MAGNETOSCOP® 1.069

- ✓ Measurement of magnetic field strengths in the range 0,1nT to max 1 mT
- ✓ Extremely high sensitivity of 0.1 nT
- ✓ Measurement of material permeabilities in the range μ_r = μ_r = 1.00001 to 2.000
- ✓ Permeability measurements with results that can be traced to national standards
- ✓ Comparison method for checking the permeability of a work piece in order to indicate material changes – for customer specific procedures only
- ✓ Scale unit selection of the measured values as Tesla, kA/m, A/m, Oersted, Gauß

Figure 1 MAGNETOSCOP 1.069

Merkmale

• Handy, microprocessor controlled compact instrument with digital display • Harmonic method with FOERSTER® probes • Position-independent measurement • Measurement not susceptible to vibration • Peak value recognition/storage • Continuous result display • RS232 interface for data transfer and remote control	• Compact flash disk for: data and instrument setting transfer to PC in .txt format • Adjustable thresholds for limit values • Optical and/or visual alarm indication • Battery or external AC power supply operation • Extensive range of probes

Application

The MAGNETOSCOP 1.069 is used in two areas of application. These are:

1. **Measurement of DC magnetic fields, DC field differences and field gradients on the basis of magnitude and direction, and measurements of AC magnetic fields up to 180 Hz.**

Examples of field measurement applications:

- Measuring the earth's magnetic field.
- Determining the magnetic moment of a dipole.
- Measuring the demagnetized state of materials.
- Determining of the coil constant of various magnetizing coils.
- Measuring the inhomogeneity of various coil arrangements.
- Determining the effectiveness of magnetic shielding arrangements.
- Measuring the inhomogeneity of the earth's magnetic field due to ferromagnetic parts.
- Detecting magnetic disturbance poles on materials.

Figure 2 MAGNETOSCOP 1.069, Permeability measurement on a turbineblade with permeability probe

2. Measurement of material permeabilities. Two different methods are used for permeability measurement:

a. Measuring Method

This method determines the actual value µr. The instrument automatically displays the current value. Correction tables are no longer needed as they are integrated. The setup of the Magnetoscop for this method uses calibration standards that are traceable to national standards (PTB=Physikalisch Technische Bundesanstalt)).

Order-No.	Drawing-No.	Nominal value
* 13623 72	1.068.01-9301-14	1.2
1362364	1.068.01-9301-13	1.05
1362356	1.068.01-9301-12	1.025
1362348	1.068.01-9301-11	1.005

*This calibration standard is suitable for calibration for all measuring ranges of the instrument.

The additional calibration standards should only be used to increase the accuracy of a measurement and only when the expected values for permeability (μ_r) are within the measuring range associated with each individual calibration standard.

b. Comparison Method (for existing customer specific procedures only)

This method is only used when performing an operation or procedure that compares the indicated permeability value for the test sample to the reading for a reference standard. If the reference standard is a calibration standard traceable to national standards (PTB), then the permeability reading is the actual value. When developing a new procedure, the calibration standards noted in the measuring methods section should be used if possible. For older procedures, see the note below.

☞ **Note:** There are established procedures for turbine blade inspection which call for using the comparison method and use the reference standard I.D.#1551272, Part#1.067-101-12, Value 1.45. If you are implementing one of these procedures you must purchase and use this reference standard. The permeability reading will not be the actual value and the results cannot be traced back or referred to national standards. This standard should not be used for any new procedures.

Order No.	Drawing No.	Nominal value
1551272	1.067-101-12	1.45

Examples of permeability measurement applications:

- Measurement of material permeabilities in the range µ = 1,00001 up to 2,000
- Detection of ferromagnetic inclusions in materials
- Proof of material changes (i.e. highly stressed parts of gas turbines)
- Detection of material defects induced by stress
- Sorting on the basis of material permeability
- Measurement of permeability variations in a material
- Quality control of stainless steel
- Non-destructive testing of materials and work-pieces
- Investigation of magnetically anisotropic materials

Function

The electrical operation is shown in the block diagram of Figure 1 below.

The FOERSTER® probe is used as a measuring element. An iron core gets magnetized by a sinusoidal field until it reaches saturation point. Due to the shape of the magnetic hysteresis loop, the shape of the magnetic flux in the iron core as a function of time will not be sinusoidal. It contains (according to Fourier), besides the fundamental frequency, the odd harmonics of the exciting frequency. If, simultaneously, a DC magnetic field is acting on the iron core, the even harmonics will also appear in the flux and consequently in the secondary voltage of the FOERSTER probe. This voltage, due to the even harmonics, is a measure for the magnitude of the magnetic field affecting the probe.

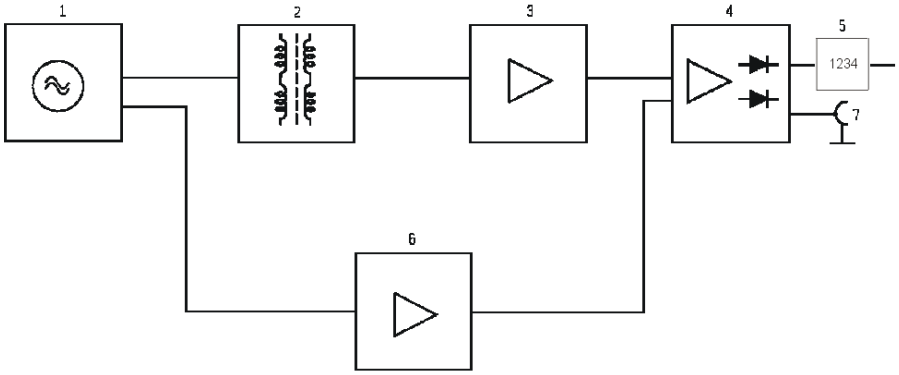


Figure 3 Block diagram for MAGNETOSCOP 1.069

1 Oscillator	5 Digital display
2 FOERSTER probe	6 Switching-voltage amplifier with
3 Measuring amplifier	Frequency doubling stage
4 Controlled rectifier	7 Analog output

Mechanical Construction

The MAGNETOSCOP 1.069 is a compact battery powered instrument.

The instrument can be powered either by alkaline or Ni-MH batteries or by an external power supply.

The connection sockets for the probes, external power supply, recorder (analog output), and RS-232 serial port are located on the end of the unit. The battery compartment is located inside the cover in the bottom end of the housing.

The following items are required for conducting a measurement with the MAGNETOSCOP 1.069:
1 MAGNETOSCOP 1.069
1 Magnetic field probe or
1 Permeability probe

and, for measurements with the permeability probe,
1 calibration standard.

INSTITUT DR. FOERSTER has compiled standard functional sets containing all required components for the most frequent applications. These are as follows:

Magnetic field measurement #1802429
Standard functional set for measurement of static and slow, dynamic magnetic field strengths and field gradients between 1 nanoTesla and 100 microTesla. The field and gradient probe used for this consists of a pair of probes incorporated in separate plastic bodies. A retaining fixture for the pair of probes permits them to be arranged parallel (absolute field strength measurement) or anti-parallel (gradient measurement).

Permeability measurement #1803492
Standard functional set for measurement of material permeabilities in the range μ_r = 1.00001 to 2.000. The permeability probe used for measurement and the calibration standard μ_r = 1.2 make it possible to calibrate the instrument so that the results then measured can be traced back and referred to national standards.

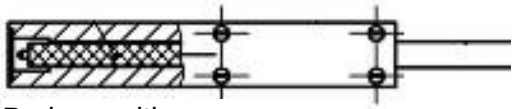
Permeability measurement #1801341
Standard functional set for measurement of material permeabilities in the range μ_r =1.00001 to 2.000 with ten times greater sensitivity than the standard (x1) probe. The high sensitivity (x10) probe is designed for fixed installation and requires a constant position in the earth's field.

Permeability comparison on the basis of μ=1,45 Reference standard #1801880
Standard functional set for checking the variation of a material on the basis of the variation of material permeability with the aid of the comparison method. A permeability probe and a reference standard are used. However, the related test procedure must also have been established on the basis of the 1.45 (#1551272) reference standard in order to use this functional set. The method ensures that the results are comparable with the limit values specified in the test procedure. The results cannot be traced back or referred to national standards.

A wide range of probes are available for field measurement with the MAGNETOSCOP 1.069.

FOERSTER Field and gradient probe #1668455

The Field and Gradient Probe Pair is suitable for the measurement of static and slow dynamic magnetic fields and field strength gradients between 1 nT and 100 µT (parallel probe orientation) and 200µT (anti-parallel probe orientation). Sensitivity ranges of 1.069 are valid together with this field and gradient probe. The effective magnetic core length of the pair of probes is 32mm. Two probes are fitted in separate plastic bodies of dimensions 10 x 10 x 70mm, each individual probe being connected by a 3 meter flexible cable. Separation of the two probes allows them to be used in parallel



Probe position

for field strength measurement or in anti-parallel for field strength difference measurement.

A plastic mount can be supplied on request to allow the probes to be mounted in parallel or anti-parallel according to the application. The probes are placed in the mount at a distance of 20mm or 70mm between the probe cores. If the two probe bodies are next to each other during measurement, the sensitivity of the probes changes by about 1% due to slight interaction. Placing the probes in a narrow non-ferrous metal tube also changes the sensitivity slightly. A white line engraved in the plastic body marks the exact position of the effective probe core. The probe cores and probes are fitted in the probe mount with an accuracy of ± 1° referred to the edge of the plastic body.

A separate mount #1806297 with 436mm in length is available for special applications. This mount

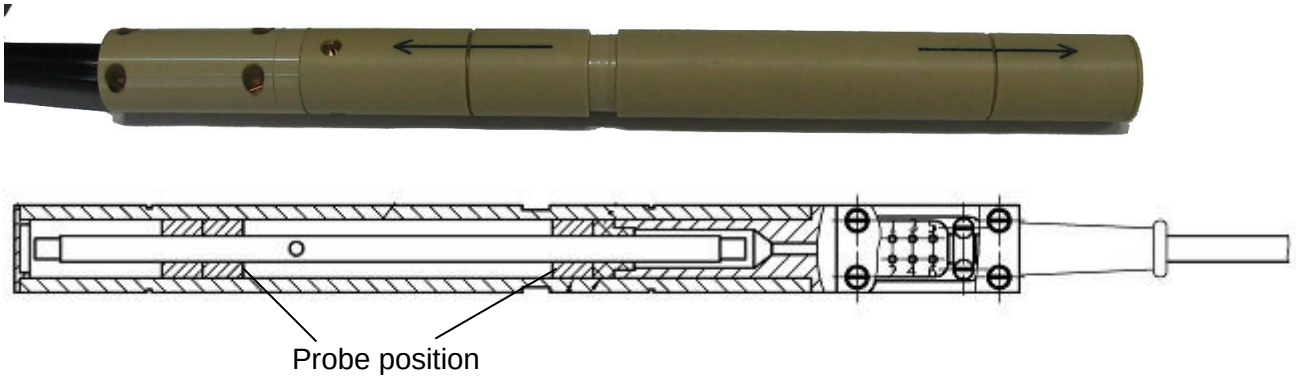
has three defined positions for placing the probes. Additionally a protective tube #1806300 is available for the special mount.

FOERSTER-Micro-Field probe, axial #1667882
FOERSTER-Micro-Field probe, transversal # 1668200
Micro field probes are suitable for spot measure-ment of static and slow dynamic magnetic fields in the field strength range from 10 nT to 1 mT. The effective magnetic core length of a micro field probe is 5 mm with a diameter of 0.2 mm. Two probes are mounted side by side in a small plastic body 10 x 10 x 50 mm, with a probe core distance of 6 mm. Two white lines indicate the position of the two cores. The angular deviation of the probe axis to the edges of the plastic body does not exceed ± 2°. The micro-field probe is connected to the instrument by a 3-meter cable.

FOERSTER-Point pole probe # 1668528
Point pole probes contain two probes each having a 5 mm effective magnetic core length in a differential connection for field strength range of 10 nT to 1 mT. The two probes are mounted coaxially, 2 mm apart in a tapered plastic body that is 12 mm in diameter. The tip of the core of probe II is approximately 2 mm behind the small metal plate that is fastened to the end of the probe body. The point pole probe is connected to the instruments by a 3-meter cable. The point pole probe is used for relative measurement of fields emerging vertically from the work piece (i.e., in the Transportation case of point pole magnetization for material sorting or similar due to different residual magnetic fields).

FOERSTER-Differential probe with 3m cable # 1668960

The differential probe contains two probes of 32 mm effective magnetic core length in a differential connection for measurement of field strengths between 1 nT to 200 µT. The two probes are mounted coaxially in a plastic tube and are spaced 100 mm apart. The MAGNETOSCOP identifies the connected differential probe and automatically switches the measuring range 100µT to 200µT. The differential probe is connected to the instrument by a 3 meter cable.
Differential probes are used for detecting magnetic interference fields and for determining the magnetic moment of interference objects.
The space relationship (i.e., movement of the probe in the earth's magnetic field) = 50 gamma.



FOERSTER Permeability probe # 1668145
FOERSTER Permeability probe 10x Sensitivity #1668170

Permeability Probe - This probe is for the accurate measurement of material permeability in the order of magnitude μ_r = 1.00001 to 2.000. The permeability probe can also be used for testing non-magnetic materials for iron inclusions or inclusion of other ferromagnetic materials. The field strength at the permeability probe tip is approximately 75kA/m.

Permeability Probe X10 Sensitivity - The permeability probe is ten times greater in sensitivity than the standard permeability probe. This probe is designed for fixed installation to obtain a constant position in the earth's field. The zero constancy is less and zero adjustment is somewhat more diffaculty. The x10 sensitivity probe is most suitable for measurement of very low value magnetic permabilities
Materials to be measured with permeability probes should be thicker than approximately 8 mm when-ever possible. Accurate measurements of materials that are thinner than 8 mm may be possible by stacking two pieces but the air gap between the two pieces must be as small as possible.
The flat area on which the permeability probe is placed must not be less than approximately 20 mm in diameter. When testing on curved surfaces the radius of curvature must not be less than approximately 40 mm.
If any of the required dimensions are less than those specified, the instrument will indicate permeability less than the actual value.
The permeability measuring method employs the following principle: A cylindrical permanent magnet possesses a definite distribution of lines of force. All lines of force of this permanent magnet run in a plane through the center of the cylinder between the two poles that are parallel to the cylinder axis. A gradient probe is placed on either side of the cylindrical magnet in this plane perpendicular to the cylinder axis at the center of the permanent magnet. The lines of force of the magnet are perpendicular to the axis of the two Foerster probes. Therefore, they do not measure the magnetic field of the cylindrical magnet. If the cylindrical magnet is placed on a material whose permeability is greater than 1, there is a minute displacement of the magnetic zero of the cylindrical magnet towards the material on which the magnet has been placed. In the lower permeability ranges this displacement is a measure of the permeability of the material.

FOERSTER-Micro-Differential probe #1667890

The Micro Differential probe measures field strength differences of small magnetic field sources from 10 nT to 1 mT. The bottom side of the probe is protected from wear and tear by a sintered material.

Technical Data

Dimensions approx.: 266mm x 144mm x 63.5mm (LxWxH); 10.5in.x5.7in.x2.5in (LxWxH).

Weight: approx. 0,86 kg (1.8lbs)

Permissible temperature range: 0 up to 40°C (32 to 104 °F)

Accuracy of field strength measurement: 2,5% of full scale value in all ranges

Response time of instrument display: ≤ 0,3 s

Limit frequency on analog output: ≤ 180 Hz

Analog output: Output impedance: 100 Ω

Output voltage: ± 1 V; Output current: 10mA max. short-circuit proof

Measuring ranges for instrument full-scale reading. Ranges are set automatically for probes listed below:

Probe	**Sensitivity Ranges**
Ranges for following probes: Field and gradient probe pair #1668455	0.01µT 0.03 µT 0.1µT 0.3µT 1µT 3µT 10µT 30µT 100µT
Micro-field probe, axial #1667882	automatic multiplication by factor 10
Micro-field probe, transversal #1668200	automatic multiplication by factor 10
Micro-differential probe #1667890	automatic multiplication by factor 20
Point-pole probe #1668528	automatic multiplication by factor 20
Differential-probe #1668960	automatic multiplication by factor 2 in range 100µT automatically turned to 200µT

Ranges for:	Resolution	Measuring accuracy (+/-)	
Permeability probe 1.069.01 – 3001			
μ_r = 1,000 - 1,001	0,00001	0,001	
μ_r = 1,000 - 1,003	0,00001	0,001	or 5% of the
μ_r = 1,000 - 1,010	0,00001	0,001	actual value,
μ_r = 1,000 - 1,030	0,00001	0,001	the bigger one
μ_r = 1,000 - 1,100	0,0001	0,01	in each case
μ_r = 1,000 - 1,300	0,0001	0,01	
μ_r = 1,000 - 2,000	0,001	0,01	

Ranges for:	Resolution	Measuring accuracy (+/-)	
Permeability probe 1.069.01 – 3010 (10x sensitivity)			
μ_r = 1,000 - 1,0001	0,00001	0,001	
μ_r = 1,000 - 1,0003	0,00001	0,001	or 5% of the
μ_r = 1,000 - 1,001	0,00001	0,001	actual value,
μ_r = 1,000 - 1,003	0,00001	0,001	the bigger one
μ_r = 1,000 - 1,010	0,00001	0,001	in each case
μ_r = 1,000 - 1,030	0,00001	0,001	
μ_r = 1,000 - 1,100	0,0001	0,01	
μ_r = 1,000 - 1,300	0,0001	0,01	
μ_r = 1,000 - 2,000	0,001	0,01	

Instrument Accessories

Wire tilt stand

- PVC coated to allow instrument operation while in stand
- Rugged wire frame construction, collapsible for easy storage
- Instrument rests at a 45° angle to reduce glare and user fatigue

Canvas Carrying Bag

- Side and rear handle straps for easier one hand operation
- Shoulder strap with storage compartment
- Durable canvas material with clear front window
- Instrument is fully operational in carrying bag
- Bag opens at both ends for easy access to instrument
- Open top access panel to allow cable connections

Order documents:

Designation	Order-No.
Standard functional sets **MAGNETOSCOP 1.069 Magnetic field measurement** comprising: 1 MAGNETOSCOP 1.069 measuring instrument 1 Field and gradient probe, 3m 1 Holder for field probe 1 Transportation case 5 "AA" Batteries 1.5V, (IEC LR6 Alkaline) 1 Operating Instructions for MAGNETOSCOP	1802429
MAGNETOSCOP 1.069 Micro-field, Axial comprising: 1 MAGNETOSCOP 1.069 measuring instrument 1 Micro-field probe, axial 1 Transportation case 5 "AA" Batteries 1.5V, (IEC LR6 Alkaline) 1 Operating Instructions for MAGNETOSCOP	1805070
MAGNETOSCOP 1.069 Micro-field, Transversal comprising: 1 MAGNETOSCOP 1.069 measuring instrument 1 Micro-field probe, transversal 1 Transportation case 5 "AA" Batteries 1.5V, (IEC LR6 Alkaline) 1 Operating Instructions for MAGNETOSCOP	1805088
MAGNETOSCOP 1.069 Point-pole comprising: 1 MAGNETOSCOP 1.069 measuring instrument 1 Point-pole probe 1 Transportation case 5 "AA" Batteries 1.5V, (IEC LR6 Alkaline) 1 Operating Instructions for MAGNETOSCOP	1805096
MAGNETOSCOP 1.069 Difference comprising: 1 MAGNETOSCOP 1.069 measuring instrument 1 Differential probe, Cable 3m 1 Transportation case 5 "AA" Batteries 1.5V, (IEC LR6 Alkaline) 1 Operating Instructions for MAGNETOSCOP	1805100
MAGNETOSCOP 1.069 Micro-differential comprising: 1 MAGNETOSCOP 1.069 measuring instrument 1 Micro-differential probe 1 Transportation case 5 "AA" Batteries 1.5V, (IEC LR6 Alkaline) 1 Operating Instructions for MAGNETOSCOP	1805118
MAGNETOSCOP 1.069 Residual-field comprising: 1 MAGNETOSCOP 1.069 measuring instrument 1 Residual-field probe 1 Transportation case 5 "AA" Batteries 1.5V, (IEC LR6 Alkaline) 1 Operating Instructions for MAGNETOSCOP	1805126

Designation	Order-No.
Permeability measurement comprising: 1 MAGNETOSCOP 1.069 measuring instrument 1 Permeability probe #1668145 1 Calibration standard μ_r = 1,2 1 Transportation case 5 "AA" Batteries 1.5V, (Alkaline) 1 Operating Instructions for MAGNETOSCOP	1803492
Permeability measurement comprising: 1 MAGNETOSCOP 1.069 measuring instrument 1 Permeability probe #1668170 1 Calibration standard μ_r = 1,2 1 Transportation case 5 "AA" Batteries 1.5V, (Alkaline) 1 Operating Instructions for MAGNETOSCOP	1801341
Permeability comparison comprising: 1 MAGNETOSCOP 1.069 measuring instrument 1 Permeability probe #1668145 1 Reference standard #1551272 1 Transportation case 5 "AA" Batteries 1.5V, (Alkaline) 1 Operating Instructions for MAGNETOSCOP	1801880
Permeability comparison, high sensitivity comprising: 1 MAGNETOSCOP 1.069 measuring instrument 1 Permeability probe #1668170 1 Reference standard #1551272 1 Transportation case 5 "AA" Batteries 1.5V, (Alkaline) 1 Operating Instructions for MAGNETOSCOP	1802518

Extension cable, optional	1.069.01-99xy	
Extension cable, 3m, optional	1.069.01-9900	1804421
Extension cable, 10m, optional	1.069.01-9901	1803972
Extension cable, 15m, optional	1.069.01-9902	1803980
Extension cable, 25m, optional	1.069.01-9903	1803964

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Version 01/14
Author DO/RI
Order-No. 1905090

Designation	Order-No.
Standard Components	
MAGNETOSCOP measuring instrument	0307769
Transportation case	0308064
Canvas Carrying Bag with shoulder strap	0313840
Battery Charger	0307475
Power supply 230V, 50Hz	0308366
Ni-MH Battery 1.2V, 1400MAH	0150932
"AA" Battery 1.5V (Alkaline)	0087700
Probe Adapter for 1.068 Probes	0308374
Flash-Disk_Compact	0309044
Field and gradient probe Pair, 3m	1668455
Holder for field probe	1606417
Micro-field probe, axial	1667882
Micro-field probe, transversal (FK 5Q-B15-1)	1668200
Point-pole probe	1668528
Differential probe, cable 3m	1668960
Protective tube 50, for differential probe	1844032
Micro-differential probe	1667890
Residual field probe	1668218
Flash Disk Compact, 64MB	0309044
Permeability probe	1668145
Permeability probe, 10x sensitivity	1668170
Permeability probe with small design	1806416
Calibration standard μ_r = 1,2 with certificate	1362372
Calibration standard μ_r = 1,05 with certificate	1362364
Calibration standard μ_r = 1,025 with certificate	1362356
Calibration standard μ_r = 1,005 with certificate	1362348
Perm probe with certificate	1551272
Connection cable, 2m for 1.069 for permeability probe with small design	1806424
Protective tube for holder, (field and gradient probe)	1806300
Holder for field and gradient probe pair probe centre space 400mm	1806297
Reference standard (is used only for older existing procedures – use not for new procedures)	1551272
Charger with accessories and battery	0339520
Battery holder	0339539
Operating Instructions for MAGNETOSCOP	