2023

PMG-2 User Manual

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6/1/2023

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1. INTRODUCTION

The proton magnetometer and gradiometer PMG2 is a portable instrument powered by an internal battery. It is intended for ground measuring the absolute value of the magnetic induction vector of the Earth's magnetic field by measuring the frequency of the precession of protons in hydrogen nuclei. The magnetic induction vector is also called the magnetic field vector.

The magnetometer PMG2 allows the Earth's magnetic field to be measured in three modes:

MANUAL mode is used in a magnetic profile survey on a grid. Based on the settings of the sensor configuration. In SINGLE sensor configuration, it detects the magnetic field's absolute value in the sensor's location. The sensor is connected to the 'Up sensor' connector. In the GRAD sensor configuration, the magnetic induction vector's absolute values in both sensors' locations are measured simultaneously. The horizontal or vertical gradient of the magnetic field between the two sensors is determined by subtraction: The value of the field measured in the location of the sensor connected to the 'Up sensor' connector minus the value of the field measured in the location of the sensor connected to the 'Down sensor' connector. The gradient measurement removes, to some extent, the undesirable influence of disturbing fields, compensates for the influence of the regional field, and does not depend on diurnal variations in the Earth's magnetic field.

WALK mode continually measures the magnetic field based on sensor configuration in intervals 0.5s, 1s, 1.5s, 2s, 2.5s, and 3s. The possible sensor configuration is the same as in manual mode. The measurements in this mode can be burdened with a more significant error than in MANUAL or AUTO measurements.

AUTO mode allows repeated measurements with one sensor in set time intervals. The starting time and the length of the intervals can be set before the measurements. This mode is used for measuring diurnal variations in the Earth's magnetic field.

The results of the measurements can be stored in internal memory. The data can be transmitted to a computer through a USB interface using the communication program, which is supplied with the instrument. The program saves the data in a gzipped XML file of the external computer.

The magnetometer PMG2 is delivered with a power supply, which is a built-in li-ion battery. The non-magnetic rechargeable battery does not contribute enough to the magnetic moment of the instrument to affect measured values. A battery charger is also supplied with the device.

All functions of the magnetometer PMG2 are controlled by an internal microprocessor. This internal microprocessor allows an operator to communicate with the instrument via a keyboard and LCD display, controls the measurement process, and transmits the acquired data to an external computer through the USB interface.

The proton magnetometer automatically checks the correctness of the measurement and the operator's activities. The operator is warned if a failure is detected with an error message on display.

2. SPECIFICATIONS

Measuring range	20 000 to 100 000 nT
Resolution	0.01 nT
Sensitivity (AUTO, MANUAL, WALK @ > 1.5s)	0.2 nT
Absolute accuracy	±0.5 nT
Maximum gradient value	1 000 nT/m
Measuring cycle	ca 0.5 s
Triggering	Manual, automatic in AUTO and WALK mode
Internal clock	Day, month, year, hours, minutes, and seconds, independent of battery condition
Data memory	1,800,000+ readings
Universal Serial Bus (USB)	
Power supply	Internal non-magnetic li-ion battery 14.8 V / 6 Ah, can be extended to 14.8 V / 12 Ah
Battery lifetime	10 000 readings on average in GRAD sensor configuration
Processing unit	
Dimensions	230 x 80 x 170 mm
Weight	2 kg, including battery
Sensor	
Dimensions	dia 80 x 200 mm
Weight	0.7 kg
Operating temperature range	- 10 to 60 °C
Storage temperature range	- 20 to 60 °C

3. DESCRIPTION OF THE INSTRUMENT

The proton magnetometer PMG2 consists of a processing unit, measuring sensors, and a post.

3.1. Measuring Sensor With Accessories

The measuring sensor contains two coils properly arranged to suppress a disturbing external field. The coils are placed in a laminated cylinder container filled with a liquid rich in hydrocarbons.

North and south are marked on the container of the sensor. The 'north' mark should point to the geographical north. The orientation of the sensor does not affect the value of the measured magnetic field, but it does affect the sensor's signal intensity and, thus, the size of the error of the measurement.

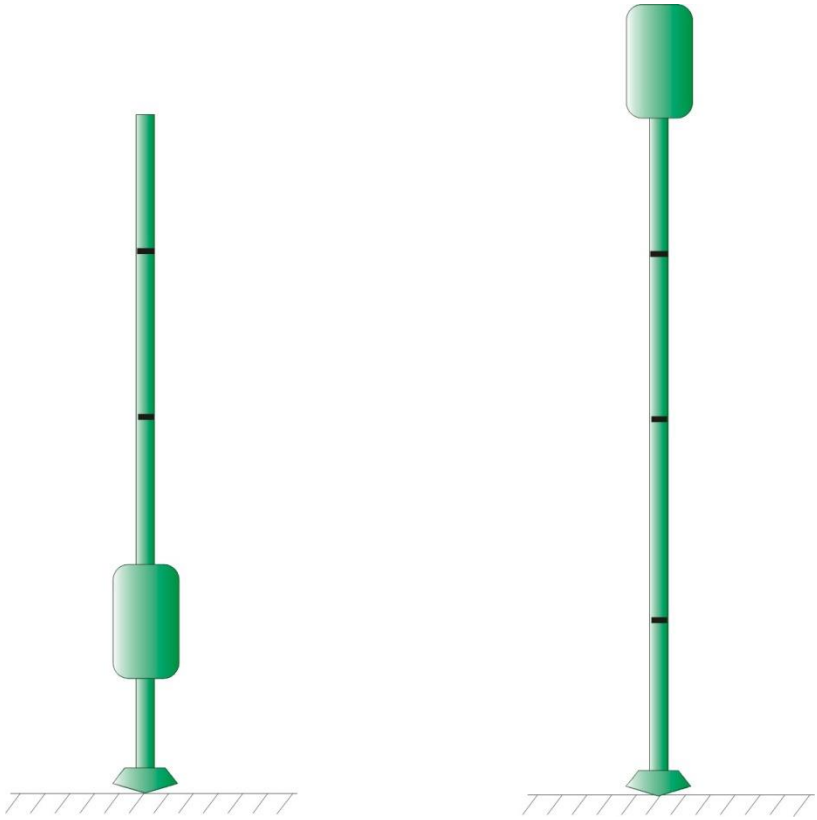


Figure 3.1 - Post assembly for line measurement.

For measurements, the sensor is mounted on a pole assembled using up to five half-meter-long sticks joined with screw coupling. In this way, the sensor can be set to various heights above the ground – see Figure 3.1. For gradient measurement, an extension (gradient stick) is used to keep both sensors 0.5 or 1 m apart – see Figure 3.2. The gradient stick allows the position of the sensors to be set so that the orientation of both sensors to the Earth's magnetic field may be the same. For AUTO mode measurements (diurnal variations), an anchor ring with ropes and pins is supplied to hold the post in place.

The measuring sensors and the processing unit are connected via 2.5 m long cables.

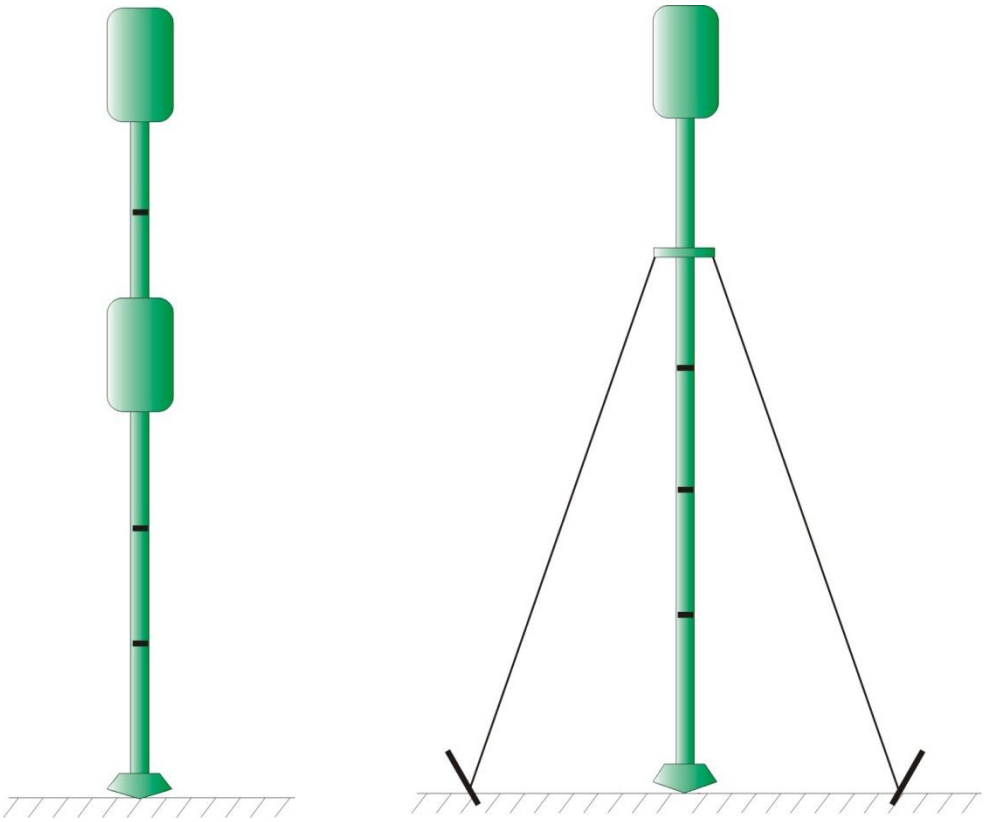


Figure 3.2 – Left – post assembly for gradient measurement.

Right – post assembly for magnetic variation measurement.

3.2. Processing Unit

The processing unit allows communication with an operator via a keyboard and a graphic LCD display. It contains circuits for processing and analyzing the measured signal: tuning circuits, low-noise amplifier, filter, and shaping amplifier.

The processing unit is placed in a duralumin box. Two watertight bayonet connectors for connecting the sensors are located on the left side of the box. Only the upper left connector is used in AUTO mode, 'Up sensor'. The booth connectors can be used based on sensor configuration in MANUAL and WALK modes. The gradient is determined by subtraction: The field's value is measured in the location of the sensor connected to the 'Up sensor' connector minus the field's value measured in the sensor's location connected to the 'Down sensor' connector.

There is one connector on the right side of the box. It connects to the computer through USB, connects our external GPS, and for charging the internal battery with the supplied charger. After removing the internal battery, the connector can also be used for an external power supply.

The non-magnetic li-ion battery is placed in the bottom part of the unit and is accessible by unscrewing the four bolts in the bottom cover. The battery compartment is hermetically separated from the electronics.

The display and keyboard are on the unit's top side. The keyboard contains 16 watertight membrane push buttons.

The instrument is delivered with a harness to fasten it on the chest of an operator.

3.3. Operation Principle

The measurement of the magnetic field is conducted in two steps. In the first measuring step, the polarization current feeds the sensor and causes uniform orientation of magnetic moments of hydrogen nuclei contained in the liquid in the sensor. The time of polarization is automatically increased, in MANUAL and AUTO measuring modes, according to the decreasing source voltage so that the precession signal gained from the sensor may remain constant. In the WALK measuring mode, the polarization time is fixed. During the polarization cycle, the sensor and the low-noise amplifier are disconnected. The first step of the measuring sequence is terminated by switching the polarization current off.

In the second step, the transient field is dumped due to an interruption of the polarization current in the sensor, and then the low-noise amplifier is connected to the sensor. The signal induced in the sensor is amplified, filtered, and shaped to suit the processing in numeric circuits. In the sampling circuit of the microprocessor, the frequency of attenuated oscillations of the precession motion of the hydrogen nuclei is evaluated. The frequency is directly proportional to the measured magnetic field.

The entire measuring cycle is controlled by a microprocessor which computes the measured magnetic field and the measurement's statistical error from the precession frequency's value. Both values are displayed and optionally stored in the data memory.

During the second step, the precession signal's amplitude and the decay's time constant are determined. The supplementary values are also stored in the data memory.

3.4. PMG-2 Magnetometer Operating Controls

[ON / OFF]	switching on and off
[ENTER]	start of measurement or other selected procedures, setting validity of modified parameters or data, storing measured data in the memory
[ESC]	termination of any going-on procedure without storing data
[NEXT]	next item
[0] to [9]	loading digits
[v]	scanning series of consecutive data towards higher ordinal numbers
[^]	scanning series of consecutive data towards lower ordinal numbers

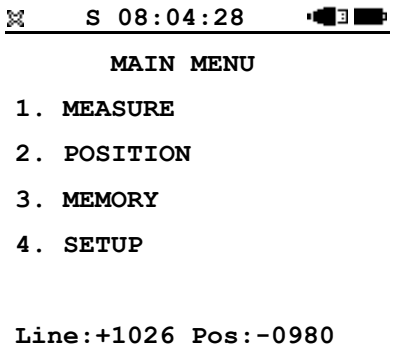
Table 3.1 - PMG-2 operating controls.

3.5. Main Menu

After switching the instrument On, by means of the pushbutton [ON/OFF], the initial logo appears on display.

After pressing any pushbutton or after 3 seconds, the main menu appears.

The backlight is switched off automatically 30 seconds (default value is 30 s, other options selectable) after the last pressing of a pushbutton. The backlight can be switched off all the time to save power consumption.



The topmost part of the display is reserved for actual time and status information. The status indicators are:

⌘ to indicate an active connection to a GPS receiver, if the indicator is inverted valid data from GPS are available.

this icon indicates that the USB cable and or external GPS is connected, and the device is ready for data transfer.

this is a battery icon to indicate battery status.

S or G symbols indicating the actually select sensor modes Single, Gradient.

Move-in the main menu, and item selection is marked by a cursor, graphically indicated by the inverted line. Pushbuttons [∨] and [∧] serve for a cursor move in the main menu. Menu items 1 - 4 are directly selectable by pressing numerical pushbuttons [1] - [4] on the keyboard.

Pushbutton [ENTER] activates an item function and confirms the newly specified parameters. Pushbutton [ESC] serves to return to the main menu without modification of parameters.

1. MEASURE – item sub-menu serves to activate measurement. The possible measurements are MANUAL, WALK, and AUTO. See chapter 6.
2. POSITION - Item serves for setting a number of a profile line, position on a profile, and step of measurement on a profile. See chapter 5.7.
3. MEMORY - Item serves as a listing of the items stored in the data memory. Further, it enables us to erase the data memory and see the memory status see chapter 7.
4. SETUP - Item serves to set up various parameters of the instrument see chapter 3.6.

3.6. Setup Menu

The setup menu serves to set up various parameters, see below. It is activated in the main menu, item 4.

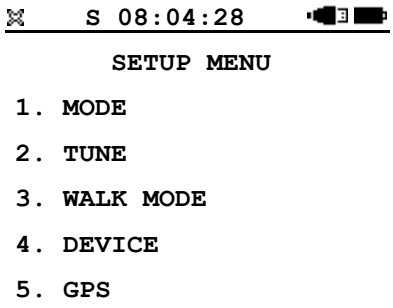
Move-in the setup menu, and item selection is marked by a cursor, graphically indicated by the inverted line. Pushbuttons [∨] and [∧] serve for a cursor move in the main menu.

Menu items 1 - 5 are directly selectable by pressing the keyboard's numerical pushbuttons [1] - [5].

Pushbutton [ESC] serves to return to the main menu.

Pushbutton [ENTER] activates an item function and confirms the newly specified parameters.

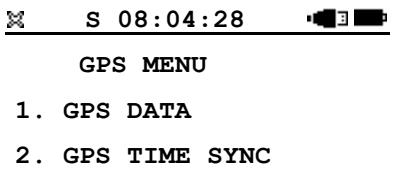
Pushbutton [ESC] serves to return to the setup menu without modification of parameters.



1. MODE – item sets the sensor mode (Single or Gradient) for MANUAL and WALK measures. This item is shown in the case that the device is a gradiometer.
2. TUNE – item servers to select the current field range. See chapter 5.2.
3. WALK MODE – item serves to select automatic measure interval for WALK measure.
4. DEVICE – item serves to select multiple device options. See chapter 5.
5. GPS – items serve to select multiple GPS options. See chapter 3.7.

3.7. GPS Menu

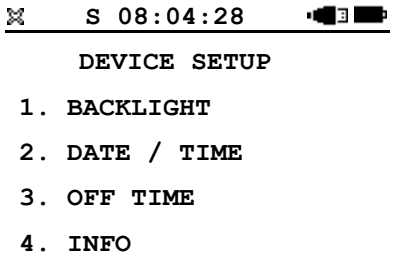
The GPS menu serves to set up different GPS parameters, see below. It is activated in the setup menu, item 5.



1. GPS DATA – item servers to show actual geocoordinate and time from GPS receiver.
2. GPS TIME SYNC – item synchronizes device time with UTC GPS time.

3.8. Device Menu

The device menu serves for setting up various device parameters, see below. It is activated in the setup menu, item 4.



1. BACKLIGHT - Item serves to switch the backlight on / off or to set the time to elapse. See chapter 5.3.
2. DATE / TIME - item sets up real date (yy.mm.dd, where y- year, m – month, d – day) and time (hh:mm:ss, where h - hours, m - minutes, s - seconds). The cursor indicates the number to edit. Editing of numerical values is carried out using pushbuttons [0],[1],[2],...[9]. Move the cursor by [∨], [∧], and [NEXT]. The pushbutton [ENTER] stores the modified date and time in the memory. The pushbutton [ESC] returns the control to the parent menu without changing the date and time see chapter 5.1.
3. OFF TIME - item serves for setting the switch-off time. See chapter 5.6.
4. INFO - Item displays the instrument's serial number and the software version.

4. PUTTING THE INSTRUMENT INTO OPERATION

4.1. Power Supply

The instrument is delivered with a built-in li-ion battery of 14.8 V / 6 Ah. The battery compartment is accessible from the bottom part of the box by unscrewing the four bolts fastening the bottom cover of the instrument.

The internal battery can be charged directly in the instrument with the charger supplied with the device.

4.2. Switch On/Off

The first check of the instrument function can be performed with the processing unit without connecting the sensor. The instrument is switched on by pressing [ON / OFF]. A startup logo appears on display.

An error message is displayed in the case of a faulty power supply. If the battery is deeply discharged, the instrument automatically switches off.

Also, the instrument automatically switches off if the time interval AutoPowerOff elapses and there are no operator activities on the keyboard or through the USB interface. The interval can be set in the Setup menu, item Time.

If the instrument does not display the information mentioned above even after repeatedly pressing [ON /OFF], it means there is an instrument failure. It is recommended to contact the distributor or the manufacturer.

4.3. Battery Condition Check

The battery condition check is performed automatically each second after the instrument is switched on. The voltage levels for error messages about the battery discharge were set from the discharge characteristics according to the power consumption at the time of the check. If an error message about the battery discharge is displayed, it is necessary to charge the battery or replace it with a charged one. The software does not allow the operation of the instrument if the battery is deeply discharged and switches it off automatically. Thus, erroneous operation and damage to the battery are prevented.

4.4. Battery Safety Instructions

1. Handle with care: Treat Li-ion batteries with care to prevent physical damage. Avoid dropping, puncturing, or crushing the battery, as it can lead to leakage, short circuits, or thermal runaway.
2. Avoid exposure to extreme temperatures: Do not expose Li-ion batteries to higher temperatures, -10 to 60 °C in operation or -20 to 60 °C in storage (e.g., direct sunlight, ovens, or hot cars) or extremely cold temperatures. Extreme temperatures can negatively affect the battery's performance, capacity, and lifespan.
3. Protect from moisture: Keep Li-ion batteries away from water, damp environments, or excessive humidity if out of the instrument case. Moisture can damage the battery and potentially cause a short circuit.

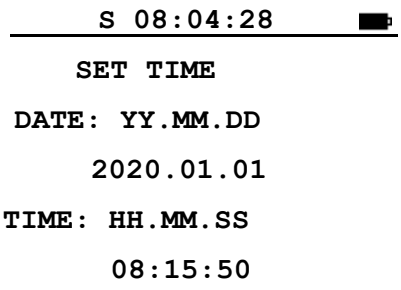
4. Avoid overcharging: Do not leave Li-ion batteries connected to a charger for an extended period once they are fully charged. Overcharging can cause overheating, reduce battery life, and pose safety risks. Unplug the battery from the charger as soon as it reaches full charge.
5. Prevent over-discharging: Avoid fully depleting Li-ion batteries before recharging them. Over-discharging can lead to irreversible damage and reduce the battery's overall lifespan. Recharge the battery when its charge level drops to a recommended threshold.
6. Use appropriate chargers: Always use a charger delivered with the device specifically designed for Li-ion batteries and compatible with your device. Using incorrect chargers or chargers not intended for Li-ion batteries can cause damage or pose safety hazards. It is recommended to charge the battery in ambient temperature environments.
7. Do not modify or tamper with the battery: Avoid modifying, disassembling, or tampering with Li-ion batteries. Any unauthorized alterations can result in damage, reduced performance, or safety risks.
8. Store properly when not in use: When not in use, remove the Li-ion battery from the device and store Li-ion batteries in a cool, dry place, away from direct sunlight, flammable materials, or sources of heat. Store them in a protective case or container to prevent accidental damage. The battery should be checked and charged at least twice a year.
9. Dispose of properly: When a Li-ion battery reaches the end of its useful life or is damaged beyond use, follow local regulations and guidelines for proper disposal or recycling. Do not dispose of Li-ion batteries in regular trash.

5. BASIC SETTING OF THE INSTRUMENT

5.1. Setting The Internal Clock

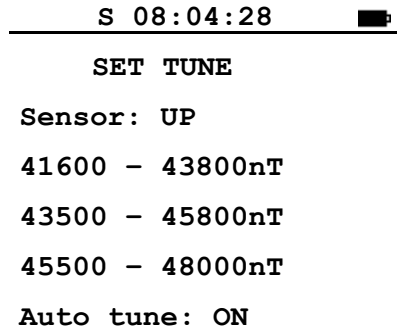
Time and date can be modified in the device setup menu, item DATE / TIME. A cursor indicates the place to be modified by numeric pushbuttons. The cursor is moved by pressing [v] and [^]. The pushbutton [NEXT] moves the cursor to the date that can be modified similarly.

The modified time and date are updated after pressing the [ENTER]. The procedure can be terminated without changing the actual time by pressing [ESC], and the control returns to the setup menu.



5.2. Tuning Of The Magnetometer

Considering the character of the signal processed by the analog part of the instrument, it is necessary to tune input circuits at least approximately to the measured magnetic field. To display the current tuning interval, select the TUNE sub-menu MANUAL SET item in the setup menu. For the SINGLE mode, the display shows, for example:



The word On/Off indicates if the function of the automatic tuning of input circuits is on or off. The automatic tuning can be switched on or off by pressing [v] and [^]. [NEXT] moves to the next item. The interval of the magnetic field can be selected by pressing [v] and [^] according to the awaited value.

The tuning configuration can be performed automatically as well. The automatic tuning is started by selecting AUTO SEARCH in the TUNE menu. The automatic tune goes through all possible tune ranges and sets a tuning range with sufficiently high signal amplitude and minimal statistical error. After the end of the automatic tuning, the result is displayed on display, and the user can confirm if to use found range as an actual tuning setting.

The tuning intervals are:

1. 20 000 - 21 000 nT	19. 45 500 - 48 000 nT
2. 20 900 - 22 000 nT	20. 47 700 - 50 200 nT
3. 21 900 - 23 000 nT	21. 49 900 - 52 600 nT
4. 22 900 - 24 100 nT	22. 52 300 - 55 100 nT
5. 24 000 - 25 200 nT	23. 54 800 - 57 700 nT
6. 25 100 - 26 400 nT	24. 57 400 - 60 400 nT
7. 26 300 - 27 700 nT	25. 60 100 - 63 200 nT
8. 27 500 - 29 000 nT	26. 62 900 - 66 200 nT
9. 28 800 - 30 400 nT	27. 65 900 - 69 300 nT
10. 30 200 - 31 800 nT	28. 69 000 - 72 600 nT
11. 31 600 - 33 300 nT	29. 72 300 - 76 000 nT
12. 33 100 - 34 800 nT	30. 75 700 - 79 600 nT
13. 34 600 - 36 400 nT	31. 79 300 - 83 300 nT
14. 36 200 - 38 200 nT	32. 82 900 - 87 300 nT
15. 38 000 - 40 000 nT	33. 86 800 - 91 400 nT
16. 39 700 - 41 800 nT	34. 90 900 - 95 700 nT
17. 41 600 - 43 800 nT	35. 95 300 - 99 999 nT
18. 43 500 - 45 800 nT	

Table 5.1 - Tuning intervals.

A preliminary approximate setting of the tuning point can be performed based on a magnetic field map - see Figure 5.1 in dependence on the geographic coordinates of the measurement location or automatic search can be used. An error message indicates if the measured value of the magnetic field is not within the tuning interval. The input circuits will be automatically tuned at the next measurement if the automatic tuning is on.

The modified tuning interval is stored in the memory after pressing [ENTER]. Pressing [ESC] terminates the tuning procedure without changing the interval.

For the GRAD sensor mode, the tuning should be repeated twice for each sensor (both UP and DOWN) separately. The automatic tuning (On/Off) is the same for both sensors.

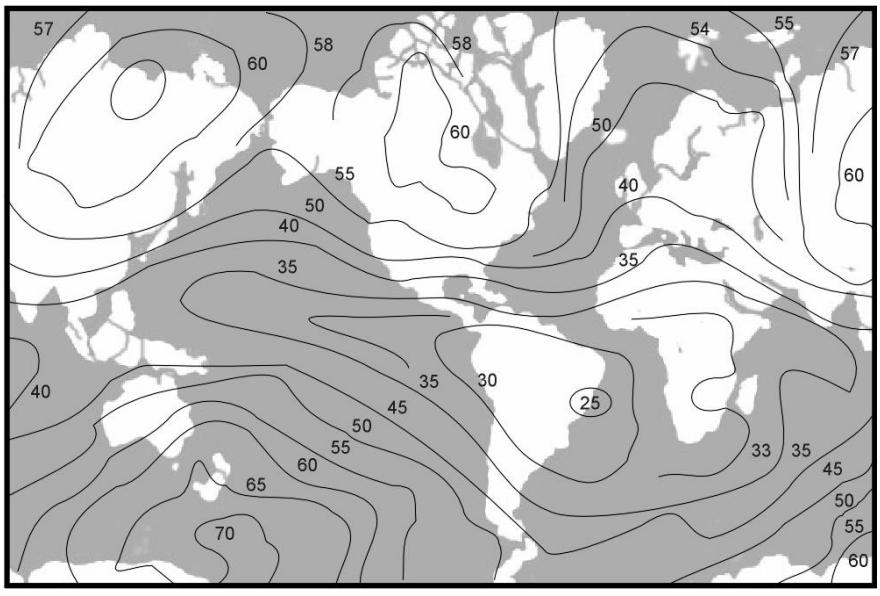


Figure 5.1 – Earth's magnetic field.

5.3. Setting The Backlight

The backlight is switched on or off by selecting the radio button in the setup menu, item backlight. It can be modified by [v] and [^]. Power consumption is relatively high when using a backlight, so it is recommended to set the time to the minimum value.

5.4. Selection Of The Sensor Configuration

The item MODE is accessible only if the device is the gradiometer. The item MODE in the setup menu allows the selection of one of the two sensor modes: SINGLE and/or GRAD. The currently selected mode is marked with the radio button. It can be changed by [v] and [^].

Pressing the pushbutton [ENTER] asserts the selection, [ESC] terminates the procedure without changing the mode.

5.5. Walk Sample Rate Configuration

The item WALK MODE in the setup menu allows the selection of one of the three sample rates for the WALK measure mode. The currently selected mode is marked with the radio button. It can be changed by [v] and [^].

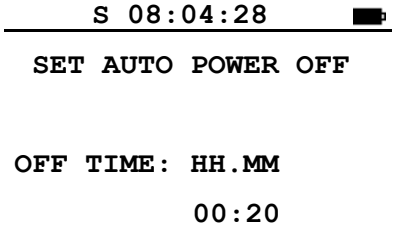
Pressing the pushbutton [ENTER] asserts the selection, [ESC] terminates the procedure without changing the mode.

5.6. Setting The Time Interval To Switch Off

To protect the Li-ion battery, the instrument is automatically switched off after elapsing the set time interval after the last activities of the operator on the keyboard. Thus, the deep discharge and the damage of the battery are prevented even if the operator forgets to switch off the instrument. The default value is 20 min.

In the setup menu, item TIME, the AutoPowerOff time is displayed. After elapsing of the time, the instrument is automatically switched off. The format is hh:mm, where hh stands for hours, mm for minutes.

[ENTER] asserts the new value, [ESC] terminates the function without saving the changes.

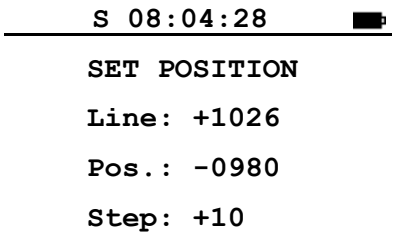


5.7. Setting The Position

The item POSITION in the main menu sets the position of the next measurement that will be conducted. The information is stored in the data memory together with the measured value. The position consists of the profile number 'Line', the position on the profile 'Pos.' and the spacing 'Step', which is the increment or decrement of the next position 'Pos.'. If the 'Step' is positive, the value of the next 'Pos.' stored with the measurement in the data memory is increased by the value of the 'Step', if the 'Step' is

negative, the value of the next 'Pos' is decreased. This allows the operator to move from the end of the profile to higher positions and back to the lower positions.

By selecting the item POSITION in the main menu, 'Line', 'Pos.', and 'Step' can be edited. The current values are displayed, for example:



A cursor appears at the place of the digit to be modified and can be moved by [v] and [^]. The value 'Line' can be set from -9999 to 9999. By pressing [NEXT] the second item, the current position on the profile' Pos.' can be modified.

The value of 'Pos.' can also be set from -9999 to 9999 the same way as with the profile. Another pressing of [NEXT] allows 'Step' to be edited.

The value of the 'Step' can be set from -99 to 99 in the same way as above. By [v] and [^], the digit to be modified is selected, and by numeric pushbuttons [0] to [9], it is changed.

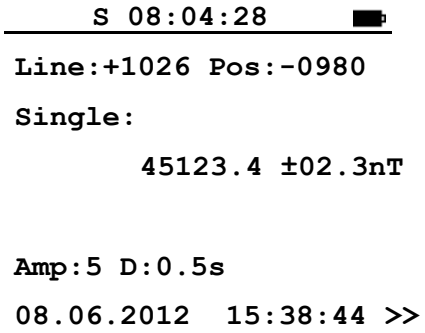
The sign + and – is changed by pressing [0] when the cursor is placed at the sign.

[NEXT] is used for switching among the items 'Line', 'Pos', and 'Step'. The modified data are stored in the memory by pressing [ENTER]. Pressing [ESC] terminates the function without saving the changes.

5.8. Recalling Stored Data

The item LIST in the memory menu displays the data stored in the data memory. The stored data are browsed by manual, walk, and single measurement types.

After entering it, the last measurement is displayed. By pressing [v] or [^], the following or the previous measurement is displayed.



In the SINGLE sensor configuration profile number and position number, the magnetic field's value, measurement error, signal intensity, and time constant of the signal decay are displayed. In the GRAD sensor configuration, appropriate values are displayed.

The symbol >> in the bottom right corner is displayed if valid GPS data were saved with the measurement. By pressing [NEXT], the saved geo positioned coordinates are displayed. You can get back to the data view by pressing [NEXT].

6. MEASUREMENT

The instrument and its accessories are transported in a case. It must be assembled before an operation.

The measured value of the magnetic field depends very much on the presence of metal objects near the sensor. The operator should remove all the metal objects prior to measuring.

6.1. Instrument Setup

Screw together the sensor and the sticks of the post to the desired length – see Figure 3.1. The processing unit can be attached to the harness and carried on the chest.

Connect the sensor to the processing unit by using the appropriate connectors. The connector' Up sensor' is used in the single sensor configuration and AUTO modes. In the GRAD sensor mode, both sensors are used. The upper sensor should be connected to the 'Up sensor' connector otherwise, the sign of the gradient value is changed.

It is recommended to keep the sensor as far as possible from the processing unit to limit the influence of the magnetic moment of the instrument.

For the same reason, it is recommended to keep the direction of the advance along with the profile during the measurement in one area.

6.2. Sensor Orientation

The measured value of the magnetic field does not depend on the sensor orientation. However, with the changing orientation of the sensor towards the Earth's magnetic field, the signal from the sensor is changed, and the statistical error of the measurement increases. The sensor must be oriented in the north-south direction to achieve the maximum signal, so the 'north' mark on the sensor must point to the geographical north.

6.3. Tuning

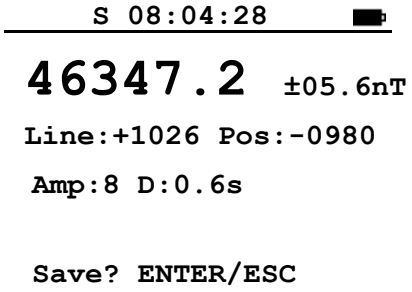
Before measuring in a new area, it is necessary to set or check the preliminary tuning of the instrument according to the map of the Earth's magnetic field, see Figure 5.1. An error message is displayed if the measurement is conducted with inaccurately tuned circuits. If the automatic tuning function is on, the tuning will occur automatically concerning the measured value. The automatic tuning is not performed in the case of an enormous difference in which the value of the magnetic field is measured with a significant statistical error. The tuning procedure is described in chapter 5.2.

6.4. Manual Measuring

MANUAL measuring is started by selecting MANUL in the measure menu. The selection is asserted by [ENTER]. The instrument is prepared to measure in the single and or gradient sensor configuration. The sensor configuration can be selected in the setup menu item MODE see chapter 5.4. In the single-sensor configuration, the instrument measures the absolute value of the magnetic field vector. In the gradient sensor configuration, the device simultaneously measures the value of the magnetic field in both sensors' locations. The displayed value of the gradient is determined by subtracting the value of the magnetic field of the sensor connected to the 'Down sensor'

connector from the value of the magnetic field of the sensor connected to the 'Up sensor' connector.

If the position on a grid should be used, the position of the first measurement must be set, which means setting the items 'Line', 'Pos', and 'Step' in the POSITION item of the main menu. This is described in detail in chapter 5.7. The measurement is started by pressing [ENTER]. After about 2 seconds, the measured value of the magnetic field with the statistical error is displayed, as well as the position of the measurement point 'Line' and 'Pos' and other information.



The value Amp means the signal intensity and the value D expresses a time constant of the decay of the precession signal. The question at the bottom indicates the option to store the reading in the data memory.

By pressing [ENTER], the reading is stored in the data memory, and the next position is displayed. The measured data is erased by pressing [ESC], and the current position is displayed.

6.5. Measuring In Walk Mode

The WALK measure mode is selected in the MEASURE menu. In this mode, the instrument is prepared to measure int the single and or gradient of the Earth's magnetic field based on sensor configuration. The sensor configuration can be selected in the setup menu item MODE see chapter 5.4.

The measurements are continually repeated and saved to memory in the WALK measure mode. The repetition interval is selectable in the setup menu item WALK MODE. The intervals are 0.5s, 1s, and 1.5s see chapter Pressing the pushbutton [ENTER] asserts the selection, [ESC] terminates the procedure without changing the mode.

Walk Sample Rate Configuration.

6.6. Measuring In Auto Mode

The AUTO measure mode is selected in the MEASURE menu. The instrument is prepared to serve as a base station and measure diurnal variations in this mode. When the measurement is started, two items are displayed: 'Start time' sets the time of the first measurement of the base station.

'Interval' sets the time interval between measurements.

The measurement results in the AUTO mode are stored automatically in the data memory.

The measurement in the AUTO mode is terminated by switching the instrument off.

7. DATA MEMORY

The instrument is equipped with a large memory where all readings and identifiers can be recorded. The capacity of the data memory is more than 1 800 000 readings. The readings obtained in various modes can be stored sequentially. The stored data can be displayed or transmitted to an external computer via USB.

It is useful before the beginning of the measuring in a new area to transmit data stored in the data memory to the external computer and to erase the data memory. Thus, the data memory is set to maximum capacity.

7.1. Erasing And Checking Off The Data Memory

The stored data will be erased during the erase procedure. Therefore, the data must be transmitted to an external computer before the procedure.

The erasing procedure starts by selecting the item ERASE in the memory menu. The operator is repeatedly asked to confirm the operation to prevent occasional memory erasing. Only after pressing [NEXT] the data memory will be deleted.

7.2. Data Storage In The Data Memory

In the MANUL measurement mode, after a measurement, the result is displayed, as well as the profile number, position on the profile of the measurement point, and other information. To store the data, the operator presses [ENTER], otherwise [ESC] (canceling the measured value), and the measurement on the point can be repeated. The position of the next measurement is displayed in both cases. The position can be changed in the item POSITION.

In the AUTO and WALK measurement modes, the measured data are stored automatically, and the profile number and the position on the profile are not incremented.

If a GPS is connected to the PMG-2 and valid geo position coordinates are available, the geo position coordinates are also stored.

7.3. Display Of Data Stored In Memory

The data stored in the data memory can be displayed or transmitted through the USB interface to a computer.

The data is displayed in the item LIST of the memory menu and selection of the measurement type (MANUL, WALK, AUTO). After entering the item, the last stored data is displayed. Pressing [v] or [^] displays the following or the previous reading. Continually pressing [v] or [^] increases the scanning speed. A notice is displayed if the data memory is empty and when there is a beginning of the data memory.

7.4. Transmission of the Stored Data to a Computer

Before transmitting the stored data to an external computer, connecting the instrument and the computer with the USB cable is necessary.

It is necessary to run the program on the computer, which allows the data to be transmitted from the magnetometer to the computer and stored in a gzipped XML file format.

The measured data can also be exported to a text file for further processing.

8. EXTERNAL GPS

The PMG-2 can use a SatisGeo external GPS receiver, which enables the storage of geo position coordinates with the measurements. The external GPS can be bought as an accessory to the PMG-2.

The GPS receiver uses a 56-channel-ublox 7 engine to receive signals GPS/QZSSL1C/A, GLONASSL1FDMA, SBAS:WAAS,EGNOS,MSAS. The position accuracy is:

		GPS	GLONASS
Accuracy	Position	2.5 m CEP	4.0 m
	SBAS	2.0 m CEP	n.a.

Table 8.1 – GPS accuracy.

There are two possible antenna configurations. One with the antenna mounted on the pole with the sensors. This configuration uses NavtechGPS antenna TW3101 L1 Non-Magnetic Antenna. The second configuration uses a modified Ublox ANN-MS antenna. This antenna is intended to be placed in supplied cap. Booths are active antennas with similar parameters.

8.1. GPS Configuration

The SatisGeo external GPS is connected to the PMG-2 console using a connector on the right side of the console. The body of the external GPS can be attached to the PMG-2 console or harness using a Velcro fastener.

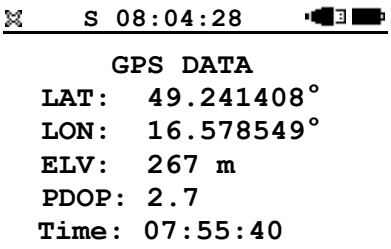
After the external GPS is connected, the cable connection symbol and satellite symbols are shown on the PMG-2 display status bar see chapter Main Menu. The GPS acquired valid geo position coordinates if the satellite symbol is inverted. If the GPS signal is lost, it is indicated by the satellite icon and as well by an acoustic signal.

Operation:

1. Based on your antenna configuration, place the GPS antenna on the probe pole or the cap, and connect it to the external GPS receiver using an SMA connector.
2. Connect the other external GPS connector to the right-side connector of the PMG-2 console. PMG-2 will indicate an external GPS connection by showing a USB connection and a satellite icon.
3. After a few minutes, based on weather and satellite constellation status, the PMG-2 should indicate that the valid GPS coordinates are available by inverting the satellite icon see chapter Main Menu.

8.2. GPS Data

In the GPS menu item GPS DATA, actual geo position coordinates and GPS UTC time can be checked.



8.3. GPS UTC Time Synchronization

The item GPS TIME SYNC servers to set the actual time and date to the UTC time from the GPS receiver. A connection to the GPS must be active and valid to successfully synchronize GPS time.

9. SUPPLEMENTARY INFORMATION

9.1. USB Interface

The magnetometer PMG2 can be directly connected to a computer through the USB cable supplied by the manufacturer.

The program supplied with the instrument transmits data from the magnetometer to the external computer.

9.2. Charger

The charger is delivered with the instrument, allowing careful and optimum charging of the built-in li-ion battery 14.8 V / 6 Ah (14.8 V / 12 Ah) to use its full capacity and lifetime. The product is double insulated.

The charger automatically sets the optimum charging mode according to the battery's condition. There is no danger of damaging the battery from overcharging.

Operation:

1. Plug the connector of the charger cable into the connector on the lower right part of the instrument.
2. Switch on the charger by plugging it in.
3. The battery is charged when the pilot light turns off.

9.3. Maintenance And Repair Work

Under normal operating conditions, the magnetometer requires no special maintenance. Only the built-in li-ion battery needs care. If the voltage drops under a certain level, the battery might be damaged, or the magnetometer might not operate correctly, so the instrument is switched off automatically. When the device is not used for a long time, it is still discharging and must be charged at least once a half-year.

Because of the complexity of the instrument, it is strongly recommended not to make any interference with the electronics.

In the case of a failure of the magnetometer, the customer should contact the distributor or the manufacturer. The service will be performed as soon as possible.

9.4. Storage And Transportation

The packed instrument can be stored and transported in the range of -20° to 60°C and at a relative humidity of up to 90%.

The built-in li-ion battery should be checked and charged with the supplied charger at least once a half-year.

9.5. Warranty

The manufacturer provides a two-year warranty after the purchase of the proton magnetometer PMG2. Other information relating to the warranty is given in the warranty certificate.

9.6. Accessories

Processing Unit (Console)	1 pcs
Sensor	2 pcs
Harness	1 set
Foot Stick	1 pcs
Middle Stick	4 pcs
Anchor Ring with Ropes	1 set
Tent Pin	3 pcs
Interface Cable to PC	1 pcs
Charger	1 pcs
Instruction Manual	1 pcs
Transport Case	1 pcs