Hall Effect Apparatus
with Hall Probe

EM1900‑101   Power Unit & Axial "Hall" Probe

Description:

The 'Hall Effect kit' consists of 3 parts:

1. Constant Current (0-2A) power source for calibration of the instrument and for energising solenoids. The constant current power supply ensures the current through the coils or solenoid is constant although the coils become warm and their resistance rises.

2. Magnetic field measurement in mT (milli Tesla) by the 'Hall' principle. The reading of this instrument is calibrated by the student from first principles using the current through an Air Cored solenoid.   A switch selects 0-10mT or 0-100mT ranges.

3. Hall Effect device on a 'wand' for sensing axial fields and fitted with a multi pin plug.   User will require 2x pair of red and black cables with banana plugs for connecting coils.

Power supply: 0-2A (constant current)   maximum voltage: 25V.DC.

Field strength: Hall probe sensor can detect field strengths from 0-100mT over 2 ranges
(0-10mT, 0- 100mT)

Additional Apparatus Required For Experiments:

- 1 Air Cored Solenoid of 700 turns (IEC EM0090-001)

- 1 pair of Helmholtz coils. (IEC EM1915-001) 148mm mean diam. To carry 1 amp.max. A stand to support the wand axially at the centre of the coils. A metric rule, 500mm long, aligns the coils and wand into a straight line.

- A set of various types of magnets: Bar, circular & horse-shoe shaped.

Length: 325mm	Width: 175mm	Height: 110mm	Weight: 2.95kg

INDUSTRIAL EQUIPMENT & CONTROL PTY.LTD.
61-65 McClure St. Thornbury. 3071 Melbourne. Australia
Tel: 61 (0)3 9497 2555   Fax: 61 (0)3 9497 2166   www.iecpl.com.au

1

EM1900-101 (new).doc   17-Feb-22

Operation:

The instrument measures magnetic field strength in milli-tesla (mT) over two working ranges of 0-10 mT and 0-100 mT. At the tip of the wand, a small electronic device produces a small voltage as a magnetic field passes through its body. This device is called a 'Hall Effect' sensor and these are used in many applications in industry where switching must occur or signals must be obtained due to the presence of a small magnetic field. The instrument must first be calibrated by measuring the magnetic field at the mid point of a Solenoid of known dimensions and turns and with a known current flowing through the coil.

The special **Constant Current power source** is different from the normal power sources used in the laboratory. Instead of presetting a particular voltage required, this power source permits the setting of a certain current through a load. As the resistance of the load changes with temperature, the output voltage rises automatically to exactly maintain the preset current through the load. Using such a power source ensures a steady magnetic field in any solenoid because the strength of a magnetic field depends on the exact current flowing and the number of turns in the solenoid.

Front Panel Controls:

One digital meter reads field strength in mT and the other meter can be selected to read either Amps or Volts of the output of the constant current power supply.

The panel controls are:

ZERO ADJUST:
>   To set the zero reading on the mT meter to compensate for temperature drift in the Hall device.

GAIN ADJUST:
>   This is a screwdriver setting to adjust the mT calibration of the instrument against a known field strength (see below).

METER SWITCH x1 / x10:
>   Range setting for 0-10 mT or 0-100 mT.

CURRENT regulated:
>   Adjusts the desired current into the load (usually a solenoid).

METER SWITCH volts/amps:
>   Select to monitor either volts or amps output.

Calibration Of The Instrument:

The Instrument must be calibrated by a known magnetic field before useful measurements can be made. Firstly, the zero field strength is checked and then an Air Cored Solenoid with a known number of turns and known length is connected to the instrument's constant current output terminals.

A certain current is passed through the coil and the field strength at the mid point of the solenoid is calculated.   The Gain is then adjusted so that the calculated field strength in milli Tesla is showing on the mT meter.

The instrument is then calibrated and can be used to accurately measure other field strengths.

The Theory of a 'Uniform Magnetic Field':

Magnetic field inside a coil is: $B = 2\pi KnI$ newtons / amp-metre.   See your Physics text books or ask your instructor for proof of the value of constant 'K'.

Constant $K = 2.00 \times 10^{-7}$ newtons / amp^2

A long thin solenoid produces an axial magnetic field given by:

> $B = \mu_o nI$ newtons / amp-metre   where μ_o is $2\pi K = 4\pi \times 10^{-7}$

> n is number of turns per metre length of the solenoid.

> I is current through the coil in amps.

Connect the Hall probe cable plug to the socket on the front panel. Connect a calibration coil (an Air Cored Solenoid) to the terminals provided on the Constant Current Power Supply.

INDUSTRIAL EQUIPMENT & CONTROL PTY.LTD.
61-65 McClure St. Thornbury. 3071 Melbourne. Australia
Tel: 61 (0)3 9497 2555   Fax: 61 (0)3 9497 2166   www.iecpl.com.au

2

EM1900-101 (new).doc

17-Feb-22

Important Note:

The magnetic field in the solenoid must be in the correct N-S direction or the Hall device cannot provide a signal to the instrument. The magnetic field being measured must always pass through the Hall Effect device directly through its flat surface.

To ensure this, be sure that the handle of the Hall probe is mounted perhaps in a boss head on a retort stand so that it lies along the centre line and is parallel to the axis of the solenoid coil.

Checking Instrument Calibration And Zero:

Plug in the Hall sensor and turn on the instrument.   Mount the Hall probe such that the Hall sensing device at the tip of the probe is at the centre axis of the Air Cored Solenoid and inserted exactly half way into the length of the coil.

With no current flowing through the solenoid, switch the meter to read field strength in 0-10 mT.   Use the 'Zero Adjust' knob to set the meter to read exactly zero.
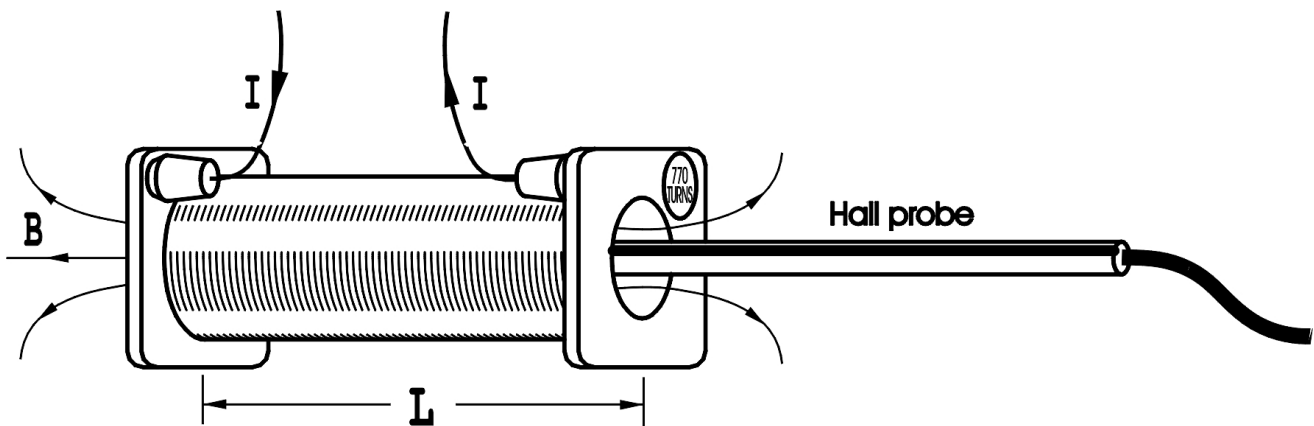
Select Constant Current meter to read amps and connect the solenoid and adjust the current through the solenoid to exactly 1.7 amp. Use the equation:

$B = u_o nI$ newtons / amp-metre   to calculate the expected field strength. The number of turns in the solenoid is marked on the coil. To find 'n' number of turns per metre length of solenoid winding, divide number of turns in the coil by length of coil in metres.

Measure the magnetic field with the Hall Effect probe and if the meter gives a different value in mT than the value calculated, usew a small screwdriver and adjust the 'GAIN ADJUST' control on the instrument until the meter reads the calculated field strength in mT.

Important Notes:

• The Hall Effect device is temperature sensitive and will alter its calibration if it becomes warm. Take care not to allow the solenoid to heat too much during the calibration period otherwise the Hall probe may gain heat from the coil and calibration will drift.

• As a check, if the Air Cored Solenoid has 700 turns (IEC standard) and the coil length is 149mm (IEC standard), then the coil current of 1.7 amp should give a field strength of very close to 10 mT.

INDUSTRIAL EQUIPMENT & CONTROL PTY.LTD.
61-65 McClure St. Thornbury. 3071 Melbourne. Australia
Tel: 61 (0)3 9497 2555   Fax: 61 (0)3 9497 2166   www.iecpl.com.au

3

EM1900-101 (new).doc   17-Feb-22

Helmholtz Coils: EM1915-001 (Pair With Mounts Etc.)

Helmholtz coils are two identical coils connected in series so that the current in each coil is exactly the same and also the current flow around the coils is in the same direction.   The coils are physically arranged to be parallel and coaxial with one another.   When the magnetic fields of each coil add together and it is possible to create a uniform magnetic field in the region between the coils.   CONNECT IN SERIES:
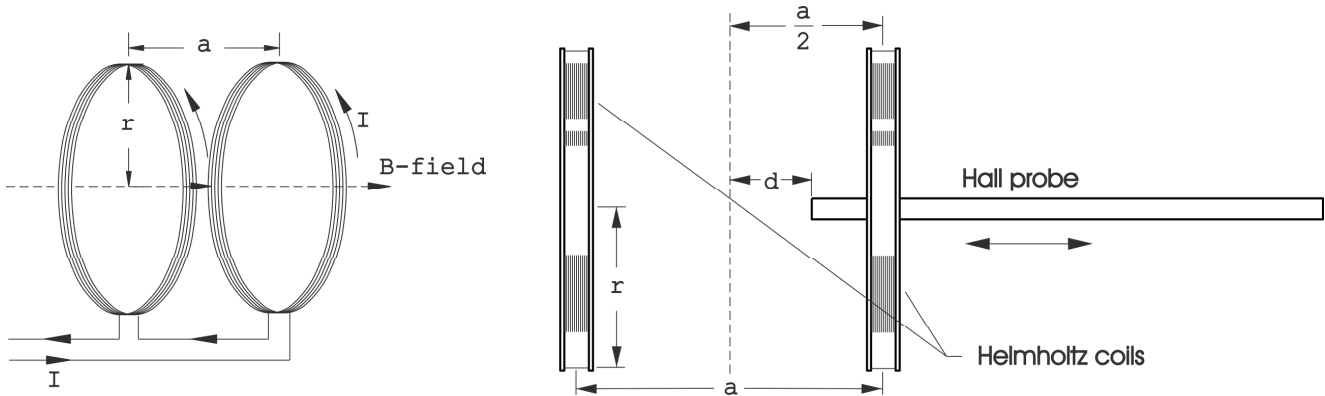
The Magnetic Field Created by Helmholtz Coils:

a = separation of coils   r = mean radius of coils
d = distance of the Hall device from the mid point between the two coils.

The coils must be connected in series for identical current in the same direction. Using the Constant Current power supply, adjust the coil current to about 1.0 amp.

Slide the coil mounts on the 1/2m rule to separate the coils so that a = 2r. After checking the zero on the Hall probe, slide the Hall Probe mount over the rule to measure the field strength every centimetre along the axis of the coils. Take measurements on the rule up to 12cm either side of the centre line. Plot a graph of B (field strength in mT) against d in cm. Note that at the mid point, distance **d = 0.**

Repeat the experiment for a = r   and   a = r / 2   and compare the three graphs.

In which case is the magnetic field strength constant between the coils ?

Experiment with Simple Permanent Magnets:

- Measure leakage magnetic fields around keepers at the ends of bar magnets.
- Measure various magnetic fields of bar magnets and plot the field strengths.
- Take measurements at different distances d from poles.
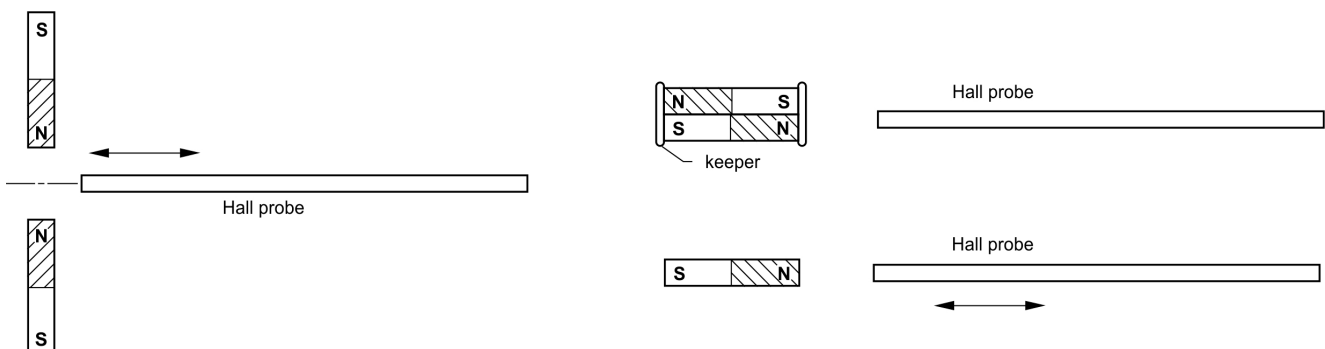
Designed and manufactured in Australia

EM1900-101 (new).doc   17-Feb-22