

User's Manual
Model FH-6
Helmholtz Coil



Lake Shore Cryotronics, Inc.
575 McCorkle Blvd.
Westerville, Ohio 43082-8888 USA

sales@lakeshore.com
service@lakeshore.com
www.lakeshore.com

Fax: (614) 891-1392
Telephone: (614) 891-2243

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Chapter 1: Introduction

1.1 Product Description

The Lake Shore Model FH-6 Helmholtz coil provides a simple method for measuring the magnetic moment of permanent magnets. Valid measurements may be obtained using linear pole (one north and opposing south) magnets fitting into a cylindrical volume 41 mm (1.6 in) long and 41 mm (1.6 in) diameter in the center of the Helmholtz coil. Other characteristics can be calculated on magnets of material with a straight line second quadrant BH curve (section 3.8). The Model FH-6 contains stored calibration data making it directly compatible with a Lake Shore Model 480 fluxmeter; consequently, little or no user inputs are required. A coil constant is supplied with every coil to allow operation with almost all makes of fluxmeters.

1.2 Physical Specifications

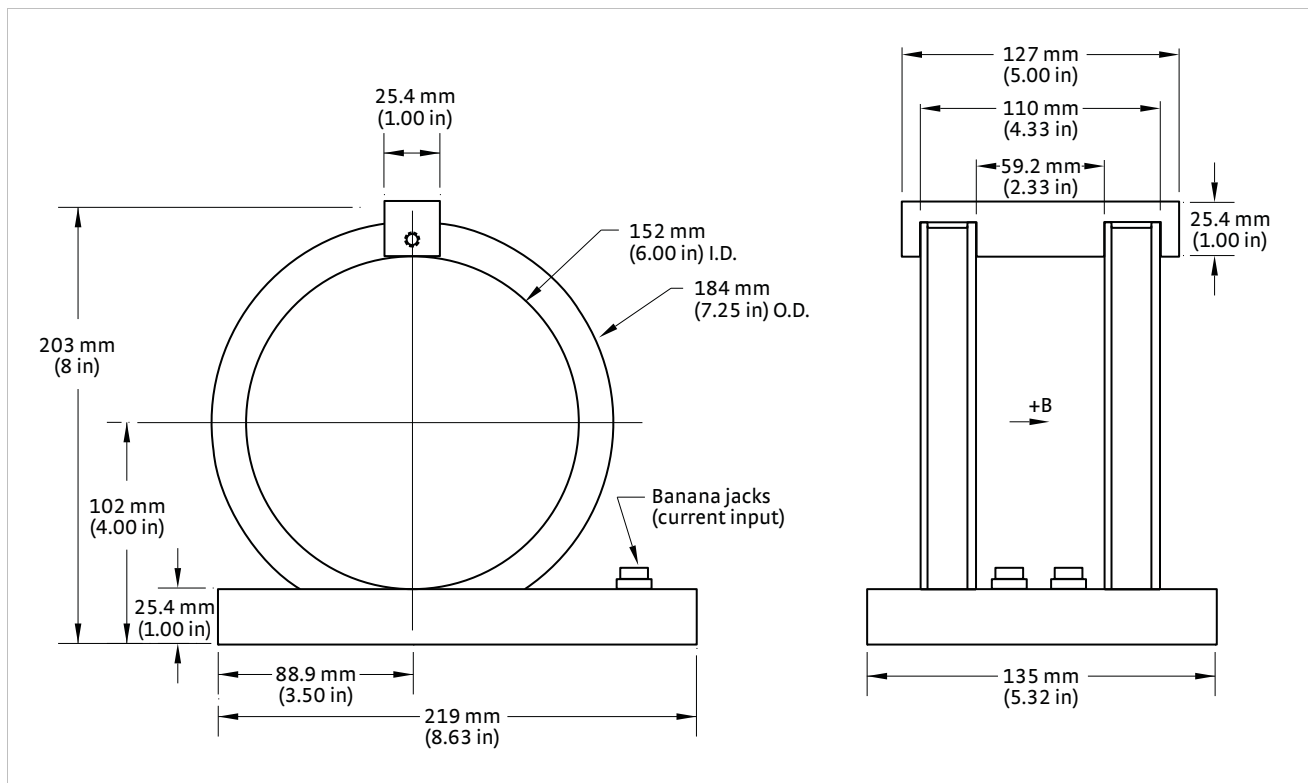


FIGURE 1-1 Physical dimensions, Left: Front view; Right: Side view

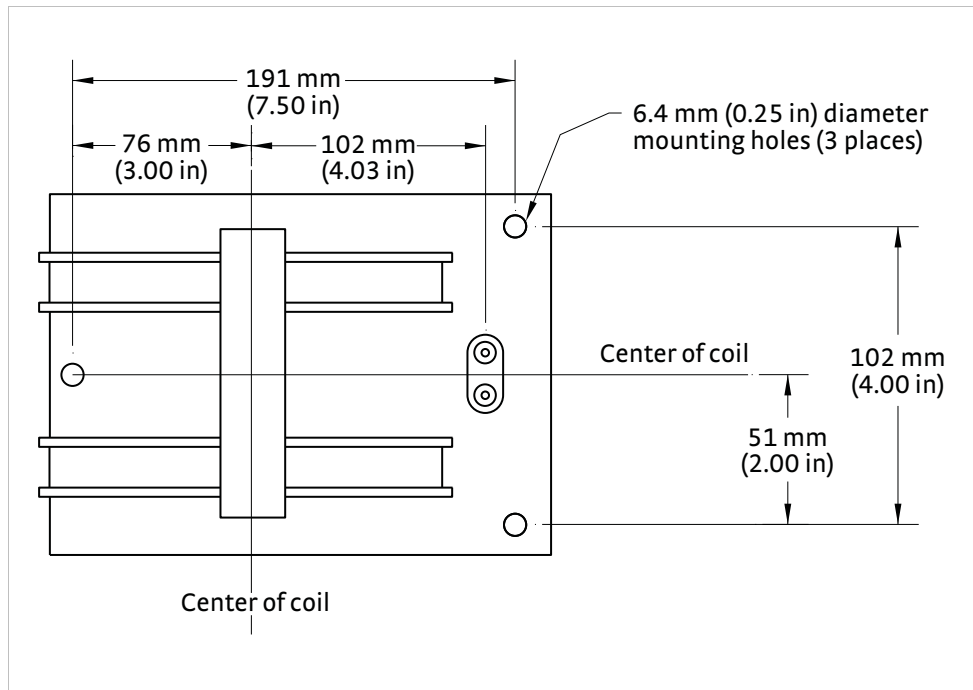


FIGURE 1-2 Top view and mounting holes

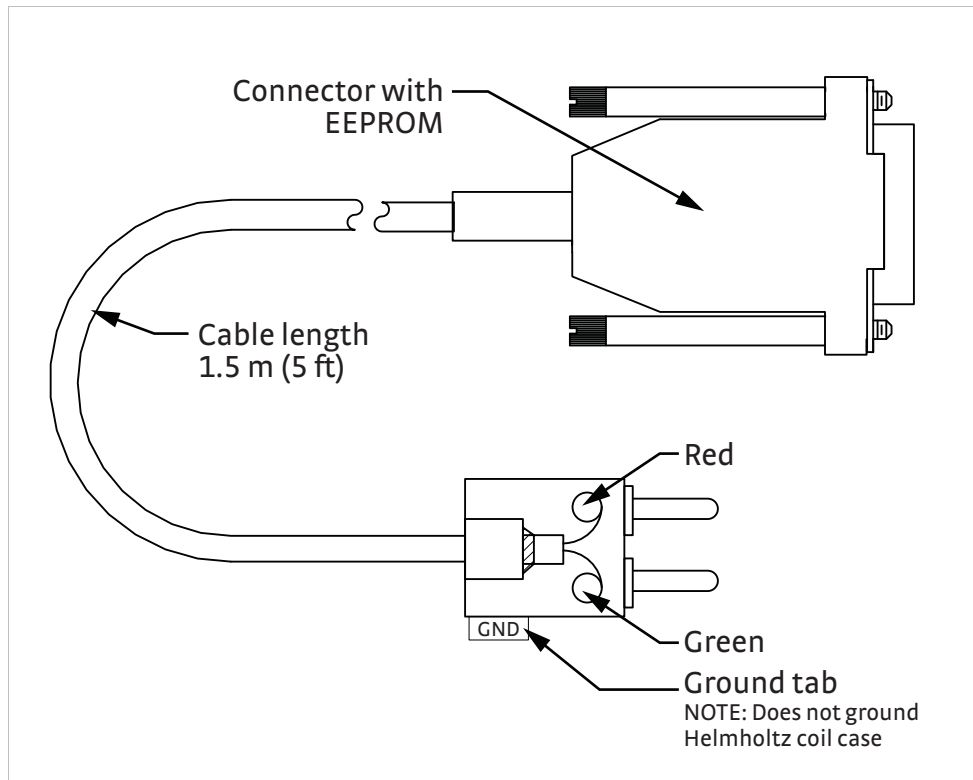


FIGURE 1-3 Cable with connector containing EEPROM data compatible with the Model 480 fluxmeter

1.3 Electrical Specifications

Description	Helmholtz coil, 152 mm (6 in) inside diameter			
Calibration accuracy	±0.75% of reading (with a total uncertainty ratio of 4:1, minimum)			
Recommended magnet size	One that fits within a cylindrical volume 41 mm (1.6 in) long, 41 mm (1.6 in) diameter, centered in the coil interior			
Coil constant (approximate)	0.016 cm			
DC coil resistance (approximate)	110 Ω			
Operating ambient temperature range	0 °C to +40 °C			
Model 480 fluxmeter input resistance	10 kΩ		100 kΩ	
Model 480 fluxmeter full scale range moment (approximate)	Base unit*	Magnetic dipole moment (magnetic moment)	Base unit	Magnetic dipole moment (magnetic moment)
	30 mV·s	480 μ W cm (3.82 Am ²)	300 mV·s	4.8 μ W cm (38.2 Am ²)
	3 mV·s	48 μ W cm (0.382 Am ²)	30 mV·s	480 μ W cm (3.82 Am ²)

*The Model 480 Monitor Output is always calibrated so that 3 V out equals the selected base, mV·s range, regardless of units selected from the front panel

TABLE 1-1 Model FH-6 Helmholtz electrical and magnetic specifications

1.4 Safety Summary and Symbols

Observe these general safety precautions during all phases of operation, service, and repair. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use. Lake Shore Cryotronics, Inc. assumes no liability for user failure to comply with these requirements.

The Model FH-6 Helmholtz coil protects the operator and surrounding area from electric shock or burn, mechanical hazards, excessive temperature, and spread of fire from the instrument. Environmental conditions outside of the conditions below may pose a hazard to the operator and surrounding area.

- Indoor use
- Altitude to 2000 m
- Temperature for safe operation: 5 °C to 40 °C
- Maximum relative humidity: 80% for temperature up to 31 °C decreasing linearly to 50% at 40 °C

Do Not Operate in an Explosive Atmosphere

Do not operate the Helmholtz coil in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Keep Away from Live Circuits

Refer component replacement and internal adjustments to qualified maintenance personnel. Do not replace components with power cable connected. To avoid injuries, always disconnect power and discharge circuits before touching them.

Do Not Substitute Parts or Modify Instrument

Do not install substitute parts or perform any unauthorized modification to the Helmholtz coil. Return it to an authorized Lake Shore Cryotronics, Inc. representative for service and repair to ensure that safety features are maintained.

Cleaning

Do not submerge the Helmholtz coil. Clean only with a damp cloth and mild detergent. Exterior only.













	Direct current (power line)		Equipment protected throughout by double insulation or reinforces insulation (equivalent to Class II of IEC 536—see Annex H)
	Alternating current (power line)		CAUTION: High voltages; danger of electric shock; background color: yellow; symbol and outline: black
	Alternating or direct current (power line)		CAUTION or WARNING: See instrument documentation; background color: yellow; symbol and outline: black
	Three-phase alternating current (power line)		
	Earth (ground) terminal		
	Protective conductor terminal		
	Frame or chassis terminal		
	On (supply)		
	Off (supply)		

FIGURE 1-4 Safety symbols

Chapter 2: Installation

2.1 General

Helmholtz coil usage is relatively straightforward. The Helmholtz coil is attached to a fluxmeter and a base reading is taken. A permanent magnet is moved into or out of the coil to produce a voltage change at its output. The fluxmeter integrates the voltage out of the coil and indicates a value related to the dipole moment of the magnet.

2.2 Connecting to a Lake Shore Fluxmeter

FIGURE 2-1 illustrates the simplicity of attaching the Model FH-6 Helmholtz coil to a Model 480 fluxmeter. Follow this procedure to attach the Helmholtz coil.

1. Ensure the Model 480 is off.
2. Attach the supplied cable D-connector to the Model 480 probe input located on the rear of the instrument.
3. Connect the banana plug connector to the Helmholtz coil.
4. If polarity is important, ensure the banana plug (GND) tab pin is connected to the black jack (-) of the Model FH-6.
5. Turn the Model 480 on.
6. Follow the procedures in Chapter 3 for operation.



If more than one Model FH-6 Helmholtz coil is used, ensure that the cable serial number matches that of the coil. Otherwise, reading accuracy will be affected.

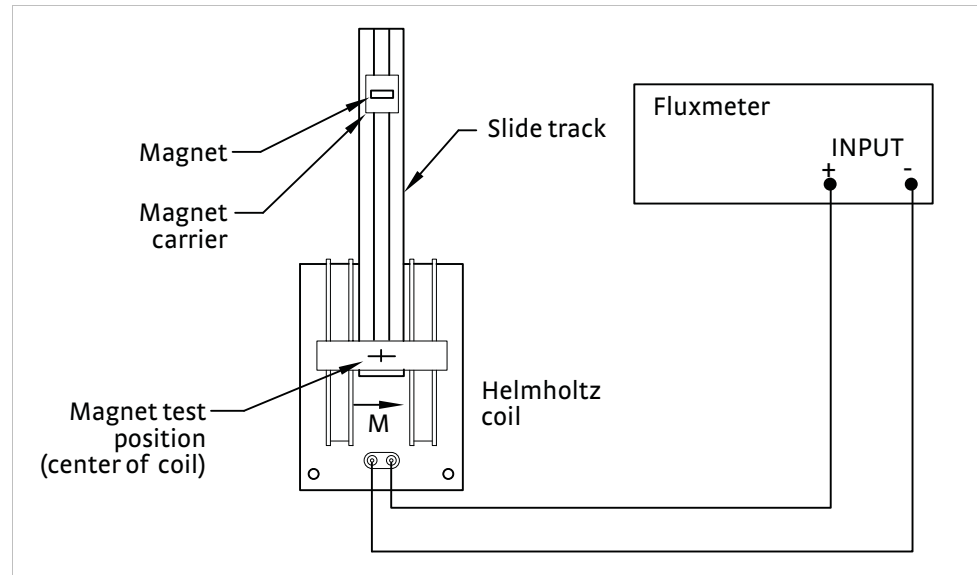


FIGURE 2-1 Connecting the Model FH-6 to a Model 480 fluxmeter

2.3 Connecting to Other Fluxmeters

The Model FH-6 should be compatible with all integrating fluxmeters that are designed to accept a passive coil output voltage.

1. Ensure the fluxmeter is off.
2. Attach a twisted pair cable between the Model FH-6 and the fluxmeter input.



In most cases a good quality commercial cable possessing a dual banana plug connector on both ends will be satisfactory.

3. If polarity is important, ensure the banana plug (GND) tab pin is connected to the black jack (-) of both the Model FH-6 and the instrument.
4. Turn the fluxmeter on.
5. Follow the procedures in Chapter 3 for operation.

2.4 Total Resistance (Coil Plus Cable)

A Helmholtz coil is a voltage source with an output resistance. The cable between the Helmholtz coil and the instrument exhibits a resistance. A fluxmeter has a finite input resistance (in the case of a Model 480 either 10 k Ω or 100 k Ω , as selected). The coil resistance, cable resistance, and instrument input resistance represent a voltage divider that affects measurement accuracy. During calibration of the coil, Lake Shore uses a specific cable of known resistance. If the Model 480 and standard Model FH-X-type cable are used, the operator can proceed with no additional inputs.

However, if the experiment necessitates a longer cable, contact Lake Shore Service to see if the additional resistance would cause any accuracy problems (contact information can be found in section 4.3). Lengths of 28 AWG or larger cables up to 3 m (10 ft) long add very little error.



When adding cable between the Model FH-6 and the Model 480, the additional length must be placed between the Model FH-6 and the banana plug end of the Lake Shore cable. The D-connector must be inserted into the Model 480 to retrieve its calibration data from the EEPROM.

Adding a very long cable extension may increase the coil/cable resistance enough to cause unacceptable errors. In this case the stored EEPROM data may not be valid. The Lake Shore supplied cable should be replaced with the user's wire, the EEPROM eliminated, and the data entered directly from the Model 480 front panel using coil setup (section 3.2.1). The Helmholtz constant would remain the same. The coil resistance would have to be entered as the sum of the Model FH-6, plus the longer user cable resistance.

If you are supplying your own cable and fluxmeter, use a voltage-ohm-milliammeter (VOM) and actually measure the total resistance of the coil/cable set. Then refer to the operation manual for the fluxmeter to see if any reading compensation is required.

2.5 Polarity

The reading polarity will change depending on the measurement method used (section 3.3). If only the magnetic moment magnitude is of interest, then the sign of the value can be ignored. If you are also interested in the direction of magnetization for a permanent magnet under test, then it is critical to be aware of the polarity for a particular test versus the orientation of the magnet.

2.6 Mounting Considerations

Place the Model FH-6 on a solid, non-magnetic surface such as a wood or plastic table.



The presence of nearby changing magnetic fields will harm the accuracy of the moment measurement. This error can be caused by moving magnets, machinery with moving ferrous parts, or high current pulses from equipment such as a welder.



The presence of ferrous material in fixed objects such as structural I-beams, steel tables, etc., will harm the accuracy of the moment measurement. Place the Helmholtz coil at least 1 m (3 ft) away from such objects.

Shielding must be used very cautiously, and its effect should be proven to be negligible versus the open field configuration.

If the Helmholtz coil must be secured, mounting holes are provided (FIGURE 1-2). The use of ferrous fasteners is discouraged. Brass or plastic fasteners are acceptable.

2.7 Slide Fixtures

Measurement repeatability is very important. It is critical that in every instance the magnet under test is positioned in exactly the same space and at the same angle to the coil longitudinal axis. The best method to achieve this requirement is to use a slide fixture to control the position, orientation, and motion of the magnet during testing.

The fixture can be fairly crude, but it should be of sufficient tolerance to maintain repeatable motion and position. We suggest using plastic materials for the fixture construction; however, brass and aluminum are also acceptable. If you consider using metal, be cautious of “non-magnetic” stainless steels. Ferrous material must be avoided in the fixture construction. FIGURE 2-2 shows an example of a slide fixture setup.

NOTE

Be sure to test the motion of the slide, with no sample present, to ensure that any magnetic signature from the slide mechanism is not picked up by the Helmholtz coil and fluxmeter.



FIGURE 2-2 *Slide fixture*

Chapter 3: Operation

3.1 General

A Helmholtz coil combined with a fluxmeter provides a convenient, low-cost method for testing permanent magnets. Information is obtained that allows quality control acceptance of magnets on the production line or at incoming inspection.

3.1.1 Flux Turns

Values of flux-turns provide simple measurements to be compared against standards or previous batches. This raw data is normally usable only within a specific facility, and is not directly comparable even between two different coils. Comparison between different Helmholtz coils can be calculated using the coil constants if they are available.

3.1.2 Moment

Some modern fluxmeters, such as the Lake Shore Model 480, provide actual moment values that can be compared at various test facilities worldwide. Since comparisons of results between facilities are considered extremely important in today's global economy, this manual concentrates on the moment measurement.

3.2 Lake Shore Model 480 Fluxmeter Setup

There are no parameter inputs required when using the Model FH-6 with a Model 480. All of this information is stored in the EEPROM of the cable, and it is downloaded into the instrument when it is turned on. If you are not using a Model 480, please refer to your fluxmeter manual for in-depth instructions.

This manual gives only basic information for use of the instrument. However, to make the proper moment measurement, section 3.2.1 and section 3.2.2 provide key entries or checks required for moment measurements.

3.2.1 Helmholtz Coil Setup

This section provides parameters for the fluxmeter input resistance and the Helmholtz constant when making moment measurements. All other Helmholtz coil setup parameters are of no value to the moment measurement, and can be ignored by pressing **Enter** until the normal display reappears.

3.2.1.1 Fluxmeter Input Resistance

This is the only parameter where user modification is allowed. Two choices are offered, 10 k Ω and 100 k Ω . Always try the 100 k Ω first. This gives the most stable reading. However, if more resolution is desired, the 10 k Ω may be selected. This offers one lower full scale range than the 100 k Ω selection, but also may provide a less stable reading.

3.2.1.2 Helmholtz Constant

The user may not change the Helmholtz constant when the Model FH-6 cable is used. Make sure the stored coil constant matches the constant marked on the Helmholtz coil. If it does not match, change to the proper cable (compare serial number).

3.2.1.3 AC/DC

Select DC.

3.2.1.4 Units

The Model 480 offers only one unit of measure for moment, Wb·cm. Press **Units**, then continue to press **Enter** until moment is selected. Afterwards, press **Enter** and proceed to the next step. See section 3.5 for a discussion of other units of measurement for the moment parameter.

3.2.1.5 Range

The Model 480 provides three ranges. See TABLE 1-1 for the ranges available with the Lake Shore FH-6. To access all three ranges, the input resistance of the fluxmeter must be changed between 10 k Ω and 100 k Ω , using the **Coil Setup** key. Depending on the value of the fluxmeter input resistance (as selected in section 3.2.1.1), the operator will be given a choice of two ranges. Select the highest full scale range that provides the desired resolution.

3.2.2 Determining the Magnetic Dipole Moment on Other Fluxmeters

Many fluxmeters display flux-turns, but they do not display moment directly. You can determine moment by multiplying the flux-turns measurement by the Helmholtz constant supplied with the Model FH-6.

- Coil constant = cm (where Wb·cm/V·s = cm)
- Magnetic dipole moment (Wb·cm) = coil constant (cm) \times flux turn (Wb)
- When the user fluxmeter reads maxwell·turns, the coil constant can be converted by using coil constant = (cm) $\times 10^{-8}$ = Wb·cm /maxwell·turn

3.3 Measurement Methods

The measurement method relates more to what the operator is comfortable with, or what company procedures dictate, than selecting a superior method. Single extraction and double extractions with rotation or in-fixture rotation are all acceptable. Using any one of these procedures measures the magnetic moment directly with the Model 480. However, the polarity displayed will vary. In all cases, the magnetization direction for the permanent magnet should be along the Helmholtz coil's central axis. Several basic measurement methods are described in section 3.3.1 to section 3.3.5.

3.3.1 Single Insertion Method

Single insertion and single extraction are quite simple, and in many cases provide good results. Follow this procedure to perform the single insertion method.

1. Start with the position of the magnet at least three coil diameters away from the center of the coil and to the side of the coil (90° to the Helmholtz coil central axis, shown in FIGURE 3-1).
2. With the magnet stationary in this position, reset the fluxmeter (zero the integrator).
3. Move the magnet to the center of the Helmholtz coil.
4. Read the moment or flux-turns value.

A positive reading polarity indicates a magnetization direction as shown in FIGURE 1-1.



Do not touch the magnet with bare hands. This may raise the temperature and change results.

3.3.2 Single Extraction

The single extraction method is similar to the single insertion method, but it is in the opposite direction of motion. Follow this procedure to perform the single extraction method.

1. Start with the position of the magnet in the center of the Helmholtz coil, with its direction of magnetization along the Helmholtz coil axis.
2. After the magnet is stationary in this position, reset the fluxmeter (zero the integrator).

3. Move the magnet out of the coil, through the side between the coils, to a point at least three coil diameters from the center.
4. Read the moment or flux-turns value.

A negative reading polarity indicates a magnetization direction as shown in FIGURE 1-1.

3.3.3 Double Insertion or Extraction with Rotation

Many operators with years of experience prefer to account for possible “hot spots” on a permanent magnet (non-uniform magnetization) by taking two measurements 180° apart.

This entails taking two measurements as described in the single extraction or single insertion method. However, after the first measurement, use a holding fixture to accurately rotate the magnet 180°. The average magnitude of the two readings is recorded. In-coil rotation method (section 3.3.4) is a variation of this process.

3.3.4 In-Coil Rotation

This method normally requires a rotary fixture providing accurate 180° rotation of the magnet. Follow this procedure to perform an in-coil rotation measurement.

1. Place the magnet in the center of the Helmholtz coil with its direction of magnetization along the coil axis.
2. After the magnet is stationary in this position, reset the fluxmeter (zero the integrator).
3. Physically rotate the magnet 180°, and record the moment or flux-turns value.
4. Divide the moment or flux-turns value by two to get the proper average value.

3.3.5 Pass Through

High speed, automated testing often requires that the magnet under test pass through the coil in a continuous motion, rather than stop, reverse, or rotate. The path can be along the coil central axis or through the sides. Unlike the previously described methods, the moment reading is not retained using the normal reading mode. During travel the reading might start at zero, then go to actual moment value in the Helmholtz coil’s sweet-spot (high uniformity central volume, shown in FIGURE 3-1), and return to near zero as the magnet exits the other side. Two possible ways of making the proper moment measurement are described in section 3.3.5.1 and in section 3.3.5.2.

3.3.5.1 Peak-Hold Mode

If the fluxmeter being used has a peak-hold mode (as the Model 480 does), then follow this procedure to take a measurement. Refer to section 3.3.5.2 if you do not have peak-hold mode.

1. As the magnet approaches the Model FH-6, and is at least three-coil diameters distant from the center, zero (reset) the peak reading.
2. With the magnet continuing on its path through the coil, the maximum reading held will be the correct moment. Record this value.
3. When the magnet is at least three-coil diameters away from the Helmholtz coil, reset the peak hold for the next magnet.

3.3.5.2 Monitor Output

If for some reason the peak-hold mode is not applicable, the user might consider using one of the analog outputs on the instrument. The voltages at these outputs are proportional to the moment value. Consult the fluxmeter user’s manual for the correct voltage-to-moment calibration factor. This voltage can be fed into a storage oscilloscope for reading, or sent to an A:D for entry into a computer file. The three-coil diameter distance criteria is still valid for the pre-entry and post-exit resetting of the integrator.

See section 3.4 for further discussion of automated, through-coil testing.

3.4 Automated Operation with Sorting

Many users are interested in high-speed, automated testing of magnets on a production line. The procedure for automated operation is provided here for this situation. To assist the user in determining the minimum total test time required for each magnet, approximate operating times for two critical functions of the Model 480 fluxmeter are as follows:

- The reset operation in step 4 takes about 0.25 s to complete after the command is received.
- The accept/reject signal in step 8 is available about 0.10 s after the magnet stops outside the coil.

The total time to complete this test sequence relies very much on the user's computer, software and motion control system. The estimated Model 480 fluxmeter response times can be considered conservative.

In this operation, fluxmeter measurement and the motion of magnets on a conveyor belt would be computer controlled. Magnet moment values would be compared to preset, allowable limits stored in a Model 480, and a user's accept/reject action would be taken. See FIGURE 3-1 for an explanation of physical positions as used in the following example. Follow this procedure to perform automated operation with sorting.

1. Set up the Model 480 as described in section 3.2.1.
2. Enter the moment limits as given in the instructions in the Model 480 manual.
3. Move the magnet to the center of the Helmholtz coil from a position at least three-coil diameters away.
4. **Reset** the fluxmeter.
5. Move the magnet out of the coil a distance of at least three-coil diameters.
6. The value is compared to the alarm setpoints stored in the Model 480.
7. An accept/reject signal is available at either the computer interface or as a relay closure.
8. User accept/reject action is taken.
9. Start this procedure over, beginning from step 3 for the next magnet.

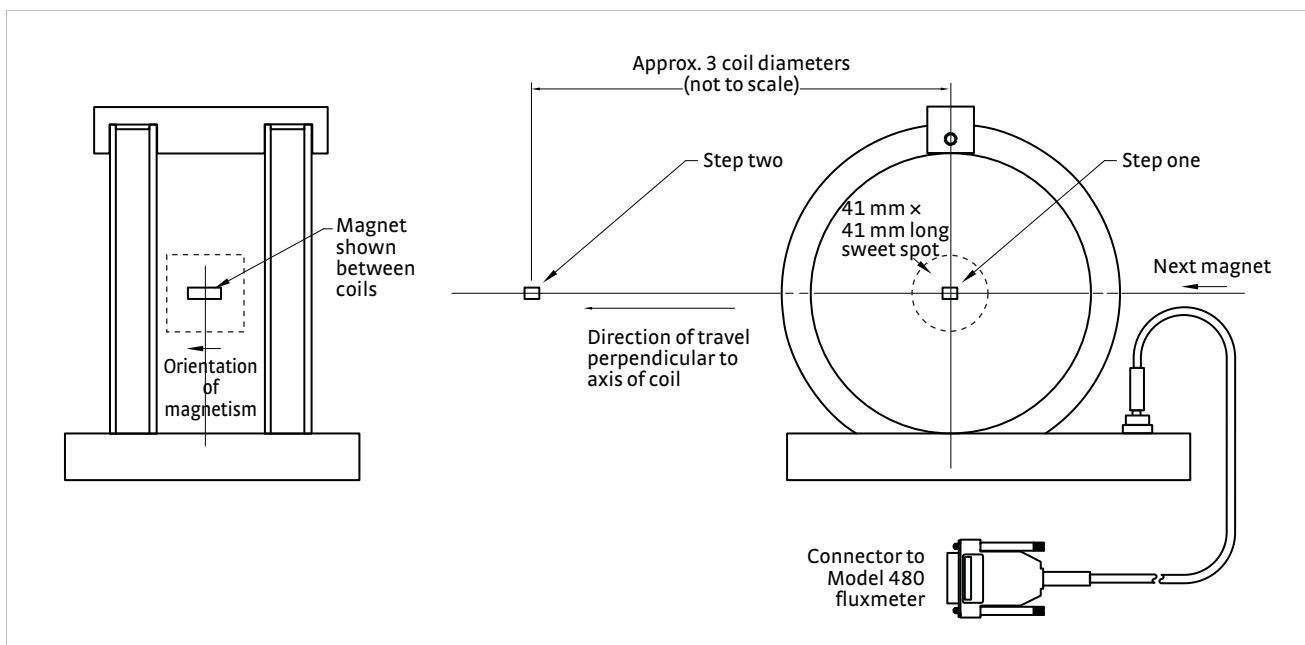


FIGURE 3-1 Automated magnet test

3.5 Magnetic Dipole Moment (Wb·cm) Compared to Magnetic Moment (Am²)

Confusion may arise when considering the proper unit of measure for the magnetic dipole moment. Two units of measure are derived depending on whether magnetization or intrinsic flux density is used as the starting parameter. These units are (Wb·m) or (Am²). The ratio between the two is μ_0 (equal to $4\pi \times 10^{-7}$ Wb/A·m). The term magnetic dipole moment refers to the moment measured in Wb·m, and the term magnetic moment refers to the moment measured in Am² or J/T.

Due to the fact that the Model 480 uses Wb·cm as its basic unit for moment, the following conversion factors are given:

- moment value in (Wb·cm)/ $4\pi \times 10^{-5}$ = moment value in (Am²)
- moment value in (Am²) $\times 4\pi \times 10^{-5}$ = moment value in (Wb·cm)
- moment value in (weber·cm) times 0.01 = moment value in (weber·m)

3.6 Compatible Magnet Size

If the user is willing to sacrifice reading accuracy, a magnet slightly larger than the suggested value (TABLE 1-1) may be tested. Each case will be different, but the larger the magnet, the greater the error. Exceeding the suggested size by 20% is not advised. If bigger magnets are to be tested, a larger Helmholtz coil should be considered. The Lake Shore Model FH-12 Helmholtz coil can provide accurate measurements on magnets that fit within a cylindrical volume 76 mm (3 in) long and 76 mm (3 in) diameter.

The size of magnet versus the Helmholtz coil size should be optimized. Accuracy can be compromised if too small a coil is selected. Conversely, using a large coil for a small magnet can reduce signal strength and reading resolution.

3.7 Determining Magnetization Vectors

The Model FH-6 output amplitude depends greatly on the angle relationship between the magnetization vector of a permanent magnet and the central axis of the coil. The coil indicates the component of the moment vector parallel to the central axis, with the maximum output occurring only when the magnetization is aligned with the coil axis.

This characteristic can prove quite valuable to a user faced with the task of determining the magnetization direction in a magnet used in future assemblies. Though a magnetizing fixture is designed to provide a specific direction, material defects or fixture problems may cause off-angle results. Since final product performance is dependent on maximum magnetic field in a particular direction, good engineering practice would benefit from a method to measure the magnetization vector direction. A test method using a single coil is provided in section 3.7.1. See FIGURE 3-2 for an explanation of angles and terms to be used.

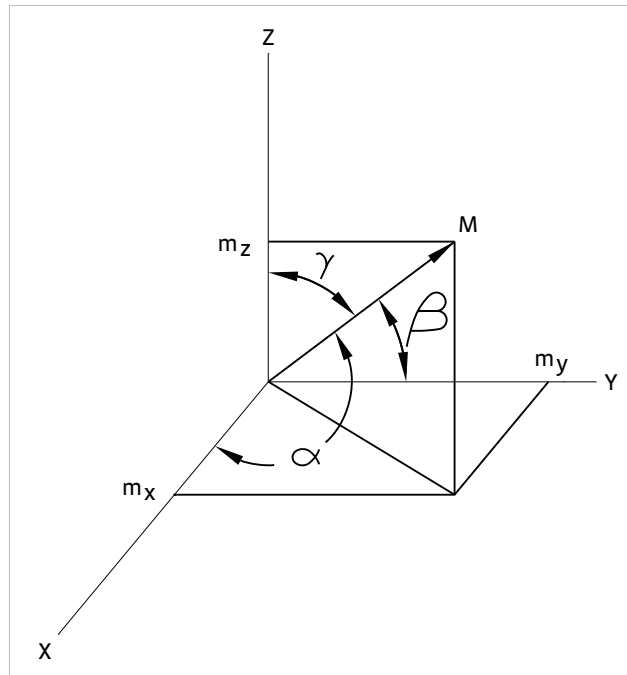


FIGURE 3-2 Definition of terms and angles

3.7.1 Method for Determining a Magnetization Vector

This method requires three separate moment measurements (m_x , m_y , m_z). Physically rotate the magnet between measurements and accurately align each of the three axes with the coil central axis. Usually, the user expects the magnetization direction to align with one of the axes, providing a very low moment measurement for the other two readings. Record each measurement for future calculations.

To determine the magnetization vector, calculate the three angles using these equations.

- $\alpha = \cos^{-1} (m_x / \sqrt{m_x^2 + m_y^2 + m_z^2})$
- $\beta = \cos^{-1} (m_y / \sqrt{m_x^2 + m_y^2 + m_z^2})$
- $\gamma = \cos^{-1} (m_z / \sqrt{m_x^2 + m_y^2 + m_z^2})$

3.8 Determining Other Magnet Characteristics

Measuring a magnetic moment with a fluxmeter and a Helmholtz coil is a convenient way to test permanent magnet materials. Other values such as operating flux density (B_d), operating field strength (H_d), coercive force (H_c), residual flux density (B_r), and maximum energy product (BH_{max}) can be derived from the measured moment value. Although this method is not as accurate as a hysteresis graph measurement, the process is easy, values are useful and reliable, and equipment cost is substantially less.

You can obtain an application note on the Lake Shore website, www.lakeshore.com, titled, *Measuring Permanent Magnet Characteristics with a Fluxmeter and Helmholtz Coil*. This paper provides simple instructions to derive the above parameters from the magnetic moment value.

Chapter 4: Service

4.1 General

This chapter provides troubleshooting and care information for your Helmholtz coil. It also provides contact information and the procedure for return of the Model FH-6.

4.2 Calibration and Repair

Model FH-6 Helmholtz coils are quite robust and resistant to damage or calibration shifts. However, section 4.2 lists some possible problems that may occur.

- *Cable PROM corrupted:* stored data is lost, or the Model 480 does not recognize the coil. The user can return the cable for repair or order a new cable for the particular serial number coil.
- *Cable or connector damaged:* a cut cable can be locally repaired in most cases with no effect on the coil calibration. If desired, the user can return the cable for repair or order a new cable for the particular serial number coil.
- *Coil physically damaged:* Lake Shore Service may have to determine if the coil damage is deemed minor. Not all damage is repairable.
- *Coil needs regular calibration check:* most formal quality assurance systems require a regular confirmation of the calibration on any piece of measurement equipment. The Model FH-6 is one of these items. We suggest that our Helmholtz coils be returned to Lake Shore for a calibration check on a yearly basis. This is only a suggestion; the regularity of calibration should always be determined by the user's quality department.

In all of these cases the user should contact Lake Shore Service. Refer to section 4.3 for contact information and technical inquiries.

4.3 Technical Inquiries

Refer to the following sections when contacting Lake Shore for application assistance or product service. Questions regarding product applications, price, availability and shipments should be directed to sales. Questions regarding instrument calibration or repair should be directed to instrument service. Do not return a product to Lake Shore without a return material authorization (RMA) number (section 4.3.2).

4.3.1 Contacting Lake Shore

The Lake Shore Service department is staffed Monday through Friday between the hours of 8:00 AM and 5:00 PM EST, excluding holidays and company shut down days.

Contact Lake Shore Service through any of the means listed below. However, the most direct and efficient means of contacting is to complete the online service request form at <http://www.lakeshore.com/sup/serf.html>. Provide a detailed description of the problem and the required contact information. You will receive a response within 24 hours or the next business day in the event of weekends or holidays.

If you wish to contact Service or Sales by mail or telephone, use the following:

Mailing address	Lake Shore Cryotronics Instrument Service Department 575 McCorkle Blvd. Westerville, Ohio USA 43082-8888	
E-mail address	sales@lakeshore.com service@lakeshore.com	Sales Instrument Service
Telephone	614-891-2244 614-891-2243 option 6	Sales Instrument Service
Fax	614-818-1600 614-818-1609	Sales Instrument Service
Web service request	http://www.lakeshore.com/sup/serf.html	Instrument Service

TABLE 4-1 *Contact information*

4.3.2 Return of Equipment

The Helmholtz coil is packaged to protect it during shipment.



The user should retain any shipping carton(s) in which equipment is originally received, in the event that any equipment needs to be returned.

If original packaging is not available, a minimum of 76 mm (3 in) of shock absorbent packing material should be placed snugly on all sides of the instrument in a sturdy corrugated cardboard box. Please use reasonable care when removing the Helmholtz coil from its protective packaging and inspect it carefully for damage. If it shows any sign of damage, please file a claim with the carrier immediately. Do not destroy the shipping container; it will be required by the carrier as evidence to support claims. Call Lake Shore for return and repair instructions.

All equipment returns must be approved by a member of the Lake Shore Service department. The service engineer will use the information provided in the service request form and will issue an RMA. This number is necessary for all returned equipment. It must be clearly indicated on both the shipping carton(s) and any correspondence relating to the shipment. Once the RMA has been approved, you will receive appropriate documents and instructions for shipping the equipment to Lake Shore.

4.3.3 RMA Valid Period

RMAs are valid for 60 days from issuance; however, we suggest that equipment needing repair be shipped to Lake Shore within 30 days after the RMA has been issued. You will be contacted if we do not receive the equipment within 30 days after the RMA is issued. The RMA will be cancelled if we do not receive the equipment after 60 days.

4.3.4 Shipping Charges

All shipments to Lake Shore are to be made prepaid by the customer. Equipment serviced under warranty will also be returned shipping prepaid by the customer. Equipment serviced out-of-warranty will be returned FOB Lake Shore.

4.3.5 Restocking Fee

Lake Shore reserves the right to charge a restocking fee for items returned for exchange or reimbursement.