AlphaLab Inc.

Vector Magnitude Gaussmeter Model VGM Instructions

Quick Start: Turn the left knob to “Measure”. The magnitude of the magnetic field (at the tip of the aluminum sensor) will be displayed. The values of the X, Y, and Z components can also be displayed by pressing “View”. If the knob is turned to “Peak Hold”, similar parameters are displayed, except that they are the peak values for magnitude X, Y and Z. Depending on how the meter has been adjusted, there may be offsets present (similar to the “tare” on a weight scale). These can be adjusted by the “Reset” button on the “OFFSET” knob, to be explained below.

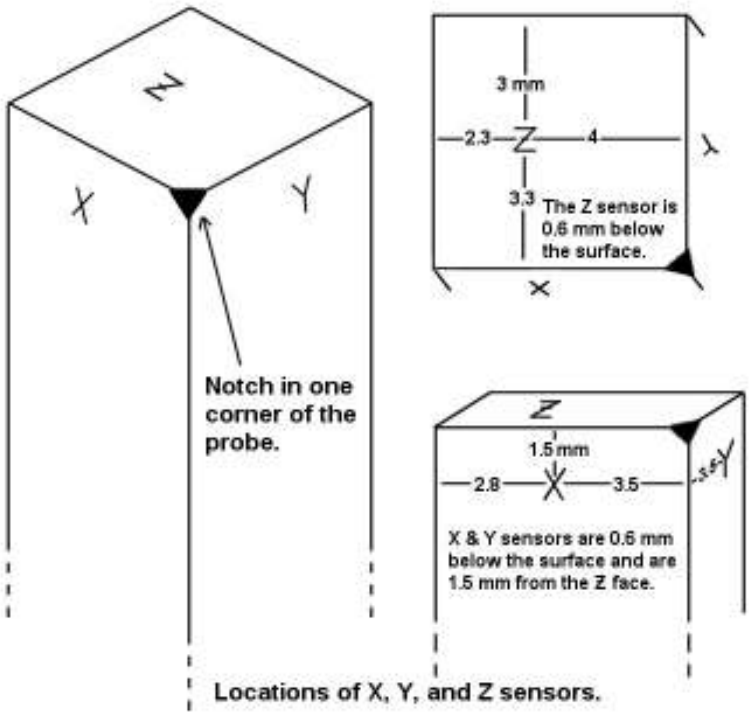
Power: As shipped, a standard 9 volt battery is installed. Battery life is about 10 hours (25 ma drain; 6.5 volt dropout). “Low battery” appears when about one hour of battery life remains. Pull off the rubber boot if present (the soft bumper around the meter) and slide off the back door to replace. It is easiest to remove the battery by tapping the meter (against a table) on the back side of the meter near the battery door. The AC adapter can be substituted for the battery. When plugged in (left edge of enclosure), the adapter disconnects the battery (does not charge the battery). If the meter is on when changing from battery to adapter, it may turn off. To restart it, see “system reset” below.

System reset (if meter does not turn on): To restart the meter (and return to the factory-preset offsets for X,Y,Z), turn the meter to “Measure” and plug the AC adapter cord ***without*** the AC adapter being connected to power. Then turn the meter off and disconnect the cord from the meter. System reset can also be done by removing the battery while the meter is on, then turning the meter off and replacing the battery. The system resets because power is interrupted. This includes interruption of internal capacitor power, which has enough energy for 30 seconds while the meter is off, or 0.01 sec while it is on.

Simple measurements: Turn the left knob to “Measure”. Notice “DC” on the display and a triangle under the word “Magnitude”. The number shown is the DC magnetic field, in gauss, and is sensed at the tip of the probe. It is the field magnitude, meaning the square root of the sum of the squares of the X, Y, and Z field components. If the probe is not near magnetized objects, it will read the Earth field, which is typically about 0.50 gauss. You can begin measuring the field immediately, although when first turned on, a transient offset in the reading of as much as 0.20 gauss may occur. This offset disappears within 5 seconds, which is the full warm-up time. If you need to read fields of less than few gauss, wait at least 5 seconds after turning on.

Besides the magnitude, the separate X,Y,Z values (the vector components of the field) can be displayed by pressing “View”. When pressed once, the displayed triangle will be under “X Axis”, and only the X component of the field will be shown. Pressing again goes to Y; again goes to Z, and pressing one more time returns to “Magnitude” Unlike magnitude, each one of these XYZ components can be *negative* (as well as positive), and the range of each of X,Y,Z is -799.99 to +799.99 gauss. (The range of the “Magnitude” is 0.00 to 799.99 gauss. Stronger fields will not harm the meter or probe, but the display will indicate over-range at 800 gauss and above, which will appear as " 1- - - . - -").

The easiest way to measure the field on a surface (of a part) is by sliding the probe along the surface. The probe can touch the surface either on the probe’s aluminum side or on its black top face. The image below shows the location of each of the X,Y,Z sensors. Each sensor is small (< 0.2 x 0.2 x 0.1 mm) so that each measures essentially one point in space. The image shows orientation relative to the small black triangle, where one of the four top corners of the probe has been notched and painted black. When trying to measure exactly at the surface of a part (or as close as possible to the surface), orient the probe so that the Z face (top face) is touching the surface. (The Z sensor is only 0.6 mm beneath the top face of the probe, whereas X and Y are 0.9 deep beneath the aluminum surface.) Select “Magnitude” for checking residual magnetization.



Locations of X, Y, and Z sensors.

In theory, this number will not change when the probe is reoriented in a different direction. In practice, the reading will often change somewhat whenever the probe direction is reoriented. This problem occurs if the meter is either not properly “zeroed” or if the probe is near a small magnetized object which has a field that is not uniform across the thickness of the probe. (As shipped, the meter is properly zeroed to within +/- 0.10 gauss for each of X,Y,Z. Methods for altering and checking the meter zero are described later.) The field is not uniform if its source is a small part or if the field is strong only in a region that if a few millimeters wide. If you find a location on a magnetized surface where the field very strong and then move the probe away a few mm, the reading will not change much if the field is uniform. If the field magnitude instead changes by more than a factor of two over a distance of a few mm, then it is not uniform and it is more difficult to read consistently with a probe that is about 6 mm wide.

Polarity of the probe: The X,Y,Z sensors read positive when the north pole of a magnet is pointed toward them. That is, if a magnet is placed on the right side with its north pole pointing to the left in the image above, then if the “View” button is pressed so that Z is displayed, the number shown will be positive (no negative sign will be present). If the magnet is then turned 180°, the number will become negative. Note that a south pole that is pointed toward the Z face will produce a negative value for Z. Also, if the Z face is pointed toward the Earth north pole, Y will read *negative*-- the Earth *north* pole is actually the *south* pole of a magnet.

Alarm: The alarm will sound (and a red light will appear from under the label) when the magnitude of the field exceeds a level that you set. The alarm will never sound or light unless you set a level, and it will not sound or light when muted (by setting it to 0.00). It will also become muted whenever the meter is turned off and back on. To set a level, Press *and continue to press* “Alarm Set”. The level will be displayed (initially 0.00) and can be changed by turning the OFFSET knob. Clockwise increases the number; counter-clockwise decreases it (one click CCW from 0.00 is the highest alarm level: 790.00 gauss; more clicks CCW will decrease that level). At any time, the level can be directly reset to 0.00 (muted) by pushing *down* on the OFFSET knob while pressing “Alarm Set”. Once “Alarm Set” is released, the level will be remembered and can be modified later by pressing and holding “Alarm Set” again. There are about 100 different alarm levels that can be selected, from 1.00 to 790.00 (these values will be obvious). The alarm will produce sound and light only *during* the times that the magnitude exceeds the level you had set, and a delay of about 5 milliseconds is required for the alarm sound to begin. There is about a 5 millisecond lag (after the

magnitude drops below the alarm level) for the sound to stop. An alarm output jack is on the left side of the meter. During the time that the alarm is sounding, the center pin of the jack will be at +3 volts; at all other times, the output is zero. This feature can be used for automated pass/fail verification.

Typically the alarm can be set at about 10.00 gauss. Then a part can be rapidly scanned. By listening for the alarm, the area of strongest magnetization can be quickly found; it is usually in the center of the zone in which the alarm sounds.

Peak hold: Whenever the meter is on (whether the left knob is set on either “Measure” or “Peak Hold”), the internal memory stores and continually updates four peak hold numbers. Every 5 milliseconds, the present values of magnitude, X, Y, and Z are compared to the four numbers in memory. If the present value of any of the variables is *higher* than the corresponding number in memory, then that memory is replaced by the higher number. This comparison occurs 50 times faster than the display update, so that peaks can be detected that are too fast to be displayed. For example, suppose the peak hold number stored for the Y axis is 322.74 gauss. Then for 7 milliseconds the Y field peaks at -455.37 gauss (or its average over a 5 ms time is that value). The Y peak hold memory will immediately be changed to -455.37 (note the change to a negative value because the actual peak field was negative in this example). The Y peak will stay at that new value until either a higher peak in Y occurs or “Reset” is pressed while peak hold is being displayed (i.e., when the left knob is set to “Peak Hold”).

Notes about Peak Hold: When peak hold is being displayed, the “View” button still toggles between the four variables (but the peak value of each is displayed, and these numbers will stay constant most of the time). Also the alarm still operates, and the peak comparison every 5 ms continues. In this mode, pressing “Reset” will return all four peak hold numbers in memory to the *present* values of magnitude, X, Y, and Z, and the peak comparison process begins again. The peak of the magnitude can only be a positive number, but X, Y, and Z peaks can be negative, depending on the polarity of the peak *absolute value* of the vector field component. If a single event causes X,Y,Z to peak simultaneously, then the displayed peak hold magnitude will exactly equal the square root of the sum of the squares of the peak values of X, Y, and Z. However, all four variables may instead have peaked at different times. If this happens, then the peak hold magnitude will be *less than* the square root of the sum of the squares of the peak values of X, Y, and Z.

In general, all functions that operate while the left knob is set on “Measure” will also operate in the same way on “Peak Hold”. Instead of displaying the actual values of magnitude, X, Y, and Z, the display on “Peak Hold” will show the highest value of these variables. These numbers remain constant most of the time; they only change when the probe is exposed to a stronger field than the previous maximum. Then they may change to a new, higher number and stay that way until there is an even stronger field.

Offsets: For most types of measurement, whenever the probe is in zero field, all four variables (on “Measure”) should also display as zero. As shipped, each of X,Y,Z reads 0 +/- 0.10 gauss when the probe is in a zero gauss environment. You can manually improve the offset zero error (of +/- 0.10 gauss) by placing the probe in a zero gauss chamber (an optional accessory for this meter) and then press “Reset” while magnitude is displayed on “Measure”. This will change the zero (tare) of X,Y,Z so they all read zero in that field. This new “tare” or offset will be remembered even after the meter is turned off and back on. The factory preset offset can be restored either by doing a **“System reset”**, as described near the top of these instructions or by pressing *downward* on the OFFSET knob and releasing it so that a triangle appears over the phrase “Offset Adjust”, and then pressing the “Reset” button. Press downward on the OFFSET knob one more time to eliminate the triangle. You can skip the remainder of this “offset” section unless you need to measure very small field variations (less than 0.10 gauss).

Fine-tuning the offset without using a zero gauss chamber: This is slower than with a zero gauss chamber, and requires about two minutes. Remember that jitter in the reading is about +/- 0.02 gauss, so it is difficult to do these adjustments perfectly. To adjust the offset, first find a horizontal nonmagnetic surface that is at least 30 cm (12”) from any magnetized objects. (You can use the meter to determine if anything is magnetized nearby.) A wood or plastic table works well at any location away from its steel supports, if it has any. Set the knob to “Measure” and press “View” so that X is displayed. In the image above (near the beginning of these instructions), note the location shown

for the X face, which is to the left of the probe's notch (notch = black triangle in the image). Suppose that the offset is presently correct. If so, then if the probe is laid on a nonmag-netic table with the X face pointing downward (i.e., with the X face in contact with the table), it will accurately display the vertical component of the Earth magnetic field at that location. In the northern hemisphere, this vertical component generally is downward (while the horizontal component points approximately to the north). In this configuration of the meter and probe, the X face is pointing downward and the meter is displaying the X value. Therefore the meter is presently reading the *vertical* component of the field. In the northern hemisphere, it should read a negative number (typically around -0.40 gauss).

If the probe is then flipped 180° (as a pancake would be flipped) so that the X face is upward, then the meter should read the *negative* of the previous number. For example, if it had read -0.40 when facing downward, it should now read 0.40 (without a negative sign) when facing upward. Whenever there is no error in the zero offset, a single axis reading, when flipped 180° about that axis, should remain the same number except that the sign will reverse.

Now suppose that the offset were *not* properly zeroed, at least in the X axis. Suppose that the X value is off by -0.15 gauss, so in true zero field, X reads -0.15 gauss. This would mean in the above example that when the X face is upward, instead of reading 0.40 gauss, it would read 0.25 gauss. Similarly, when face-down it would read -0.55 gauss (which is 0.15 gauss *more negative* than the true value of -0.40). Because 0.25 and -0.55 are not negatives of each other, we know that the offset is not set properly in this example.

The OFFSET knob can be used to change the offset of each of X,Y,Z. However, these three offsets can only be modified while viewing X,Y, or Z on the "Measure" mode, and then pushing *downward* on the OFFSET knob so a triangle appears in the display over the words "Offset Adjust" on the label. After turning the left knob to "Measure", pressing "View" to select X, Y, or Z, and pressing down on the OFFSET knob so a triangle appears over the words "Offset Adjust", then by rotating the OFFSET knob, you can change the offset on the axis (X, Y, or Z) that is being viewed. Turning clockwise will add; CCW will subtract. It is 0.01 gauss per click of the knob and there are 24 clicks per rotation. The effect of the offset is displayed immediately. For example, if X is stable and reading -0.15 gauss, and then the knob is turned 2 turns CW, the reading will become -0.15 + 0.48 = 0.33 gauss. You can press **"**Reset**"** while in this mode to restore the factory offsets. Once these offsets are modified, they will be remembered until new offsets are entered.

The triangle is removed by pressing OFFSET again, or by toggling the view back to "Magnitude" (magnitude does not technically have a its own offset; it is a computed variable taken from the measured values of X,Y,Z so its offset cannot be adjusted). The triangle is also removed if the left knob is turned to "Peak Hold" (or of course to OFF).

To adjust for zero offset, view X and press down on OFFSET so the "Offset Adjust" triangle appears, as above. Lay the X face of the probe on the table (facing down) and note the reading. Then flip the probe 180° so the X face is up. Note this and then compute the average of the two numbers. This average is the offset error of X. For example, if the first number was -0.43 and the second was 0.43, then the average is zero and there is no offset error. If the numbers are instead 0.25 and -0.55 (as in a previous example), the average is -0.15 so that 0.15 would need to be added to the X offset to correct it. This amount is added by turning the OFFSET knob 15 clicks clockwise. If the two numbers are 1.50 and 1.70, the offset error is 1.60, so the knob must be turned CCW 6 complete rotations + 16 clicks. When offset is adjusted correctly, the two numbers will be the same amount but of opposite signs (subject to the 0.02 gauss jitter). Note and remember the final value when the X face is downward, which is the correct value of the vertical field component. Knowing this value will make the Y and Z offset corrections simpler to do.

To correct Y for zero offset, press "View" to display Y and lay the Y face downward on the table. If the Y offset is correct, it will read the same number as the X did when X was facing downward (assuming the X offset was first corrected). Rotate the OFFSET knob until Y reads this number (the vertical field). You can confirm that the adjustment is correct by flipping Y so it is face-up; the number should reverse sign just as X did, and both numbers should be the same as the numbers for X. To correct Z, press "View" to display Z, lay the top surface of the probe (the Z face) against the table, so that the probe is vertical, and rotate OFFSET so that Z reads the same number as X did (when X was face-down). Now press downward on the OFFSET knob to remove the triangle, and the offset adjustment is done. (Accidentally turning the OFFSET knob will now not affect anything.)

Changing the factory-set offsets: This operation would never normally need to be done, however if the factory offsets have been accidentally changed (by accidentally doing the steps listed below), you can restore them to the correct values, which will remain in non-volatile memory (stored even if the battery is removed for a long time). Make sure that you have first adjusted the offsets to zero properly, as described above. Then push downward on the OFFSET knob so a triangle appears over “Offset Adjust”. Release the knob and then press and hold down the “Alarm Set” button until the display blinks. While still pressing “Alarm Set”, press and release “Data Option”. The offsets at that moment will be stored (this will not change the present offsets).

Subtracting out the ambient (background) field: In some situations, the change in the field (from its ambient value) is the variable that needs to be measured. If that is the case, place the probe in the ambient field *in the orientation in which it will be used* and press “Reset” (knob must be on “Measure”, while displaying “Magnitude”). This will subtract the ambient field from X,Y,Z so that all variables will read zero (within a few counts). Then any displayed values (including peak hold values) will be with respect to the ambient field. Generally the ambient field present is just the Earth field (typically 1/2 gauss), but any field up to 799 gauss in any direction can be subtracted this way.

Be careful about the meaning of “subtraction” here. An example will clarify this. Suppose the probe is oriented so that X is facing up, Y is facing east and Z is facing north, and that the ambient field is X = 10.00 gauss and Y and Z are each 0.00 gauss. Then the magnitude is also 10.00 gauss. Press “Reset”; this produces no change in the Y or Z offsets (which are already zero) but this action causes 10 gauss to be subtracted from whatever X reads from that moment on, so X will read zero, and thus the magnitude will also read zero. If the actual field is now reversed so that the vertical component becomes -10.00 gauss (as opposed of its former value of +10.00), then of course Y and Z will continue to read zero. However, now X will read “-20.00” and magnitude will read “20.00”, even though the true magnitude remains 10.00 gauss (magnitude has not actually changed). In general, if an offset reset is done, the magnitude will initially read zero, but it will increase if the field direction changes (or if the probe is reoriented).

SPECIFICATIONS: 3-axis DC Gaussmeter VGM	
Range/Resolution:	0-799.99 G/ 0.01 G. Includes polarity of X, Y, Z. Magnitude = is sqrt of sum of squares.
Accuracy:	1° of reading (16° to 29° C), 2% of reading (-4° to 65° C) Pointing accuracy 1% of arc.
Offsets:	Relative zero (subtracts present field from X, Y, Z);Unlimited manual offset of X, Y, Z.
Probe:	3-axis non-detachable 6.3 x 6.3 x 50 mm long. All three sensors are within 1.5 mm of probe end.
Peak Hold:	0.005 sec time constant. Peaks in X, Y, Z and magnitude are recorded and stored separately.
Alarm:	Associated with magnitude only, 5 millisecond response time; Simultaneous red light.
Alarm Levels:	100 levels can be selected, from 1.00 to 790.00 G
Meter Size:	5.8 x 3.8 x 2.0 inches; 147 x 97 x 51 mm
Weight:	11.7 oz
Battery:	9 volt alkaline (~ 10 hour life) / "Low Battery" indicator.

The warranty period for this meter is one year from the date of delivery.

Manufactured in the USA by AlphaLab, Inc. 3005 South 300 West Salt Lake City, Utah 84115 USA www.trifield.com - mail@trifield.com - (801)487-9492