E-Magnets UK Ltd

A dedicated and specialist supplier of Magnets

Mission Statement –
"Through operational excellence, we will provide our customers with a superior service experience and the highest quality magnet components and assemblies."

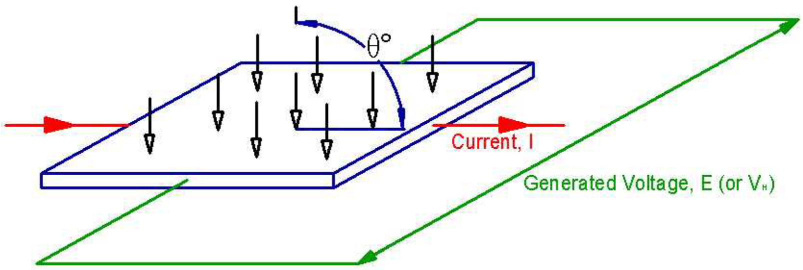
Hall Effect Probes – An overview of Transverse and Axial Hall Probes

There are many manufacturers of Hall Effect Probes (Gauss meters). Hall Effect devices are used to measure magnetic field strength. The Hall Effect device can be mounted in a chip or in a probe. There are two types of probe – Transverse and Axial. The choice of probe depends on the application as to which is more suitable.

The Hall Effect

Every magnetised permanent magnet produces a magnetic field. The Hall Effect is that of a magnetic field interacting with a current flow to generate a voltage proportional to the strength of the applied magnetic field (*Figure 1*). The angle of the Hall Effect device relative to the magnetic field direction affects the accuracy of measurement as the magnitude of generated voltage changes (*Figure 2*). The voltage is converted to a Gauss or Tesla reading on a meter that has been calibrated to that probe.

The magnitude of field measurement depends on how and where the measurement is taken. The field measurement at the magnet pole face is much higher than measuring at a distance away from the magnet pole face. For conventional disc and bar magnets (in free space) the magnetic field strength is inversely proportional to the square of the distance away from the magnet. In critical measurements this matters because the Hall Effect device is not on the probe surface – it is a small distance away.



The Hall Effect
A current I flows in one axis (typically 20-200 mA).
A voltage E is created perpendicular to the current flow when a magnetic field is applied perpendicular to the voltage and current planes.
The more perpendicular the applied field, the greater the voltage.
The Hall Voltage (VH) = E = BIL.sine(θ°)
where:-
B = applied magnetic field;
I = applied electric current;
L = a constant for the Hall crystal material;
sine = a trigonometric function, often appearing on calculators as "sin"; and
θ° = angle between magnetic field and Active Hall device element.

Figure 1:- The Hall Effect.

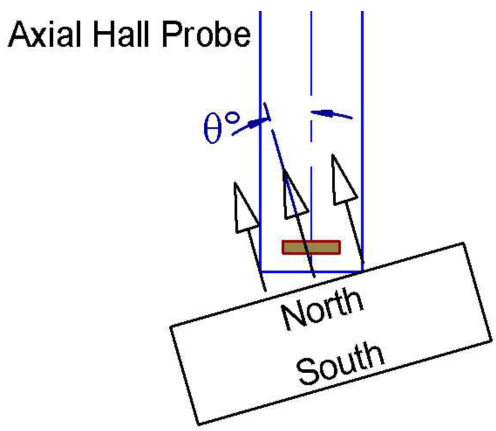


Figure 2:- The effect of having the probe and magnet at an angle to each other (cosine error).

Cosine Error
The angle the field is measured at affects the accuracy of the measurement.
The percentage of total available field measured is given by:-

cosine(θ°) x 100%

where cosine is a trigonometric function, often appearing on calculators as "cos".
If the Hall Element is aligned perfectly (θ°=0°), 100% of the available field strength is measured.
If the Hall Element is 30° out (θ°=30°), 86.6% field strength is measured.
If the Hall Element is 45° out (θ°=45°), 70.7% field strength is measured.
If the Hall Element is 60° out (θ°=60°), 50% field strength is measured.
If the Hall Element is 90° out (θ°=90°), 0% field strength is measured.

This effect applies to both Axial and Transverse Hall Probes.
Be aware that the Active element is rarely perfectly placed within the probe and may be displaced/offset by not only a distance but also by an angle. This can limit the accuracy and repeatability of the measurements. The errors caused by any offset/angular displacement may be too small to measure or too small for concern for many applications but it may require consideration in repeatability tests.

Transverse Hall Probe

The Transverse Hall Probe (*Figure 3*) has two surfaces that can be used to measure the magnetic field. The active Hall Effect element (the part that is actually generating the Hall voltage) is embedded on a substrate and this offsets the element from the central axis (i.e. D1 ≠ D2 in *Figure 3*). The result is that a difference is obtained when measuring a magnet using each side of the probe. An example difference is 100 Gauss for a 1500 Gauss magnet (surface measurement). The difference is because one side is closer to the magnet surface than the other. It is important to consider than thinner probes allow the active Hall element to be nearer to the magnet surface (thinner substrate, less protective casing) but such probes are easier to accidentally break. Thicker probes do not break as easily but are further away from the magnet and measure lower fields at the surface. Manufacturers tend to say where the Active element is in relation to the probe surface but there are dimensional tolerances which mean that the active element position is not clear. It is theoretically possible to determine the exact location including angular offset of the position of the probe to make future measurements more accurate. Most Transverse Hall Probes have one side marked to indicate the side giving a positive value from a North face (which also allows for repeatability in measuring).

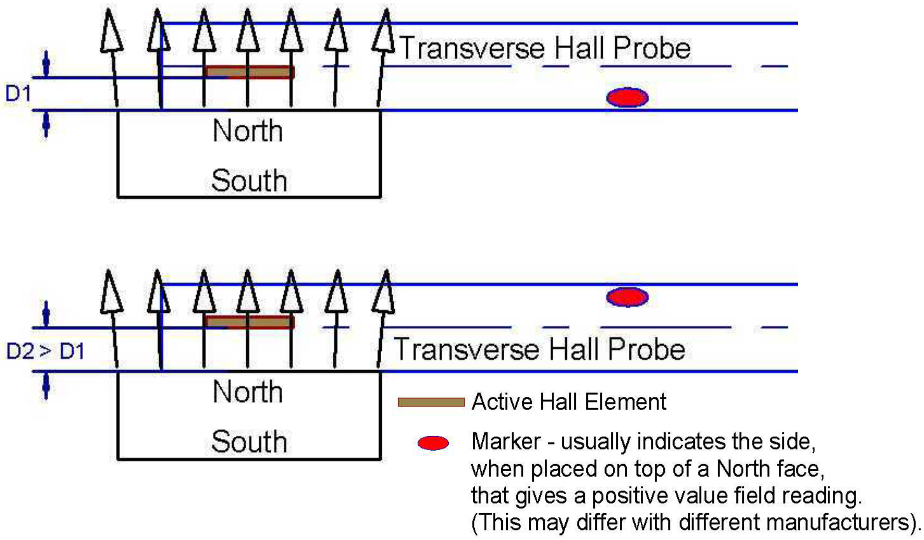


Figure 3:- Transverse Hall Probe.

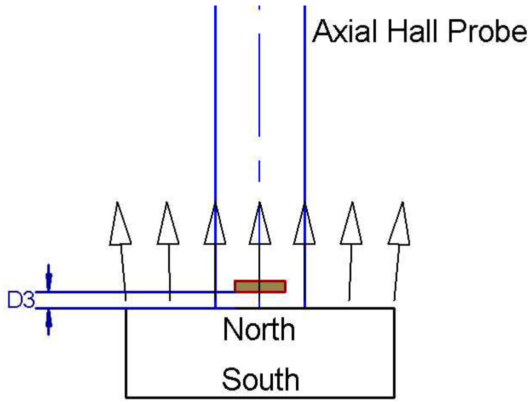


Figure 4:- Axial Hall Probe.

Axial Hall Probe

The Axial Hall Probe only has a single method of measuring a magnetic field strength. The probe is at the end of a cylinder and it measures the field parallel to the axis of the cylinder (*Figure 4*). The probe is not at the exact end of the probe (i.e. D3 ≠ 0) so the measurement has a distance offset to compensate for (like the Transverse probes). The manufacturer usually states the probe location but the active element is usually not perfectly located centrally or with perfect angularly placement (as with Transverse probes) but the effects are (like Transverse probes) usually too small to be concerned with for most measurements. Like with Transverse probes, X-ray scans can reveal the location of the active element for improving accuracy.

Axial probes are usually of sturdy design and are hence good for general measurements. Transverse probes are often better for placing onto flat surfaces and can be used to measure in small air gaps. The choice depends on where the measurements are to be taken – sometimes either can be used.

How to contact us:

We believe in listening to, understanding and working with our customers. We have a dedicated, expert sales team who are available Monday to Friday from 8.30am to 5.30 pm (GMT). If you have any queries or would like us to visit you, please get in touch.

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