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Flat Magnets

Flat Magnets: Supplement #1 to New Magnetism

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New Magnetism Supplement: Measuring Flat Magnets

In classical electromagnetism, magnets are rated in terms of Gauss or Teslas. This rating system is ambiguous since it is impossible from an engineering standpoint to know where these measurements are valid. The New Magnetism philosophy is to treat a magnet as a purely non-Gaussian current loop (for flat magnets). With this philosophy the following benefits are realized:

1) It is easier to design with a magnet based on published specifications
2) Faster development time.
3) Easier Numerical integration algorithms
4) other benefits

This supplement explains how to measure a magnet with a standard Hall Effect probe and convert that reading into a New Magnetism amperage (Magnetic Amperage--MA) rating utilizing the accompanying software →flatmags.exe.

Flatmags.exe is a PC based windows program containing proprietary numerical integration algorithms.

Flatmags.exe has been tested on both Windows 98 and Windows XP. It should work on Windows NT, ME, 2000 and 95. There is no installation required for flatmags.exe. It is a small program that runs in a self contained fashion.

Note: The future supplements for New Magnetism are dependent upon the results of this publication and software. This is especially true for the Homopolar Technology releases which are expected for release before December 2003.

Note: this supplement was written in less than 4 hours; please expect there to be grammatical and spelling errors. – We will fix them as timely as possible.

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1 Measuring flat magnets

1.1 Equipment

The equipment used is the 100GV Hall Effect probe shown in the following photograph. This device is available from the www.Distinti.com Online store (SKU EM002)

Figure 1-1: The 100GV Hall Effect probe

Banana jumpers are used to connect this device to a DVM.

1.2 Setup

The 100GV probe is mounted such that the Hall Effect point is centered over the origin of a graduated line. In our setup, the graduated line is the centerline of a wooden yardstick as show in the following photograph.

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Figure 1-2: Setup to measure flat magnets

The height of the hall point above the origin of the graduated line should be ½ the height of the magnet being measured (see Figure 1-3).

For orientation purposes, the direction heading to the right along the graduated line is the positive x direction. The positive y direction is in the same plane as the yardstick heading away from us (toward the meter) and the positive z direction is upward normal to the table top.

The Hall Probe should be mounted perfectly level such that it yields a positive reading for flux lines (using classical flux model) in the positive z direction.

Note: The Hall Point is the point within the Hall Sensor where the measurement is performed. See the 100GV (em002a_man.pdf) manual for more details about the Hall Point and the apparatus shown above.
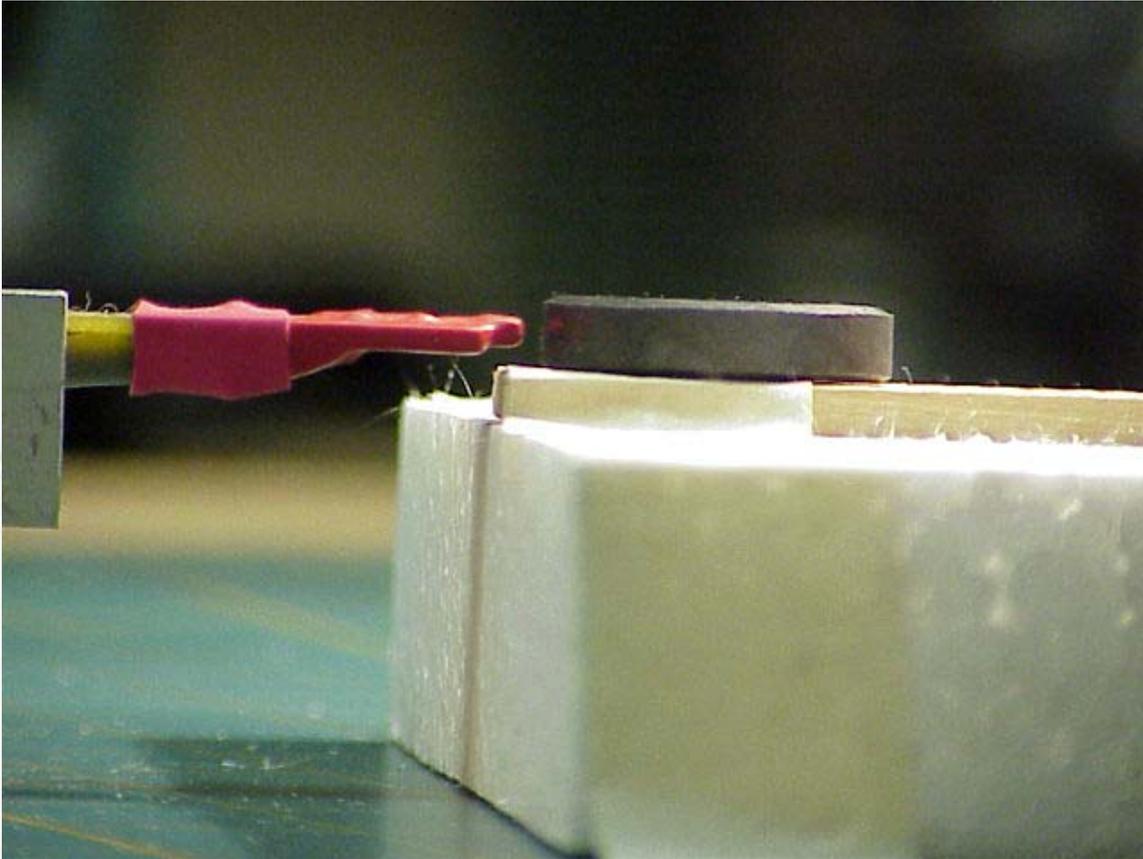
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Figure 1-3: Height of probe above origin

1.3 Making Measurements

1.3.1 Step 1 record offset

The 100GV is sensitive enough to be affected by the Earth's magnetic field and other stray field effects. The first job after constructing the measuring fixture is to remove all magnets to a distance of 2 or more meters and allow the 100GV to stabilize. The reading from the 100GV (11.3mV as shown in Figure 1-4) represents the sum of all the stray effects. This reading is written down and subsequently subtracted from each measurement made.

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Figure 1-4: Measuring Offset

1.3.2 Measurement distance

The key to accuracy is the distance at which measurements are taken.

Far away measurements reduce the error contributed by distance, and the error in the height of the probe. For example, our low accuracy yardstick is probably only accurate to 1/32 of an inch (the width of the markings). An error of 1/32 inch at a distance of ¼ inch represents a 12.5% error while at 2 inches it represents less than 2% error.

Even worse is the fact that the field is an inverse square which means errors at close distances cause much more problems than the same error in distance at a farther distance.

The drawback in making measurements at far distances is that the low field intensity present at the instrument may be to low to measure accurately.

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The following list represents guidelines that should be adhered to when deciding on what distance to make the measurements at.

1) No distance less than 1 inch (or 3cm) unless you are using highly accurate methods to measure distance.
2) The distance should be as far away as possible.
3) The distance should be close enough to result in a reading that is at least 10 times the offset, a minimum of three whole digits in the display and (if possible) near the center of the range of the instrument.

The above are just recommendations, there may be other mitigating factors, or you may have own accuracy requirements which render one or more of the above irrelevant.

The following photo shows the reading taken from a hobby store disk magnet. In order to get three whole digits in the display, and at least 10 times the offset, we measured at 1 inch.
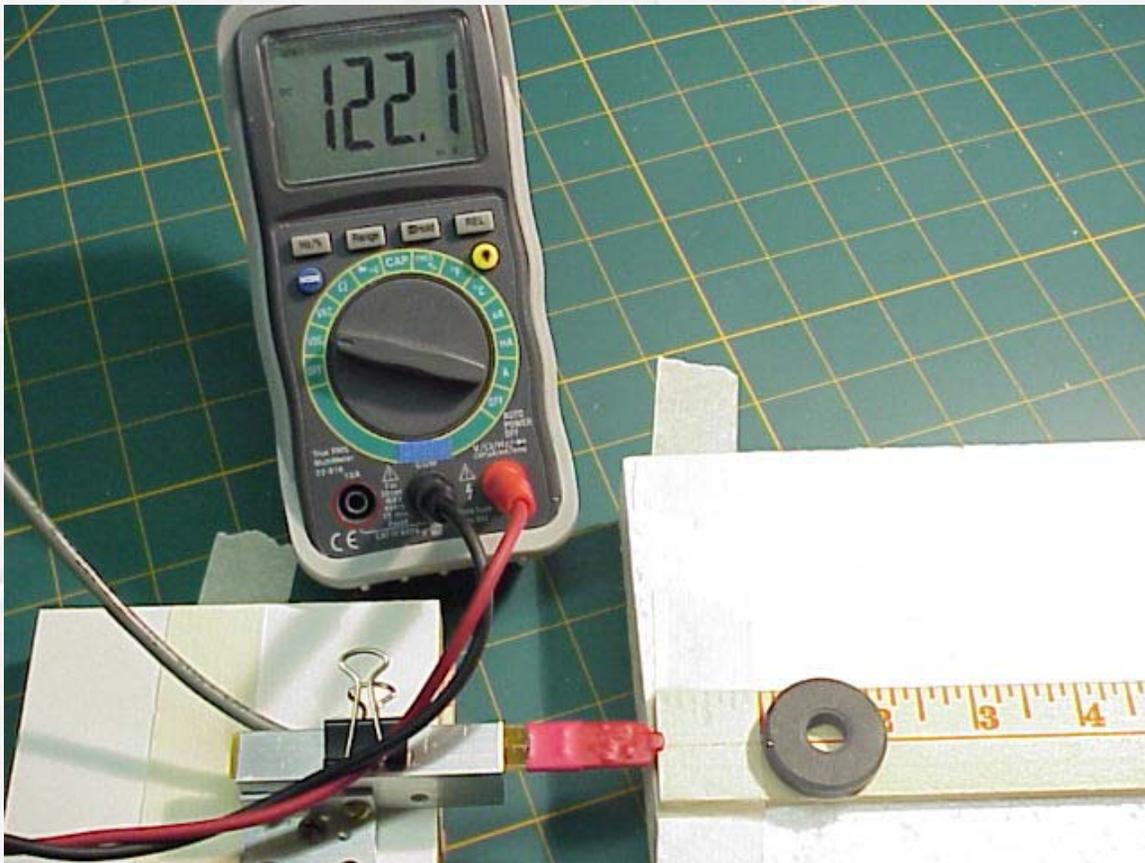

Figure 1-5: Measuring

1.3.3 Calculating the result

The measured result is the reading from Figure 1-5 reduced by the offset recorded in from Figure 1-4. Thus

mV = 122.1-11.3 = 110.8mV

The software requires the result to be in Gauss. To convert the 100GV reading into Gauss, we recall from the 100GV manual that the output conversion is 100 Gauss per Volt (100G/V). Thus, the result is 0.1108*100 = 11.08 Gauss. Or more simply, just divide the millivolt reading by 10.

Result = 11.08 Gauss
Distance = 1 inch

1.4 Computing the Amperage

The magnet amperage is calculated from the Hall Effect sensor reading using the flatmags.exe software. The software does not need to be installed, it is a self contained executable, just double click on the file to execute it.

1.4.1 Disk magnets (with or without holes)

This section describes how to use the faltmags.exe software in order to calculate the amperage of disk magnets.

1) Obtain the Gauss measurements of the magnet as show in previous sections. (in our example it is 11.08 Gauss).
2) Measure the diameter of the magnet and the diameter of the magnets hole (use zero if it does not have a hole).
3) Run the software (if not already)
4) Click disk under magnet geometry.
5) Select the preferred units (inches or CM). All entries must be in the selected units (except magnetic field intensity which is Gauss)
6) Enter magnet diameter (1.125in in our example)
7) Enter the hole diameter (0.375in in our example). Enter zero if your magnet does not have a hole.
8) Enter the measurement distance (1inch in our example).
9) Enter the reading in Gauss (11.08Gauss in our example).

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10)   Click the compute button and the result of (1023 Amps in our example) should appear in the output.

Note the output shows a check value. This check value takes the output amperage and calculates the resultant field intensity at the point where the field was measured. This provides a check of the numerical integration algorithms. If there is a difference between the input reading and the check value, it indicates that either the measured distance is too close or there is an error in the algorithms—let us know.

1.4.2 Rectangular Magnets (with or without holes)

The software calculates for rectangular magnets with or without holes. For optimal performance, the longer side of the magnet should be aligned to the y-axis (perpendicular to the graduated line). The magnet should also be centered over the line.
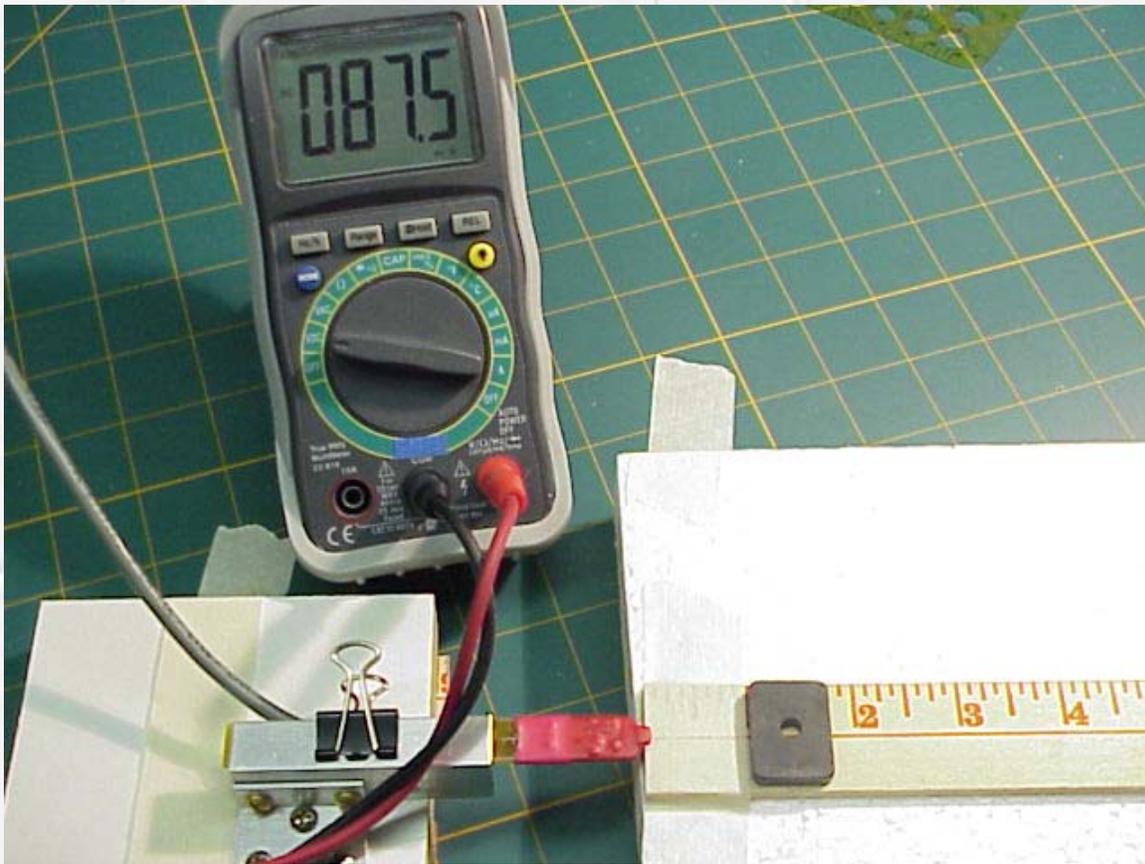
The above photo shows a small magnet commonly available at hobby stores. The strength of this particular magnet is too small to obtain three full digits on the meter at 1 inch. By using a graduated line with much finer graduations, it would be possible to bring the magnet in for a much closer reading (for example, see section 2.1.1). For this section we will just enter what we have to see what we get.

Here are the values entered into the software
Geometry =Rectangular
Length =3/4 inches (x axis)
Width= 1 inch (y axis)
Hole diameter =3/16 =0.1875
Distance = 1
Reading =((87.5)-(11.3))/10=76.2/10=7.62 Gauss

Result
642 Amps

1.4.3 Demonstrating the effects of error in measurement

From the example in the previous section, if we offset the distance by 1/32 inch (distance =1.03125) and re-calculate, the result jumps to 689 amps. This represents (689-642)/642*100 or about 7% change in the result. Therefore, each 1/32inch of error, at a distance of 1 inch, results in a 7% error in the result.

Performing the same comparison at 2 inches and 2.03125 inches (using same readings and dimensions) we get 3490 amps and 3632 amps respectively.

Thus, at 2 inches, this 1/32 inch error results in only 4% error.

This is why farther distances are preferred unless precise means of accurate measurement are employed.
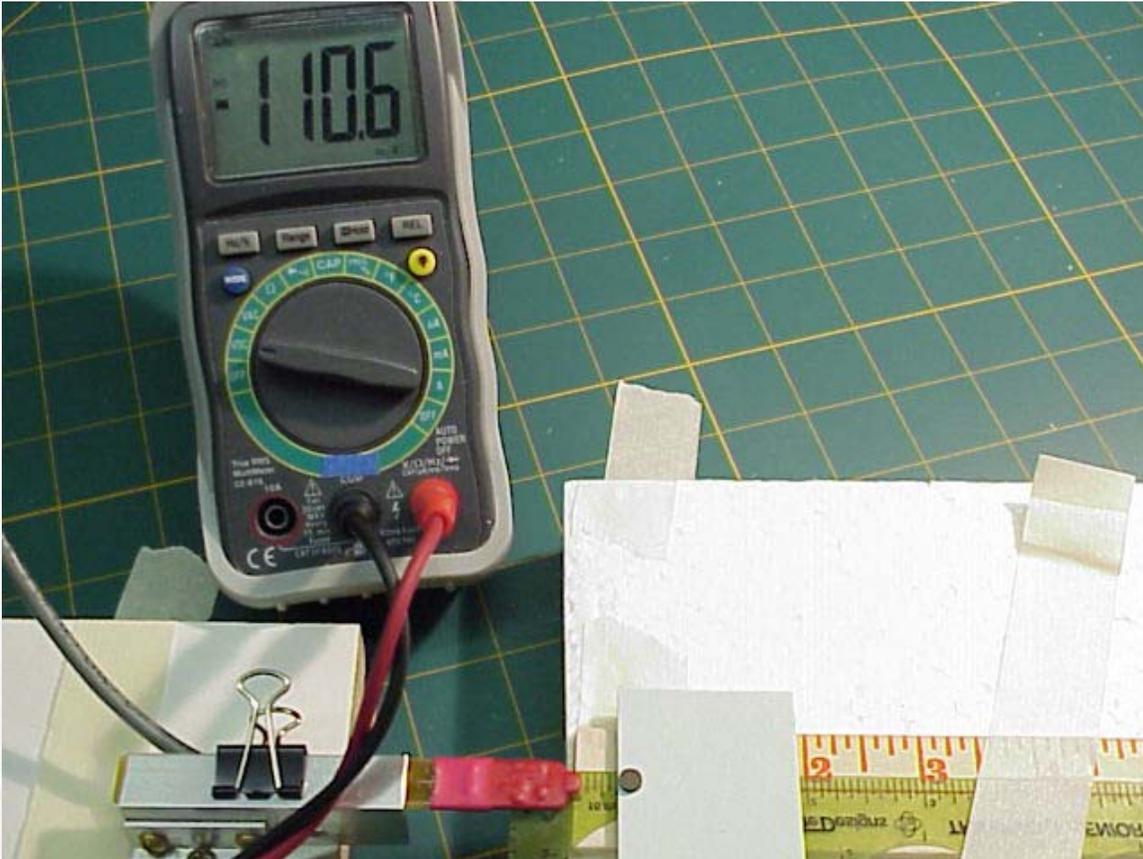
We are developing automated instruments to measure magnetic amperage and nullify all errors using proprietary numerical methods.

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2 Other Examples

2.1.1 Very Small Rare Earth Disk magnet –no hole

The above photo shows a very small but very powerful disk magnet made from rare Earth materials (Radio Shack number 64-1895)

Because it is so small (3/16 inch in diameter), the opposite edges of the magnet are very close together. This causes the field to be extremely powerful close to the edge; however, the field attenuates quickly as the distance increases.   The reason for this is that at a far distance (let us say 2 inches) the effect on the probe is effect of the close side of the magnet minus the far side of the magnet which is highlighted by the following demonstrative equation $\frac{1}{2^2} - \frac{1}{2.1875^2} = 0.041$.

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In order to effectively measure a small magnet, we must get close. In the above photo we employ a plastic ruler with finer graduations and use a stack of post-it notes to raise the small magnet up, parallel to the sensor.

Here are the values entered into the software
Geometry =disk
Diameter =0.1875in
Hole diameter =0;
Distance = 0.375
Reading =((-110.6)-(11.3))/10=-121.9/10=-12.2 Gauss

Result
1104 Amps

(Note: the minus sign in the -12.2 reading states that the field direction was going into the table – for simplicity, we try to measure it coming out of the table. This example was performed this way in order to show how to handle the negative values).

2.1.2 Long Rectangular Magnet –no hole

Long rectangular magnets should be measured with the longest edge toward the sensor as shown in the following photograph.

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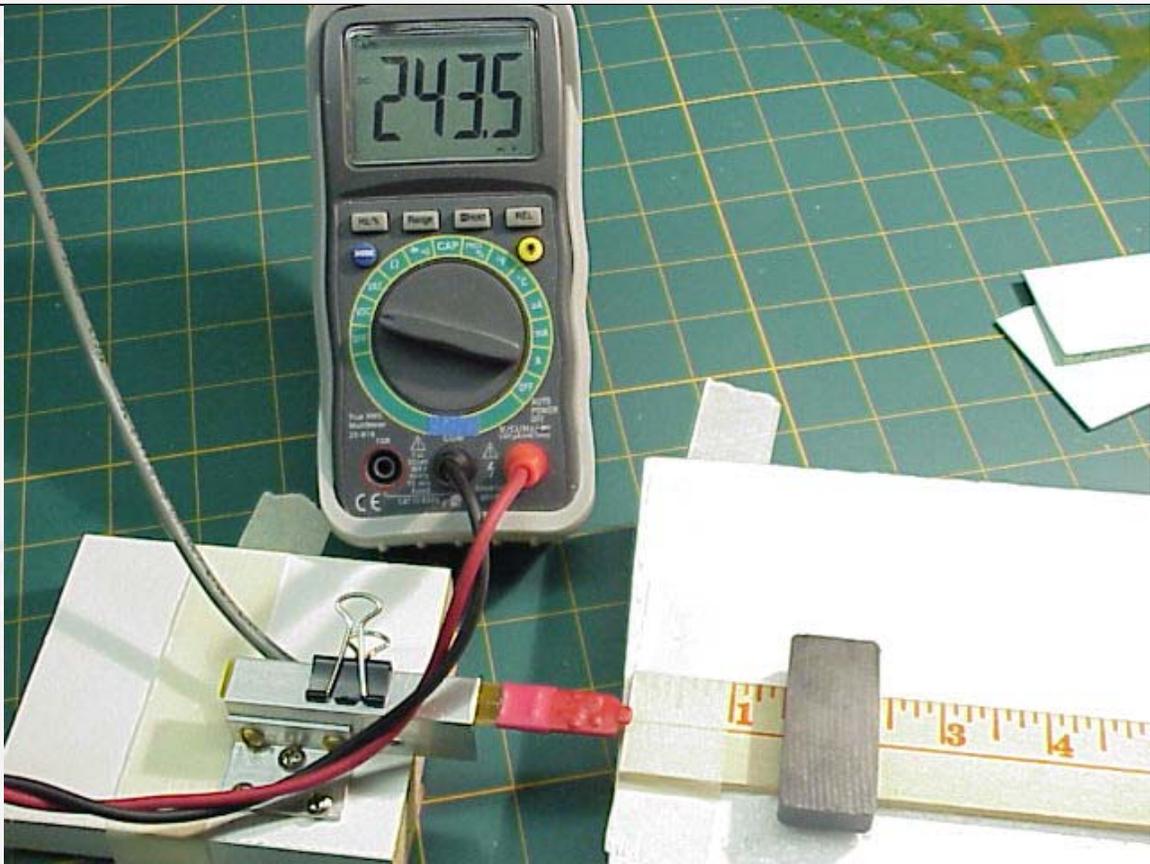
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Use a plastic square (not shown) to ensure that the magnets long edge is normal to, and centered on, the graduated line.

Here are the values entered into the software
Geometry =Rectangular
Length =7/8 inches (x axis)
Width= 1 7/8 inches (y axis)
Hole diameter =0;
Distance = 1.5
Reading =((+243.5)-(11.3))/10=232.2/10=23.2 Gauss

Result
2652 Amps

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3 Thank You

This supplement was developed based on the feedback from our book New Magnetism.

This feedback shows that our readership is primarily interested in Homopolar devices and the Homopolar Paradox. This supplement is required since the Homopolar Technology that we are going to release in the near future depends upon and will reference the techniques demonstrated in this Supplement.