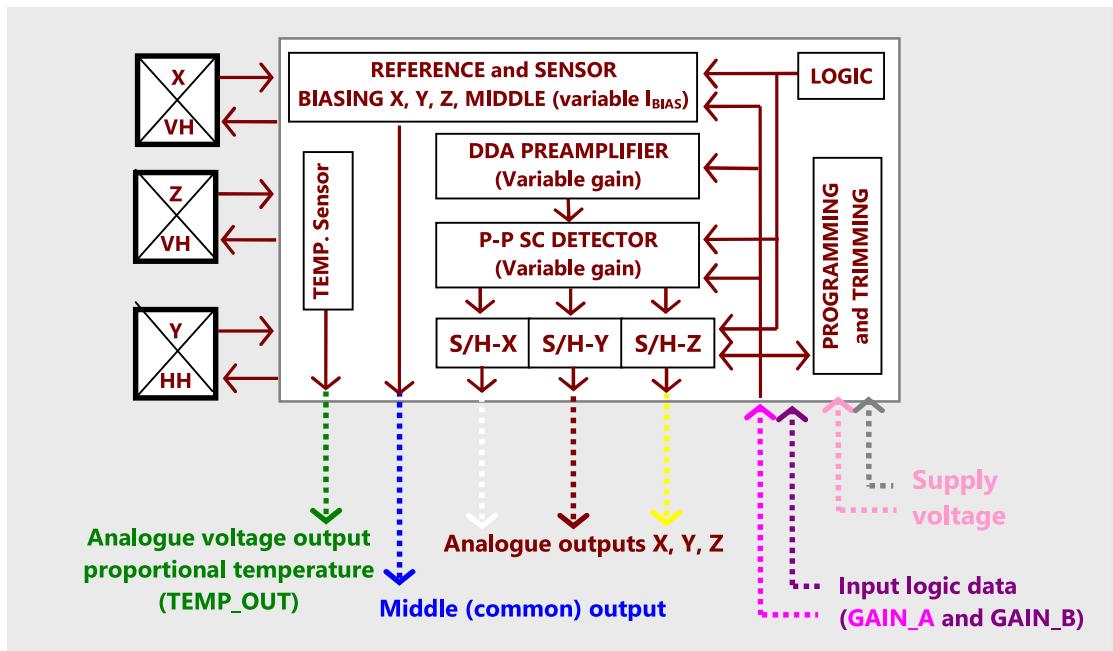


Figure 1. Functional block-diagram of the fully integrated 3-axis Hall sensor

PROBE and CABLE-MECHANICAL SPECIFICATIONS:

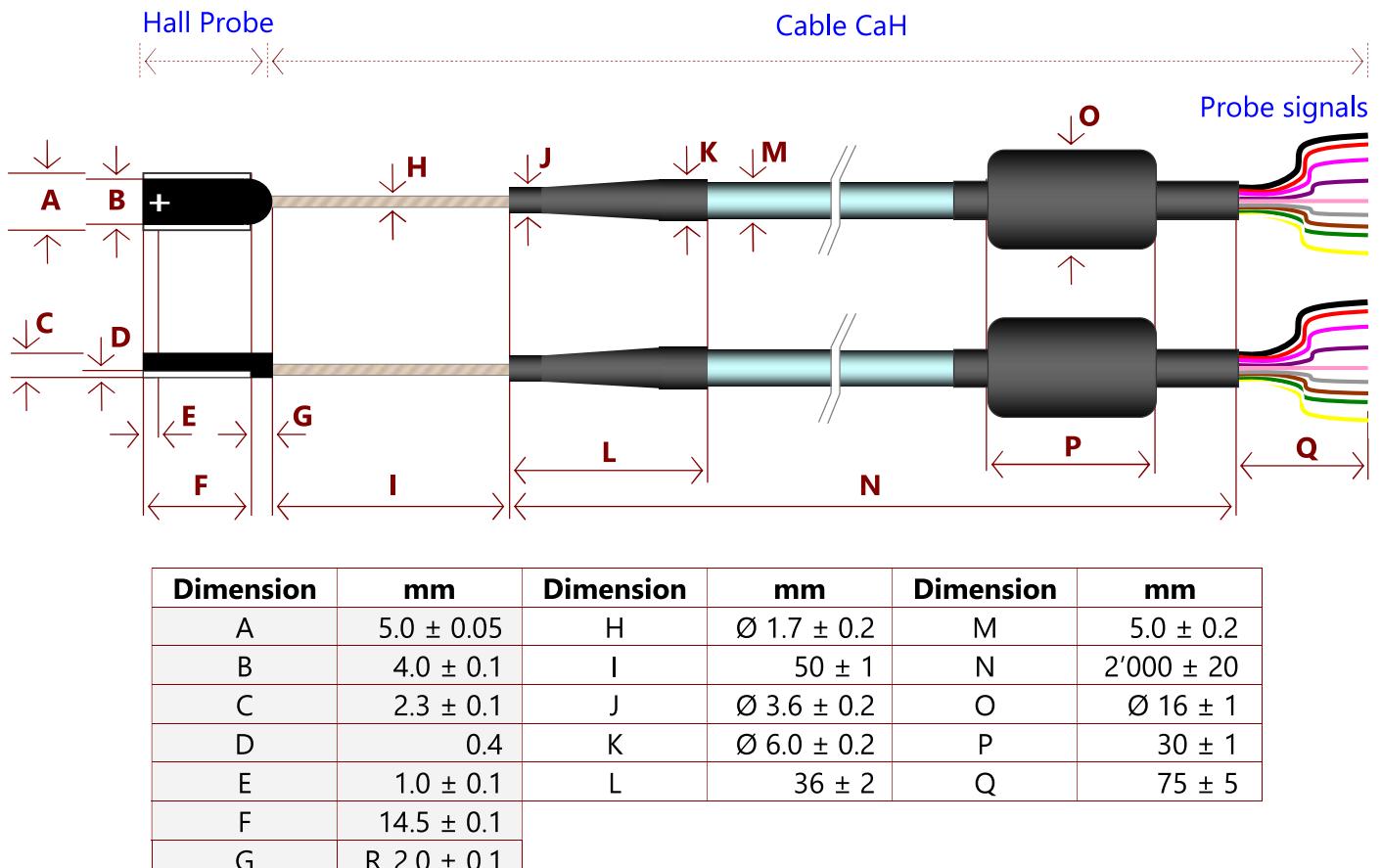


Figure 2. Dimensions and tolerances of the 03A Hall probe and CaH cable

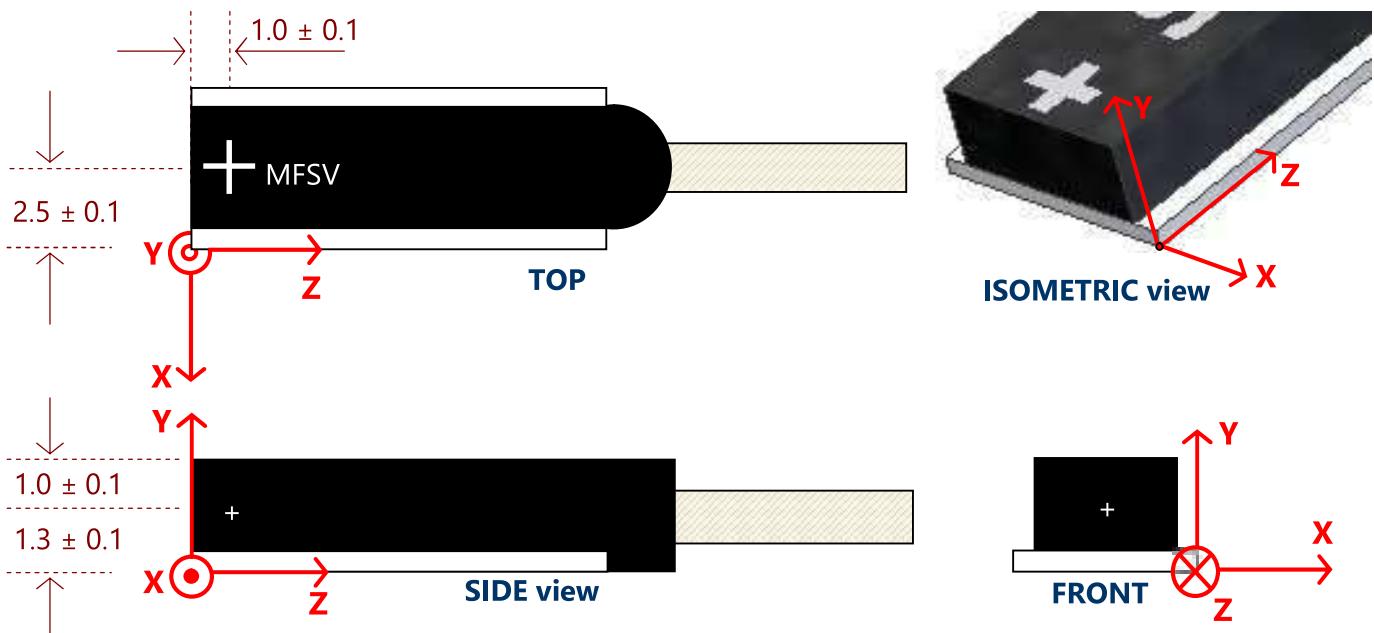


Figure 3. The reference Cartesian coordinate system of the 03A Hall probe: RED arrows denote POSITIVE sensing directions of each measurement axis X, Y, and Z. Magnetic field sensitive volume (MFSV) is marked with the cross on the top surface of the Probe (as shown on ISOMETRIC view). All measures are in mm.

Dimension	X [mm]	Y [mm]	Z [mm]		
Magnetic Field sensitive volume (MFSV)	0.15	0.01	0.15		
Position of the centre of MFSV (see Fig. 3)	-2.5±0.1	+1.3±0.1	+1.0±0.1		
Total external dimensions of the Probe	5.0 (ref. ceramics)	2.3±0.1	16.5±0.1		
	4.0±0.1 (Probe head)				
Angular accuracy of the axes	±0.5° with respect to the reference surface				
CaH Cable	Shielded, with a flexible thin part near the probe and ferrite sleeve on the thicker part (see Fig. 2)				
Total length of the CaH cable:	<ul style="list-style-type: none"> ▪ Standard: 2 m (Probe notation: 03A02) ▪ Optional: xx m (Probe notation: 03Axx) Various lengths are available upon request.				

APPLICATIONS INFORMATION:

For a reliable operation within the specifications the Hall probe must 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 μ 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	+5V (single supply)	+2.5V (dual supply)
VSS (logic 0)	GREY	0V (GND, single supply)	-2.5V (dual supply)
GAIN_A	PINK	Measurement range selection	
GAIN_B	VIOLET		
X_OUT	WHITE	differential output voltages, referenced to MIDDLE_OUT	
Y_OUT	BROWN		
Z_OUT	YELLOW		
MIDDLE_OUT	BLUE	$\approx (V_{dd}-V_{ss})/2$	
TEMP_OUT	GREEN	$\approx +2V \pm 0.3V$ (single supply)	$\approx -0.5 \pm 0.3V$ (dual supply)
CABLE SHIELD	BLACK	to be connected to power grounding	

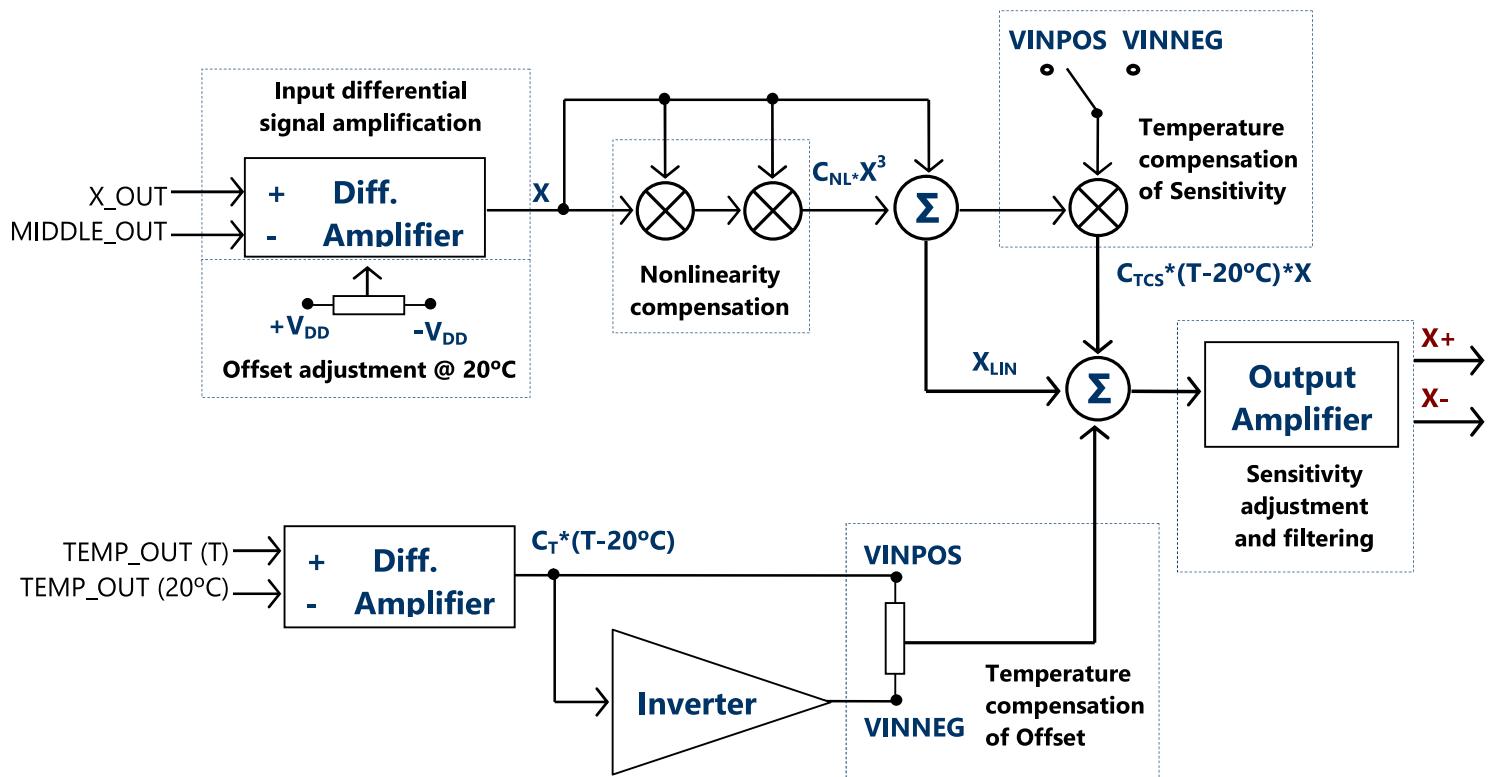


Figure 4. Typical block-diagram for conditioning the raw output signals from the 03A Hall probe (applied to X_{OUT} , Y_{OUT} and Z_{OUT} , respectively)

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: $V_{\text{DD}}-V_{\text{SS}}=5\text{V}$, 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 $(V_{\text{DD}}-V_{\text{SS}})/2$)

Parameter	Value			Unit	
	Min.	Typ.	Max.		
Maximum (full scale) magnetic flux density	± 0.1			T (tesla)	
Linear range of magnetic flux density	± 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_{NORMAL}				
Temperature Coeff. of Sensitivity @ Temperature range $23 \pm 10^\circ\text{C}$	X & Z axes	-1200	-1500	ppm/ $^\circ\text{C}$	
	Y axis	-450	-600		
Offset (@ $B = 0\text{T}$, @ 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	μT (microtesla)
	Y axis	12	15	20	
Output noise					
Noise Spectral Density (NSD_W) @ $f > 10\text{ Hz}$ (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	
Typical frequency response					
Frequency Bandwidth	DC to 25 kHz				
Temperature output (TEMP_OUT, ground-referred voltage)					
- for Single-supply ($V_{\text{DD}}=+5\text{V}$, $V_{\text{SS}}=\text{GND}$):	1.8	2.0	2.3	V	
- for Dual-supply ($V_{\text{DD}}=+2.5\text{V}$, $V_{\text{SS}}=-2.5\text{V}$):	-0.7	-0.5	-0.2		
Sensitivity of TEMP_OUT	8.0	8.5	9.0	mV/ $^\circ\text{C}$	
Operating temperature range	-40	---	+85	$^\circ\text{C}$	
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 _{NORMAL}				
Temperature Coeff. of Sensitivity @ Temperature range 23±10°C	X & Z axes Y axis	-1200 -450	-1500 -600	-1800 -800	ppm/°C
Offset (@B = 0T, @ Temp. range 23±5°C)		-30	---	+30	
Offset fluctuation & drift (peak-to- peak value) ($\Delta t = 0.05s$, t = 100s)	X & Z axes Y axis	30 25	35 30	40 35	μ T (microtesla)
Output noise					
Noise Spectral Density (NSD _W) @ f > 10 Hz (white noise)	X & Z axes Y axis	0.7 0.6	1.0 0.8	1.4 1.1	μ T/ $\sqrt{\text{Hz}}$
Typical frequency response					
Frequency Bandwidth	DC to 25 kHz				
Temperature output (TEMP_OUT, ground-referred voltage)					
- for Single-supply (V _{DD} =+5V, V _{SS} =GND):	1.8	2.0	2.3	V	
- for Dual-supply (V _{DD} =+2.5V, V _{SS} =-2.5V):	-0.7	-0.5	-0.2		
Sensitivity of TEMP_OUT	8.0	8.5	9.0	mV/°C	
Operating temperature range	-40	---	+85	°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_{NORMAL}					
Temperature Coeff. of Sensitivity @ Temperature range $23 \pm 10^\circ\text{C}$	X & Z axes	-1200	-1500	ppm/ $^\circ\text{C}$		
	Y axis	-450	-600			
Offset (@ $B = 0\text{T}$, @ Temp. range $23 \pm 5^\circ\text{C}$)	-30	---	+30	mV		
Offset fluctuation & drift (peak-to- peak value) ($\Delta t = 0.05\text{s}$, $t = 100\text{s}$)	all 3 axes	70	80	85	μT (microtesla)	
Output noise						
Noise Spectral Density (NSD_W) @ $f > 10\text{ Hz}$ (white noise)	all 3 axes	0.8	0.8	0.9	$\mu\text{T}/\sqrt{\text{Hz}}$	
Typical frequency response						
Frequency Bandwidth	DC to 25 kHz					
Temperature output (TEMP_OUT, ground-referred voltage)						
- 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	-40	---	+85	$^\circ\text{C}$		
Storage temperature	-20	---	+80	$^\circ\text{C}$		

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 _{NORMAL}				
Temperature Coeff. of Sensitivity @ Temperature range $23 \pm 10^\circ\text{C}$	all 3 axes	$\leq \pm 500$	$\leq \pm 400$	$\leq \pm 300$	ppm/ $^\circ\text{C}$
Offset (@B = 0T, @ Temp. range $23 \pm 5^\circ\text{C}$)		-20	---	+20	mV
Offset fluctuation & drift (peak-to- peak value) ($\Delta t = 0.05\text{s}$, $t = 100\text{s}$)	all 3 axes	0.65	0.70	0.75	mT (millitesla)
Output noise					
Noise Spectral Density (NSD _W) @ $f > 10\text{ Hz}$ (white noise)	all 3 axes	14	15	17	$\mu\text{T}/\sqrt{\text{Hz}}$
Typical frequency response					
Frequency Bandwidth	DC to 25 kHz				
Temperature output (TEMP_OUT, ground-referred voltage)					
- 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	-40	---	+85	$^\circ\text{C}$	
Storage temperature	-20	---	+80	$^\circ\text{C}$	

INSTALLATION MANUAL FOR THE 03A HALL PROBE

MECHANICAL PRECAUTIONS:

The 03A Hall probe is built as robust as possible for a small and high precision device. Nevertheless it has to be handled with care in order to avoid damage. The following precautions will help not to damage the probe when installing or handling.

The mounting of the probe should be carried out by application of very low pressure to its head and thin wires. 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 Fig. 5). Do not apply more force than required to hold the probe in its mounting.

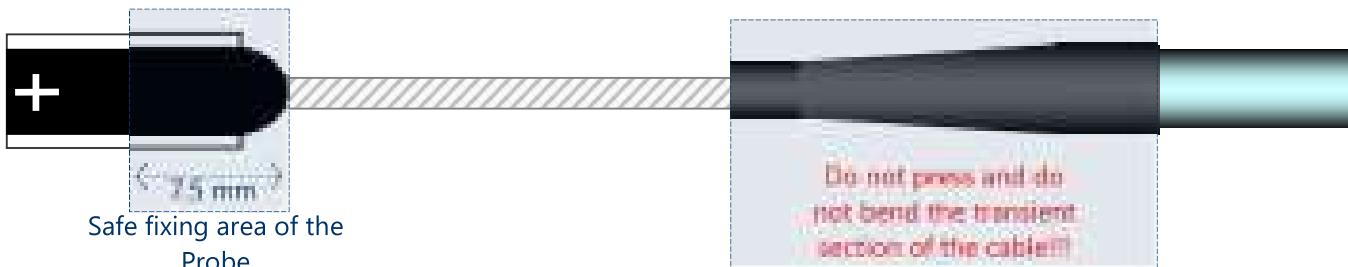


Figure 5. Safe fixing area of the 03A Probe head

In order to prevent rupture of the thin 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 strong bending should be avoided.

Also, avoid any high pressure and bending of the transient section between the thin and the thick cables.

ELECTRICAL PRECAUTIONS:

The probe is delivered in an ESD bag. Free wire ends of the probe are wrapped with the ESD protective tape in order to prevent damage by electrostatic discharge or antenna effect. Remove the tape and connect the probe to the appropriate part of your system only in electrostatic and electromagnetic protected areas! For basic information on how to avoid problems with static electricity and antenna effect, see the text below.

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.

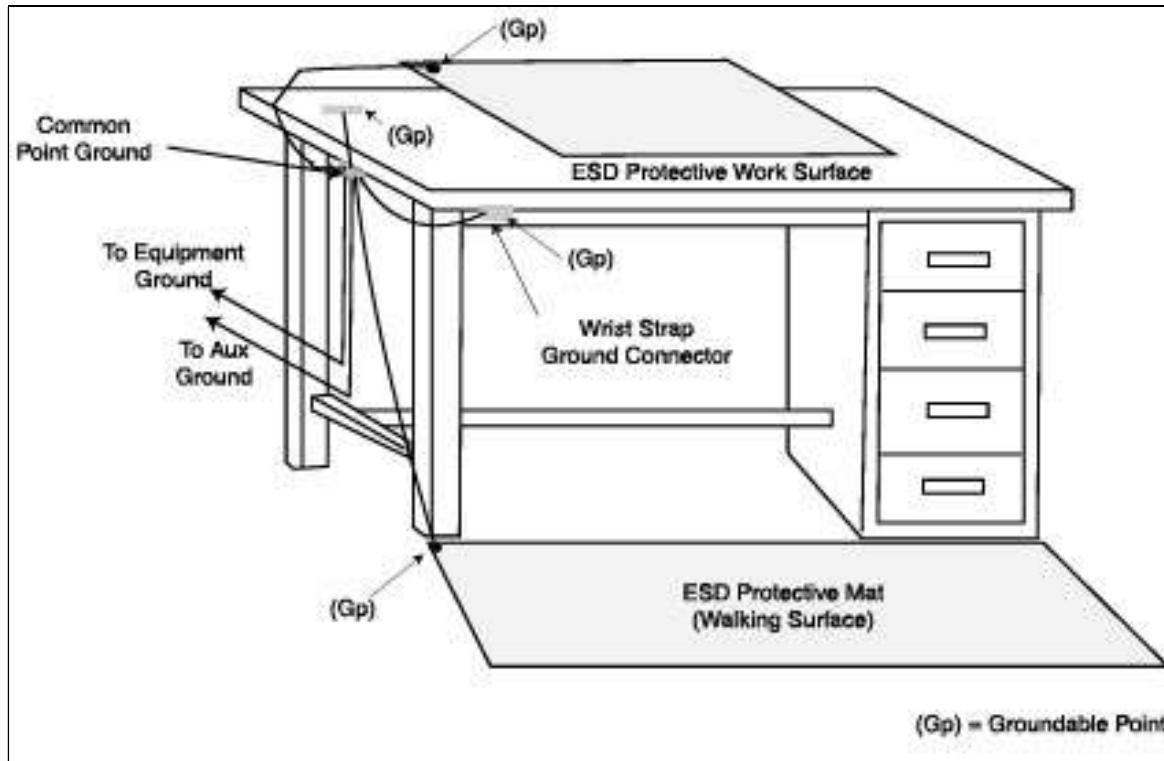


Figure 6. Typical ESD Workstation

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.