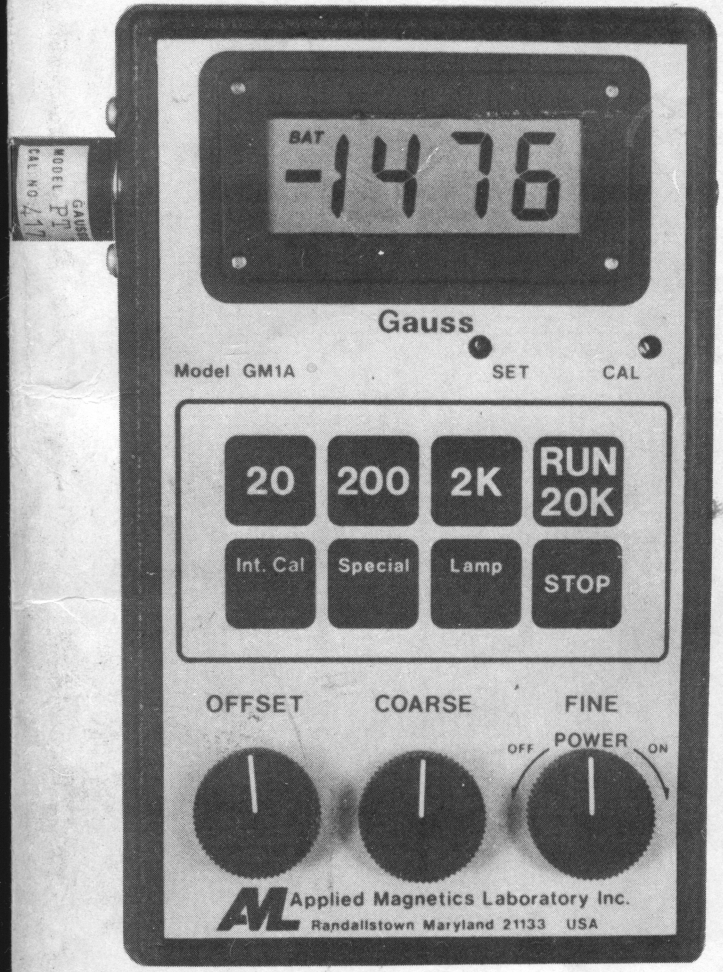


• OWNER'S MANUAL • GAUSSMETER GM1A •

TABLE OF CONTENTS

INTRODUCTION

The model GM1A Micropover Gaussmeter is a precision measuring instrument. It is extremly portable, easy to operate, and has a number of very unusual features.

The instrument is intended for the measurement of DC (steady) magnetic fields, and measures flux density (the number of flux "lines" per square centimeter). One "line"/cm^2 is one Gauss. The Earth's field measures about 0.35 Gauss.

The measurement system uses the Hall Effect, which is explained in detail later. A wide variety of probes is available to tailor the instrument to your individual measurement needs.

UNUSUAL FEATURES

Unlike all other high-performance Gaussmeters, this one operates at MICRO-POWER levels, on one ordinary 9-volt Duracell* radio battery. Battery life is about 100 hours, with automatic low-bat warning.

The instrument is the SIZE of a pocket calculator, and WEIGHS only 10 oz., yet is more ACCURATE than many expensive and cumbersome laboratory bench-style units.

It has a LARGE DIGITAL READOUT display, with AUTOMATIC POLARITY indication, plus a calibrated ANALOG OUTPUT jack.

SELF-CALIBRATING: Eliminates need for reference magnets for most applications.

SENSITIVE: Resolution is 0.01 gauss on the 20G scale, using the standard probe, yet it will easily measure 20KG fields.

INCREMENTAL/EXPANDED-SCALE OPERATION: You can null out about 4KG of ambient field using standard probes (more with optional probes). You can also PRE-SELECT the OFFSET amount for each use.

SENSES the TYPE of PROBE plugged into it, and adjusts its signal processing system accordingly. GM1A will operate with probes made for other instruments. (Low-cost adapter connector required.)

GM1A uses the latest technology to give you fast, reliable TOUCH BUTTON function and range SELECTION, and human engineered controls to make measurement chores easy.

MAGNETOMETER probe a LOW COST OPTION which extends the range down to a resolution of one gamma (1/100,000 gauss) FOR LOW FIELD MEASUREMENTS, flux mapping, ambient field surveys, AIR SHIPMENT PACKAGE INSPECTION, etc. This probe increases sensitivity by a factor of 1,000, greatly extending usefulness.

Perhaps the best feature of all is that this instrument costs so much less and gives you so much more performance than other currently available gaussmeters.

SPECIFICATIONS

FULL-SCALE RANGES: 20.00, 200.0, 2000, 20.00K Gauss with standard probes. Special probes available extend ranges up to 200 KG full-scale, and down to 2000 gamma (0.02 gauss) full-scale. Decimal point automatically placed.

ACCURACY: +/- 0.25% of reading, +/- one digit. Accuracy specifications apply for a 4-month calibration cycle, assuming an ambient temperature of 24°C +/- 4°C at 30-80% Relative Humidity for readings between 2% and 99% of range.

READOUT DEVICE: 3-1/2 digit liquid crystal display, 1/2" characters. Decimal points auto-selected. Leading zero suppression. Automatic polarity. Overrange indicated by a "1" (with a minus sign for negative overrange) at extreme left of display. Meter is protected, and not harmed by continuous overrange operation. Auto Low-Battery indicator.

ANALOG OUTPUT: Tracks with digital display. 200 mv = Full-Scale of display. Analog output can validly go to -300 mv and +1 volt, even though the digital readout will show overrange. Thus, you can get valid measurements of up to 1KG on the 200 Gauss range using the analog output. Output is defined as positive when the meter shows a positive indication and the center terminal of the output jack is positive with respect to the body terminal ("ground" side).

OUTPUT JACK: Standard 1/8" (3.5 mm) miniature phone jack. PLEASE caution operators NOT to plug a power source or battery charger into this jack!

ANALOG OUTPUT LOADING: To maintain calibration, keep load above 10K ohms.

EXPANDED-SCALE/INCREMENTAL OPERATION: 4KG of offset is available with standard probes, and more with optional probes. The operator can null out the ambient field, and then select a more sensitive range to measure small variations in the large ambient field.

OFFSET PRESELECT: The amount of offset is a calibrated quantity. You can dial in an exact offset before measurement is begun. Offset amount is selected and read on the regular ranges.

PROBE TYPE SENSING: Probe type (general sensitivity) is sensed when a probe is plugged in, and the instrument then sets up its signal processing accordingly. Probes with vastly different basic sensitivities can thus be accommodated with little effort to calibrate the instrument for each probe.

MODE AND RANGE SELECTION: Touch switches. Electronic high speed switching. Range select time: 0.0003 sec. max.

OFFSET AND ZERO CONTROLS: Three front-panel controls, with effects balanced for maximum speed of zeroing and offset selection.

SELF-CALIBRATION: Unit switches in a precision on-board calibration source when "Int. CAL" or "Special" is touched. Calibration source is accurate to 0.25 % or better (actually factory adjusted at 0.05% or better). The operator uses this on-board source in conjunction with the probe calibration number to match the probe to the instrument.

"SPECIAL" is a calibration function for special probes and measurement situations. It is used to extend instrument dynamic range and resolution.

Each probe carries a calibration number, determined by exacting measurement of each probe's sensitivity. These procedures, plus the precision on-board calibration source in each instrument, permit any probe to be used accurately with any instrument. Thus reference magnets are generally not needed.
External Calibration: When needed, can be done using a reference magnet.

MAGNETOMETER OPERATION: Probe Model PM-85 is an available low-cost option, which extends instrument range down to 2,000 gamma (0.02 Gauss) full-scale, allowing resolution of one gamma, on the most sensitive range. When this probe is plugged in, simply divide all ranges and readings by a factor of 1000.

POWER REQUIREMENTS: 9 volt alkaline battery, DURACELL MN1604, included with instrument. Do not use another type.

POWER CONSUMPTION: 40 millivatts (4.5 milliamperes at 9 volts). Life: approximately 100 hours. A Lov-Battery warning "BAT" appears in display when the battery is depleted to about 7.5 V.

DISPLAY LIGHTING: Pressing "Lamp" will illuminate the display.

TEMPERATURES: Operating, 0 to 50 degrees C; Storage, -20 to +80°C

Temperature Coefficient: Less than 0.05% / deg C, for the instrument. Hall probes have temperature coefficients of their own. See probe specs for details.

Size: 5.75" x 3.6" x 1.6" (146 x 91 x 41 mm). Weight: 10 oz. (280 grams).

Note: Specifications subject to change without notice.

OPERATING INSTRUCTIONS

1. Check to see that a battery is in hatch at rear of case. If not, install DURACELL MN1604. Plug a probe into the receptacle, left side of case.

2. Turn FINE control to mid-rotation position. This turns on the main power. Press RUN/ZOK button. Allov a fev seconds for unit to stabilize.

3. Place probe in zero field chamber, or avay from magnets. Zero the display using OFFSET knob, unless display shovs under 0.05 or so.

4. Select 2K range, and zero display using COARSE control. Select 200 range, and zero the display using FINE control. You are now ready to use the instrument.

TO TURN OFF, PRESS STOP. Display will fade out. When finished using the unit, and to prevent accidental operation, as when the unit is in transit, turn the FINE control left, until it clicks. This disables the power system.

TO SELF-CALIBRATE

1. Place probe in zero field chamber, or just lay the probe down so that it does not move. The important thing here is that the probe experience NO CHANGE in magnetic field during calibration.

2. Zero display as above (steps 2-4).

3. Press INT. CAL. Allow 5 seconds for display to stabilize. Adjust "CAL" control (small hole, upper right of case), with a small screwdriver so that display value is equal to the calibration number printed on the probe connector.

4. Select the 2K range to verify that display returns to zero. If necessary, re-zero display and repeat the sequence.

TO SPECIAL CALIBRATE:

Probes requiring this function will have a special ("SPC") notation with the calibration number, on probe connector.

To calibrate the instrument for use with these probes, first zero the instrument as noted above (steps 1 and 2).

3. Press "Special" and adjust the "Cal" control so that the display value is equal to the probe calibration number.

4. Select 2K range to verify that display returns to zero. If necessary, re-zero display and repeat the procedure.

The "Special" calibration function is just like the regular "Int. Cal." function, except that it is "seen" as ten times "Int. Cal." by the instrument. Thus you will find that if you have calibrated the instrument to a probe at Special 1500, and you later dial up "Int. Cal.", the display will read 150.

You will also find that if the unit is set for an "Int. Cal." value of over 200, and you then select "Special", the display will go to overrange, as it will be trying to display a value over 1999.

"Special" can also be used to reduce sensitivity by calibrating the unit at a value of, say 1/10 normal for a given probe, thus extending system range to 200KG using the 20KG scale.

TO EXTERNALLY CALIBRATE:

The most accurate calibration procedure is to calibrate both the instrument and probe, using a reference magnet, at a level near to the measurement level.

1. Zero the instrument with the probe in a zero-gauss chamber, or away from magnets. Select the appropriate range, and place the probe in the reference magnet. Move probe until you get a peak reading.

2. Adjust the "Cal" control until the display equals reference magnet value. Remove probe from the reference magnet and place in zero gauss chamber. Verify that you get a zero indication. If not, re-zero and repeat above steps.

3. When you get a proper swing between zero and reference value, place probe in zero field again and press "Int. Cal." Record the calibration number displayed for future use of that probe, meter, and flux combination. Only occasional use of the reference magnet will then be required to verify calibration accuracy.

"SET" ADJUSTMENT

This adjustment is factory-set, and normally will not need readjustment.

1. Lay the probe down so that it sees NO CHANGE in magnetism during the procedure, or place probe in a zero chamber.

2. Select 2K range, and adjust controls for a (plus) 10 indication.

3. Select 20K range and adjust "SET" for an indication that alternates equally between (plus) .00 and .01 Repeat steps 2 and 3 if necessary.

OFFSET OR INCREMENTAL OPERATION

You can use the OFFSET control to null out up to about 4,000G of ambient field, and then use the more sensitive ranges to measure small variations within this larger field. For example, you may wish to plot field variation against physical displacement of the probe, or see small deviations due to external influences on the field, as might occur when another magnet or chunk of iron is brought near.

The amount of offset available will depend on the probe type used. You can predict available offset by multiplying the probe calibration number by ten.

If a probe has a calibration number of 402, you can expect about 4000 Gauss of offset. If the number is 1506, you can expect about 15KG of offset. Standard (PT 70, PA 70, PB 70) probes run about 4KG. Higher cost probes will typically allow 12-15 KG of offset. These special probes are usually more linear and have a wider dynamic range than standard probes. They also cost a lot more.

OFFSET PRESELECTION

This mode of operation may be used for repeat-inspection procedures. Suppose that you want to inspect magnets for flux output uniformity, and that all are supposed to produce 1,810 gauss at a certain point measured from each magnet.

First, zero the probe where it will be used. Then dial in -1810 gauss of offset (use the 2K scale for best resolution). Now if a "perfect" magnet is placed at the measurement point, the instrument will read zero, and thus any deviation from the desired value will show up as a positive or negative error.

If you are looking for small errors, just punch up a more sensitive range to suit your requirements. Remember that if you select the 200 range, for example, the instrument will go to overrange (display blanks out) while the magnet is away from the test point. This is normal and of no significance -- the instrument is trying to display that -1810 gauss you dialed in, and cannot do so on the 200 gauss range!

If a record of such inspections is desired, use the analog output jack to connect the instrument to a recorder, plotter, or computer interface.

MEASUREMENT TECHNIQUE

It is important to remember that Hall devices are very directional, and that the sensing area is small compared to the overall dimensions of the probe.

When making measurements, the peak reading will be obtained by rotating the probe in the field, in addition to simply moving the probe around.

Because the sensing area is very small (only .18" X .08", or .0144 sq.in. total area for probes PA70, PB70, and PT70) you are only looking at a very small area with each measurement. As you poke around magnets using this equipment, you will see large variations in field strength with little physical movement of the probe. Thus, you may have to make quite a few measurements to completely describe what is happening in a specific magnetic circuit.

If you are doing incoming quality inspection on magnets, it is important that the magnet specifications be understood. For example, suppose you are buying Alnico V magnets. The specifications say that B_r (residual induction) should be 12,500 Gauss.

So you have the magnet fully magnetized, but no matter where you look on this bar magnet, you can't seem to get over 2,000 Gauss! You have just performed what is known as an "open circuit" measurement.

That magnet you bought really is as advertised, and you will get that 12,500 gauss reading, but only in an iron yoke type circuit, with no gaps, just after magnetization in the yoke to saturation.

Permanent magnets are specified under rigid test conditions that anyone can duplicate with proper equipment. If you are going to do open-circuit inspections, ask your supplier what your

reading should be under those conditions. Better yet, select a magnet that works in your application and establish your own standards for open-circuit measurements for that type of magnet, using a uniform procedure.

If you are measuring highly non-uniform fields, note that two probes of the same model number may not read the field identically. This is due to normal tolerances in the placement of the Hall element within the probe. If this is a problem, simply tag each probe for the normal reading in that measurement fixture, for that particular probe.

If you are measuring fields under 200 gauss, remember to consider the effect of the Earth's field. To null out this field, rotate the probe around its sense axis and adjust the zero (FINE) control for an equal positive and negative indication, or place the probe in a zero field chamber and adjust the FINE control for a zero indication.

PROBES

In general, probes come in three types: transverse, axial, and bare. TRANSVERSE probes are flat-bladed, with the element buried in the flat blade. They sense fields in a direction through the thickness of the blade. The Hall device contained within the probe is delicate. The challenge to the manufacturer is to

make the probe thin, but not so thin that the delicate element is too easily damaged. Model PT70 is heavily protected, but only .060" or so thick overall.

An AXIAL probe is usually cylindrical, with the element buried at one end. It senses fields along its axis. The challenge here is to put the sensing area of the element as near to the end as possible, but still to protect it. Our Model PA70 is heavily protected, with the element sensing area approximately 0.032" from the end of the cylinder.

The BARE probe element hangs out by its wires (covered by a thin sheath). This allows the user to place the actual sensing area wherever he wants to. The curse which comes with this convenience is that the extremely fragile element is completly unprotected. The user has to be expecially careful in handling and protecting it. Model PB70 is an example of this type of probe. The element is encapsulated in a very thin layer of epoxy paint on top of its ceramic substrate. The wires are thin and delicate. This is an extremely handy probe, but be careful!

PROBE CALIBRATION INFORMATION

All probes exhibit some reversibility error. This type of error shows up when a probe is exposed to equal but opposite flux levels. The probe will show one flux level as greater than the other.

To keep things standardized, all of our probes are calibrated in the positive direction. In general, the reversibility error will be not more than 1.5 times the linearity error. So if a probe has a linearity of 1.5% to 10 KG, expect that reversibility error will be under 2.25%. Instrument reversibility error is 0.25% or less, guaranteed, and usually is actually quite a bit less.

Probe Polarity Information: If a probe carries a "North" or spot marking on one side, this means that a probe put into a magnetic field with the marking towards the north pole of a MAGNET, will cause the instrument to read positive.

"NORTH" is DEFINED as "north-seeking", or that pole of a magnet which would point towards Canada if the magnet were freely suspended. This is fundamentally irrational, but it is also current practice in the art, so we are stuck with it. This convention originated with the British Admiralty, which avoided the issue, but perpetuated the convention by simply ordering that all marine compass needles have the north-seeking end painted red. Most people have called the red pole "north" ever since.

All probes have some temperature drift for zero and sensitivity. Sensitivity drift can be compensated, using the proper probe information. Zero drift will be insignificant for most measurement situations. In any event, the

For temperatures ABOVE 25°C, INCREASE the basic probe calibration number by the difference from 25°C x .2% . For temperatures BELOW 25°C, DECREASE the probe cal number by the difference from 25°C x .2% .

Example: Probe Cal number is 400, used at 5°C above standard. 5 deg X .2%/deg = 1% , so increase that 400 cal number to 404. Use Cal 404 for this temperature, and use 400 for standard temperature.

If the temperature is LOWER, than standard, DECREASE the Cal number in the same way. For use at 20°C, Cal = 396.

All probes have some temperature coefficient. More expensive probes have a smaller thermal sensitivity coefficient.

We can supply probes with low thermal coefficients, high linearity (complete with linearity deviation curves), for very high field operation (up to 200 KG), and for cryogenic operation as optional equipment.

Generally, one feature occurs in a probe at the expense of some other feature.

We can adapt almost any Hall effect probe or element for use with this instrument. Usually this involves a cable adapter and a new calibration number for the probe selected.

The LOW-COST MAGNETOMETER PROBE, Model PM-85, (optional equipment) enormously increases the instrument sensitivity. When using this probe, all ranges and readings should be divided by a factor of 1000. Readings are interpreted thus:

DISPLAY VALUE	RANGE USED	ACTUAL FIELD VALUE (gamma)		(Gauss)
18.65 KG	20K	1,865,000	**	18.65
1865 G	2K	186,500		1.865
186.5 G	200	18,650		.1865
18.65 G	20	1,865		.01865

** Please note that this probe becomes non-linear in levels over 2 gauss. Use other probes for these higher levels.

The magnetometer probe senses along its axis. The free end of the probe (the end opposite the cable), when pointed towards the geographic South pole, or towards the "north" pole of a magnet, will cause the instrument to read more positive. If this confuses you, please see the definition of "North", page 16. Sensitivty coefficient is -0.1%/^{o}C.

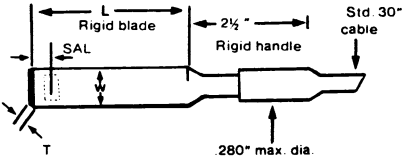
"10X" PROBES

Certain probes are specified as " 10 X " types. This means that after the instrument is calibrated for the probe, all readings on the instrument should be multiplied by a factor of ten. The probe label will indicate if the probe is a 10X type. In general, high-accuracy probes are 10X type probes.

STANDARD PROBES

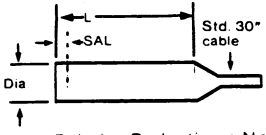
TRANSVERSE PROBES

"PT" MODELS



AXIAL PROBES

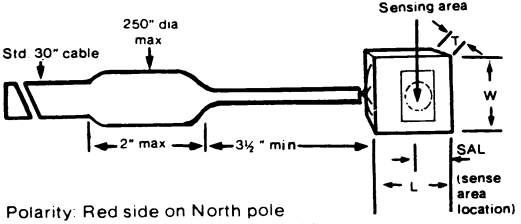
"PA" MODELS



Polarity: Probe tip on North pole of a magnet drives instrument positive.

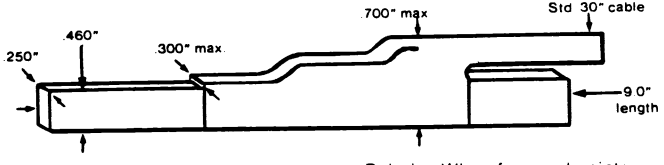
BARE PROBES

"PB" MODELS



Polarity: Red side on North pole of a magnet drives instrument positive.

MAGNETOMETER PROBE PM 85



Polarity: When free end points to geographic South, instrument reads positive.

MODEL	DIMENSIONS (INCHES) L	W	T	SAL	SENSING AREA	SENSITIVITY COEFFICIENT	LINEARITY (MAX. ERROR)	PRICE (4 /84)
PT70	2	.375	.062	.075	.080x.180	-.2%/ °C	1.5% to 10KG	$ 58.00
PT72	2	.275	.115	.100	.050x.075	-.07%/°C	1% to 20 GAUSS	206.00
PT75	2	.375	.062	.085	.060x.120	-.08%/°C	1% to 10KG	190.00
PA70	2	.390 DIA.		.025	.080x.180	-.2%/ °C	1.5% to 10KG	58.00
PA72	2	.390 DIA.		.025	.050x.075	-.07%/°C	1% to 20 GAUSS	206.00
PA74-10	2	.250 DIA.		.025	.020 DIA.	-.04%/°C	.25% to 10KG	362.00
PA74-30	2	.250 DIA.		.025	.020 DIA.	-.04%/°C	1.0% to 30KG	362.00
PB70	.200	.250	.028	.065	.080x.180	-.2%/ °C	1.5% to 10KG	58.00
PB72	.200	.200	.082	.100	.050x.075	-.07%/°C	1% to 20 GAUSS	206.00
PB75	.265	.125	.020	.080	.060x.120	-.08%/°C	1% to 10KG	190.00
PB71-10	.235	.62	.043	.180	.040 DIA.	-.04%/°C	.25% to 10KG	362.00
PB71-30	.235	.62	.043	.180	.040 DIA.	-.04%/°C	.25% to 10KG	362.00
PM85	MAGNETOMETER PROBE - SEE SKETCH					-.1%/ °C	1% to 1.5 GAUSS	168.00
SPECIAL PROBES. Instruments can be fabricated and calibrated to your exact needs.								INQUIRE
SC1	SOFT CARRYING CASE: thick, richly padded black vinyl; holds meter, probe,							15.00
GM1A	MICROPOWER GAUSSMETER, 1 year warranty, DURACELL, and Manual							324.00

STANDARD PROBES SPECIFICATIONS

probe data should be consulted for drift and linearity correction information.

Because of the difficulties of manufacture, you will find that the lovest-cost probes (such as our PA70, PB70 and PT70) may exhibit considerable drift on the 20 gauss range. If this is a problem, we suggest use of the highly sensitive and stable PA72, PB72, and PT72 probes or the Magnetometer probe #PM85 instead.

Low-Cost Probes PT-70, PA-70, and PB-70 share these specifications:
Accuracy: +/- 1.5% of reading to 10KG.
Reversibility error: 2% maximum.
Calibrated: room temp.(25°C) at +5KG.
Thermal Sensitivity coefficient: approx. -0.2% per degree C.

COMPENSATING FOR PROBE TEMPERATURES

To correct for temperatures higher than ambient, multiply the temperature difference (from 25°C) by .2%, and then increase the reading by the difference.

Example: Reading 1856 Gauss at 28°C. This is 3 degrees x .2%, or .6%. So just MULTIPLY the reading by 1.006. True reading is 1867 Gauss. For 22°C (3 degrees colder than 25°C), DIVIDE by 1.006. True reading is 1845 Gauss.

Alternate Procedure: If you expect to use the probe at some specific temperature, you can compensate using a different calibration number for the probe.

PROBES -- DISTINGUISHING FEATURES

PT70: Low cost, Moderate accuracy. Rugged brass enclosure.
PT72: Very stable, Accurate. Excellent for weak field work. Brass Cased.
PT75: Low drift, Higher accuracy. Rugged brass enclosure. Moderate cost.

PA70: Low cost, Moderate accuracy. Tough Lexan enclosure.
PA72: Very stable, Accurate. Excellent for weak field work. Lexan cased.
PA74-10 AND PA74-30: Very accurate, Low temperature drift. Supplied with custom linearity deviation curve. Ruggeceramic tip.

PB70: Low cost, Moderate accuracy. Good for tight spaces.
PB72: Very Stable, Accurate. Excellent for weak field work.
PB75: Low drift, Accurate. Thin profile, for tight spaces. Ceramic cased.
PB71-10 AND PB71-30: Very accurate, Low temperature drift. Supplied with custom linearity deviation curve. Ceramic enclosure.

PM85: Extremely (1000x) sensitive, directional, rugged, Low Cost.

SPECIAL PROBES and INSTRUMENTS can be fabricated, or STANDARD units calibrated, to your exact needs.

SC1: SOFT CARRYING CASE: thick, richly padded black vinyl. Clips to your belt.

REFERENCE MAGNETS AND ZERO CHAMBERS

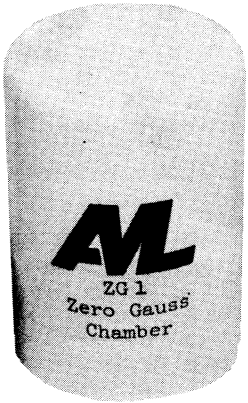
Reference Magnets provide a convenient means to verify the accuracy of Gaussmeters equipped with built-in calibration systems. They are required for units which are not self-calibrating.

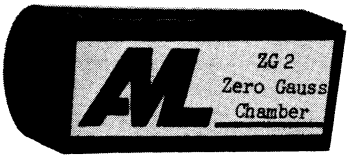
Reference Magnets are self-shielded, to minimize the effects of external fields. Manufacturing processes include temperature cycling and substantial demagnetizing from saturation. This results in exceptional stability over wide ambient temperature ranges, and the ability to retain calibrated values for many years.

In general, the Reference Magnets may be expected to retain initial accuracy over temperaturess from 0 to 40 degrees C. It should be noted that the field value will change -0.02%/°C but will return to its reference value at 25°C, providing the temperature extremes noted above are not exceeded. References with values of 1000 Gauss and higher will not be affected by ambient fields up to 200 Gauss. Magnets with values lower than 1000 Gauss will retain their calibrated value after being subjected to demagnetizing influences of up to 100 Gauss.

Note that the normal magnetic ambients do not exceed one or two gauss. Larger fields are generally found only in close proximity to large electric motors, magnetron tubes and other unusual electromagnetic and magnetic assemblies.

REFERENCE MAGNETS and ZERO GAUSS CHAMBERS





REFERENCE MAGNETS- TRANSVERSE

Gap: .062" thick to admit the probe.

Model RMT62	Value Gauss	Tolerance (+/-)	Price (4/'84)
-200	200	1 %	$130.00
-500	500	1 %	130.00
-1KG	1000	0.5 %	130.00
-2KG	2000	0.5 %	130.00
-5KG	5000	0.5%	130.00
-10KG	10000	0.5 %	570.00

REFERENCE MAGNETS- AXIAL

.312" Diameter Hole to admit the probe.
Caution: Larger probes will not fit !

RMAX			
-100	100	1 %	160.00
-200	200	1 %	160.00
-500	500	1 %	160.00
-1KG	1000	1 %	450.00
-2KG	2000	1 %	450.00

ZERO GAUSS CHAMBERS

Caution: Larger probes may not fit !

ZG-1	.5" DIA. X 1.5" opening, Double Shielded.	70.00
ZG-2	.33" DIA. x 2" opening, Single Shielded.	40.00

THEORY OF OPERATION

This instrument measures flux density, or "lines" of flux per unit area. One gauss is defined as one "line" of flux per square cm. A "line" is also called a "Maxwell". 10 kilogauss = 1 tesla.

The tesla (T) is defined electrically and mechanically as follows:

One T is the magnetic flux density (assumed to be uniform) required to produce a torque of one Newton-meter on a plane loop carrying one ampere of current, and having a planar area of one square meter, when the plane of the loop is perpendicular to the field vector.

This is the "official" S.I. definition for flux density. Appropriate conversions can be made for more common usage: One gauss is simply 1/10,000 of the quantity noted above. The field of the earth is approximately .3 to .4 gauss, depending on where measured.

The sensor is a Hall-effect device, located in the probe tip. It consists of a thin layer of semiconductor material (usually gallium arsenide or indium arsenide) deposited on a thin ceramic wafer, with four leads attached.

A precisely defined current is passed through two of the leads, (the control current leads). In a magnetic field, a voltage appears at the other two leads (the Hall voltage leads).

This voltage is proportional to the control current, the field intensity, the thickness of the Hall layer, the angle of incidence of the field to the Hall layer, and the basic sensitivity of the Hall material; that is,

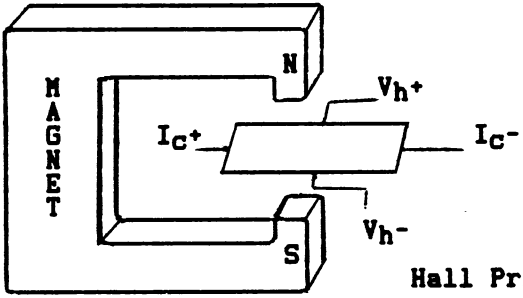
$$V_h = \frac{I_C \times B \times \text{SIN } A}{T_h} K_h$$

Where:
V_h= Hall voltage, I_C= Control current
B= Flux density, A= Angle of incidence
T_h= Hall material thickness
K_h= Material sensitivity constant

Note that if the flux angle is 90°, the output is maximized (SIN 90°= 1), and that if I_C, T_h, and K_h remain constant, then output is directly proportional to flux density, which is the goal. The device also responds to both electrical (control current) and magnetic polarity.

PRINCIPLE OF THE HALL EFFECT

The Hall device responds because a moving charge is deflected at right angles to a magnetic field. The "moving charge" is the flow of electrons across the device (the control current). The magnetic field deflects these charges to one side of the Hall layer, depending on polarity. This is known as an effect of the Lorenz force. It is the same force which deflects electron beams to "write" the picture on a television screen.



Hall Principle

In the Hall layer, electrons deflected to one side result in a charge build-up on that side, and a depletion of charges on the other side. This difference is detected as the Hall voltage, measured at the V_h terminals.

Virtually any electrical conductor could be used as the Hall material, with some vastly more sensitive than others. Sensitive Hall materials will exhibit some change of sensitivity with temperature, due to changes in the mobility of electrons. These changes can be compensated for high accuracy measurements, in accordance with probe specifications.

MEASUREMENT SCHEME

The instrument delivers a precise alternating current to the control current leads. A sychronous processor

detects the Hall voltage and a zeroing and offset circuit corrects the Hall voltage to the desired zero point. The corrected Hall voltage is then further processed by a preamplifier system.

The preamplifier contains a special circuit to sense the type of probe and automatically adjusts preamplifier gain to the approximate value for that probe type, optimizing overall amplifier performance. The corrected, zeroed, preamplified signal is then processed through a precision digital ranging amplifier system and sent to the output jack and to the analog-to-digital converter input.

A dual-slope precision A-to-D converter then converts the signal to drive the 3-1/2 digit display, with polarity information preserved. The final signal delivered to both the A/D converter and the analog output jack is filtered progressively for each range, with minimal filtering on the least sensitive range (20KG) and maximum on the most sensitive range (20 G). Thus, response will be slower on the more sensitive ranges.

Self-Calibration is achieved by injecting a precision reference voltage into the preamplifier when any calibration mode is selected. This voltage is very precisely set at the factory. With the factory-adjusted control current setting, it forms the basis of the precision on-board measurement standards. Probes are factory-precalibrated to work

in harmony with the instrument, assuming these electrical yardsticks are intact.

The "CAL" adjustment potentiometer is adjusted by the operator through the hole marked "CAL" on the instrument face. This adjustment changes the final amplifier gain to match the probe being used. The "set" adjustment compensates for final amplifier offset, to assure zero stability during range changes.

A low battery condition is detected by another reference system, which drives the "BAT" display signal whenever the battery drops below about 7.6 volts. At this point, instrument readings become unreliable and the battery should be replaced. The TYPE of BATTERY is VERY IMPORTANT. Use only a 9V alkaline type. DURACELL* type MN-1604 is highly recommended. An ordinary zinc-carbon 9V battery will not work properly - it has too high an impedance.

All of the control functions of the instrument are digitally selected, including "on" and "stop". Thus, the instrument can be remotely controlled with optional equipment. The control functions are selected at very high speeds. The maximum time for any selection to take place, once commanded, is about 250 microseconds. Thus, even the briefest touch to one of the front-panel touch switches will activate and "lock on" the desired function.

WARRANTY

This instrument is warranted for one year from shipment to the user according to the records of the selling dealer. We will repair or replace any defective component or defect in materials or workmanship free of charge during the warranty period, provided that:

1. Customer pays shipping to us; we pay return shipping.
2. Warranty EXCLUDES:
   a. Willful neglect, damage, and physical abuse.
   b. Batteries and probes.
   c. Damage or failure due to the use of an improper battery. DURACELL MN-1604 is the proper battery.
   d. Damage due to connecting a power source to the output jack.
3. Warranty VOID if in our opinion, the instrument has been improperly repaired or altered, or if the anti-tampering seal on the instrument is not intact when the instrument is received at the factory for service.

5. We limit the duration of any implied warranty of merchantibility to one year and exclude incidental or consequential damages for breach of any warranty on this product. Some states do not allow limitations on how long an implied warranty lasts, or the exclusion or limitation of incidental or consequential damages, so the above exclusions may not apply to you.

SERVICE INFORMATION

The SERIAL NUMBER is located in the battery hatch. This instrument contains a number of highly unusual features. Internal check-out and adjustments require very special knowledge, procedures, and equipment.

Attempted repair or adjustment by people not trained and authorized by us is not recommended. Unit contains no user-serviceable components.

We reserve the right to refuse to repair any instrument that has been opened (as shown by disturbance of anti-tampering seal, or other marks) or altered by others.

Since this policy puts our customers, whom we value highly, in a position of being able to get service only from us, we have established MAXIMUM CHARGES for OUT-OF-WARRANTY service, equal to 25% of the current list price of the instrument.

MINIMUM CHARGES for OUT-OF-WARRANTY service will be equal to 8% of the current list price. IN-WARRANTY SERVICE is explained above. Service will take a maximum of two weeks from receipt by us.

FACTORY INTERNAL RECALIBRATION will cost 8% of the current list price.

For service, please pack carefully, and ship prepaid and insured.

APPLIED MAGNETICS LABORATORY, INC.

New Address & Phone No.
1404 Bare Hills Road
Baltimore, Maryland 21209
(301) 583-2100

INSTRUMENTS * RESEARCH MAGNETS
CUSTOM EQUIPMENT * SYSTEMS
RESEARCH AND DEVELOPMENT