

2021

PMG-2 User Manual



SatisGeo s.r.o.

1/29/2021

Contents

- 1. Introduction 3
- 2. Specifications 4
- 3. Description of the instrument..... 5
 - 3.1. Measuring Sensor With Accessories..... 5
 - 3.2. Processing Unit 6
 - 3.3. Operation Principle 7
 - 3.4. PMG-2 Magnetometer Operating Controls..... 7
 - 3.5. Main Menu..... 7
 - 3.6. Setup Menu 8
 - 3.7. Device Menu..... 9
- 4. Putting the instrument into operation11
 - 4.1. Power Supply11
 - 4.2. Switch On/Off11
 - 4.3. Battery Condition Check11
- 5. Basic setting of the instrument12
 - 5.1. Setting The Internal Clock.....12
 - 5.2. Tuning Of The Magnetometer12
 - 5.3. Setting The Backlight.....14
 - 5.4. Selection Of The Sensor Configuration.....14
 - 5.5. Walk Sample Rate Configuration14
 - 5.6. Setting The Time Interval To Switch Off.....14
 - 5.7. Setting The Position.....14
 - 5.8. Recalling Stored Data.....15
- 6. Measurement16
 - 6.1. Instrument Setup16
 - 6.2. Sensor Orientation.....16
 - 6.3. Tuning16
 - 6.4. Manual Measuring16
 - 6.5. Measuring In Walk Mode17
 - 6.6. Measuring In Auto Mode.....17
- 7. Data memory.....18
 - 7.1. Erasing And Checking Of The Data Memory18
 - 7.2. Data Storage In The Data Memory18
 - 7.3. Display Of Data Stored In Memory18
 - 7.4. Transmission of the Stored Data to a Computer18
- 8. Supplementary information.....19

8.1. USB Interface	19
8.2. Charger	19
8.3. Maintenance And Repair Work	19
8.4. Storage And Transportation	19
8.5. Warranty	19
8.6. Accessories	20

1. INTRODUCTION

The proton magnetometer and gradiometer PMG2 is a portable instrument which is powered by an internal battery. It is intended for ground measuring of 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 profile magnetic survey on a grid. Based on settings of sensor configuration. In SINGLE sensor configuration, it detects the absolute value of the magnetic field in the location of the sensor. The sensor is connected to the 'Up sensor' connector. In GRAD sensor configuration, the absolute values of the magnetic induction vector in the locations of both sensors 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 three 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. Both 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 lead-acid 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 of the activities of the operator. If a failure is detected, the operator is warned with an error message on display.

2.SPECIFICATIONS

Measuring range	20 000 to 100 000 nT
Resolution	0.01 nT
Absolute accuracy	±0.5 nT
Sensitivity (AUTO, MANUAL, WALK @ > 1.5s)	0.2nT
Maximum gradient value *	1 000 nT/m
Maximum displayed value of gradient	9999.9 nT
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 lead-acid battery 12 V / 3.4 Ah
Battery lifetime	5 000 readings on average in GRAD sensor configuration
Processing unit	
Dimensions	230 x 80 x 170 mm
Weight	3.2 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 70 °C

* The maximum gradient 1000nT/m means that if a change in gradient in consecutive measurements is smaller than 1000nT, there is no need to change the tune significantly, and we are sure that results are reliable.

Otherwise, there are two scenarios.

1. In the case that there was no need to change the tune for either of the probes significantly, the results are as well reliable.
2. In the case that there was a need to change the tune for either of the probes significantly, the results are not reliable. The user is informed that such a situation occurred and that the tune changed. So to get reliable results, an additional measurement in the same place needs to be taken.

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 intensity of the signal from the sensor and, thus, the size of the error of the measurement.

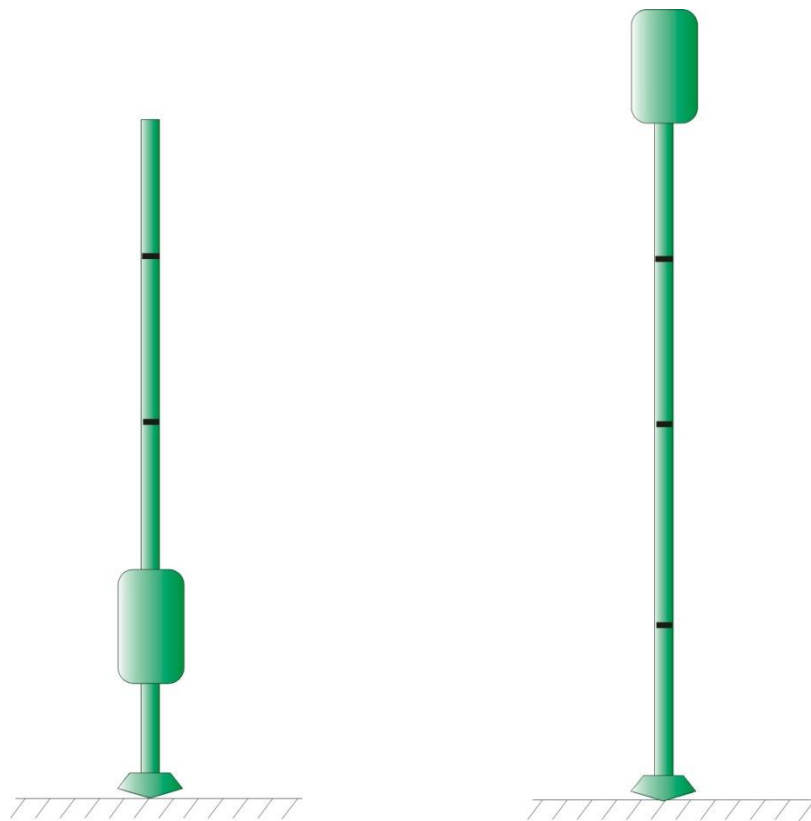


Figure 3.1 - Post assembly for line measurement.

For measurements, the sensor is mounted on a post which is 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.

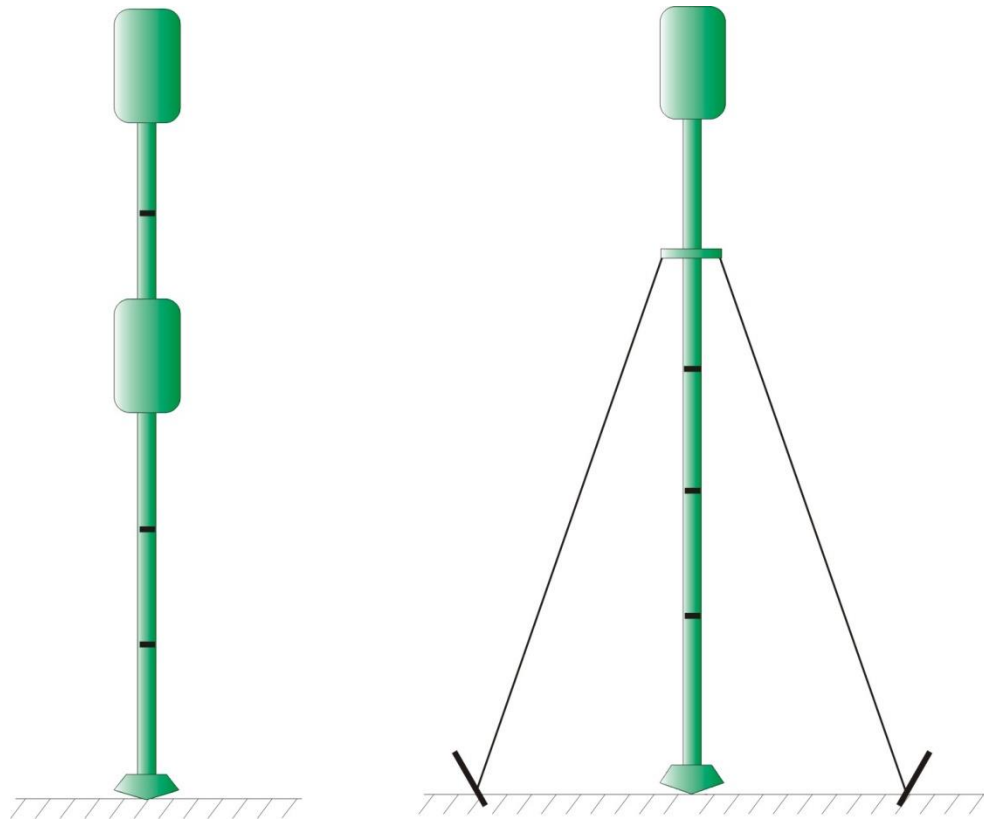


Figure 3.2 – Left – post assembly for gradient measurement.

Right – post assembly for magnetic variation measurement.

3.2. Processing Unit

The processing unit allows for 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. In AUTO mode, only the upper left connector is used, 'Up sensor'. In MANUAL and WALK modes, the booth connectors can be used based on sensor configuration. The gradient 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.

There are two connectors on the right side of the box. The upper one serves to connect to the computer through USB. The connector for charging of the internal battery is located in the lower part of the instrument. The connector can also be used for an external power supply after removing the internal battery.

The lead-acid 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 the keyboard are located on the top side of the unit. 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 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, due to an interruption of the polarization current in the sensor, the transient field is dumped, 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 statistical error of the measurement from the value of the frequency of the precession. Both values are displayed and optionally stored in the data memory.

During the second step, the amplitude of the precession signal and the time constant of the decay 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 push-button [ON/OFF], the initial logo appears on display.

After pressing any push-button 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 push-button. The backlight can be switched off all the time to save power consumption.


**MAIN MENU**

1. **MEASURE**
2. **POSITION**
3. **MEMORY**
4. **SETUP**

Line:+1026 Pos:-0980

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

 this icon indicates that the USB cable 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. Push-buttons [v] and [^] serve for a cursor move in the main menu. Menu items 1 - 4 are directly selectable by pressing numerical push-buttons [1] - [4] on the keyboard.

Push-button [ENTER] serves for item function activation and to confirm the newly specified parameters. Push-button [ESC] serves to return to the main menu without modification of parameters.

1. **MEASURE** – item sub-menu serves to activates measurement. The possible measurements are MANUAL, WALK, and AUTO. See chapter 6.
2. **POSITION** - Item serves for the setting of 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 for a listing of the items stored in the data memory. Further, it enables us to erase the data memory and see 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. Push-buttons [v] and [^] serve for a cursor move in the main menu.

Menu items 1 - 5 are directly selectable by pressing numerical push-buttons [1] - [5] on the keyboard.

Push-button [ESC] serves to return to the main menu.

Push-button [ENTER] serves for item function activation and to confirm the newly specified parameters.



Push-button [ESC] serves to return to the setup menu without modification of parameters.

```
S 08:04:28    
-----  
          SETUP MENU  
1.  MODE  
2.  TUNE  
3.  WALK MODE  
4.  DEVICE
```

1. MODE – item sets the sensor mode (Single or Gradient) for MANUAL and WAL measure. This item is shown in the case that the device is a gradiometer.
2. TUNE – item serves 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.

3.7. Device Menu

The device menu serves for setting up various device parameters, see below. It is activated in the setup menu, item 5.

```
S 08:04:28    
-----  
          DEVICE SETUP  
1.  BACKLIGHT  
2.  DATE / TIME  
3.  OFF TIME  
4.  INFO
```

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 by means of push-buttons [0],[1],[2],...[9]. Move the cursor by [v], [^], and [NEXT]. The push-button [ENTER] stores the modified date and time into the memory. The push-button [ESC] returns the control to the parent menu without any change of 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 serial number of the instrument and version of the software.

4. PUTTING THE INSTRUMENT INTO OPERATION

4.1. Power Supply

The instrument is delivered with a built-in hermetically closed lead-acid battery 12V / 3.4Ah. 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.

In the case of a faulty power supply, an error message is displayed. 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 activities of the operator 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 above-mentioned information 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 to 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 of the battery are prevented.


If the instrument is not used for a long time, the battery should be checked and charged at least twice a year.

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 push-buttons. The cursor is moved by pressing [v] and [^]. The push-button [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.

```
S 08:04:28   
-----  
SET TIME  
DATE: YY.MM.DD  
      2020.01.01  
TIME: HH.MM.SS  
      08:15:50
```

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:

```
S 08:04:28   
-----  
SET TUNE  
Sensor: UP  
41600 - 43800nT  
43500 - 45800nT  
45500 - 48000nT  
Auto tune: ON
```

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 select tune 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 on the basis of a magnetic field map - see Figure 5.1 in dependence on the geographic coordinates of the location of measurement or automatic search can be used. An error message indicates if the measured value of the magnetic field is not within the tuning interval. If the automatic tuning is on, the input circuits will be automatically tuned at the next measurement.

The modified tuning interval is stored in the memory after pressing [ENTER]. By pressing [ESC], the tuning procedure is terminated 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.

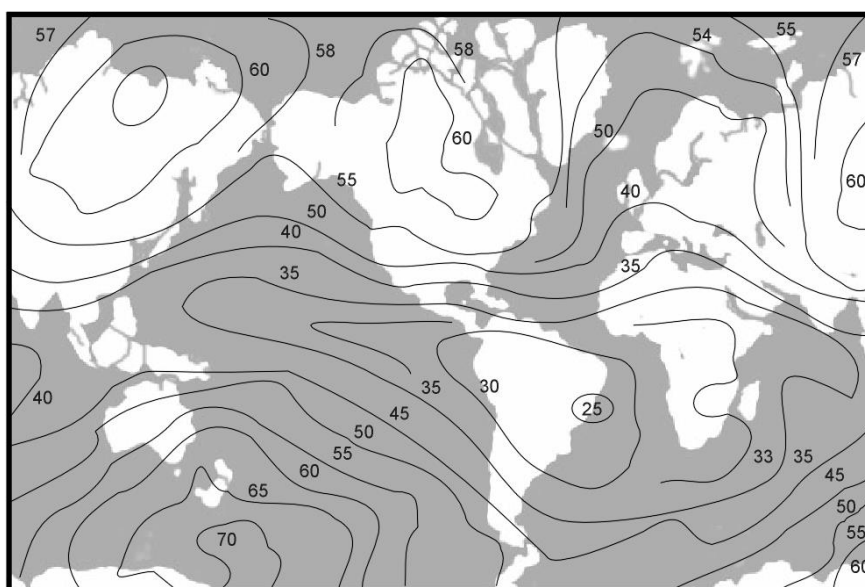


Figure 5.1 – Earth's magnetic field.

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 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 [^].

The pressing of the push-button [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 [^].


The pressing of the push-button [ENTER] asserts the selection, [ESC] terminates the procedure without changing the mode.

5.6. Setting The Time Interval To Switch Off

To protect the lead-acid 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.

```
S 08:04:28   
-----  
SET AUTO POWER OFF  
  
OFF TIME: HH.MM  
00:20
```

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 to the end of the profile, to higher positions, and also 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:

```
S 08:04:28   
SET POSITION  
Line: +01026  
Pos.: -00980  
Step: +10
```

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 -99999 to 99999. 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 -99999 to 99999 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 the same way as above. By [v] and [^], the digit to be modified is selected, and by numeric push-buttons [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 is used to display the data stored in the data memory. The stored data are browsed by measurement type manual, walk, and single.

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

```
S 08:04:28   
Line:+1026 Pos:-0980  
Single:  
45123.4 ±02.3nT  
  
Amp:5 D:0.5s  
08.06.2012 15:38:44
```

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

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. In the single sensor configuration and AUTO modes, the connector 'Up sensor' is used. 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. To achieve the maximum signal the sensor must be oriented in the north-south direction, 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. If the measurement is conducted with inaccurately tuned circuits, an error message is displayed. 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 measures the value of the magnetic field in both locations of the sensors simultaneously. 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.

```
S 08:04:28   
46347.2 ±05.6nT  
Line:+1026 Pos:-0980  
Amp:8 D:0.6s  
  
Save? ENTER/ESC
```

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. By pressing [ESC], the measured data is erased, 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.

In the WALK measure mode, the measurements are continually repeated and saved to memory. The repetition interval is selectable int setup menu item WALK MODE. The intervals are 0.5s, 1s, and 1.5s see chapter

6.6. Measuring In Auto Mode

The AUTO measure mode is selected in the MEASURE menu. In this mode, the instrument is prepared to serve as a base station and measure diurnal variations. 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 results of the measurement 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 through the USB interface.

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 Of The Data Memory

The stored data will be erased during the erase procedure. Therefore it is necessary to transmit the data to an external computer before the procedure.

The erasing procedure starts by selecting the item ERASE in the memory menu. To prevent occasional erasing of the memory, the operator is repeatedly asked to confirm the operation. 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 and the 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.

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 speed of the scanning. 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 the transmission of the stored data to an external computer, it is necessary to connect the instrument and the computer with the USB cable.

On the computer, it is necessary to run the program, 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 be as well exported to a text file for further processing.

8. SUPPLEMENTARY INFORMATION

8.1. USB Interface

The magnetometer PMG2 can be directly connected with 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.

8.2. Charger

The charger is delivered with the instrument, allowing careful and optimum charging of the built-in lead-acid battery 12 V / 3.4 Ah, to use its full capacity and lifetime. The product is double insulated.

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

Operation:

1. Plug the connector of the charger cable in 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.

8.3. Maintenance And Repair Work

Under normal operating conditions, the magnetometer requires no special maintenance. Only the built-in lead-acid 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.

8.4. Storage And Transportation

The packed instrument can be stored and transported in the range of temperatures -20° to 70°C and at the relative humidity of up to 90%.

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

8.5. 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.

8.6. 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