MAGNET-PHYSIK
Dr. Steingroever GmbH

Emil-Hoffmann-Str. 3
50996 Cologne
Germany

Operating Instructions

FH 54
Gauss-/Teslameter

Preserve for future application!

BA - Nr.: 2000540EBA01

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 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 operating instructions give a survey about the application and functionality of the FH 54. Gauss-/Teslameter

Target Group

In the following chapters the user of the devicet will find all necessary information regarding handling and operation.

Address

MAGNET-PHYSIK
Dr. Steingroever GmbH
Emil-Hoffmann-Str. 3 Tel. : +49 2236 3919-0
50996 Köln, Germany Fax. : +49 2236 3919-19

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.

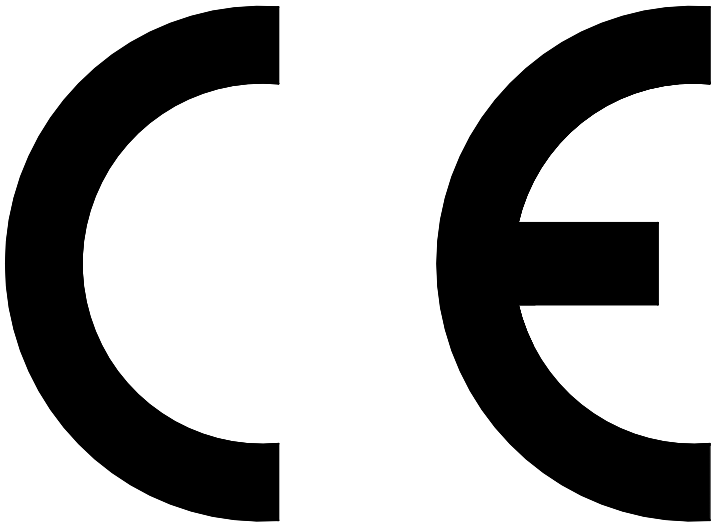


Table of Contents

1 General Information 6

1.1 Safety Instructions 6
1.2 Intended Purpose 6
1.3 Sources of Danger 7
1.4 Authorized Operator 7
1.5 Safety Measures at Place of Installation 8
1.6 Safeguard Installations 8
1.7 Emergency Measures 8

2 Transport and Installation 9

2.1 Unpacking and Checking 9
2.2 Transport and Storage 9
2.3 Technical Data 9

3 Introduction 11

3.1 General 11
3.2 Description 12

4 Operation 14

4.1 Initial Setup 14
4.2 Standard Display 15
4.3 Keys 15
4.4 Probe Handling 17

5 Functions 19

5.1 AC/DC 19
5.2 Range 19
5.3 Auto 19
5.4 Zero 20
5.5 Filter 20
5.6 Unit 20
5.7 Temp. 21
5.8 Limit 21
5.9 Reset 22
5.10 Max./Min. 22
5.11 Peak 22
5.12 Relative 22
5.13 Field Correction (Menu function) 23
5.14 Temp. Correction (Menu function) 23
5.15 Remote Access (Menu function) 23
5.16 Remote Baudrate (Menu function) 23
5.17 Battery indicator 23

6 Probes 25

6.1 Changing Probes 25
6.2 Probe Handling 25
6.3 Probe Operation 26
6.4 Probe Types 26
6.5 Probe Sensitivity and Measuring Ranges 28
6.6 Probe Accuracy 28

7 Remote Operation 30

7.1 Access Rights 30
7.2 Command Format for the Serial Interface 30

8 Maintenance 35

8.1 Maintenance Plan 35
8.2 Checking for Damage 35
8.3 Calibration 35
8.4 Troubleshooting 35
8.5 Connectors 36
8.5.1 Probe Input 36
8.5.2 Analog Output 36
8.5.3 Serial Interface RS 232 C / Limit Relays Output 36
8.5.4 Connector for Optional Power supply 38
8.6 Accessories 38
8.7 Taking Out of Operation 38

List of Tables

TABLE 1 : AMBIENT CONDITIONS 9
TABLE 2 : ELECTROMAGNETIC TOLERANCE (EMV) 10

List of Illustrations

FIG. 1 : GAUSS-/TESLAMETER FH 54 13
FIG. 2 : MAGNETIC SHIELDING CHAMBER NK 1 14
FIG. 3: PROBE ORIENTATION FOR POSITIVE READING 26
FIG. 4 : SURFACE FIELD PROBE 27

1 General Information

The FH 54 is a handheld instrument for measuring the magnetic field strength *H* in Ampere per Meter (A/m) and the magnetic flux density or induction *B* in Tesla (T) or Gauss (G). Particular features of the FH 54 are high accuracy, easy handling and a multitude of functions.

1.1 Safety Instructions

Special warning signals, whose non-observance may lead to injuries and/or property damage, as well as important tips 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 serious bodily injury or considerable material damage may occur if the appropriate safety measures are not taken.

Important!

Indicates important information which is to be paid particular attention.

1.2 Intended Purpose

Important!

It must be explicitly stated that the field strength meter FH 54 is to be used only for its intended purpose.

The intended purpose of the FH 54 is the measurement of the magnetic field strength or flux density of static, periodically alternating or pulsed magnetic fields.

Every application not in accordance with this intended purpose is absolutely prohibited and implies the deliberate dealing with non-calculable risks for both the operator as well as the equipment.

Unauthorized reconstruction of and/or alterations to the equipment are strictly forbidden!

The instructions as stipulated in this operating manual for operation and installation are to be strictly observed!

1.3 Sources of Danger

The field strength meter FH 54 is operated with battery power or with a special mains power supply. At this point, for reasons of work-place safety and accident prevention the sources of danger emanating from such a device will be especially pointed out. The respective instructions to the operator and owner of the field strength meter are to be strictly adhered to.

Danger!

Under no circumstances the equipment must come into contact with liquid mediums, such as water, oil, etc. If in spite of all precautions taken, such a medium does come into contact with the electronics of the FH 54, there is considerable danger for the smooth operation of the device!

In this case the device must be shut down immediately with the „Power Off“ - key.

The equipment must similarly be switched off when being cleaned. Never clean with water! Dry cloths only to be used for cleaning!

Danger!

The Hall probe must never brought into contact with an electrical voltage conductor. The paint on the probe surface is not an electrical insulation. Disregard of this warning can cause danger to life of the user. Additionally the device and the probe can be damaged.

Danger!

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

Important!

Although the FH 54 is water protected, it is not waterproof. Under no circumstances should the unit be immersed in water or subjected to continuous high-humidity conditions.

1.4 Authorized Operator

The field strength meter FH 54 may only be used and connected by personnel authorized by owner.

The owner must in this case:

- **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 considered 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. If possible, the original packing should be used for dispatch.

Due to their fragility, most probes are dispatched in special covers or foamed packaging. The same packaging should be used for storage and when the probe is shipped for calibration or repair.

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 : Ambient Conditions

Temperature:	- for operation	0 °C to +40°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)

Table 2 : Electromagnetic Tolerance (EMV)

Immunity from discharge of static electricity: based on EN 61000-4-2	Air discharge: 8 kV Contact discharge: 4 kV
Immunity from incident high frequency: based on EN V 50141	0.15 to 80 MHz 10 V/m 80 % AM (1 kHz)

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.

Important!

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

3 Introduction

3.1 General

The FH 54 Gauss-/Teslameter is a hand-held, portable measuring device that provides measurements of AC and DC magnetic fields using Hall sensors. The unit is designed for wide range, high accuracy, and ease of use. The instrument is operated by front panel keys or the RS232 interface. Most user features are one pushbutton away. The settings are stored if the instrument is switched off. The FH 54 features:

- Magnetic Field Measurement:
  - High accuracy with high resolution
  - Auto range function
  - DC or AC field measurement
  - Individual linearization of Hall Probes
  - Temperature compensation of Hall Probes
- Alphanumeric Display:
  - ¾ -digit display, 1 part in 3000 resolution on all ranges
  - Liquid crystal display.
- Other Major Operating Functions:
  - Display Filter
  - Tesla, Gauss or Ampere/Meter units
  - Max Hold, Min Hold
  - Peak measurement
  - Relative Reading
  - Limit function
- Output:
  - Serial Interface (RS-232C)
  - Monitor Analog Output
- Probe Compatibility:
  - Standard Probes with small active area – 3 mT to 3 T Full-Scale Ranges.
  - High Field Probes to 30 T Full-Scale Range.
  - High Sensitivity Probes – 30 µT to 300 µT Full-Scale Ranges.

If you have just received your new FH 54, please proceed to the next chapter and become familiar with the installation instructions. Complete and detailed instrument operational information is contained in chapter functions. Chapter Probes contains important information concerning the choice and operation of the Hall probes. The chapter remote operation describes the use of the serial interface. Basic service hints and the rear panel connector definitions are

contained in chapter Service. Additional details on FH 54 accessories and probes is provided in Chapter Accessories.

We welcome your comments concerning this manual. Although every effort has been made to keep it free from errors, some may occur. When reporting a specific problem, please describe it briefly and include the appropriate paragraph, figure, table, and page number. The material in this manual is subject to change without notice.

3.2 Description

The FH 54 is an extremely accurate full-featured gaussmeter. It covers a wide range of magnetic fields and applications. The instrument provides the user with easy-to-use front panel programming and incorporates a liquid crystal display. This alphanumeric format allows for message-based front panel operation. Most operations can be performed and monitored through the front panel keypad. Some rarely used functions can be accessed through a menu.

The FH 54 measures the magnetic flux density (induction) either in Tesla (T) or Gauss (G) or the magnetic field strength in Ampere per Meter (A/m). Magnetic field ranges can be set manually or with auto ranging. The instrument measures both DC (static) and AC (periodically alternating) magnetic field values. In DC operation, the display shows the DC field at the probe with the sign (orientation) followed by the appropriate field units. In AC operation, the display shows RMS or Peak value for the field at the probe. The values are available over the Serial Interface and also the Monitor Analog Output. This Analog Output allows the user to observe the actual magnetic field waveform on an oscilloscope.

The Max./Min. function captures and displays the largest field magnitude seen since the last Reset. The maximum value is shown in the second display line while the upper display line contains the live field reading. Alternatively, also the largest and the smallest value can be displayed. The Peak function allows in DC mode the peak value of a pulsed magnetic field to be measured.

The relative function is intended to let the user see small variations in larger fields. The user defined setpoint becomes the center or zero point of the relative reading and is shown on the second line of the display. The difference from the setpoint or the relative reading appears in the top display line.

In the following figure, the front side of the field strength meter FH 54 is shown. The plug on the upper side is used for probe connection.

Fig. 1 : Gauss-/Teslameter FH 54

4 Operation

4.1 Initial Setup

To take the FH 54 into operation proceed as follows.

1. Install batteries: The batteries are located in a compartment at the lower end of the FH 54. Press the two fingerboards at the sides of the case to remove the cap. Take hold of the strap and press it slightly down to unlock the battery compartment and pull it straight out. Remove the screw to open the cover of the battery compartment. Install 5 "AA" Batteries observing the polarity signs for each cell. Always replace all cells. Close the battery compartment door. Move the battery compartment into the instrument and make sure that it clicks into place. Close the cap.
2. Install probe: Plug the probe into the connector at the top of the field strength meter. Use the side screws to secure the connector.
3. Make sure that all other connections are made before you switch on the instrument (Interface, analog output, power supply)
4. Push the **Power On** key for minimum one second. The LCD will display FH 54 and then the display will return to the state it was in before being switched off. For best results, the instrument and probe should warm up for at least 5 minutes before zeroing the probe, and at least 30 minutes for rated accuracy. The probe and the shielding chamber should be at the same temperature.
5. Place the probe in the magnetic shielding chamber and press the **Zero** key on the front panel.

Fig. 2 : Magnetic shielding chamber NK 1

6. Press the **Enter** key. The message Adjusting Zero is shown until the normal display appears again. Do not move the probe while the Adjusting Zero message is being displayed.
7. If the unit has performed well to this point, the unit is functioning properly. If you have a reference magnet available, you can continue with the test using the magnet to verify the accuracy of the FH 54.
8. If continuing the procedure with a reference magnet, ensure the probe can accommodate the range of the magnet. Use the **Range** key to select the proper range (or press **Auto** for

automatic ranging). Set the display for **DC**. Finally, since orientation of the probe is very selective, press the **Max./Min.** key once. This will capture additionally the highest reading.

Caution!

Care must be exercised when handling the probe. The tip of the probe is very fragile. Any excess force may break the probe.

Probe readings are dependent upon the angle of the tip in relation to the magnetic field. The greater the angle between the probe and the field, the higher the percentage of error. For example, a 5° angle will cause a 0.4% error, a 10° angle will induce a 1.5% error.

9. Carefully place probe in contact with reference magnet. You may have to hunt around a bit for the maximum reading.

   For this example, we are using a 250 mT ± 1% reference magnet. In the top line the actual reading of +198 mT is displayed. In the second line the measured maximum value of 201 mT is shown, which is within the tolerance of the reference magnet. The top line will keep changing as the probe moves, but the bottom will remain fixed on the highest reading. To capture a new maximum value, press the **Reset** key.

   Once this short checkout procedure is successfully completed, the unit is ready for normal operation. Please proceed to the following chapter for further operational information.

4.2 Standard Display

During a measurement the actual reading is shown in the top line of the display in big characters. Numerical value and unit are displayed.

In the second line the outputs of several special functions are shown, e. g.
- Maximum or maximum and minimum, if the Max./Min. function is activated
- Probe temperature, if a probe with temperature sensor is connected and the Temp. Function is activated

Always the output of the function that was activated (switched on) last is shown. If it is deactivated (switched off), the output of the previously active function is displayed again.

The two lowest lines serve to show several information:
- Measuring mode AC or DC
- Selected range
- Rel, if relative reading is switched on
- High / Low / OK, if the limit function is switched on
- Filter, if the Filter function is switched on
- Battery state (if Filter is on, the Battery state is only shown, if the battery is empty)
- Remote-State (R): the instrument is being controlled from the interface

4.3 Keys

For the input of numerical values the numerical keypad is used. It consists of the keys 0 to 9, the +/- key and the decimal separator.

The most important functions can be accessed directly from the standard display via function keys. The functions are noted in the upper half of the keys.

Here follow only brief descriptions of the key functions. Detailed descriptions you can find in the next chapter (Functions).

Power On Turns power to the unit on.

Power Off Turns power to the unit off.

AC/DC Toggles between AC (periodic) and DC (static) magnetic field measurement.

Range Allows to select the field measurement range. The available ranges depend on the probe type.

Auto Switches on the auto range function

Zero Used to zero offsets of ambient low level field, or from the probe. When the user pushes the Zero Probe key, Zero Probe and "Press Enter to start" will be displayed. The user may than press the Enter key to begin the zero probe routine. The unit then automatically accepts whatever residual field it reads as a zero offset, forcing the display to zero. Zero Probe is normally activated if the probe is placed in the magnetic shielding chamber. It can also be activated with the probe outside of the chamber to suppress ambient magnetic fields. After about 4 to 5 seconds the display returns to normal reading.

Filter Switches Filter on and off.

Unit The FH 54 can display the magnetic flux density (induction) B in Tesla (T) or Gauss (G) or the magnetic field strength H in Ampere per Meter (A/m). By pressing the unit button the user can select between these units.

Temp. Switches probe temperature display on or off. This function is only available, if the probe has a built in temperature sensor.

Limit This key is used to invoke a small menu that allows to activate, deactivate and configure the limit function.

Max./Min. Turns the Max./Min. feature on and off. Max./Min. captures and displays the absolute value of the highest field reading or the smallest and highest reading.

Peak Allows the measurement of the maximum of peak magnetic fields or the peak value of AC fields.

Reset Works with the Max./Min. and the DC Peak function. Resets the reading back to zero to capture the next reading.

Relative This key is used to invoke a small menu that allows to activate or deactivate relative function and to set the relative value.

Mode Switches between the standard display and the main menu. In the menu additional functions can be invoked.

Enter Used to accept the numbers displayed during numerical entry.

Escape The Escape key is used to terminate a function without making changes to the existing settings. The unit will the return to normal operation.

Delete Used to erase numerical inputs

Inside a menu dialog **Delete, Enter, Mode and Escape** have the following functions:

With the **Delete** key you erase the last numerical input.

With **Enter** you confirm the last input and take over the setting. After the last input in a dialog you leave it with **Enter**.

With **Mode** you return from a dialog directly to the measurement display. The settings are taken over.

With **Escape** you go back one step in the operation. The last input gets not valid.

Numbers are input by the numerical keypad.

4.4 Probe Handling

To avoid damage and for best results during use, the probes have a number of handling and accuracy requirements that must be observed.

An Electrically Erasable Programmable Read Only Memory (EEPROM) is included in each probe. The EEPROM stores specific information that the gaussmeter requires for operation. The information includes serial number and probe sensitivity, and may also include field and temperature compensation data.

When the probe is connected, the probe memory is downloaded to the gaussmeter. This is how the gaussmeter knows which ranges are available and which error correction to apply. To change probes, remove the existing probe carefully, and then plug in the new probe.

Caution!

Care must be exercised when handling the probe. The tip of the probe is very fragile. Stressing the Hall sensor can alter its calibration. 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, the probes are still fragile. This is especially true for the exposed ceramic tip of very thin probes. Care should be taken during measurements that no pressure is placed on the ceramic tip of the probe. The

probe should only be held in place by securing at the handle. The probe stem should never have force applied. Any strain on the ceramic substrate may alter the probe calibration, and excessive force may destroy the Hall sensor.

Avoid repeated flexing of the sensor mounted at the end of a flexible stem. Force should never be applied to the tip of the probe. On all probes, do not pinch or allow cables to be struck by any heavy or sharp objects. Although damaged or severed cables should be returned for repair, please understand that probes are not always repairable.

When probes are installed on the instrument but not in use, the protective tubes provided with some probes should be placed over the probe stem in order to protect the tip. When the gaussmeter is not in use, the probes should be stored separately in some type of rigid container. The foam container that some probes are shipped in may be retained for probe storage.

5 Functions

In the present chapter all functions of the FH 54 are described in detail. The most important functions can be accessed directly over function keys. Some rarely used function can be invoked in a menu. This main menu is accessed with the **Mode** key. The submenus are selected with the arrow keys (⇐, ⇒) and opened with the **Enter** key.

5.1 AC/DC

With this key the user can select between AC (periodically alternating) and DC (static) magnetic field measurement. Every push changes to the other field type.

A DC magnetic field is for example generated by a permanent magnet or by a DC current flowing in a coil. An AC magnetic field is generated by an AC current in a coil.

In DC-mode the static magnetic field value is shown together with sign and unit. The value can also be read from the serial interface and the analog output.

In AC-mode the RMS (root mean square) value of the field strength or flux density is displayed unless the **Peak** key is not pressed (see below). The AC RMS reading is a measurement of true RMS, defined as the square root of the average of the square of the field function taken through one period. A DC component will be rejected if it is not large enough to overload the selected range.

When changing to AC or DC, previously established Relative and Limit setpoints are maintained.

The functions **Max./Min.** and **Peak** are switched off when changing to AC or DC, as they operated different in both modes.

5.2 Range

Pressing the range key opens a menu that allows to select one of ranges that are available for the connected probe. The actually selected range is shown inversely. Select the desired range with the arrow keys. Press **Enter** to confirm your choice or press **Escape** to return to the previously selected range.

5.3 Auto

By pressing **Auto**, the Auto Range mode can be activated. In this mode, the FH 54 selects automatically the range with the best resolution for the field to be measured. It can take up to 2 seconds for Auto Range to work, so manual ranging may be better in some conditions.

Auto cannot be used together with the functions **Peak** and **Max./Min..**

Auto Ranging should not be used when measuring small fields in large background field, i.e., measuring a small DC field in presence of a large AC field, or measuring a small AC field in the presence of a large DC field.

5.4 Zero

The **Zero** function sets the display to zero. It is used to zero offsets of ambient low level field or from the probe. Zero Probe is normally activated if the probe is placed in the magnetic shielding chamber. It can also be activated with the probe outside of the chamber to suppress ambient magnetic fields, e.g. the earth magnetic field.

For best results, the instrument and probe should warm up for at least 5 minutes before zeroing the probe, and at least 30 minutes for rated accuracy. The probe and the shielding chamber should be at the same temperature.

When you push the **Zero** key, "Zero Probe" and "Press Enter to start" will be displayed. Place the probe into the magnetic shielding chamber, that the probe tip is approximately in the middle. Do not touch the end of the chamber with the probe tip, some very sensitive probe may even be damaged by this. Then press the **Enter** key to begin the zero probe routine. The unit then automatically accepts whatever residual field it reads as a zero offset, forcing the display to zero. The time needed for the zero routine depends on the number of ranges that are available for the specific probe. It may take several seconds. Do not move the probe until the normal display appears again.

Zero should be periodically executed, especially if the most sensitive ranges are used. If you want to suppress large magnetic fields, you should use **Relative** instead of **Zero**.

The obtained zero setting remains stored for the probe if the instrument is switched off.

5.5 Filter

The **Filter** function is used to achieve a more quiet reading. It makes the display better readable, if the probe is exposed to a noisy magnetic field. Be careful, if **Filter** is switched on and changing magnetic fields shall be measured, as peaks are evened out and the instrument reacts slower. The **Filter** function of the FH 54 is configured, that slowly changing fields are displayed and noise is suppressed.

5.6 Unit

The FH 54 displays the magnetic flux density (induction) *B* in Gauss (G) or Tesla (T) or the magnetic field strength *H* in Ampere per Meter (A/m). With the **Unit** key you can select the desired unit. Every push changes to another unit. Between the units and their multiples there are the following relations:

Magnetic Flux Density *B*:	Magnetische Feldstärke *H*:
1T = 1000 mT = 1000000 µT	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 = 1000000 mG	1 A/cm = 0,1 kA/m = 100 A/m
	1 MA/m = 1000 kA/m = 1000000 A/m

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:

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

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

When the units for field measurement are changed, relative and limit setpoints are converted to the new units with no interruption in operation.

The units T and A/m belong to the international unit system SI (Système international d'unités) which is provided by law in many countries. The unit G belongs to the old CGS (Centimeter, Gram, Second) unit system that is frequently used until today.

5.7 Temp.

The **Temp.** dialog allows to switch on or off the display of the probe temperature. Additionally you can select between the display in °C and °F. The function is only available, if the probe connected to the instrument contains a temperature sensor. As the probe is heated by the control current, the probe temperature usually will be slightly higher than the ambient temperature.

The FH 54 is no temperature measuring instrument. Do not use the probes for temperature measurement. Extreme temperatures and mechanical stress due to fast temperature changes can alter the calibration or destroy the Hall sensor.

5.8 Limit

The **Limit** function gives an optical signal, if the measured value is inside or outside a user defined range. Two limits can be set.

The displayed texts have the following meaning:
- Low: the measured value is below the lower limit
- OK: the measured value is between the upper and the lower limit
- High: the measured value is above the upper limit

Pressing the **Limit** key calls up a small menu dialog. Selections can be made by the arrow keys and **Enter**. Select **On** or **Off** to activate or deactivate the function.

Limit can be operated in two modes. These can be chosen by selecting the **mode** command with the arrow keys and pressing **Enter**.

The first mode is +/-. In this mode the sign of the measured value is taken into account when evaluating measured values with regard to the limits. In this way the magnets for example can be sorted for their orientation.

The second mode **abs.** In this mode the sign of the measured value is not taken into account. Only the absolute value is evaluated. In this way the magnets for example can be sorted for their field strength, regardless of the orientation.

Before the **Limit** function can be used, the limit values must be defined. Therefore select **Set.** The actual setting is displayed. The actual range is the range used last. If you want to enter a limit value in another range, press the **Range** key until the desired range appears. Use the numerical keypad to enter the desired high limit point. After you have entered the value press **Enter** to confirm the input.

The menu changes to the low limit point. Use the numerical keypad to enter the desired low limit point. As soon as you press the **Enter** key, the Limit function is activated.

5.9 Reset

The **Reset** key is used to set the values captured with **Max./Min.** or **Peak** (see below) back to zero.

5.10 Max./Min.

If the **Max./Min.** key is pressed once, the largest value that was measured since the last pressing of **Reset** is displayed in the center of the second display line. The sign of the measured value is not taken into account, only the absolute value is taken to determine the maximum. Left from the displayed value Max is indicated.

If the **Max./Min.** key is pressed a second time, the minimum value is displayed on the left side and the maximum value on the right side of the second line. Now the sign is taken into account. A third pressing of the **Max./Min.** key switches the function off.

The **Reset** key deletes the captured values. They are also deleted, if the instrument is switched off or a change is made to AC or DC. **Max./Min.** can also be used together with the **Relative** function.

The **Max./Min.** function is intended to observe slowly changing signals. A change that is faster than the measuring rate of the instrument (about four measurement per second), can not be recorded. To capture fast pulses the **Peak** function must be used.

In the following cases Max Hold is particularly useful:

- to capture readings in hard to get at places and if the user can always observe the display.
- to display the maximum field when field orientation is unknown. The probe is rotated slowly and the largest value will be displayed.
- measuring high gradient fields, for example on the surface of magnets. Here often only the measurement of the maximum value is sufficiently reproducible.

5.11 Peak

The **Peak** key allows to switch on the **Peak** function. The **Peak** function works different if the instrument is in DC or AC mode.

In DC mode is used to display the maximum of short magnetic field impulses, e.g. magnetizing impulses. The Maximum value is displayed in the first line of the display, regardless of the sign. The rise time of pulse must be at least 100 µs. Use the **Reset** key to make the instrument ready to capture the next peak.

In AC mode, **Peak** allows to show the peak value of a periodically alternating signal instead of the RMS value.

Pressing **Peak** again switches of the **Peak** function.

5.12 Relative

The **Relative** function lets the user see small variations in larger fields. If the function is switched on, only the difference to the setpoint or reference value is displayed.

If the function is activated, REL is shown in the lowest line of the display.

By pressing the **Relative** key, a dialog for the configuration of the **Relative** function is invoked. With **On** and **Off** the function is activated or deactivated. **Set** allows to define the setpoint. If **Set** is selected, the actual reading shown. It can be accepted as setpoint by pressing **Enter** or, by using the keys, another value can be entered.

You can check for the actual setpoint by using the **Show** command.

The relative feature also interacts with other features. When Relative and Max Hold functions are used at the same time, the relative reading is still in the top display, but the second line shows the relative maximum instead of the relative setpoint.

5.13 Field Correction (Menu function)

In this menu the use of the correction tables for probe linearity and temperature dependence can be switched on or off. Of course, therefore suitable correction data must be present in the probe eeprom.

Many probes have, to enhance accuracy, a linearity correction table stored to the probe eeprom. The choice "Field correction off" makes the FH 54 to ignore this table. Only the mean sensitivity, that is also stored to the eeprom is used for calculation.
If a probe is connected to the FH 4, or if the instrument is switched off and on again, all correction functions, that have correction data available, are switched on automatically.

5.14 Temp. Correction (Menu function)

Some probes contain a temperature sensor to correct for temperature dependence of sensitivity and offset. This correction can be switched off in the menu **Temp. Correction**.
If a probe is connected to the FH 54, or if the instrument is switched off and on again, all correction functions, that have correction data available, are switched on automatically.

5.15 Remote Access (Menu function)

After switching on the FH 54, the instrument is in local mode. The instrument can be operated via the keypad. If the interface starts an access to the instrument it is set to remote mode and the keypad access is limited.

To allow the keypad access again, the interface must receive the #LOCAL command or the user must select the **Local** command in the remote access menu.

5.16 Remote Baudrate (Menu function)

Here the transfer rate for the serial interface can be set (4800, 9600, 19200 Baud). The number of data bits is fixed to 8, the number of stop bits to 1. No parity bit is transferred.

5.17 Battery indicator

The battery indicator in the lower left corner of the display shows the remaining battery power. It changes from ▮ for full batteries to ☒ if the batteries reach the end of their useful life. Readings may not be as accurate when the batteries get low. The battery indicator works best

with alkaline batteries. If rechargeable NiCd batteries or other batteries with a lower cell voltage are used, the indicator may not be filled black completely even if the batteries are full. Nevertheless, such batteries can be used.

If the **Filter** is switched on, the battery indicator is only shown when the battery gets empty.

If the instrument is not used for a longer time or operated with the optional power supply, the batteries shall be removed to avoid damage from an eventual leakage.

6 Probes

To avoid damage and for best results during use, the probes have a number of handling and accuracy requirements that must be observed.

6.1 Changing Probes

To connect the probe, take hold of the probe connector and move it straight into socket. Secure the connector with the two screws. To remove the probe, unlock the screws and pull the connector straight off. Do not pull at the cable.

The instrument does not work without probe. If the instrument is switched on without a probe, you will read "Probe missing". The instrument is automatically initialized when a probe is connected.

6.2 Probe Handling

Danger!

The Hall probe must never be brought into contact with an electrical voltage conductor. The paint on the probe surface is not an electrical insulation. Disregard of this warning can cause danger to life of the user. Additionally, the device and the probe can be damaged.

Caution!

Care must be exercised when handling the probe. The tip of the probe is very fragile. Stressing the Hall sensor can alter its calibration. 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, the probes are still fragile. This is especially true for the exposed ceramic tip of thin probes. Care should be taken during measurements that no pressure is placed on the ceramic tip of the probe. The probe should only be held in place by securing at the handle. The probe stem should never have force applied. Any strain on the ceramic substrate may alter the probe calibration, and excessive force may destroy the Hall sensor.

Avoid repeated flexing of the sensor mounted at the end of a flexible stem. Force should never be applied to the tip of the probe. On all probes, do not pinch or allow cables to be struck by any heavy or sharp objects. Although damaged or severed cables should be returned for repair, please understand that probes are not always repairable.

When probes are installed on the gaussmeter but not in use, the protective tubes provided with some probes should be placed over the probe handle and stem in order to protect the tip. When the gaussmeter is not in use, the probes should be stored separately in some type of rigid container. The foam container in that many probes are shipped in may be retained for probe storage.

6.3 Probe Operation

For best results, the instrument and probe should warm up for at least 5 minutes before zeroing the probe. The probe and the shielding chamber should be at the same temperature.
In the DC mode of operation, the orientation of the probe affects the polarity reading of the gaussmeter. On a transverse probe, either a label on the handle or a dot on the handle or on the probe stem indicates the side for positive (+) flux entry. On an axial probe, positive (+) flux entry is always from the front of the probe.

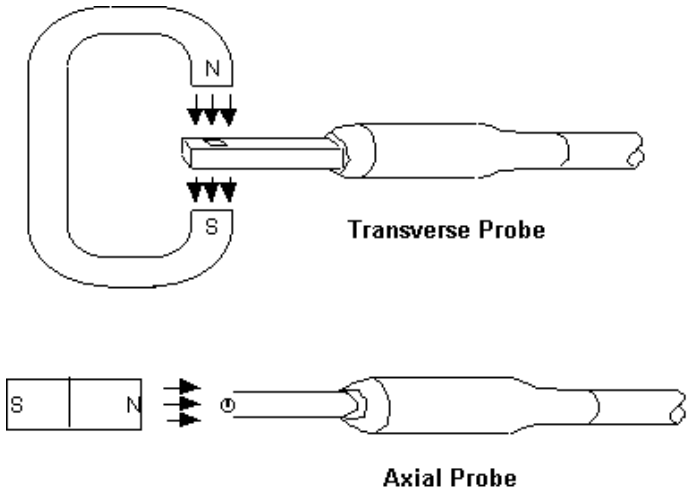
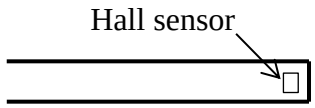


Fig. 3: Probe orientation for positive reading

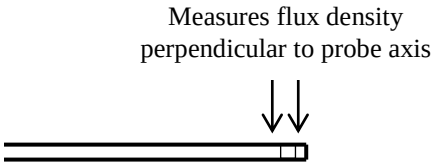
If the exact direction of the magnetic field is unknown, its orientation is determined by turning on **Max./Min.** and slowly rotating the probe. As the probe turns and the measured field rises and falls, its maximum value is held on the display. Make note of the probe orientation at the maximum reading to identify the field orientation.

6.4 Probe Types

Three different standard probe Types are available for the FH 54. They are transverse, axial and surface field probe.
The transverse probe has a Hall sensor that is mounted parallel to the probe axis. It measures fields, that are perpendicular to the probe axis. A typical application is the measurement in the air gap of magnet systems.

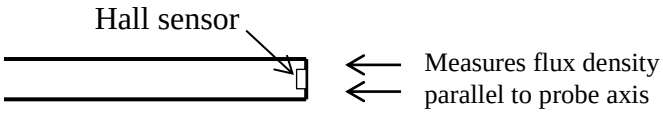


Transverse probe – top view



Transverse probe – side view

The axial probe has a Hall sensor, that is mounted perpendicularly to the probe axis. It measures fields that are parallel to the probe axis. A typical application is the measurement in a solenoid coil.



Axial probe – top view

A surface field probe is shaped like a little stamp. The Hall sensor is mounted in the center of the lower surface. The surface field probe is used for measuring the field strength on the surface of magnetized foils.

Fig. 4 : Surface field probe

6.5 Probe Sensitivity and Measuring Ranges

As the H 54 is covering a wide field strength range, probe with different sensitivities are necessary You can find the standard probe types on the Magnet-Physik homepage http://www.magnet-physik.de.

The user of a field strength meter can have difficulties in choosing the best probe. Therefore, please find below some simple rules that can help making the right choice.

1. Choose a probe that matches your application. Do not buy more accuracy, ranges or sensitivity as necessary.
2. The thinner a probe is, the more fragile it is. Overcome the temptation buying a probe that can be easily damaged for just a possible future application. Avoid using a probe with an exposed Hall generator for general field strength measurements. If the probe stem or sensor is damaged, the probe cannot be repaired.
3. Be careful when using metal covered probes for measuring AC magnetic fields. Eddy currents in the cover can impact the accuracy of the measurement or even unduly heat a probe. Probes with a stem made of fiber-glass enforced epoxy are a good choice for AC measurements.
4. Different stem lengths are offered for the most probes. The operator's demands and the dimensions of the measurement set-up influence the final choice. Long probes are easier broken away.
5. Take notice of the different active areas of the probes. These are given in the data sheets. A Hall sensor measures the average of the field, taken from the total active area of the probe. Chase a probe with a small active area if you want to measure a field with a high gradient over the sensor width.
6. Our probes cover different field strength ranges that can be used. Check the data sheets for the required ranges. High field probes are specially calibrated for use above 3 T (30 kG). High sensitivity probe work in the ranges from 30 µT (300 mG) to 300 µT (3 G).
7. If none of the standard probes matches your configuration, keep in mind that Magnet-Physik also can make customized probes for fulfilling special demands regarding dimensions, temperature range or accuracy. Please contact us with the details of your application.

6.6 Probe Accuracy

The user must consider all the possible contributors to the accuracy of the reading. Both the probe and gaussmeter have accuracy specifications that may impact the actual reading. The probe should be zeroed before making critical measurements. The zero probe function is used to null (cancel) out the zero offset of the probe or small magnetic fields. It is normally used in conjunction with the shielding chamber, but may also be used with an open probe (registering the local earth magnetic field). Users wishing to cancel out large magnetic fields should use the Relative function.

Probe temperature can also affect readings. To help offset the effects of temperature on the Hall sensor, a thermistor is included in some probes.

Probe readings are dependent on the angle of the Hall sensor in relation to 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 three axes), the larger 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, etc..

Tolerance of unit, probe, and magnet must be considered for making critical measurements. The accuracy of the gaussmeter reading is better than ±0.05% of reading and ±0.005% of range. An absolute accuracy reading for gaussmeters and Hall probes is a difficult specification to give, because all the variables of the measurement are difficult to reproduce. For example, a 1° error in alignment to the magnetic field causes a 0.015 % reading error. In addition, reference Nuclear Magnetic Resonance (NMR) standards are typically accurate to 5 ppm, or ±0.005%. Finally, the best probes have an accuracy of ±0.1%.

7 Remote Operation

7.1 Access Rights

After switching on, the FH 54 is in LOCAL-Mode. In this mode it can be operated from the keypad. When the serial interface starts to write to the instrument, the access from the keypad is restricted (remote mode).

Important: to allow the access via the keypad again, the interface must receive the #LOCAL command or you must execute the **Local** command in the **Remote Access** menu.

7.2 Command Format for the Serial Interface

Read parameters:

?*COMMAND*$^{C}_{R}$

COMMAND stands for one of the command texts listed below.

Set parameters:

#*COMMAND VALUE*$^{C}_{R}$

VALUE stands for the numerical value.

Each command must be terminated by a carriage return (chr$(13)).

The FH 54 answers with string, that is terminated by a carriage return followed by a line feed.

The following parameters can be read or changed.

COMMAND	Description	
MODE	Write:	#MODE 1 switches to AC mode
		#MODE 0 switches to DC mode
	Answer:	MODE 0 or MODE 1
	Read:	?MODE
	Answer:	MODE 0 or 1
RANGE	Write:	#RANGE n n = 1...7
	Answer:	RANGE 1...7
	Read:	?RANGE
	Answer:	RANGE 1...7

1 = 30 µT, 2 = 300 µT, 3 = 3 mT, 4 = 30 mT, 5 = 300 mT, 6 = 3 T, 7 = 30 T

AUTO	Write:	#AUTO 0 Auto range off
		#AUTO 1 Auto range on
	Answer:	#AUTO 0 or 1
	Read:	?AUTO
	Answer:	AUTO 0 or 1
ZERO	Write:	#ZERO 1 Starts the Zero routine without further request
	Answer:	OK, if accepted
	Read:	?ZERO
	Answer:	Error message, if Zero is not finished
		OK if Zero is finished
FILTER	Write:	#FILTER 1 Filter on
		#FILTER 0 Filter off
	Answer:	FILTER 0 or FILTER 1
	Read:	?FILTER
	Answer:	FILTER 0 (off) or FILTER 1 (on)
UNIT	Write:	#UNIT 0 for T
		#UNIT 1 for G
		#UNIT 2 for A/m
	Answer:	UNIT 0...2
	Read:	?UNIT
	Answer:	UNIT 0...2
TEMP	Write:	#TEMP 0 Temperature display off
		#TEMP 1 Celsius
		#TEMP 2 Fahrenheit
	Answer:	TEMP 0...2
		Error message, if a probe without temperature sensor is connected
	Read:	?TEMP
	Answer:	Temperature, e. g. 25 °C
		Error message, if a probe without temperature sensor is connected
LIMIT		#LIMIT 0 Limit off
		#LIMIT 1 Limit +/-
		#LIMIT 2 Limit abs
	Answer:	LIMIT 0…2
	Read:	?LIMIT
	Answer:	LIMIT 0…2

LIMU	Write:	#LIMU n,m,u	set upper limit value and switch on function n = 1...7 (range) m = -3000...3000 (digits) u = 0...2 (unit)
	Answer:	LIMU n,m,u	
	Read:	?LIMU	
	Answer:	current stting	
LIML	Write:	#LIML n,m,u	set lower limit value and switch on function n = 1...7 (range) m = -3000...3000 (digits) u = 0...2 (unit)
	Answer:	LIMU n,m,u	
	Read:	?LIML	
	Answer:	current setting	
SETREL	Write:	#SETREL n,m,u	set relative value and switch on function n = 1...7 (range), m = 0...3000 (digits) u = 0...2 (unit)
	Answer:	current setting (n,m,u)	
	Read:	?SETREL	
	Answer:	current setting (n,m,u)	
REL	Write:	#REL 1 on #REL 0 off	
	Answer:	REL 1 or REL 0	
	Read:	?REL	
	Answer:	REL 1 or REL 0	
PEAK	Write:	#PEAK 1 on #PEAK 0 off	
	Answer:	PEAK 1 or PEAK 0	
	Read:	?PEAK	
	Answer:	PEAK 1 or PEAK 0	
	Remark: the peak value captured in DC mode is shown in the fist display line and can be read with ?MEAS.		

MAX	Write:	#MAX 2	Show Max/Min
		#MAX 1	Show Max
		#MAX 0	off
	Answer:	MAX 0, MAX 1 or MAX 2	
	Read:	?MAX	
	Answer:	MAX 0, MAX 1 or MAX 2	
MMAX	Read only:	?MMAX	Read the Max value
	Answer: digits and unit, e.g.. 123 mT		
MMIN	Read only:	?MMIN	Read the Min value
	Answer: digits and unit, e.g.. -123 mT		
RESET	Write only:	#RESET	Max./Min. or Peak are set to Zero
	Answer :	OK	
LOCAL	Write:	#LOCAL	Go to local mode
	Answer:	OK	
	Read:	?LOCAL	
	Answer:	LOCAL 0	Remote mode
		LOCAL 1	Local mode
MEAS	Read only:	?MEAS	Read a single value
	Answer:	digits and unit, e.g. 123 mT	
NMEAS	Write:	#NMEAS n	n > 0: Presets a number of values to be sent;. the measurement is started by MULTI 1
		#NMEAS 0	Permanent sending of values until MULTI 0 is received
	Read:	?NMEAS	
	Answer:	number of values	
MULTI	Write:	#MULTI 1	Starts automatic data sending
		#MULTI 0	Stops automatic data sending
	Read:	?MULTI	
	Answer:	MULTI 0 (off) or MULTI 1 (on)	
CFIELD	Write:	#CFIELD 1	Linearity correction on
		#CFIELD 0	Linearity correction off
	Answer:	CFIELD 0 or CFIELD 1	
	Read:	?CFIELD	
	Answer:	CFIELD 0 or CFIELD 1	

CTEMP	Write:	#CTEMP 1 Temperature correction on
		#CTEMP 0 Temperature correction off
	Answer:	CTEMP 0 or CTEMP 1
		Error message, if a probe without temperature sensor is connected
	Read:	?CTEMP
	Answer:	CTEMP 0 (off) or CTEMP 1 (on)
		Error message, if a probe without temperature sensor is connected
INIT	Write only:	#INIT System reset

8 Maintenance

8.1 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.

8.2 Checking for Damage

The FH 54 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.

8.3 Calibration

Only regular calibration ensures accurate and reliable measuring results.

The FH 54 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.

8.4 Troubleshooting

In case of trouble with the FH 54, refer to the following instructions.

1. If the instrument cannot be switched on, please check or replace the batteries. If you use the optional power supply, make sure that the power line is OK, and the power supply is properly connected to mains and to the instrument. Remember that the Power on key must be pressed at least one second to switch the instrument on.
2. **Probe missing:** Probe missing is always displayed if no probe is connected to the FH 54. If it is displayed although a probe is connected to the instrument, probably the probe became defective. Connect the probe without the cable. If furthermore Probe missing is displayed, you can send the probe to MAGNET-PHYSIK for inspection. If available, you can also check the instrument with another probe.
3. **Zero probe** fails to set the display to zero: Check if the Relative function is switched off. Make sure, that the probe is apart from larger magnetic fields (AC and DC) during zeroing and that it is not moved. Use the shielding chamber. If the display still cannot be set to zero,

probably the Hall sensor in the probe is defective. You may send it to MAGNET-PHYSIK for inspection.

A Hall sensor may be damaged by mechanical stress, as it can occur if the probe stem is bent. Strokes or excessive temperatures can also cause damage.

8.5 Connectors

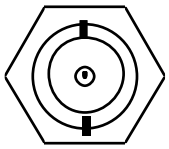
The 9-pole connector for the serial interface, the analog output and the 15-pole connector for the probe are located on the upper side.

8.5.1 Probe Input

The DB 15 connector is used for probe connection. The plug of the probe must carefully be inserted to avoid bending of the contact pins. Use the two screws to fix the plug.

8.5.2 Analog Output

The analog output can be accessed via the BNC (Bayonet Nut Connector). The signal is on the center contact. The analog output gives a 3 V signal, that is proportional to the output voltage of the sensor. It is not corrected for linearity and offset and will therefore differ from die value shown in the display.



BNC connector

PIN	DESCRIPTION
1	**Analog output - center connector**
2	**Ground – Connector shielding**

8.5.3 Serial Interface RS 232 C / Limit Relays Output

The serial interface is a standard feature of the FH 54. The relay output is available as an option.

Pin assignment of the DB 9 connector (relay output):

PIN	DESCRIPTION	
1	Relay 1	Normally closed contact
2	RS 232	TXD
3	RS 232	RXD
4	Relay 2	Normally closed contact
5	RS 232	GND
6	Relay 1	Normally open contact
7	Relay 1	Center contact
8	Relay 2	Normally open contact
9	Relay 2	Center contact

Serial interface:

For the connection to a PC a cable with the following wiring is required:

PC PIN	FH 54 PIN
2	3
3	2
5	5

If no limit relays are installed, a standard null-modem cable can be used.

Communication parameters:

Baudrate:	4800, 9600, 19200 (to be selected in the menu)
Data bits	8
Stop bits	1
Parity	no
Handshake	no

Limit relays (optional)

The relay contacts can be accessed via not otherwise used pins of the DB 9 connector. Then a special cable is necessary for the serial interface.

The center contact of limit relay 1 is connected to the normally open contact when the upper limit is exceeded.

The center contact of limit relay 2 is connected to the normally open contact when the lower limit is gone below.

Limit	Limit relay 1 (1-7)	Limit relay 1 (6-7)	Limit relay 2 (4-9)	Limit relay 2 (8-9)
LOW	Connected	Open	Open	Connected
OK	Connected	Open	Connected	Open
HIGH	Open	Connected	Connected	Open
Device off	Connected	Open	Connected	Open

Attention!

Maximum values for the relay contacts: Voltage: U_{max} = 30 V
Current: I_{max} = 500 mA

The relay contacts are galvanically separated.

8.5.4 Connector for Optional Power supply

The connector jacket for the power supply connection is located on the right side of the instrument. Use it only together with a certified power supply. An input voltage that is too high will destroy the instrument.

8.6 Accessories

- Connector power supply SV 54, different line plug styles available
- Magnetic shielding chamber NK 1 (included with instrument). **Used for the Zero adjustment of standard probes**
- Large magnetic shielding chamber (optional). **Used for the Zero adjustment of high sensitivity probes**
- Operating instructions FH 54 Gauss-/Teslameter, German
- Operating instructions FH 54 Gauss-/Teslameter, English
- HS-TGB5-104005, standard transverse probe
- HS-AGB5-4805, standard axial probe
- Other Hall probes: ask for data sheets or refer to www.magnet-physik.de

8.7 Taking Out of Operation

Switch off the device. Unplug the probe, the interface cable and the AC adapter if applicable. You should remove the batteries from the FH 54 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.