Magnetic Field Sensor

(Order Code MG-BTA or MG-DIN)

The Magnetic Field Sensor can be used for a variety of interesting experiments involving magnetic fields. Examples include

- measuring and studying the earth's magnetic field.
- studying the magnetic field near a permanent magnet.
- measuring the field near a current-carrying wire.
- measuring the field at the opening of a solenoid.

NOTE: This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.

Using the Magnetic Field Sensor with a Computer

This sensor can be used with a Macintosh or PC computer and any of the following lab interfaces: Vernier LabPro™, Universal Lab Interface, or Serial Box Interface. Here is the general procedure to follow when using the Magnetic Field Sensor with a computer:

1. Connect the Magnetic Field Sensor to the appropriate port on the interface.
2. Start the data-collection software on the computer. If you are using a Power Macintosh or Windows computer, run the Logger *Pro*™ software. If you are using older Macintosh, DOS, or Windows 3.1 computers, run the Data Logger program.
3. Open an experiment file for the Magnetic Field Sensor, and you are ready to collect data.

Using the Magnetic Field Sensor with TI Graphing Calculators

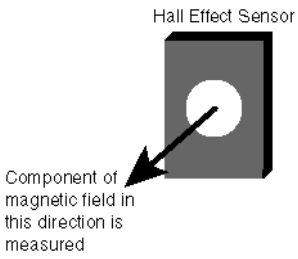
This sensor can be used with a TI Graphing Calculator and any of the following lab interfaces: LabPro, CBL 2™, or CBL™. Here is the general procedure to follow when using the Magnetic Field Sensor with a graphing calculator:

1. Load a data-collection program onto your calculator:
   - LabPro or CBL 2 - Use the DataMate program. This program can be transferred directly from LabPro or CBL 2 to the TI Graphing Calculator. Use the calculator-to-calculator link cable to connect the two devices. Put the calculator into the Receive mode, and then press the Transfer button on the interface.
   - Original CBL - Use the PHYSICS program. This program is available free on our web site at www.vernier.com. Our programs can also be obtained on disk. (Contact us for more information.) Load the program into a calculator using TI-GRAPH LINK™.
2. Use the calculator-to-calculator link cable to connect the interface to the TI Graphing Calculator using the I/O ports located on each unit. Be sure to push both plugs in firmly.
3. Connect the Magnetic Field Sensor to any of the analog ports on the interface. In most cases, Channel 1 is used.
4. Start the data-collection program, and you are ready to collect data.

The MG-BTA version of this sensor is equipped with circuitry that supports auto-ID. When used with LabPro or CBL 2, the data collection software identifies the sensor and uses pre-defined parameters to configure an experiment appropriate to the recognized sensor. This greatly simplifies the setup procedures for many experiments. Auto-ID is required for the Quick Setup feature of LabPro and CBL 2 when the unit operates remotely from the computer or calculator.

How the Magnetic Field Sensor Works

The sensor uses a SS94A1 Hall effect transducer. It produces a voltage that is linear with magnetic field. The sensor measures the component of the magnetic field that is perpendicular to the flat sensor covered with black heat-shrink tubing. The maximum output occurs when the white dot on the sensor points toward a magnetic north pole. When no magnetic field is present, the sensor should read about 2 volts. This is called the *offset voltage*.



Hall Effect Magnetic Field Sensor

A magnetic field will cause the voltage to increase or decrease, depending on the direction of the field. The minimum voltage is 0 volts and the maximum is 4 volts. If the offset voltage is set incorrectly, or if the magnetic field is beyond the range of the sensor, the voltage will reach one of these limits.

The switch on the box is used to select the amplification. The low amplification is used to measure relatively strong magnetic fields around permanent magnets and electromagnets. Each volt represents 32 gauss (3.2×10^{-3} tesla). The range of the sensor is ±64 gauss or $\pm 6.4 \times 10^{-3}$ tesla.

The high amplification is used mainly to measure the magnetic field of the earth and very weak fields. It can be used for other magnets, but the sensor must remain in one position so that the reading is not affected by the background field of the earth. It is 20 times more sensitive than the low amplification. Each volt represents 1.6 gauss (1.6×10^{-4} tesla). The range of the sensor is ±3.2 gauss or $\pm 3.2 \times 10^{-4}$ tesla. If the sensor tube is held vertically and rotated until the maximum voltage is found, magnetic north will be perpendicular to the sensor in the direction of the green and white side. The magnetic inclination in your area can be found by holding the tube so that the white dot is facing north, and rotating the sensor end of the tube down until the voltage reaches a maximum. The angle of the tube from vertical is the magnetic inclination.

Do I Need to Calibrate the Magnetic Field Sensor? "No."

We feel that you should not have to perform a new calibration when using the Magnetic Field Sensor in the classroom. We have set the sensor to match our stored calibration before shipping it. You can simply use the appropriate calibration file that is stored in your data-collection program from Vernier in any of these ways:

1. If you ordered the MG-BTA version of the sensor, and you are using it with a LabPro or CBL 2 interface, then a calibration (in millitesla) is automatically loaded when the Magnetic Field Sensor is connected.
2. If you are using Logger *Pro* software (version 2.0 or newer) on a Power Macintosh or Windows computer, open an experiment file for the Magnetic Field

Sensor, and its stored calibration will be loaded at the same time. **Note:** If you have an earlier version of Logger *Pro*, a free upgrade is available from our web site.

3. If you are using Data Logger software (version 4.6 or newer) on an older PC or Macintosh computer, open an experiment file for the Magnetic Field Sensor, and its stored calibration will be loaded at the same time. **Note:** If you have an earlier version of Data Logger, contact us about a free upgrade.
4. Any version of the DataMate program (with LabPro or CBL 2) has stored calibrations for this sensor.
5. Any version of the PHYSICS program (for CBL), version 4/1/00 or newer, has stored calibrations for this sensor. Go to our web site, www.vernier.com, to download a current version.

Stored Calibration Values for the Magnetic Field Sensor

Low amplification in gauss
slope = 32.25 intercept = –80.625
High amplification in gauss
slope = 1.6 intercept = –3.2
Low amplification in millitesla
slope = 3.225 intercept = –8.063
High amplification in millitesla
slope = 0.160 intercept = –0.320

If you want to calibrate the Magnetic Field Sensor yourself, you need to follow a somewhat different procedure than that used in calibrating most Vernier probes. The standard two-point calibration is usually not feasible, because few people have equipment that allows them to place the sensor in two different magnetic fields with known flux densities. Instead, we will use the pre-determined sensitivity of the sensor to simulate a two-point calibration.

The sensitivity (volts/gauss) of the Magnetic Field Sensor is a known quantity with two different values, one for each of the two amplification switch settings. When you calibrate, make sure the switch on the Magnetic Field Sensor box is set to the amplification you want to use. If you want to calibrate for both amplifications, you will have to do the following procedure twice, and treat each amplification as a separate probe.

Follow the instructions on the screen and in your data collection program manual to begin calibration. The input should be named something like “Mag.Field”, and the units should be “gauss” or “tesla”. The first of the two calibration points is the voltage when no magnetic field is present. If you are using the low amplification, simply remove all magnetic and metal objects from the probe area. If you are using the high amplification, move the probe until the voltage is halfway between the maximum and minimum. Use this situation as the first calibration point and enter 0 for the magnetic field. Also write down the voltage you used for this point; you will need it later. For the second calibration point, place a magnet close enough to the sensor to produce at least a 1 volt change, but not so close that either the maximum or

minimum voltage is exceeded. Use this situation as the second calibration point. To calculate the field strength, first subtract the voltage from the first point (which you wrote down) from the voltage value at the second point.

This is the voltage change. Then use one of the following equations to calculate the magnetic field:

Low Amplification: B (gauss) = voltage change/0.03125, or
B (tesla) = voltage change/312.5

High Amplification: B (gauss) = voltage change/0.625, or
B (tesla) = voltage change/6250

This calculation gives you the magnetic field (in gauss or tesla) that corresponds to the voltage change produced by your magnet. This calculation uses the known sensitivity of the unit for the switch setting. Enter your calculated value for the second calibration point value.

Save the calibration file on disk. Use a name for the calibration file that indicates the setting of the amplification switch, such as MAGHIGH or HIGAUSS. You can then load the calibration file whenever you need it. You will need to set the switch to the correct amplification whenever you reload your calibration file.

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