HALL EFFECT PROBE

Measure the Magnetic Fields that You Teach

- **Measures Magnetic Fields of Simple Configurations**
- **Student Calibrated**
- **Transverse and Radial Sensors**
- **High Sensitivity: 2 x 10^{-3} mT**

TeachSpin's two-axis Hall Effect probe is specifically designed to measure the magnetic fields discussed in introductory electricity and magnetism courses at both colleges and secondary schools. The axial magnetic field of a current loop is often the textbook's example of an application of the Biot-Savart Law. The $1/r^3$ dependence of the field of a magnetic dipole and the uniformity of the axial field in a Helmholtz pair are other examples that can be found in the problem section of many texts. Because of the small magnitude of the fields created, students are rarely given the opportunity to make the measurements that will verify their predictions. This Hall Effect Probe makes the measurement of these "textbook" fields both possible and affordable.

THE INSTRUMENT

The HE1-A Hall Effect Probe is a rugged, versatile device that produces a low impedance output voltage directly proportional to the magnetic field at its sensors.

It has orthogonally placed sensors that measure both the radial and transverse components of the field at a given region of space. This instrument is also able to measure not only constant but also low frequency alternating magnetic fields.

HE1-A has a built-in power supply that plugs directly into a standard wall outlet of 110 VAC. A standard analog or digital voltmeter, routinely available in most physics labs, is required to read the output of the probe. Because the instrument has a maximum sensitivity of about 10^{-3} mT/mV and a voltage stability of ± 2mV, the voltmeter used to determine the output of the probe should be capable of measuring millivolts. The maximum output of the probe is ±11 volts.

The two gain settings on the probe (x 1 and x 10) give the instrument a large dynamic range of 10^{-3} to 100 mT, with a linear response to better than 0.1% over the entire range. A manual zero adjust allows the operator to set the output voltage to zero in the local ambient Earth's magnetic field.

HE1-A includes a hardwood non-magnetic stand constructed with aluminum and brass components. The probe has a built-in aluminum ring stand clamp with nylon thumb screws and can be oriented so that the axial probe reads either the horizontal or vertical field.

Instruments Designed For Teaching

TEACH SPIN

STUDENT EXPERIMENTS

1. Calibration

HE1-A is not calibrated. The job of calibration is an excellent first exercise for a student, but can also be done by the instructor. We recommend using a Helmholtz pair, such as the one provided with TeachSpin's "Magnetic Force," since the field is very uniform in the central region between the two coils.

Figure 1 is a typical calibration curve using our MF1-A coils. Because the dimensions of the coils are well defined, the slope can be accurately converted to mT/mV.

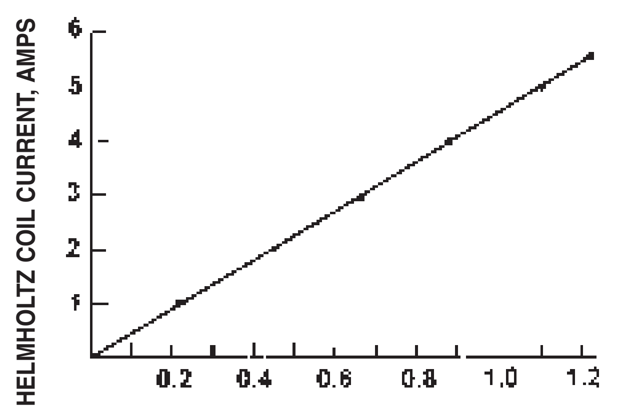

Fig. 1: Calibration Curve

2. Examining the Magnetic Fields of Typical Textbook Configurations

Since the probe can be zeroed in the ambient magnetic field and the voltage outputs are linear, the voltage readings themselves can be used to verify, or even predict, the algebraic field descriptions derived from the Ampere's or Biot-Savart laws.

Using just voltage data, students can "discover" the uniformity of the field of the Helmholtz coil and the gradient of the anti-Helmholtz condition. They can even compare the magnetic and magnetic force fields of a single loop and "discover" that magnetic force depends on field gradients.

Magnetic field as a function of radial distance from a long straight wire carrying 10 amperes of current is easily measured. Students can then deduce the 1/r dependence as shown in Figure 2.

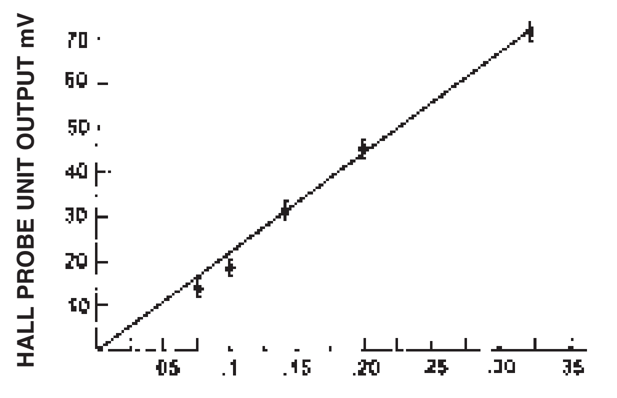

Fig. 2: Graph of V vs. 1/r for Wire with 10A

The axial magnetic field of a small neodymium-iron-boron magnetized cylinder, like the ones used in both Magnetic Torque and Magnetic Force can also be measured.

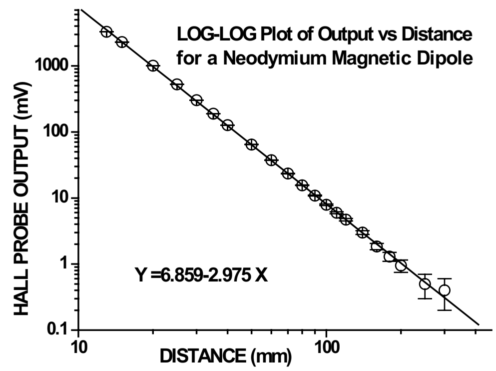

Fig. 3: Log-Log Plot of V vs. d for Magnetic Dipole

The Log-Log plot of Figure 3 clearly demonstrates the $1/r^3$ far field dependence of this "dipole." If the unit is calibrated, this measurement can be used to determine the magnetic dipole moment of the magnetized cylinder. This checks the results found using either Magnetic Torque or Magnetic Force.

SPECIFICATIONS

Maximum output: ±11 volts
Two sensitivity ranges: x1, x10
Stability: ± 2 mV
Zero offset adjustment
Transverse and radial sensors
Linear on both ranges to better than 0.1 %
AC response to 300 Hz, Half gain at 100 Hz
Internal power supply requiring 110 VAC
Requires external voltmeter

TEACHSPIN, INC.
2495 Main Street, Suite 404, Buffalo NY 14214-2153
Phone: 716-885-4701 www.teachspin.com Fax: 716-836-1077