MAGNET-PHYSIK
Dr. Steingroever GmbH

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Germany

Operating Instructions

FH 52
Gauss-/Teslameter

CE

Preserve for future application!

BA - Nr.: 1620010102

Introduction

Dear customer,

You have decided on a product of high technical standard from MAGNET-PHYSIK. We are convinced that our product will be a valuable help in your daily work. Condition is that the operating instructions are read carefully and are observed. We will not take over any warranty or liability in case of deliberate faulty operation or disregard of our safety notes.

If you face any problems while working with the equipment or the operating instructions or if you have any proposals for improvements please do not hesitate to contact us.

Purpose

The user's manual gives a survey about the applications and functionality of the FH 52 Gauss-/Teslameter.

Target Group

In the following chapters the user of the equipment will find all necessary information regarding the handling of the product or device.

Manufacturer

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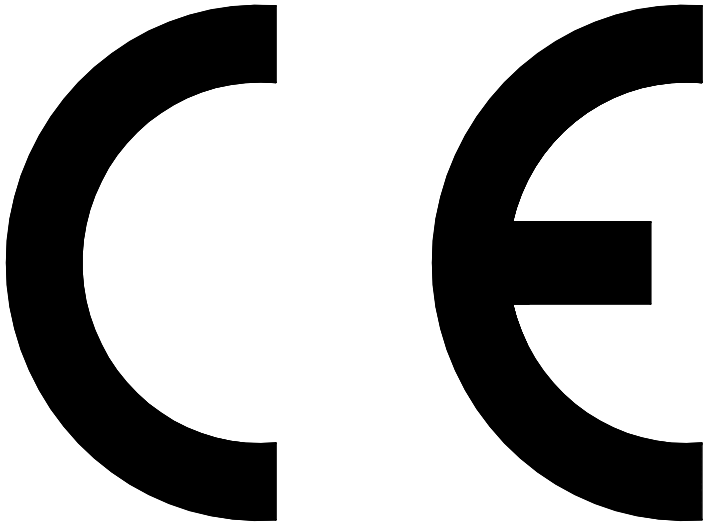
Notes

- This instruction cannot cover every possible aspect of installation, operation and maintenance, or every error that might occur.
- If you would like more information, or if you encounter particular problems that are not discussed in sufficient detail in the instructions, please contact company MAGNET-PHYSIK.
- We also state that the content of these Instructions is not part of a previous or existing agreement, undertaking, or legal relationship, and is not intended to amend the same. All obligations of MAGNET-PHYSIK result from the applicable warranty: These contractual warranty provisions are neither extended nor limited by statements in these instructions.



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Although the contents of this publication have been checked for agreement with the hardware and software described, we do not accept liability for total agreement since differences cannot be completely excluded. The information in this publication is checked at regular intervals and necessary corrections included in the next release. Your suggestions for improving this publication are welcome.

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1 General Information

The Gauss-/Teslameter FH 52 is a measuring instrument for the quantities “Magnetic Field Strength” and “Magnetic Flux Density” or “Magnetic Induction”.

The following instructions with regard to use and operation must be strictly adhered to. The user or operator of the equipment must make sure that only suitably qualified personnel operates or services the device.

1.1 Safety Instructions

Special warnings, whose non-observance may lead to injuries and/or property damage, as well as important hints, are indicated in these operating instructions as follows:

Danger!

Means that serious bodily injury resulting in death or considerable material damage may occur if the appropriate safety measures are not taken.

Warning!

Means that bodily injury or material damage **may** occur if the appropriate safety measures are not taken.

Important!

Indicates important information that is to be paid particular attention.

1.2 Intended Purpose of Operation

Important!

It must be explicitly stated that the FH 52 is to be used only for its intended purpose.

The intended purpose of the FH 52 is the measurement of the magnetic field strength or the magnetic flux density of static or periodically alternating magnetic fields.

Every application not in accordance with this intended purpose is prohibited and implies the deliberate dealing with non-calculable risks for both the operator as well as the equipment. Unauthorized reconstructions of and/or alterations to the equipment are forbidden for safety reasons!

1.3 Sources of Danger

The FH 52 is operated with battery power. For reasons of work-place safety and accident prevention the sources of danger emanating from the use of the device will be pointed out here. The respective instructions to the operator and owner of the FH 52 are to be strictly adhered to.

Danger!

Do not operate the instrument in an explosive atmosphere. Do not operate it in the presence of flammable gases or fumes. Operation of any electrical device in such an environment constitutes a definite safety hazard.

Danger!

The measuring instrument and the software of this product are not designed, tested, intended or authorized for use in any medical applications, surgical applications, medical device manufacturing or any similar procedure or process. Disregard of this limitation can cause danger to life.

Danger!

The Hall probe must never be brought into contact with an electrical voltage conductor or close to an electrical high voltage conductor. The coating or sleeve on the probe surface is not an electrical insulation with defined properties. Disregard of this warning can cause danger to life of the user. Additionally the measuring instrument and a connected computer can be damaged.

Warning!

Although the FH 52 is protected against splashes, it is not waterproof. Therefore it must not be immersed in water or permanently exposed to conditions of high humidity.

The device must not come into contact with liquid media, like water, oil, etc. If, in spite of all precautions taken, a liquid should get into the FH 52, there is a considerable risk for the operation of the device. In this case the device must be switched off immediately and the USB cable and the batteries must be removed.

The device must be switched off when being cleaned. Never clean it with water. Only use a dry cloth for cleaning!

Warning!

Keep away from live circuits:
Operating personnel must not remove instrument covers, except the cover of the battery compartment. Only qualified maintenance personnel must make component replacement and internal adjustments. Do not replace components with the USB cable connected.

Warning!

Do not substitute parts or modify the instrument:
Due to the risk of electrostatic discharge and because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to MAGNET-PHYSIK Dr. Steingroever GmbH, Cologne, Germany or an authorized representative for service and repair to ensure that safety features are maintained.

1.4 Authorized Operators

The FH 52 must only be used by personnel authorized by the owner.

In this case the owner must:

- **place operating instructions at the operator's disposal at all times and**
- **make sure the operator has read and understood them.**

1.5 Safety Measures at Place of Installation

No special safety measures are necessary.

1.6 Safeguard Installations

The device does not have any special safeguard installations as safety concerns have been taken into account in construction. A potential danger only arises if the device is used against its intended purpose of operation or safety regulations are disregarded.

1.7 Emergency Measures

In the case of emergency, when all safety instructions fail, proceed as follows:

Important!

1. Take emergency measures, such as "First-aid".
2. Secure the device and working place against further use.
3. Write the case report.

2 Transport and Installation

2.1 Unpacking and Checking

Check the packaging for signs of damage. Any correspondence regarding damage (evident or hidden) or partial loss of the consignment must be made in written form immediately after receipt of goods. Also inform the freight forwarder immediately.

Open the packaging. A packing list is enclosed which enables you to check that the ordered device and accessories have been received. Use the packing list to check that all parts of the device have been unpacked. Check them for damages. Make sure everything has been removed before discarding the packaging.

If the device has been damaged in transit, make sure the forwarder and insurance are informed. Inform Magnet-Physik of the same. If there are parts or accessories missing, let Magnet-Physik know immediately. Magnet-Physik cannot accept responsibility for any missing parts if not informed within 60 days from date of dispatch.

Important!

Check on receipt of goods and before taking the device or accessories into operation whether they show visible signs of damage. The device must otherwise not be put into operation before being cleared by an authorized person.

2.2 Transport and Storage

Always use suitable packing or containers for transport and storage, so that damage is avoided. Store the instrument in the hard case in which it has been delivered.

Do not store the device in places where one or more of the limiting values for the ambient conditions are exceeded.

2.3 Technical Data

Table 1: Specifications

Display	3½ digits (0...±1999), backlight when powered from USB				
Units	Tesla (T), Gauss (G), Ampere per Meter (A/m), Ampere per Centimeter (A/cm), Oersted (Oe)				
Ranges (with standard probes)	20 mT	200 G	16 kA/m	160 A/cm	200 Oe
	200 mT	2 kG	160 kA/m	1600 A/cm	2 kOe
	2 T	20 kG	1600 kA/m	16 kA/m	20 kOe
Resolution (in most sensitive range, with standard probes)	0.01 mT, 0.1 G, 0.01 kA/m, 0.1 A/cm, 0.1 Oe				
Frequency range	DC (with polarity display +/- or N/S) AC 20 Hz - 10 kHz (true rms)				

Accuracy (instrument with standard probe, at 23 °C)	DC: 1 % of reading + 0,05 % of range AC ≤ 5 kHz: 3 % of reading + 0,25 % of range AC > 5 kHz: 5 % of reading + 0,25 % of range
Precision (reproducibility), (instrument with standard probe, at 23 °C)	DC: 0,5 % of reading + 0,05 % of range AC: 2 % of reading + 0,25 % of range
Temperature Coefficient of Sensitivity (instrument with standard probe)	Approx. -0,05 %/K
Sampling rate	Standard 4.17 Hz, at USB operation up to 16.7 Hz
Power source - Battery life time - Current consumption	Exchangeable batteries, 4 pcs. 1.2 V to 1.5 V, size AA (LR6) or power supply from USB Approx. 300 hours with high quality alkaline batteries Approx. 165 mA from USB, approx. 6 mA from batteries
Accessories/Options:	
- Hall probes	Transverse probe or axial probe; the probe connection cables are fixed to the probes, length 1.5 m (5 ft);
- Hard case	Included
- USB cable	USB type A to micro USB type B, length approx. 1.8 m (6 ft)
- Magnetic shielding chamber	Optional, see data sheet “NK Shielding Chambers”
- USB AC adapter	Optional, different AC line plug styles available
Outer dimensions	228 mm x 70 / 117 mm x 47 mm
Weight	approx. 0.4 kg

Table 2: Ambient Conditions

Temperature:	- for operation	0 °C to +40 °C (the FH 52 can be operated from -10 °C to +40 °C, but AC accuracy is not specified below 0 °C)
	- for storage and transport	Class 1K4 according to EN 50178 -25 °C to +55 °C
Relative humidity:	- for operation	Class 3K3 according to EN 50178 5 % to 85 % (indoor), no dew, 1 g/m^3 to 25 g/m^3
	- for storage and transport	Class 1K3 according to EN 50178 5 % to 95 % (indoor), no dew, 1 g/m^3 to 29 g/m^3

Air pressure	- for operation	Class 3K3 according to EN 50178 86 kPa to 106 kPa
	- for storage and transport	Class 2K3 according to EN 50178 70 kPa to 106 kPa
Pollutants:	- SO_2	≤ 0,5 ppm (rel. humidity ≤ 60%, no dew)
	- H_2S	≤ 0,1 ppm (rel. humidity ≤ 60%, no dew)
Oscillations:		according to IEC 68-2-6 10 ... 55 Hz (const. amplitude 1.0 mm), 57 ... 150 Hz (const. acceleration 2 g)
Immunity from discharge of static electricity: based on IEC 61000-4-2		Air discharge: 8 kV Contact discharge: 4 kV
Immunity from electromagnetic HF field, amplitude modulation: based on IEC 61000-4-3		80 MHz to 1000 MHz 3 V/m 80 % AM (1 kHz)
Immunity from electromagnetic HF field, pulse modulation: based on IEC 61000-4-3		(900 ± 5) MHz 3 V/m 200 Hz repetition frequency

Regulations regarding immunity from electromagnetic fields of power line frequency are not applicable as the device is a measuring instrument that is measuring in this frequency range.

2.4 Installation

Important!

Never store or operate the device in places where one or more of the limiting values for the ambient conditions are exceeded.

2.5 Structure of the Device

Fig. 1: Front view of the device

The FH 52 Gauss-/Teslameter is a hand-held measuring instrument that provides measurements of AC and DC magnetic fields. The device is designed for wide range, high accuracy, and ease of use. User interface are front panel keys and a liquid crystal display (LCD). Most important user features are only one pushbutton away.

In Fig. 1, the front side of the FH 52 is shown. The sockets on the upper side are used for probe and USB connection.

2.6 Accessories (included in delivery)

The field strength meter is provided with the following accessories:

- Carrying and storage case: a hard case is provided.
- One probe is included in the delivery.
- One set of size AA batteries (4 pieces).
- USB cable (USB type A to Micro-USB type B)
- Operating instructions.

2.7 Options (to be ordered separately)

The following parts are optionally available for the FH 52:

- Further probes, see also chapter 3.7
- Shielding chamber: a small chamber in which the tip of probe is placed to eliminate background magnetic fields like the earth's magnetic field during zeroing.
- AC adapter with USB connector (different power line connector styles are available).

2.8 Taking Into Operation

To take the FH 52 into operation, please proceed as follows:

1. **Install the batteries:** Open the door on the bottom side of the FH 52. Install 4 batteries observing the polarity for each cell into the battery compartment. Close the door again.
2. **Connect the probe:** Plug the probe into the socket on the top face of the measuring instrument. An arrow on the top side of the plug housing indicates the proper plug position. You can remove the probe again by pulling the plug. Do not try to twist the plug.
3. **Switch on the device:** Press the On/Off key. First the Magnet-Physik logo and the device name appears. Then the device returns into the operating condition in which it was when switched off.

The FH 52 should always be switched off before a USB power supply (AC adapter) is connected or removed. For details see chapter 3.4.

3 Operation

The FH 52 is a measuring instrument that allows measuring the magnetic flux density or induction *B* and the magnetic field strength *H* of static or periodically alternating fields. The instrument is characterized by a large measuring range, high accuracy and easy operation. It is operated via keys or the USB interface. The measured values, information about the operating conditions and the menus are shown on a liquid crystal display.

The display content depends on the selected language. The devices are delivered with the language setting “English”. The language can be changed in the Display menu (chapter 3.3.14). The following figures show the English displays.

The most important functions are invoked by the touch of a key. Further settings can be carried out in a menu that is opened using the **Mode** key. The settings are automatically saved when the device is switched off.

3.1 Display

The figure below shows the measurement display of the FH 52 with all available elements enabled. In real operation you will normally use only some functions and the displayed information will be less complex.

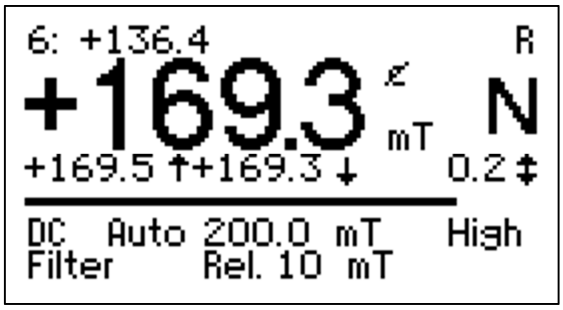

Fig. 2: Display during measurement operation

In measurement operation, the actual reading is shown in large characters in the center of the display. The numerical value is displayed with 3½ digits at maximum, followed by the unit. If an overrange condition occurs, the reading will flash.

If the Max./Min. function (chapter 3.3.10) is enabled, the values captured using this function are shown in the line below the reading.

Below a separator line is shown, or if the Bargraph function is switched on, a horizontal bar whose length is proportional to the measured value.

The following information is shown in the two lower lines:

1. Signal mode: DC or AC (measurement of static or alternating fields).
2. Range: Auto, if automatic range selection is enabled and the upper range limit of the currently selected measuring range.

3. State of the limit comparator: Low, OK, High. Therefore the Limit function must be enabled.
4. If the Filter function is enabled, the term Filter is shown.
5. Rel.: The reference value for a relative measurement. Therefore the Relative function must be enabled.

If the **Polarity** display is enabled, the polarity of the magnetic field is indicated by a large **N** or **S** behind the measured value. More information regarding this point is given in chapter 3.7.2.

The symbol ¢ is shown behind the reading if the displayed value is outside the calibrated range of the probe. This is never the case for standard probes.

Readings that are stored in the measured data memory are shown in the upper left corner of the display together with their sequential number. The unit behind the actual reading also applies to these values.

If the FH 52 is set to remote mode via the USB interface, an **R** is shown in the upper right corner. In remote mode, the operation using the key pad is restricted.

3.2 Key Pad

The key pad consists of an integrated block of 9 keys and a line arranged above with 3 keys.

The block contains the following keys: On/Off, Delete, Mode, Escape, Enter and arrow keys in 4 directions. The line contains the Range, Zero and Reset keys.

Short descriptions of the key functions are given below. Detailed information on the functions is provided in the next chapters.

On/Off	The instrument is switched on and off using this key.
Mode	With this key you can switch between the measurement display and the menu display. If the Mode key is pressed in a submenu, the current selection is accepted and the measurement display is activated.

The arrow keys and the Enter and Delete keys have different functions, depending on whether the measurement display or a menu is active.

In the measurement display:

Enter	Saves the current reading to the measured data memory. The saved value is shown in the upper left corner of the display.
←, →, ↑, ↓	The arrow key are used for navigation in the measured data memory.
Delete	Deletes the value that is shown in the upper left corner of the display from the measured data memory. The remaining values are renumbered in ascending order.

In a menu:

Enter	Using this key the selected submenu is invoked or inputs that are shown in the display are accepted.

←, →, ↑, ↓ The arrow keys are used to move the selection mark. The selection is shown inverted.

Escape This key is used to cancel an input and to return to the previously set values.

Using the **Range**, **Zero** and **Reset** keys, frequently used functions are carried out immediately.

Range Pressing this key multiple times allows switching between the available measuring ranges and the automatic range selection (Auto).

Zero Starts the automatic zero adjustment.

Reset Resets the stored maximum and minimum values.

3.3 Functions

3.3.1 On/Off Key – Switching the Device On and Off

Press the **On/Off** key to switch on the instrument. First the logo of Magnet-Physik and the device name are shown. Then the device returns to the state it was in before being turned off. The device cannot be switched off again until the logo has disappeared.

To switch off the device, press the **On/Off** key again. Before the device powers down, all eventually changed settings and changes to the measured data memory are copied from the volatile to the no-volatile memory. Therefore you should always switch off the device using the **On/Off** key. If the device does not contain operational batteries and the USB cable is removed while the device is on, settings or measured data can be lost.

Settings and changes to the measured data memory are also copied from the volatile to the no-volatile memory when the device enters the standby mode (chapter 3.3.17).

3.3.2 Range Key – Range Selection

Pressing this key multiple times allows switching between the available measuring ranges and the automatic range selection (Auto). The available measuring ranges depend on the selected unit and are given in the following table.

Table 3: Ranges

20 mT	200 G	16 kA/m	160 A/cm	200 Oe
200 mT	2 kG	160 kA/m	1600 A/cm	2 kOe
2 T	20 kG	1600 kA/m	1.6 kA/cm	20 kOe

In **Auto** mode, the FH 52 automatically selects the range with the best resolution for the value to be measured. It can take about 1 second until the range is set. Besides the device switches already at 90 % of the upper range limit into the next higher range and it returns at 7 % of the upper range limit into the next lower range. So manual ranging might work better under some conditions, especially if the reading is close to the upper range limit.

3.3.3 Zero Key – Zeroing the Probe

The Zero function is used to null the display. The purpose is to cancel out small magnetic fields and probe offsets. The zero routine is normally initiated while the probe is outside the magnetic field to be measured:

(a) Place the probe outside the magnetic field to be measured and start zeroing by pressing **Zero**.

(b) Zeroing can also be carried out when the probe is located inside the optional shielding chamber. Therefore carefully place the tip of the probe about in the center of the chamber. Do not move the probe to the rear end and do not touch the end face of the chamber with the probe tip. Then press the **Zero** key.

The zeroing routine can take a few seconds. Do not move the probe until the normal display appears again.

For best measurement results periodic zeroing of the probe is commended, especially if the most sensitive range is used. If you want to suppress large magnetic fields, you should use the Relative function instead of Zero.

3.3.4 Reset Key – Resetting the Display of Maximum and Minimum

Using the **Reset** key, the memories for the maximum and minimum measured values are reset to the current reading.

The FH 52 allows capturing the maximum absolute reading, the maximum and minimum, and the difference between maximum and minimum. For details see chapter 3.3.10.

3.3.5 Menu Operation

In the single menus the title is shown in the first line. Below it is indicated which keys can be used for inputs. The keys **Enter**, **Mode** and **Escape** are nearly always available. These keys have the following functions:

In the main menu you open the selected submenu by pressing **Enter**. In a submenu you complete the current input with **Enter** and move to the next line. If there are multiple input lines in a submenu, each input has to be confirmed with **Enter**. Following the last input in a submenu you leave it with **Enter** and return to the main menu.

By pressing the **Mode** key you will return immediately from the main menu or a submenu to the measurement operation. For submenus the last input or selection is accepted.

Using the **Escape** key, you can go back one step in operation without accepting the latest input.

3.3.6 Main Menu

The following menus can be invoked from the main menu:

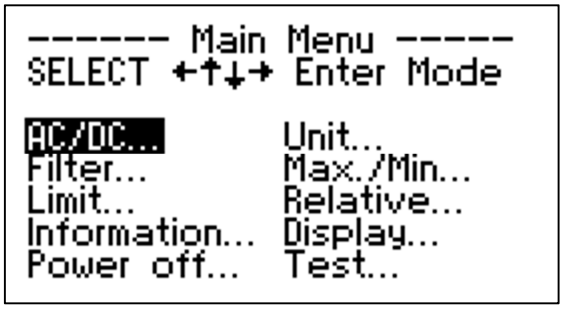

Fig. 3: Main menu

3.3.7 AC/DC Menu

In the AC/DC menu you can choose whether you want to measure static (DC) magnetic fields or periodically alternating (AC) fields. Make your choice using the arrow keys and finish the input with the **Enter** or the **Mode** key.

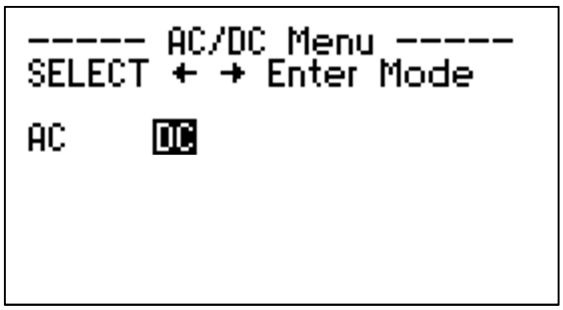

Fig. 4: AC/DC menu

If AC is selected, the root mean square (RMS) value of the field strength or flux density of a periodically alternating magnetic field is displayed.

If DC is selected, the measured value for a static magnetic field is shown. The sign gives the field direction according to the definition in chapter 3.7.2. Additionally the polarity can be shown with the characters N (for North) and S (for South), see chapter 3.3.14.

3.3.8 Unit Menu

The FH 52 shows the magnetic flux density or induction *B* in Tesla (T) or Gauss (G) or the magnetic field strength *H* in Kiloampere per Meter (kA/m), Ampere per Centimeter (A/cm) or Oersted (Oe).

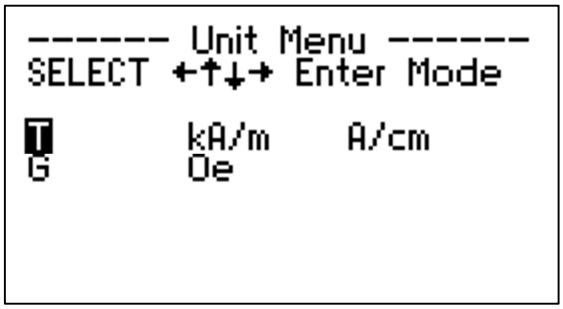

Fig. 5: Unit menu

Between the units and their multiples there are the following relations:

Magnetic Flux Density *B*:	Magnetic Field Strength *H*:
1T = 1000 mT	1 kA/m = 1000 A/m = 10 A/cm
1 T = 10000 G	1 A/m = 0.001 kA/m = 0.01 A/cm
1 kG = 1000 G	1 A/cm = 0.1 kA/m = 100 A/m
1 G = 0.001 kG = 0.0001 T	1 Oe = 0.001 kOe
	1 A/m = $4\pi/10^3$ Oe ≈ 0.01257 Oe

The relation between the magnetic flux density *B* (in Tesla) and the magnetic field strength *H* (in A/m) is given by the following relation:

$B = \mu_0 \cdot H = 4 \cdot \pi \cdot 10^{-7}$ Vs/Am $\cdot H \approx 1.257 \cdot 10^{-6}$ Vs/Am $\cdot H$.

Here μ_0 is the magnetic field constant or permeability of the vacuum.

If the unit for the measurement is changed, the relative and limit set points and stored measured values are automatically converted to the new unit.

3.3.9 Filter Menu

The Filter function averages several sequential field readings (moving average). It is used to quiet the display, making it more readable when the probe is exposed to a noisy field.

Fig. 6: Filter menu

Filtering slows down the reaction on changes of the field strength. Therefore care must be taken, especially if filtering is used together with the Max./Min. function.

3.3.10 Max./Min. Menu

The Max./Min. function allows capturing maximum and minimum values.

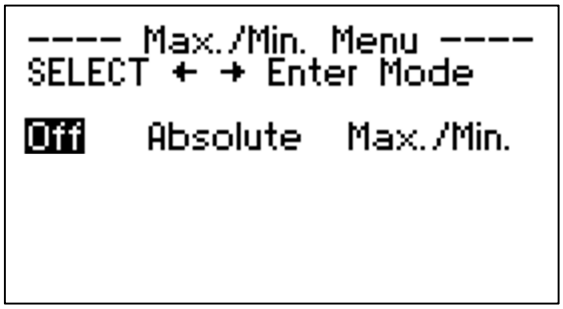

Fig. 7: Max./Min. menu

If Absolute is selected, the maximum is shown in the line below the measured value. The maximum is the highest reading that was captured since the **Reset** key was pressed last. When this maximum is evaluated, the sign of the reading is not taken into account.

If Max./Min. is selected, the maximum, the minimum and the difference between maximum and minimum are shown in the line below the actual reading. The maximum is the highest reading that was captured since the **Reset** key was pressed last. The minimum is the lowest reading that was captured since the **Reset** key was pressed last. Here in DC mode the sign of the readings is taken into account.

The **Reset** key deletes the captured values. These are also reset if the device is switched off, if the signal mode is switched between AC and DC and if the device enters standby. The Max./Min. function can be used together with the relative function.

The Max./Min. function is designed to observe slowly changing signals. A change in the magnetic field, that is not visible in the display, cannot be captured. The Max./Min. function should not be confused with a fast Peak function of more sophisticated measuring instruments.

In the following cases the function is particularly useful:

- Measuring very inhomogeneous fields, for example on the surface of magnets. Here often only the measurement of the maximum value is sufficiently reproducible.
- To capture readings in hard to get at places.
- To display the maximum field when field orientation is unknown. The probe is rotated slowly and the largest value will be captured.

3.3.11 Limit Menu

If the Limit function is enabled and the measured value is larger than the upper limit level, High will be displayed. If the measured value is smaller than the lower limit level, Low is displayed (see Fig. 3). If the measured value is in between, OK is shown.

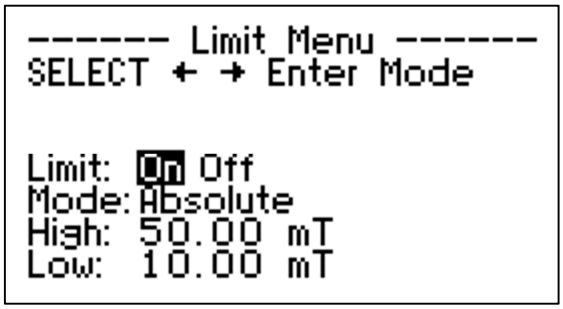

Fig. 8: Limit menu

Before the Limit function can be used, it must be configured. In the first line, it can be switched on or off. The selection is done with the arrow keys and confirmed with **Enter**.

In the second line the limit mode can be selected: +/- or Absolute. If +/- is chosen, the sign of the reading is taken into account in the evaluation. If Absolute is chosen, only the absolute value, without sign, is used. The Absolute mode can e.g. be used to sort magnets after their field strength, without caring about the polarity. In the +/- mode, magnets can be sorted according to their polarity.

In the next two lines, the switching levels for the limit function can be entered: first the high limit and then the low limit. The low limit must always be smaller than the high limit. If the limit vales are entered in the wrong order, they are exchanged automatically when the menu is left. A sign can only be defined if the +/- mode is selected. Move the cursor using the ← → arrow keys onto the sign or onto the digit to be changed and change them with the ↑ ↓ arrow keys. Terminate editing using **Enter** or **Mode**.

Please note that the RMS values that are measured in AC mode are always positive. Entering limits with a negative sign is then not meaningful and respective settings are not evaluated.

If the desired switching level cannot be entered in the active range, you can change the range using the **Range** key without leaving the input line. Please note that the automatic range selection (Auto) is switched off in this case.

In measurement operation, Low is shown in the information area of the display if the reading is below the low limit. The display changes to OK, if the reading is between the two limits. High is shown if the reading is above the high limit. If both limits are set to the same value, the display changes directly from Low to High when the value is exceeded.

3.3.12 Relative Menu

Using this function, small changes in a larger magnetic field can easier be observed. If the function is switched on, only the difference to a reference value that was previously set is displayed.

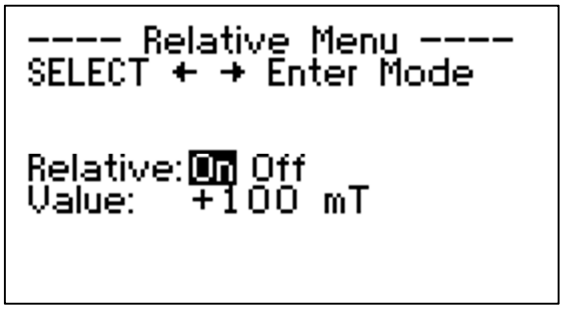

Fig. 9: Relative menu

In the first line of the Relative menu the function can be switched on or off. If it is switched on, the reference value is shown in the status line of the measurement display.

In the following line the reference value can be entered. First the currently stored value is shown. If this value shall not be changed, simply press **Enter** or **Mode**. If you want to enter a new reference value, replace the current value. Move the selection mark with the ← → arrow keys onto the sign or onto the digit to be changed and change them with the ↑ ↓ arrow keys. Terminate editing using **Enter** or **Mode**.

If the desired reference value cannot be entered in the active range, you can change the range using the **Range** key without leaving the input line. Please note that the automatic range selection (Auto) is switched off in this case.

You can also make the actual reading become the reference value. Therefore press the **Zero** key while the selection mark is in the input line for the reference value. The actual reading becomes the reference value.

If the functions Relative and Max./Min. are used together, the maximum and minimum deviation from the reference value is shown.

3.3.13 Information Menu

The following information can be retrieved in this menu:

- The version number of the device
- The serial number of the device
- The name and the version number of the probe
- The serial number of the probe

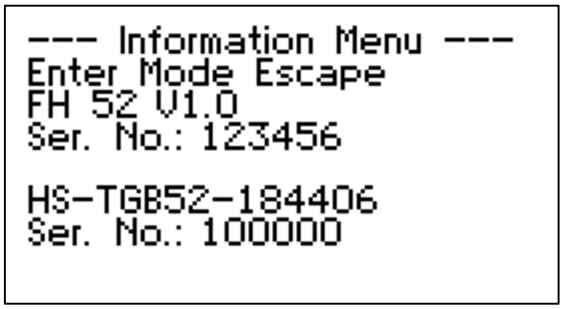

Fig. 10: Information menu

3.3.14 Display Menu

Several settings regarding the display can be carried out in this menu.

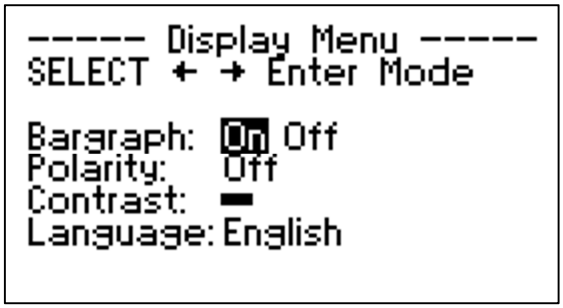

Fig. 11: Display menu

- Bargraph: If the Bargarph is switched on, a slightly thicker bar is shown between the reading and the information area instead of the separator line. The length of this bar is proportional to the absolute value of the reading. For a reading of 0 the bar is not visible. For the range limit is reaches from the left to the right border of the display area.
- Polarity: In DC mode, the sign of the reading always shows the polarity. By setting Polarity to On, additionally a letter N (for north pole) and S (for south pole) can be shown behind the reading. N means that the sensor is opposite to a north pole and S means that the sensor faces a south pole, see also **Fehler! Schalterargument nicht angegeben.**.
- Contrast: Here the contrast of the display can be adjusted. It is reduced using the ← key and increased using → key. Make the desired setting with the ← and → keys and confirm it by pressing **Enter** or **Mode**.
- Language: The display language can be selected here. Carry out the selection with the ← or → keys and confirm it with **Enter** or **Mode**.

3.3.15 Power Off Menu

To save battery current, the FH 52 can automatically power down itself after a selectable time. You can set this time to 5 minutes or 20 minutes or you can disable this function. If any key is pressed the timer is reset, i.e. the waiting time starts from the beginning.

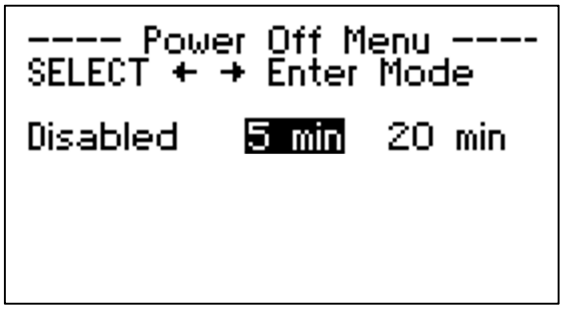

Fig. 12: Power Off menu

The automatic Power Off function is not active if the FH 52 is powered from the USB.

3.3.16 Test Menu

When the Test menu is invoked, the FH 52 will carry out some self-tests. The results of the tests are shown.

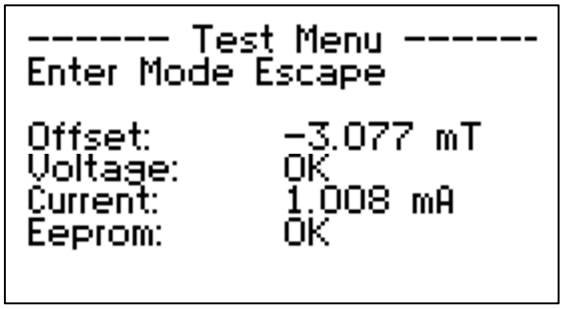

Fig. 13: Test menu

First the Offset of the probe that was obtained during the last run of the **Zero** is shown. An offset with an absolute value of more than 20 mT can indicate that the probe is defective. If a high offset is shown you should first check if the plug of the probe is properly inserted. Then leave the menu and carry out **Zero** again. Check the result in the Test menu. Please also take notice of the hints in chapter 4.4.

Secondly the Voltage path of the probe is checked. If no probe is connected or if the voltage path is interrupted, "open" is shown. If "OK" is shown, the voltage path is operational.

For third the probe Current is measured. It should be about 1 mA. Small deviations (up to approx. 5 %) are automatically corrected by the FH 52. A probe current that is much too small can indicate damage to the sensor. A probe current of 0 mA is shown if no probe is connected or if the current path is interrupted, i.e. the probe is defective.

At last the probe memory (Eeprom) is checked. "Missing" is shown if no memory is detected. If a memory is present, a check of the cyclic redundancy of the data is carried out (CRC). On success "OK" is shown, otherwise "CRC error".

3.3.17 Measuring Data Memory

Up to 120 measured values can be saved to the measuring data memory of the FH 52. These are also kept in memory when the device is switched of. Saving is carried out during the measuring

operation using the Enter key. The captured vale is then shown in the upper left corner of the display together with its sequential number. If multiple values are stored, the list can be browsed using the arrow keys. A new measured value is always appended to the end of the list. The shown value can be removed using the Delete key. If this key is held down, multiple values are deleted until the key is released again. After ten deleted values the deletion is processed faster.

3.4 Switching between Battery Power and USB Power

Important!

The FH 52 should always be switched off before an USB power supply (AC adapter) is connected or removed.

If a USB power supply (AC adapter) is connected while the FH 52 is operated from batteries the FH 52 might enter standby mode and not recover from this mode again. If this should happen, you must remove the USB power supply again. If the FH 52 does not resume operation in battery mode immediately, wait approximately 30 seconds and try to switch it on in battery mode again. Then switch it off and connect the USB power supply.

If a USB power supply is removed while the FH 52 is on, the FH 52 will normally continue operation on batteries. On weak batteries it might happen that the FH 52 restarts or extinguishes.

3.5 Standby Mode

If the FH 52 is connected to a PC and the PC enters the standby or energy saving mode, the FH 52 will also go into standby mode. In this case the display shows "Entering Standby" for a short time. Modified settings and saved measuring data are copied from the volatile to the non-volatile memory. Then the display backlight is switched off and the device is set to standby. The display remains empty. The device is not fully switched off. It only stays in a state of low energy consumption.

When the PC is wakened up from standby, the FH 52 will also continue operation. The display shows shortly "Resuming from standby" and thereafter the device returns into measurement operation.

During standby the FH 52 cannot be switched on or off from the keypad. However, it switches to active battery operation if the USB cable is removed.

3.6 Battery State Indicator

The battery state indicator in the upper right corner of the display is only visible if the FH 52 is powered from the battery. It is deactivated if the FH 52 is powered from the USB socket.

You can estimate the remaining battery capacity from the battery state indicator. The display changes from ▮ for a full battery to ▯ if the battery is too weak to ensure full measuring accuracy.

You can power the FH 52 either from non-rechargeable or from rechargeable batteries (accumulators). Rechargeable batteries have to be charged externally.

The indicator is configured for batteries with a cell voltage of 1.5 V. If rechargeable batteries with a lower cell voltage are used, the indicator will never indicate completely full batteries, even if they are fully charged. However, this does not mean that they cannot be used.

Switch off the device using the On/Off key before opening the battery compartment and removing the batteries. This ensures that the device settings and the measured values are saved.

Important!

You should remove the batteries from the FH 52 if the device will not be used for a longer time. This will avoid damage due to leaking batteries.

3.7 Probes

Two standard probes are available for the FH 52: a transverse and an axial probe. The transverse probe has a Hall sensor that is mounted parallel to the probe axis. It measures a magnetic field that is aligned in one direction perpendicular to the probe axis.

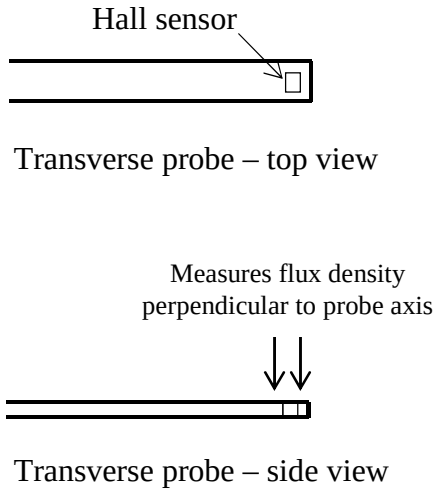

Fig. 14: Transverse probe

The axial probe has the Hall sensor mounted perpendicular to the probe axis which measures magnetic fields parallel to the probe axis.

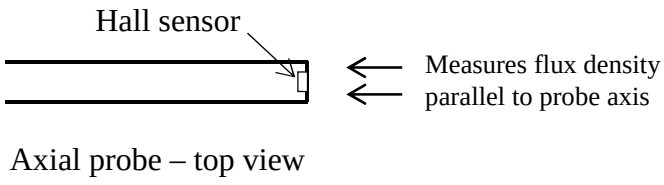

Fig. 15: Axial probe

In addition a surface field probe, shaped like a little stamp, is available. It is used to measure the field strength on the surface of magnetized foils.

3.7.1 Probe Handling

To avoid damage and for best measuring results, the following handling requirements need to be observed.

For connecting a probe, move the plug straight into the connector. Pull the plug straight out for removing the probe.

The FH 52 does not work without a probe. "The probe is missing!" is displayed if the device is switched on without a probe connected. When a probe is attached, the probe data are automatically read into the instrument. It is not necessary to switch off the FH 52 for changing a probe.

Danger!

The probe must never be brought into contact with not sufficiently isolated components that carry an electrical voltage. The sleeve on the probe is not an electrical insulation with defined properties. Disregard of this warning can cause danger to life of the user. Additionally the device, the probe and an eventually connected computer can be damaged.

Warning!

Care must be exercised when handling the probe. The sensor of the probe is very fragile. Stressing the Hall sensor can alter its calibration. The probe must not be clamped or pressed at its tip. Any excess force can easily break the sensor. Broken sensors are not repairable.

Although every attempt has been made to make the probes as sturdy as possible, they are still fragile. The probe should only be held in place by securing it at the handle. The probe stem should never have force applied. Mechanical stress in the Hall sensor can cause a permanent change of the measuring sensitivity or the offset. Excessive force may destroy the Hall sensor.

The axial sensor is exposed on the end of the probe. A collision with a hard surface can damage the sensor or wear away its protective coating.

The transverse sensor is more protected, but is nevertheless susceptible to bending stress and erosion of the protective coating. Do not apply any force to the front part of the probe (approx. 10 mm from the tip).

For all probes, do not pinch or allow cables to be struck by any heavy or sharp objects. Damaged probes are not repairable in most cases. When the instrument is not in use, the probes should be stored separately in the supplied protective hard case.

Important!

For best results, the instrument and probe should warm up for at least 5 minutes before operation. If used, the optional shielding chamber and the probe should be at the same temperature.

3.7.2 Polarity of the Magnetic Field

In the DC signal mode, the orientation of the probe in the magnetic field affects the polarity reading (+ or – resp. N or S). On a transverse probe, the label on the handle indicates the side for positive (+) flux entry. On an axial probe, positive (+) flux entry is always from the front of the probe, see Fig. 16.

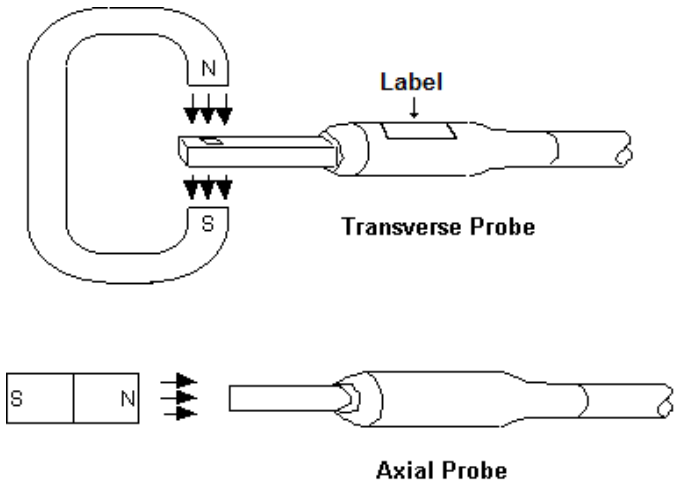

Fig. 16: Probe orientation for positive measurement and polarity display "N"

If the exact direction of the magnetic field is unknown, its orientation can be determined by slowly rotating the probe while the Max./Min. function is switched on. As the probe turns, the measured field rises and falls and the maximum is captured. Make note of the probe orientation at the maximum reading to identify the field direction.

You should consider all the possible contributions to the accuracy of the reading. Both, the probe and the instrument, have limited accuracy specifications that may affect the actual reading. The probe should be zeroed before making critical measurements. The **Zero** function is used to cancel out the offset of the probe or small magnetic fields, like the earth's magnetic field. If the probe tip is not inside a shielding chamber during zeroing, the local magnetic field will be suppressed. Note that the reading changes, if you turn the probe in the earth's magnetic field. If you wish to cancel out large magnetic fields, you should use the Relative function.

Important!

The probe temperature can also affect readings. Please refer to the technical data.

The readings are dependent on the angle between the Hall sensor and the magnetic field. Maximum output occurs when the flux vector is perpendicular to the plane of the sensor. This is

the condition that exists during factory calibration. The greater the deviation from orthogonality (from right angles in either of the axes), the larger is the error of the reading. For example: A 5° variance on any one axis causes a 0.4 % error, a 10° misalignment induces a 1.5 % error.

3.8 Remote Operation

The FH 52 is equipped with a USB interface. This can be used to transfer measurements to a computer and the FH 52 can be remotely controlled.

For communication with the FH 52, suitable software must be installed to the computer. At the time of creation of these operating instructions Magnet-Physik supplies software for the following operating systems: Microsoft Windows® Vista, 7, 8, 10. The installation of a special hardware driver is not necessary; a diver included with Windows® is used. Some operating systems are configured to search the internet for hardware drivers automatically by default, which can take several minutes. If the search has been started once, it should not be interrupted.

On the web page of Magnet-Physik, www.magnet-physik.de, a software package named “FH 52 Software” is available for free download. This contains the following components:

- FH 52 Teslameter: a simple program for displaying and saving readings and for remote control of the most important functions of the FH 52.
- MagnetPhysik.FH52.dll: a .NET assembly that you can use in your own programs created with Microsoft C#, Visual Basic .Net or National Instruments LabVIEW® to capture readings or to control the FH 52.
- Programming examples in Microsoft C#, VB.net and a description, how to use the FH 52 with National Instruments LabVIEW®.

More information can be found in the documentation inside the software package.

Furthermore you can purchase the program “MagDat” that has among others the following features:

- Display of readings, continuous recording and saving in various file formats.
- Remote control of almost all functions of the FH 52.
- Simultaneous display and recording of the readings from multiple FH 52 devices and other measuring instruments made by Magnet-Physik.

3.9 Operating Principle

The operation of the field strength meter is based on the Hall Effect. This is named after the American physicist Edwin Herbert Hall, who explored the effect in 1879.

The sensor element, the so-called Hall generator, is made of a semi-conducting material. The schematic construction is shown in the following figure.

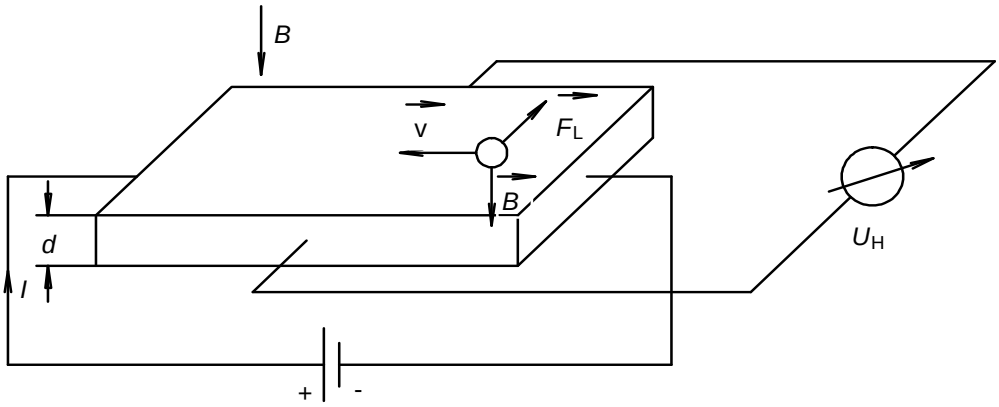

Fig. 17: Operating principle of a Hall generator

A control current *I* is flowing through the Hall generator. When this is exposed to a magnetic flux density *B* that is directed perpendicular to the surface of the sensor element, a force known as the Lorentz force acts on the moving electric charge carriers,

$$\vec{F}_L = q \cdot (\vec{v} \times \vec{B}),$$

where $\vec{v}$ is the drift speed of the charge carriers, *q* their charge and $\vec{B}$ the flux density of the magnetic field.

The Lorentz force diverts the charge carriers to the side surface of the Hall generator so that an electric voltage, the Hall voltage U_H, can be measured between the opposite sides,

$$U_H = R_H \cdot \frac{I \cdot B}{d}.$$

The Hall voltage is thus in the first approximation proportional to the flux density. The Hall constant R_H depends on material parameters and therefore also on the temperature and to a small extent on the flux density *B*.

The simplest method to keep the resulting linearity error as small as possible is loading the Hall voltage with an appropriate resistor.

High quality instruments, as the FH 52, additionally carry out a computed correction for the non-linearity. Therefore the characteristic curve of the sensor is measured. The points are stored in a data memory that is integrated in the plug of the probe.

4 Maintenance

4.1 Maintenance Plan

WHAT?	WHEN?	WHO?
Checking the instrument and the accessories for damages	monthly	Operator
Calibrating the instrument and probe(s)	e.g. once a year or every two years	Manufacturer or authorized calibration laboratory

The checks shall be periodically repeated and documented.

4.2 Checking for Damage

The FH 52 and all accessories must be checked once a month for damages. If any of the components, in particular the instrument housing, a probe or an optional line power supply (AC adapter) are damaged, the equipment must only be used if it has been cleared for operation by an authorized person. The damaged parts shall be replaced or sent to the manufacturer (Magnet-Physik) for repair as soon as possible.

4.3 Calibration

Only regular calibration ensures accurate and reliable measuring results.

The FH 52 and the probe(s) should be calibrated using suitable references normally once a year. We recommend having this calibration carried out by the manufacturer (Magnet-Physik) or an authorized calibration laboratory.

4.4 Troubleshooting

Using the **Test** menu (chapter 3.3.16), you can carry out a self-test of the FH 52 and the connected probe.

Furthermore some problems that you might face while operating the FH 52 are listed below:

- The instrument cannot be switched on using the On/Off key:
  If you use the device with batteries, these might have become empty. Replace the batteries or connect the device to a USB power supply or a computer.
  If you are using a USB power supply (AC adapter), verify that the power supply is working and that the line socket that you are using is powered.
  If you have connected the USB power supply while the FH 52 was operational in battery mode, the FH 52 might have entered standby mode. In this case disconnect the USB power supply and wait approximately 30 seconds, so that the internal capacitors can discharge. Then switch on the FH 52 in battery mode and switch it off again. Then connect the USB power supply while the FH 52 is off.
  If you have connected the FH 52 to a computer which is in standby mode, also the

FH 52 has entered standby mode. If you reactivate the computer, the FH 52 should wake up again.
If the device can nevertheless not be switched on, disconnect it from the USB power supply and remove the batteries for at least 10 seconds to reset the device.

- The reading cannot be set to zero using **Zero**:
  First check if the Relative function is switched off. Make sure that the probe is placed out of larger magnetic fields (AC and DC) and that it is not moved during zeroing. If available, use a shielding chamber. If zeroing fails nevertheless, the Hall sensor is probably defective and the probe needs to be replaced. If available, test the device with another probe. You can also send the device and the probe for inspection to Magnet-Physik or an authorized representative.
- "The probe is missing" is displayed although a probe is connected:
  Probably the probe is defective. If available, test the device with another probe. You can also send the device and the probe for inspection to Magnet-Physik or an authorized representative.
- "This probe is not supported!" is displayed:
  You are trying to use a probe that is not suitable for a FH 52 or the present version of the FH 52. In case of doubt, ask Magnet-Physik. Therefore, it is necessary to submit the serial numbers of the FH 52 and of the probe.
- "Invalid Probe Data!" is displayed:
  The data memory of the probe contains invalid data or might be defective. You can send the probe for inspection to Magnet-Physik or an authorized representative.

A Hall sensor can be damaged by mechanical stress, as it can occur if the probe stem is bent. Pressure to the surface or tip of the probe, strokes or excessive temperatures can also cause damage.

4.5 Taking Out of Operation

Switch off the FH 52 using the **ON/Off** key. Unplug the probe and the USB cable if applicable. You should remove the batteries from the FH 52 if the device will not be used for a longer time. This will avoid damage due to leaking batteries. Put the device and the probe into the storage case. Store the case in a safe place under suitable environmental conditions. It is advisable to register the date of the last operation.

Important!

To prevent any possible environmental pollution or violation of environmental regulations, only a specialized company should carry out disposal.