AlphaLab Inc.

Gaussmeter Model GM2 Instructions

Operation: Plug in the probe on the top edge of the meter. Turn the meter on ("DC"). There are several probe styles available. The most popular is the ST universal probe, which is described in this paragraph. (The ST probes measure up to 29,999 gauss whereas the more sensitive HS probes measure up to 799.99 gauss.) Note that the last few millimeters at the (black) end of the universal probe has a square bulge on one side; the other side is flat. The center of that square bulge is the location of the Hall-Effect sensor, which is very small (0.2 x 0.2 mm). The "bulge" side is also indicated by a black mark on the gray cable. Place the flat side of the probe's end (not the square bulge side) against the surface to be measured. A negative sign indicates that the probe is facing the south pole of a magnet; in contrast, a north pole will read positive ("positive" is indicated by the absence of a polarity sign on the display). The actual center of the sensor is 0.85 mm above the flat surface or 0.65 mm below the top of the square bulge) and is centered in the center of the square bulge.

An axial ST probe is available as an option. It is 6.6 mm (0.25") diameter and 100 mm (4") long on a 100 cm cable. It detects the field component in the same direction as its 100 mm axis. A rigid transverse ST probe is also available. It is 0.80 mm thick (= direction of magnetic axis) x 3.6 mm wide x 66 mm long on a 100 cm cable. All sizes and lengths can be custom-modified. **A high-stability probe** (HS probe) is another option. When this probe is plugged into the meter, the displayed decimal point changes so that two digits are to the right of it. Then the display reads up to +/−799.99 gauss. This probe is stable down to +/−0.03 gauss. These instructions refer to the ST (not the HS) series of probes.

Below 10 gauss, only two digits (such as "3.7") will be displayed. For stronger fields, more digits will appear. For fields stronger than +/- 9999.9 gauss, the extreme left digit will also be seen. (It will be a "1" or "2"). Very few magnet assemblies have a field this strong, which is usually found only in the gap between two rare earth magnets or in a high-power electromagnet. If the field is stronger than +/- 19,999.9 gauss, the display will switch to the 29.999 kG range. (A triangle will appear under the word "Kilogauss" and a decimal point will appear after the first two digits.) When the field decreases below 18.000 kG, the display will switch back to the gauss range. If the field is over 29.999 kG (unlikely to be encountered except with a superconducting magnet), it is over range and will display "1- - - - -". These high fields will not harm the meter, although some styles of batteries may malfunction if exposed to such high fields. (This malfunction would only occur if the battery itself is exposed to the high field.)

If the display reads "LO BATT", there is about one hour of battery life remaining. Remove the soft bumper (the "boot") if the bumper is present, and then slide off the battery door on the back side. Replace with a common 9-volt rectangular battery. Alkaline is preferred. Current drain is 15ma and the LO BATT reads if battery voltage remains below 6.8V for at least one minute. (Accuracy errors will occur only below 5V). The USB adapter can be substituted for the battery. When plugged in (top of enclosure), the USB adapter does not attempt to charge the battery.

System Reset: In the event the meter freezes up, restart the meter—remove the battery for 60 seconds and then turn it on for at least 1 second ***without*** the USB adapter being connected to power. 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.

Offset adjustment (only necessary if measuring weak fields): On "DC", pressing the "Relative Zero" button will subtract the present field from the display, causing it to read zero. Then if the field increases to higher than that value, the display will become a positive number; it will display a negative number in the opposite case. This subtraction of the field at the time (when "Relative Zero" was pressed) will continue in effect until "Relative Zero" is pressed again. When this subtraction is in effect, a triangle will appear over the label phrase "Relative Zero". The OFFSET knob also allows you to add or subtract any number from the displayed number of gauss. Clockwise increases the number and vice-versa. This offset stays in effect until you change the offset again or turn the meter off and then on. This is the magnetic equivalent of adjusting the "tare" weight of a weight scale, because there may be an ambient magnetic field that you'll want to subtract out. Note that the OFFSET knob is 2.4 gauss per rotation. At any time, the offset can be returned to near zero by pressing **down** on the OFFSET knob. This will also remove the "Relative Zero" indicator. You can perfectly adjust the offset to zero if you do one of two things, either:

1) Place the sensor in a “zero gauss chamber” (not supplied with this meter) and then either turn OFFSET until the display shows a zero reading or press “Relative Zero”. (However, a “zero gauss chamber” is sometimes accidentally magnetized, so it is not always reliable.) or

2) Place the sensor end flat on a non-magnetic table or desk with the square bulge facing up. If already properly zeroed in this orientation in the northern hemisphere, the meter will read the upward-pointing component of the magnetic field (a positive number-- if the field is instead *downward*-pointing there, the meter should then read a negative number.) Note the number on the display. Then flip the sensor so the square bulge is facing down. This 2nd reading should be the *negative* of the 1st reading. That is, if the 1st reading was −0.4 (gauss), then the 2nd should be 0.4 (gauss). If the two readings are not the negative of each other, then the OFFSET is not adjusted perfectly for a zero reading in zero field. For example, if the 1st reading is 1.0, and the 2nd reading is 0.0, then the OFFSET is off by 0.5 gauss (the average of the two readings). Generally, this fine level of adjustment is not necessary because it makes a difference of only a fraction of a gauss when measuring a multi-thousand gauss magnet.

AC measurement: Set the knob to “AC”. The display will show AC (pseudo-RMS, +/−3% of reading +/−10 counts, from 45 to 800 Hz; 3 dB corners are at 11 to 1500 Hz). When using an AC adapter, a significant background AC reading may appear; it can be removed by pressing “relative zero”. The OFFSET does not affect the AC reading.

Peak Hold: The highest value of the DC field (whether + or − polarity) since the last time the “Peak Reset” button was pressed will be held in memory. This value has a capture time of only 2 milliseconds, so even a brief spike will be detected. It can be displayed at any time by switching the knob to “Peak Hold”. The peak hold detection circuitry continues to operate regardless of the setting (DC, AC, or Peak Hold), and is retained in memory even when the meter is off. Therefore, in order to clear the previous peak hold value, press “Peak Reset”, which will return the peak hold number to within about one gauss of the present field. (Noise at this high sampling speed will cause the peak hold displayed to be slightly higher than the actual value.) If kilogauss is desired without auto range, hold peak reset for five seconds while in DC and peak hold mode. To turn off locked kilogauss mode, hold peak hold for five seconds again and this will turn it off.

Alarm: The alarm will sound (and the light will illuminate) when field either exceeds a threshold that you set or is between two levels that you set. The alarm will never sound unless you set it and it will not sound when muted (by setting it to 0.0). It will also become muted whenever the meter is turned off and back on. To set a threshold, press *and continue to press* “Alarm Set”. The threshold will be displayed (initially 0.0) and can be changed by turning the OFFSET knob. Clockwise increases the number; counter-clockwise decreases it (a few clicks CCW from 0.0 is the highest alarm value: 19000.0 gauss; more clicks CCW will decrease that value). At any time, the value can be directly reset to 0.0 (muted) by pushing *down* on the OFFSET knob while pressing “Alarm Set”. Once “Alarm Set” is released, the value will be remembered and can be modified later by pressing and holding “Alarm Set” again. There are 94 different alarm values that can be selected, from 1.0 to 19000.0 gauss (these values will be obvious). The alarm will sound only *during* the times that the field exceeds the threshold you had set, and a delay of about 2 milliseconds is required for the alarm sound to begin. There is about a 2 millisecond lag (after the magnitude drops below the alarm level) for the sound to stop. This mode of the alarm is often used to check for the presence of magnetized objects. For this, the threshold is typically set at about 30.0 gauss. Then an area can be rapidly scanned. By listening for the alarm, the area of strongest magnetization can be quickly found.

A second alarm mode makes the alarm sound only when the field is *between* two limits (e.g., between 100 gauss and 200 gauss). To activate this mode, press and hold Alarm Set and rotate the offset to set one of the two limits. Then while continuing to hold Alarm Set, press and release Data Option. Then set the other limit using the offset knob. It doesn’t matter whether the upper or lower limit is entered first; the alarm will sound only when the field is between the lower and upper numbers entered.

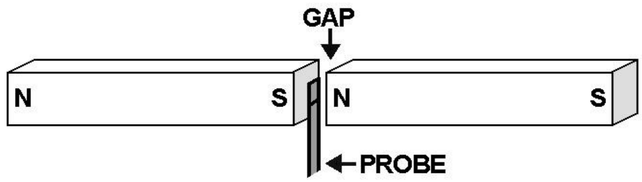
To activate a digital output that will go high (+3.5V) when the alarm sounds, press “Alarm Set” and while holding that button press “Relative Zero”. You will notice a flag turn on at the bottom of the display telling you the output jack is now a logic signal. To return to a linear output, repeat the procedure.

Alarm notes: The alarm can be set whenever the meter is on (DC, AC, or Peak Hold). It detects the DC signal when on "DC" and the AC signal when on "AC". When the left knob is set either to "DC", or "AC", the alarm operates based on the *displayed number*, not the actual field, and the alarm ignores the negative sign, if present. Therefore, if the alarm is set to sound over 500 gauss, and the actual field displayed is −600 gauss (DC), the alarm will sound. If the "Relative Zero" button is then pressed, 600 gauss will subsequently be added to the displayed number so it will drop to approximately 0.0, and the alarm will stop sounding. When set to "DC", any strong oscillating magnetic field (AC field) may cause the alarm to alternate rapidly between sound and no sound. On "AC" this effect does not occur.

Output: The output jack (left edge of meter) represents the actual instantaneous magnetic signal. It is unaffected by the choice of "DC", "AC", or "Peak Hold". With the standard (not high-stability) probes, on the gauss range, the output is 1 volt per 10000 gauss (maximum is +/− 2 volts). On the kilogauss range, which the meter automatically switches to at 20000.0 gauss, the output becomes 0.1 volt per 10000 gauss (10.000 kilogauss). Maximum in that range is +/− 0.3 volt. Output example: if the actual field is a 10000 gauss (pp) sine wave, the output voltage will be a 1 volt (pp) sine wave, regardless of the left knob setting. When a high-stability probe is being used, the output is 0.1 volt per 100 gauss up to +/−0.8 volt (800 gauss).

Datalogging and downloading using USB: This meter includes a USB port on top edge of the meter and a USB to micro USB cable. To begin datalogging and downloading readings, download the AlphaApp software at: https://www.alphalabinc.com/content/alpha-app/ For instructions, click Help then Help Topics.

Measurement of magnets: Most magnet materials have a published "remnant magnetization" or "internal flux density". This is typically as high as about 5000 gauss for ceramic magnets and up to about 14,000 gauss for some rare earth magnets. The actual field (technically, "flux density") on the surface of a single magnet is at most half this number, and it's only that high if the magnet is long compared to its diameter. A stubby magnet, such as a disk or pill-shaped magnet will have a surface flux density that is even lower than half the published remnant magnetization. You will see the highest number of gauss (for a given type of magnetic material) in the gap between two long, thin magnets if the poles of each magnet are separated from each other, but the north of one magnet is almost touching the south of the other, as illustrated.



If the gap spacing is much less than the diameter (or width) of the magnets, and the length of each magnet is much *greater* than the diameter, then the reading in the gap (with the thin dimension of the probe slipped into the gap) should be almost as high as the published remnant magnetization number.

Magnets produce an additive field in general. This fact can be demonstrated from the gap magnet setup illustrated. If the meter reads 13,000 gauss in the gap, and then you take away one of the magnets, the new reading will be about 6500 gauss, or half as much. The field from each permanent magnet adds together, because the two magnets do not alter each other's field. (If iron or steel is used as part of a magnetic structure, then it's a different story, because the permanent magnets in the structure *do* magnetize the iron or steel.

Magnets may lose strength because of overheating (100°C will demagnetize some types of FeNdB magnets, but over 800°C is required to demagnetize some types of ceramic magnets). They may also partially demagnetize if struck hard or exposed to a sufficiently strong reversed magnetic field, either from coils that carry electric current (as in a permanent magnet electric motor) or from another strong permanent magnet. In any case, it's easy to detect demagnetization: when a new magnet comes in, measure the number of gauss in one or more critical spots and record this. Then compare these to later measurements. There is one warning: all magnets have a slightly lower field when they're warm than when they're cool, so try to standardize the temperature at which you measure. (Each type of magnetic material has a published percent change/°C temperature sensitivity. Note that magnets are *not* permanently demagnetized by going through repeated warming and cooling cycles. They only permanently demagnetize if heated above their maximum allowed operating temperature.

Measurement of residual magnetism: This type of meter can also be used to check residual (accidental) magnetization of parts. In general, this accidental magnetization is *perpendicular* to the surface of the part, so the probe can be placed flat against the part, and this is the correct direction for detection of that field. You may need to scan the probe across the surface to find the highest number. It is helpful to set the alarm at a threshold of about 10 gauss for this. This highest reading is usually found at the ends or sharpest points of the part.

There are some peculiarities of measuring residual magnetization. Long, thin steel parts will often “amplify” the Earth field by a factor of 10 or so, at the ends of the part. If the long-axis of the part is pointed east-west, or perpendicular to the local indoor field, this is not a problem. The strength of the Earth field is about 0.5 gauss, so you may see up to about +/−5 gauss at the end of a properly *demagnetized* steel rod if the rod is pointed in the direction of the Earth field. The north pole of the earth is not horizontal in most locations. In most of Asia the magnetic field direction *is* within about +/−20° of horizontal. In North America if you face north and then look downward from horizontal 20° (Central Mexico) to 55° (Northern US) to as much as 90° down in parts of Canada, *that* is the direction of magnetic north. You can detect the field strength and direction with the meter. If the offset is properly adjusted, then with the bulge in the probe pointing toward the Earth north, you will read a positive number, because it's pointing toward the *south* pole of a magnet. If you flip the sensor 180° so that the flat part is facing Earth north, you will read a negative number, of course.

SPECIFICATIONS: 1-Axis DC/AC Gaussmeter Model GM2	
Range/Resolution (ST Probe):	0-19,999.9 G / 0.1 G; 20kG- 30kG /1G indicates polarity
Range/Resolution (HS Probe):	0-799.99G / 0.01G indicates polarity
Accuracy (w/ probe) 16° to 29°C:	1% of DC reading / 3% AC +/- 10 Counts / 1% peak hold
Accuracy (w/ probe) -4° to 65°C:	2% of DC reading / 4% AC +/- 10 Counts / 2% peak hold
AC Frequency Range:	45-800 Hz; 3 dB limits are 11 to 1500 Hz.
Peak Hold Speed:	2 millisecond pulse is 71% (29% low), 5+ millisec pulse is 100%±1%
Output Type:	Analog DC Signal.
Output Magnitude (ST Probe):	Below 20kG, output is 0.1mV/G. Above 20kG, it is 0.01 mV/G
Output Magnitude (HS Probe):	1mV/G
Meter Size:	5.2 x 3.6 x 1.6 inches; 138 x 91 x 41 mm
Weight:	7.5 oz
Battery:	9 volt alkaline (~40 hour life with ST probe, ~ 20 with HS probe); "Low Battery" indicator

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

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