

## PERMAGRAPH<sup>®</sup> C

for the computer controlled  
measurement of hysteresis curves  
of hard magnetic materials



### • Introduction

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The PERMAGRAPH<sup>®</sup> C is a fully automatic, computer controlled measuring system to determine magnetic characteristic quantities of hard magnetic materials.

Together with the high performance software package Perma and the required control unit we offer an automatic measuring station which facilitates quick and reliable measurements.

With the PERMAGRAPH<sup>®</sup> C a measuring system has been devised which will meet your present and future requirements.

The system design conforms to IEC 60404-5, ASTM A977, DIN EN 10332. The temperature upgrade conforms to IEC 61807TR, DIN IEC 68/190/CDV.

The equipment has been optimized for years and has been made especially to the requirements of our customers. The following measurements are possible:

- Automatic measurement of the hysteresis curves of permanent magnets
- Determination of magnetic quantities as remanence, coercivity, max. energy product
- Measurement with surrounding coils to determine the magnetic mean values
- Measurement of different areas on the magnets with pole coils

## ● Measuring Method

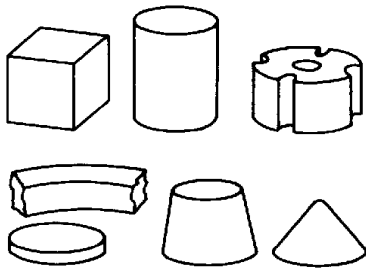
Depending on serial model modification of the PERMAGRAPH<sup>®</sup> C magnet tester the following measuring methods are possible with our components:

**Measurement of Ferrite magnets** using measuring poles with incorporated pole coils.

**Measurement of Ferrite segment magnets** with segment pole sets with incorporated pole coils, each pole corresponding to the radii of the segment magnet.

### Magnet forms

which may be measured with the PERMAGRAPH<sup>®</sup> C - without determination of their cross section.



**Measurement of AlNiCo, Ferrite or Rare earth magnets (samarium-cobalt and neodymium-iron-boron)**

with J-compensated surrounding coils and measuring poles without pole coils.

### Attention:

For the saturation of the rare earth magnets an impulse magnetizer and a magnetization coil are additionally required.

**Measurement of AlNiCo, Ferrite or Rare earth magnets at high temperatures (up to 200 °C)**

with heatable measuring poles up to 200 °C and temperature resistant JHT surrounding coils.

All important applications and examples for measuring techniques especially regarding the PERMAGRAPH<sup>®</sup> C are described in our booklet

**“MAGNETIC MEASURING TECHNIQUES”**  
by Dr. E. Steingroever  
and  
Dr. Gunnar Ross

which we supply free of charge.

## ● Product Family

The PERMAGRAPH<sup>®</sup> C can be composed by a variety of components.

For the measurement of the different magnetic materials we offer a Standard package which can be completed by further components according to your application.

On the following pages we list up the components which are included in the package and give technical details.

We also enclose a list with all available measuring equipment and accessories.



Reg. No. 004201 QM

## ● Description of Standard Package

### Basic equipment Permagraph® C – 300

- 1 PERMAGRAPH power supply SVP 2
- 2 Electronic Fluxmeters EF 5
- 1 Cabinet for PERMAGRAPH® C
- 1 Electromagnet EP 3
- 2 Poles P 0/0, 92 mm Ø, without pole coils
- 1 Flat pole coil measuring system (P-3/3 or P-6/6 at your option)
- 1 Field measuring coil FS-100/2
- 1 J-compensated surrounding coil JH 26-1 (other diameter on request)
- 1 PERMAGRAPH-control unit consisting of :
  - 1 PERMAGRAPH-control board ST-P/R2
  - 1 Computer Hardware PC-PERM
- 1 Software PERMA for Windows
- 1 Training in our works

### Basic equipment “Rare Earth” Permagraph® C – 300

- 1 PERMAGRAPH power supply SVP 2
- 2 Electronic Fluxmeters EF 5
- 1 Cabinet for PERMAGRAPH® C
- 1 Electromagnet EP 3
- 2 Poles P 0/0, 92 mm Ø, without pole coils
- 1 J-compensated surrounding coil JH 26-1 (other diameter on request)
- 1 PERMAGRAPH-control unit consisting of :
  - 1 PERMAGRAPH-control board ST-P/R2
  - 1 Computer Hardware PC-PERM
- 1 Software PERMA for Windows
- 1 Training in our works

### Basic equipment “Ferrit” Permagraph® C – 300

- 1 PERMAGRAPH power supply SVP 2
- 2 Electronic Fluxmeters EF 5
- 1 Cabinet for PERMAGRAPH® C
- 1 Electromagnet EP 3
- 2 Poles P 0/0, 92 mm Ø, without pole coils
- 1 Flat pole coil measuring system (P-3/3 or P-6/6 at your option)
- 1 Field measuring coil FS-100/2
- 1 PERMAGRAPH-control unit consisting of :
  - 1 PERMAGRAPH-control board ST-P/R2
  - 1 Computer Hardware PC-PERM
- 1 Software PERMA for Windows
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### UPGRADE OF PERMAGRAPH® C for measurements at temperatures up to 200 °C

- 1 Temperature control unit TC 3
- 1 Thermocouple Type J
- 2 Heating poles PT 200
- 1 Temperature surrounding coil (Ø at your option)

### Permagraph® C Electromagnet EP 5

Electromagnet EP 5 instead of the electromagnet EP 3 which is included in the standard package.

## ● Our Measuring Method

For the measurement of the field strength  $H$  we use either integrated or separate field measuring coils. Therefore a Hall effect gaussmeter is superfluous. If Hall sensors are used to measure  $H$  next to the specimen additional space for the probe and an additional gaussmeter is required. Hall sensors are very fragile and can easily be damaged. Because of the linearity error and the temperature dependence of the sensitivity of a Hall sensor, corrections are necessary to achieve an acceptable accuracy. Additional errors can arise from the facts that the Hall probe has always to be aligned truly perpendicular to the magnetic field direction and that it is, due to the small active area, more sensitive to local field strength variations. Therefore it is the better solution to use a field measuring coil instead of a Hall probe.

If a surrounding coil is used field strength and polarisation are measured with only one combined coil system. As no space for the Hall probe is required, specimens of a thickness down to only 1 mm can be measured.





Reg. No. 004201 QM

## ● Description of Hard- and Software

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### PERMA

#### Software for PERMAGRAPH® C – 300

The electronic fluxmeters are controlled by the computer. The measured data are received from the two fluxmeters via the RS 232 interface and displayed on the monitor in real-time. This allows the results to be checked while the measuring procedure is in progress.

The measuring process is controlled by the control board ST-P/R-2.

The set specimen and measuring parameters can be stored. Thus in the case of new measurements only a few new inputs must be made.

The measured results and curves are output on the monitor, printer or in result files, which can then be processed by other programs such as Excel etc. This enables a statistical treatment, e.g. of series measurements, to be carried out over a longer period of time.

## ● Software Features

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- User friendly, menu driven operation
- Fast access to important functions via function keys
- Context sensitive help
- Automatic detection of coils and measurement type
- Real time display of the curve during the measurement
- Saving of measuring data and parameters
- Automatic saving (e.g. below a test number)
- Calculation of results
- Print preview
- Output of measuring results and curves on a printer
- Output of measuring results and curves as graphic files (.gif, .jpeg, .bmp) or via the Windows clipboard
- Output of measuring results in files or data bases
- Various possibilities for customer specific output design
- Display of demagnetization curve and/or hysteresis loop, for  $J(H)$  and  $B(H)$
- Display of up to 5 curves in one diagram with results
- Language separately selectable for program menus and output (English, German, French, Spanish)
- Microsoft Windows 98/2000/XP compatible

## ● Parameters

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- Default parameters minimize the number of necessary input
- Calculation of the cross-sectional area from specimen geometries

## ● Drift Correction

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- Automatic drift correction during warm-up (max. 1 minute)
- Proposal for drift correction by software if required, automatically before measurement or on command (20 s).
- Automatic calibration during warm-up or before drift correction (10 s)
- Duration of measurement: adjustable, usually 20 – 120 seconds according to specimen type. Increase of speed by faster magnetisation and slower demagnetisation.

## • Curves

- Demagnetization curve
- Complete hysteresis loop
- Recoil curves
- Automatic stop with  $H_{cJ}$
- Measurement with J-compensated surrounding coils or pole coils
- Automatic drift correction

## • Evaluation

- Remanence ( $B_r$  or  $J_r$ )
- Normal or intrinsic coercivity ( $H_{cJ}$  and  $H_{cB}$ )
- Maximum energy product  $(BH)_{max}$
- Maximum field strength
- $H_k$ : Knee shape parameter (H coordinate of intrinsic curve when  $B = 0.9 \cdot B_r$ )
- $H_x$ : H coordinate of intrinsic curve when  $B = x \cdot B_r$
- Tables of  $J(H)$  and  $B(H)$ , where  $H$  are user defined field strengths. Tables of  $H$  values can be predefined and stored.
- Output of specimen and measurement parameters and calculated results in ASCII files, for import by other programs
- Output of specimen and measurement parameters and calculated results in data bases
- Temperature correction: conversion of results by means of temperature coefficients

## • Units

- Full support of SI and CGS units in software and output
- Change of unit system possible at any time
- Simultaneous display of SI and CGS units on diagram axis

### CONTROL UNIT

Computer-Hardware for Permagraph<sup>®</sup> C included in standard packages

For the set-up of an automatic measuring system and smooth operation of the before mentioned software the following hardware components are required:

- |  |  |  |
|--|--|--|
| <ul style="list-style-type: none"><li>• Personal computer with<ul style="list-style-type: none"><li>• Hard disk drive</li><li>• CD/DVD drive</li><li>• Network connection</li><li>• LCD flat screen</li><li>• Keyboard</li><li>• Mouse</li></ul></li></ul> | <ul style="list-style-type: none"><li>• Interfaces (2 x COM, USB)</li><li>• Various connection cables for printer, computer etc.</li></ul> | <ul style="list-style-type: none"><li>• WINDOWS (current version)</li><li>• HP Deskjet (current model)</li></ul> |
|--|--|--|

The computer has to be configured by Magnet-Physik.

We cannot guarantee faultless operation if apart from the programs loaded by us further software is installed.

## • Electromagnets

### Electromagnet EP 3



For the use with PERMAGRAPH® C

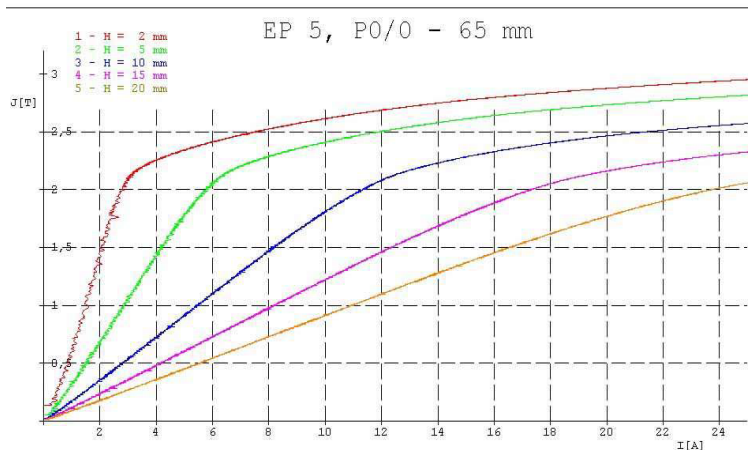
- High field strength in the air gap up to 1700 kA/m (21.5 kOe) with 2 mm air gap and straight poles
- Exchangeable pole caps with following options:
  - made of Fe or FeCo
  - diameter 92 mm straight or tapered
  - with or without pole coils
  - without or with heating (up to 200 °C)
  - air gap plane parallel or with segment profile
- Minor heating of the field coils
- Easy movement of upper poles by handwheel  
No danger of injuries by skewed yoke frame  
Required power supply: 3 kW

### Electromagnet EP 5

The measurement of hysteresis curves of permanent magnets in a measuring yoke requires very high field strengths for the demagnetization of the modern, high coercive materials (Samarium-Cobalt and Neodymium-Iron-Boron).

- Exchangeable pole caps with options like EP 3
- Easy movement of the upper pole by handwheel on the front side
- No danger of injuries by closed frame of yoke
- Required power supply: 3 kW

Achievable field strength with poles tapered to  $\varnothing$  65 mm:



With the measuring yoke EP 5 the high field strength in the air gap is achieved by moving the upper field coil together with the upper pole in the frame of electromagnet so that the magnetic field of the two coils has an optimum effect.

In addition the pole shape and the winding cross sections are of optimum design.

## ● Electronic Fluxmeter 5



## ● Description

The Electronic Fluxmeter EF 5 is an electronic integrator of high sensitivity and extremely low drift. Therefore it is used successfully in the magnetic laboratory as well as in the production. A multitude of measuring coils is available and we design coils for special application.

This new device type has all the tested properties of the EF 3 and EF 4 series which have been successfully in use world-wide for the past few years. This new generation of electronic fluxmeters has been developed by using of modern technology. We would like to point out the following specifications:

- microprocessor controlled
- automatic drift compensation and zero reset
- continuously working integrator without measuring ranges
- complete control by menu, the most important functions can be activated by function keys
- memory for coil parameters (measuring coil constants, resistances)
- calculation of measuring values taking into account the probe parameters
- automatic taking over of the coil parameters of measuring coils
- display of the measured value in Volt seconds, Weber or other units according to measuring coils
- The EF 5 can be used in systems for automatic measuring and production equipment
- compact design, insertion in 19"-cabinets possible
- modern and attractive design

## ● Technical Data

Display	:	LCD, 240 x 64 dots	Interfaces	:	RS 232
Display of measured value	:	max. 6 digits		:	24 V I/O für SPS
Resolution	:	$10^{-7}/10^{-6}/10^{-5}/10^{-4}$ Vs		:	RS 485 (optional)
Measurements per seconds	:	25		:	IEEE 488 (optional)
Input resistance $R_i$	:	0 $\Omega$ , 10 k $\Omega$	Comparator (Limit)	:	4-fold, relay output
Drift	:	$<10^{-6}$ Vs/min	Peak	:	Max, Min, Max-Min
	:	( $R_i + R_s \geq 10$ k $\Omega$ , $R_s =$ coil resistance)	Supply	:	100/120/220/240 V $\pm$ 10%
Max. input voltage	:	60 V	Weight	:	50-60 Hz, 80 W
Analog output	:	$\pm$ 10 V, scaling of analog output can be adjusted	Dimensions	:	approx. 6.2 kg
			Width x Depth x Height	:	484 x 310 x 114 mm <sup>3</sup>



## ● Accessories for Permagraph® C

### Measuring poles

with and without pole coils, for insertion in the electro magnets EP 3 and EP 5 for measurement at room temperatures. Measuring poles are made of soft magnetic steel or iron cobalt alloy.

#### ▪ Standard Poles (without pole coils)

##### Pole P 0/0, 92 mm Ø

for measurement with surrounding coils or a flat pole coil measuring system (2 pieces needed)

##### Pole P 0/0, 80 mm Ø

for measurement with surrounding coils or as counterpart to a pole coil measuring system with 80 mm Ø



Pole P 0/0, 92 mm Ø



Pole P 0/0, 65 mm Ø FeCo

#### ▪ Flat Pole Coil Measuring Systems

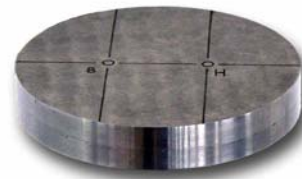
Recommended for ferrite magnets. The measuring system can be positioned on standard poles 92 mm Ø. The poles are made of FeCo (Vanadium Permendur).

##### Flat Pole Coil Measuring System P 3/3, 92 mm Ø

with 2 incorporated pole coils 3 mm Ø

##### Flat Pole Coil Measuring System P 6/6, 92 mm Ø

with 2 incorporated pole coils 6 mm Ø



Flat pole coil measuring system P 3/3

#### ▪ Pole Coil Measuring Systems

for measurement of the polarization  $J = B - \mu_0 \cdot H$  with two incorporated pole coils (suitable for ferrite magnets). The poles are fixed in the electromagnet. As counterpart a pole P 0/0 Ø 80 mm is required. The poles are of soft magnetic steel.

##### Pole P 3/3, 80 mm Ø

with 2 incorporated pole coils 3 mm Ø

##### Pole P 6/6, 80 mm Ø

with 2 incorporated pole coils 6 mm Ø

##### Pole P 9/9, 80 mm Ø

with 2 incorporated pole coils 9 mm Ø



Pole P 6/6

## ● Accessories for Permagraph® C

### Field measuring coil FS 100/2

for the measurement of the magnetic field strength or flux density on permanent magnets or in magnet systems. Required for the use of pole coil measuring systems.

Area turns: approx. 100 cm<sup>2</sup>.



Field Coil FS 100/2

### J-compensated surrounding coils

with integrated fields coil for measurements at room temperature. Coil thickness: 1 mm

#### J-compensated surrounding coil JH 10-1

Diameter 10 mm, specimen diameter 5 ... 10 mm

#### J-compensated surrounding coil JH 15-1

Diameter 15 mm, specimen diameter 10 ... 15 mm

#### J-compensated surrounding coil JH 26-1

Diameter 26 mm, specimen diameter 15 ... 26 mm

#### J-compensated surrounding coil JH 40-1

Diameter 40 mm, specimen diameter 26 ... 40 mm

#### J-compensated surrounding coil JH 60-1

Diameter 60 mm, specimen diameter 40 ... 60 mm



J-compensated surrounding coil JH 26-1

Other J-compensated surrounding coils, also in rectangular shape, can be supplied on request.

## ● Accessories for Permagraph<sup>®</sup> C

### Heating poles

with incorporated heating element, for insertion in the electro magnets EP 3 and EP 5. For measuring the hysteresis curves at temperatures up to 200 °C. Diameter: 60 mm.

**Heating pole PT 200** (2 pieces needed)  
for measurements with temperature surrounding coils



Temperature pole PT 200

### Thermocouple

Temperature sensor for the measurement of the specimen temperature



Thermocouple

### Temperature surrounding coils

with integrated field coil, for measurements at temperatures up to 200 °C. Coil thickness: 4 mm.

**Temperature surrounding coil JHT 10-4**  
Diameter 10 mm, specimen diameter 5 ... 10 mm

**Temperature surrounding coil JHT 15-4**  
Diameter 15 mm, specimen diameter 10 ... 15 mm

**Temperature surrounding coil JHT 26-4**  
Diameter 26 mm, specimen diameter 15 ... 26 mm

**Temperature surrounding coil JHT 40-4**  
Diameter 40 mm, specimen diameter 26 ... 40 mm



Temperature surrounding coil JHT 40-4

### Thin temperature surrounding coils

with integrated field coil, for measurements at temperatures up to 200 °C. Coil thickness: 2 mm.

**Temperature surrounding coil JHT 10-2**  
Diameter 10 mm, specimen diameter 5 ... 10 mm

**Temperature surrounding coil JHT 15-2**  
Diameter 15 mm, specimen diameter 10 ... 15 mm

**Temperature surrounding coil JHT 26-2**  
Diameter 26 mm, specimen diameter 15 ... 26 mm



Temperature surrounding coil JHT 26-2

## • Variants

### **PERMAGRAPH® – REMAGRAPH® – COMBINATION C – 750**

For the measurement of the static hysteresis loops of soft and hard magnetic materials.

The PERMAGRAPH®–REMAGRAPH®–COMBINATION C–750 combines the measuring possibilities of PERMAGRAPH® C and REMAGRAPH® C in one instrument. As some components are only required once, the combination offers a reasonable alternative to separate devices.

Components of the standard package:

Cabinet for PERMAGRAPH®- REMAGRAPH®-  
COMBINATION C-750

Electronic Fluxmeters EF 5 (2 pieces)

REMAGRAPH® power supply SVR 4

PERMAGRAPH® power supply SVP 2

REMAGRAPH® measuring yoke MJR 5 with  
exchangeable pole pieces

J-compensated surrounding coil, round JRR

J-compensated surrounding coil, flat JRF

Potential coil PS-R-40/58

Connection box for ring specimens CB-R

PERMAGRAPH® electromagnet EP 3

Pole caps P-0/0 (2 pieces)

J-compensated surrounding coil JH 26-1  
(other diameter on request)

Flat pole coil measuring system P-6/6-FeCo

Field measuring coil FS-100/2

Computer-Hardware incl. deskjet printer

Control board ST-P/R2

Software PERMA and REMA

Introduction and training in our works



**Cabinet of PERMAGRAPH® – REMAGRAPH® –  
COMBINATION C – 750  
(with optional Temperature control TC 3)**

You can find a detailed description of all features of the REMAGRAPH® C and of the optional accessories in the specification of this instrument.

## • Options

### **Nickel specimens**

with calibration diagram

for testing and calibrating the PERMAGRAPH® C hysteresis recorder.

Cylinders with a length 10 mm and available with cross-sectional areas of:

0.5 cm<sup>2</sup>, 1.0 cm<sup>2</sup>, 2.0 cm<sup>2</sup>, 5.0 cm<sup>2</sup>

Saturation polarization: 0.6 T, ± 1.5 %

### **Other computer accessories available on request:**

Laser printer, LCD flat screen etc.

## • Services

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### **Taking into operation and training – at MPS**

in the operation of the computer controlled PERMAGRAPH® C and its software.

The training will take 1 day and is free of charge.

The customer has to bear all costs in connection with the journey, the stay in Germany, accommodation, food, etc.

### **Taking into operation and training – at the customer**

in the operation of the computer controlled PERMAGRAPH® C and its software.

The training will take 1 day and is liable for the costs.

Additionally the customer has to bear all costs for our engineer in connection with the journey (incl. expenses for travelling hours), the stay, accommodation, food, etc.

## • Special Applications

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### **Segment Poles with pole coils**

for the measurement of segment magnets. Both the upper and the lower pole contain pole coil systems. Thus the polarization can be measured either on the lower or the upper side of the segment magnet or both pole coil systems can be connected in series to obtain the average.

The set of poles is constructed corresponding to the radii of the segment magnet.

#### **Set of segment poles**

Fe quality

#### **Set of segment poles**

FeCo quality

The poles are suitable for the use in the electromagnets EP 3 and EP 5. For the measurement you require furthermore: one field measuring coil FS 100/2.

Optionally available:

#### **Spring loaded holding device TP 2** (not suitable for EP 3)

This device makes the mounting of the set of segment poles to the electromagnet faster and easier.



**Segment Poles with pole coils**



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### Segment Poles MC-BLW

for the measurement of ferrite segment magnets according to a BOSCH standard. The set of poles is constructed corresponding to the radii of the segment magnet.

A coil in one of the poles senses the total magnetic flux penetrating the magnet. The pole distance is fixed and the measurement is carried out with a well defined air gap. A sheared hysteresis loop is obtained.

The poles are suitable for the use in the electromagnets EP 3 and EP 5. For the measurement you require furthermore: one field measuring coil FS 100/2.

An extension of the Perma software allows the evaluation of the measurements according to the test directions of BOSCH.



**Segment Pole MC-BLW**

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