MAGNETIC PRODUCTS

DATA HANDBOOK

Permanent Magnets

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Philips Components

PHILIPS

Permanent Magnets

Contents

Introduction

GENERAL DESCRIPTION

Modern permanent magnets are far removed from the traditional horseshoe magnet. Today, magnets are available in a variety of shapes to suit many applications, and the introduction of magnetic alloys and magnetic-oxide based ceramics has made the simple iron magnets the exception rather than the rule. Advances in magnet technology over the past 50 years have naturally led to an increase in the number of applications. Modern industry uses permanent magnets in many products ranging from computer disk drives to cars. A top-range motor can contain up to seventy permanent magnet motors. A modern household contains more than forty magnets, ranging from the refrigerator door catch to the microwave oven.

Normally, a magnet is an integral part of a construction, therefore mechanical as well as electrical properties have to be considered. Moreover, each application has its own special requirements, so a range of materials must be available if the user is to find one that fully satisfies his needs. The following sections provide the relevant data on our extensive range of magnetic materials. Should further information or technical assistance be needed, please contact our technical departments.

Magnets are often identified by the way they are made or by their construction. Knowledge of their manufacture is useful since it provides an indication of their mechanical properties and tolerances, as well as of the possible shapes they can be supplied in. Since the magnet is usually an integral part of its mechanical system, these factors must be considered when selecting a magnetic material for a particular application.

Our permanent magnets fall into two main groups: hard-ferrite and metal-alloy (the so-called rare-earth magnets). Hard-ferrite magnets offer the best value for money, but cannot match the high performance of rare-earth magnets. The two groups can be further subdivided according to the manufacturing technology; sintering and plastic bonding. Finally, magnets can be produced with isotropic or anisotropic magnetic properties, the latter being produced during manufacture by imparting an enhanced magnetic direction to the material using an external field.

Rare-earth magnets (RES) are extremely powerful. Made by a powder-metallurgy process using the rare-earth elements samarium or neodymium (neodure), they have a higher magnetic strength than ferroxdure but they are more expensive. Rare-earth magnets are used where high magnetic strength and small size are needed, as in micro-motors and miniature magnetic switches. Conventional motor designs are not always suited to rare-earth magnets because the iron parts can be easily saturated by the high flux density.

Plastic-bonded ferrite permanent magnets are made from magnetic powders mixed with bonding agents, using methods common in the plastics industry such as extrusion, pressing and injection-moulding. They can have elastic properties and can be made in complex shapes to fine tolerances without the need for machining.

However, their magnetic density is low compared with sintered ferroxdure. Nevertheless they are an inexpensive solution in applications where complex shapes or unusual magnetization patterns are more important than magnetic strength.

Anisotropic sintered ferrite permanent magnets (ferroxdure) are made using ceramics technology similar to that used for making porcelain. Strontium or barium ferrite powders are pressed and sintered. An external magnetic field is applied during the pressing to impart the enhanced magnetic direction to the grains. We then machine the products to the required shape. Ferroxdure magnets offer good magnetic properties at low cost and they are being used more and more in large-scale mass production. They are now used extensively, particularly in the automotive industry as rotors or stators in motors, and as loudspeaker rings.

TYPE DESCRIPTION

The type description of Permanent Magnets consists of 7 groups of data. These groups have fixed positions within the type description and are not separated from each other by a slash, a dash or another letter sign.

Because some groups are not mandatory for certain products or a dimension or weight is less than 3 positions long the through that arised open spaces have to be filled in with a "." (point).

There are two main product types:

- ferroxdure (sintered FXD anisotropic only, bonded FXD isotropic and anisotropic)
- rare earth (sintered anisotropic only).

The following procedure for type designation is used for all Permanent Magnets

Type designation

Type description

Group	A	B	C	D	E	F	G
Position	1	2-10	11	12-14	15	16-19	20

Group A

This group consists of a letter indicating the shape and, if applicable, directions of magnetic orientation c.q. magnetization (Table 1).

Table 1 Shape

PRODUCT TYPE	ABBREVIATION
Assembly	A
Blocks	B
Rings / Cylinders (rad./diam.)	C
Discs / Rods (axial)	D
Discs / Rods (diam.)	E
Plates (axial) with special circumference profile	P
Rings / Cylinders (axial)	R
Segments (rad./diam.)	S
Strip / Tape	T
Segments (axial)	V
Other shapes	X

Group B

GROUP B		
1	2	3
(...)	(...)	(...)

This group at position 2 till and including 10 of the type description must be used to indicate the dimensions. The total number of positions of 9 have to be divided into 3 groups of 3 positions. Dimensions with a value behind the decimal point must be round off according to the examples below.

Dimensions

DIMENSIONS	GROUP B1, B2 or B3
not applicable	...
0.1 - 0.4	..0
0.5 - 0.9	..1
1.1 - 1.4	..1
1.5 - 1.9	..2
12.4	.12
12.5	.13
999	999
>999	999

The dimensions, to fill in for group B1, B2 and B3, depend on the product type of group A (see Table 2). A survey with drawings is given at appendix 1.

Table 2 Dimensions

INDEX GROUP A	GROUP B1	GROUP B2	GROUP B3	EXAMPLE
B	a	b	c	B.40.21.10
C	d_o	d_i	h	C.15..4..8
D	d	-	h	D.12.....6
E	d	-	h	E.12.....3
P	a	b	c	P.13..3.13
R	d_o	d_i	h	R23.18.22
S	a	b	c	S.12..5.12 U-shape
S	d_o	d_i	l	S.44.33.47 Conc.Conv.
S	d_o	d_i	l	S999.31.54 Flat Conc.
S	d_o	d_i	l	S114999.25 Flat Conc.
T	a	b	c	T.13..3.40
V	d_o	d_i	l	V.44.20..4

Notes

a/l = length
b = width
c = thickness
d/d_o = outside diameter
d_i = inside diameter
h = height

Group C

Group C at position 11 indicates the Magnetic Material, used for the product, by a letter according to Table 3.

Table 3 Materials

MAGNETIC MATERIAL	ABBREVIATION
Ferroxdure	F
Plastoferrite P Materials	P
Rare Earth Materials	R
Plastoferrite SP Materials	S

Group D

Group D at position 12, 13 and 14 indicates the Quality of the Magnetic Material. Some examples are given in table 4.

Table 4 Quality

INDICATION IN GROUP C	INDICATION FOR QUALITY MATERIAL	INDICATION IN GROUP D
F	FXD 380	380
P	P40B	.40
R	RES 270	270
S	SP 170	170

Group E

In group E (position 15) the direction of magnetization is indicated. The letter code for group E can be found in chapter Magnetic Axis.

Group F

Group F (position 16, 17, 18 and 19) indicates the weight of the product in grammes. Weights below 10 gr with a digit behind the decimal point must be indicated by a digit, a "." (point) followed by maximal one decimal. Table 5 shows some examples.

Table 5 Weight

WEIGHT (gr)	INDICATION IN GROUP F
150	.150
9.7	.9.7
9	...9
0.6	.0.6
0.4	...0
0.05	.0.1
Unknown	....

Group G

In Group G (position 20) important specification items, if applicable, can be indicated by using a letter code. A survey of available letters is given in table 6. Only one item can be indicated (most important one).

Table 6 Special item

SPECIFICATION ITEM	INDICATION IN GROUP G
No important spec item	.
Aluminium coating	A
Epoxy coating	E
Marking	M
Special packing	P
Rumbling	R
Special shape	S

Appendix 1

Examples of coding dimensions within the type designation in group B

B1 / a
B2 / b
B3 / c

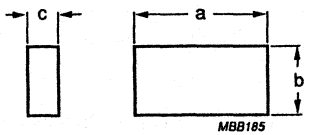


Fig.1 B Blocks.

B1 / d_o
B2 / d_i
B3 / h

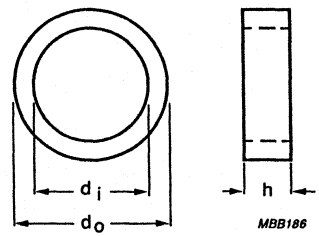


Fig.2 C Rings/Cylinders (rad/diam).

B1 / d_o
B2 / d_i
B3 / h

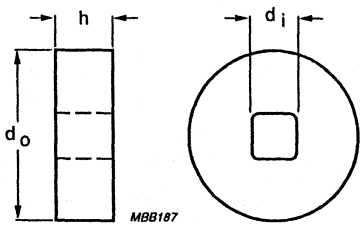


Fig.3 R Rings/Cylinders (axial).

B1 / d
B2 / –
B3 / h

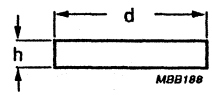


Fig.4 D Discs/Rods (axial).

B1 / d
B2 / –
B3 / h

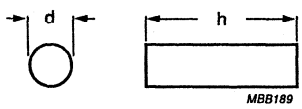


Fig.5 E Discs/Rods (diam).

B1 / a
B2 / b
B3 / c

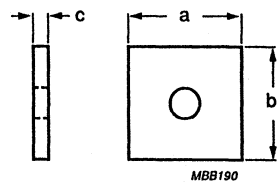
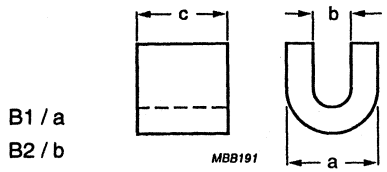
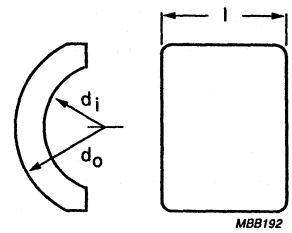


Fig.6 P Plates (axial).



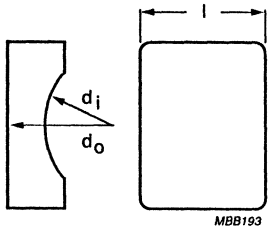
B1 / a
B2 / b
B3 / c

Fig.7 S Segment U-shape (rad/diam).



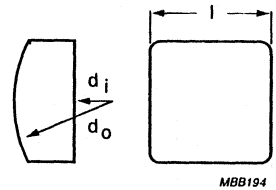
B1 / d_o
B2 / d_i
B3 / l

Fig.8 S Segment Concave-Convex (rad/diam).



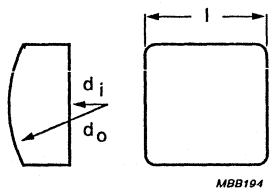
B1 / d_o
B2 / d_i
B3 / l

Fig.9 S Segment Flat-Concave (rad/diam).



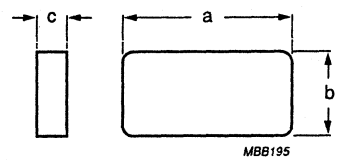
B1 / d_o
B2 / d_i
B3 / l

Fig.10 S Segment Flat-Convex (rad/diam).



B1 / d_o
B2 / d_i
B3 / l

Fig.11 V Segment axial (see S).



B1 / a
B2 / b
B3 / c

Fig.12 T Strip/Tape.

Survey of materials

SURVEY OF PERMANENT MAGNET MATERIALS

There is a wide range of electrical and mechanical requirements encountered in magnetic systems, and no one material exists that satisfies all of them. However, it is usually possible to find a suitable material within our range. Selection will be based on magnetic and mechanical considerations, magnetic configuration and the cost effectiveness of the resulting system (not necessarily the same as magnet cost).

The family tree shows our range of permanent magnet materials.

Units

In the following tables the main properties of the various materials are given in SI and c.g.s units. More detailed information is to be found in the relative data pages further down the book.

Typical values

The term typical values ("typ.") denotes a value which frequently occurs. Typical values enable the user to compare various grades; they are intended to be average or mean values.

Minimum values

The minimum values quoted are guaranteed for specified test pieces.

Minimum values of B_r and H_{cB} do not occur simultaneously. The minimum value of B_r coincides with an H_{cB} well above the quoted typical value, whereas the minimum value of H_{cB} is coupled with a high value of B_r.

Material designation

The material designation consists of the name of the material:

- FXD (Ferroxdure)
- RES (Rare Earth alloys)

followed by a type classification. Plastic bonded Ferroxdure grades include a letter for the bonding material:

P = flexible thermoplastic

SP = rigid thermoplastic

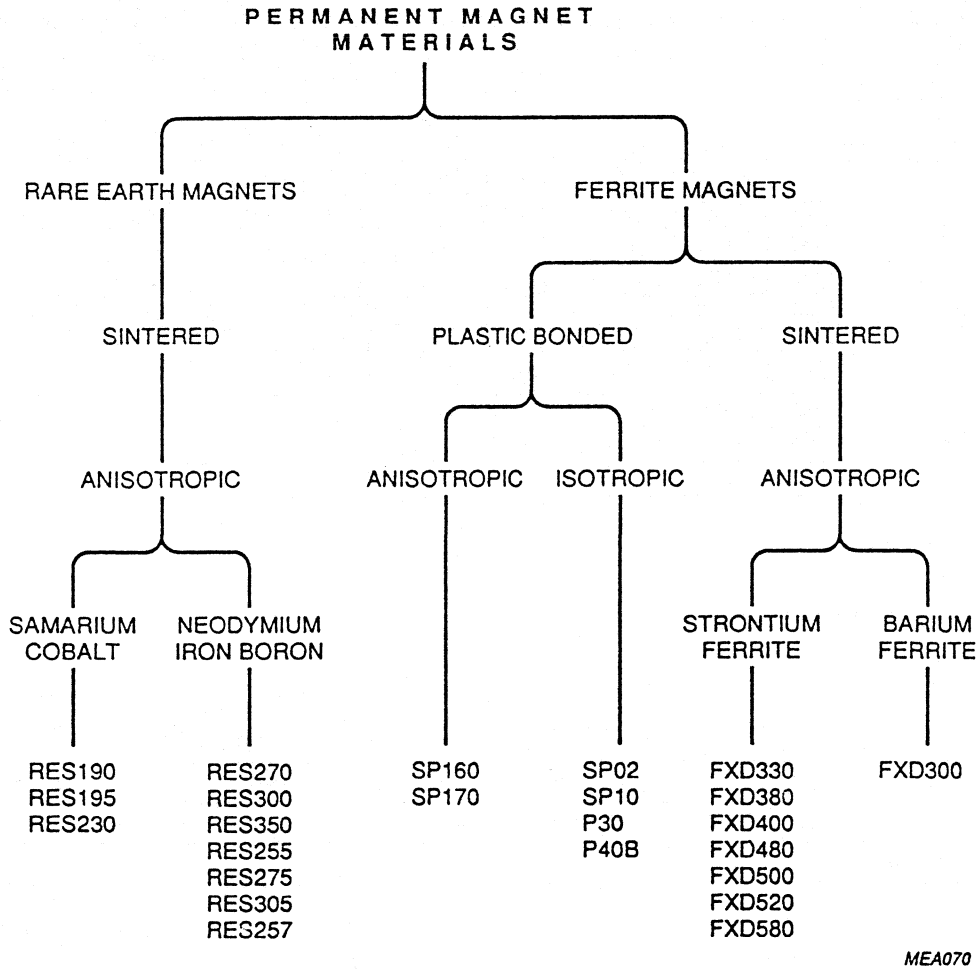


Fig.1 Survey of permanent magnet materials.

Permanent Magnets Survey of Materials

S.I.

MATERIAL DESIGNATION	REMANENCE		COERCIVITY		POLARIZATION COERCIVITY		MAX. BH PRODUCT		$B_r \times H_{cJ}$	
	B_r (mT)		H_{cB} (kA/m)		H_{cJ} (kA/m)		$(BH)_{max}$ (kJ/m³)		(kJ/m³)	
	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.
RARE - EARTH (sintered)										
ANISOTROPIC										
RES190	870	890	620	670	1100	1200	144	154	-	-
RES195	870	890	650	675	1400	1600	144	154	-	-
RES230 (note) 1	950	1000	550	650	650	750	160	185	-	-
RES270	1050	1100	700	750	750	1000	-	215	-	-
RES300 (note) 2	1100	1150	750	800	750	1000	-	240	-	-
RES350 (note) 2	1150	1200	800	850	750	1000	-	280	-	-
RES255	1000	1050	700	750	1200	1500	-	200	-	-
RES275 (note) 2	1050	1100	750	800	1200	1500	-	215	-	-
RES305 (note) 2	1100	1150	800	850	1200	1500	-	240	-	-
RES257	950	1000	700	750	1800	1900	-	188	-	-

Notes

1. Tentative data.
2. Special pressing process.

S.I.

MATERIAL DESIGNATION	REMANENCE		COERCIVITY		POLARIZATION COERCIVITY		MAX. BH PRODUCT		$B_r \times H_{cJ}$	
	B_r (mT)		H_{cB} (kA/m)		H_{cJ} (kA/m)		$(BH)_{max}$ (kJ/m³)		(kJ/m³)	
	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.
FERROXDURE (plastic bonded)										
ISOTROPIC										
FXD SP02	9	10	7	8	-	130	-	0.02	-	-
FXD SP10	75	80	54	58	-	190	0.8	0.9	-	-
FXD P30	115	125	84	88	-	190	2.4	2.8	-	-
FXD P40B	135	145	88	96	-	190	3.2	3.6	-	-
ANISOTROPIC										
FXD SP160	235	245	160	180	-	260	11	12	-	-
FXD SP170	260	270	185	190	-	220	13	14	-	-

Permanent Magnets Survey of Materials

S.I.

MATERIAL DESIGNATION	REMANENCE		COERCIVITY		POLARIZATION COERCIVITY		MAX. BH PRODUCT		$B_r \times H_{cJ}$	
	B_r (mT)		H_{cB} (kA/m)		H_{cJ} (kA/m)		$(BH)_{max}$ (kJ/m³)		(kJ/m³)	
	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.
FERROXDURE (sintered)										
ANISOTROPIC										
FXD330	360	370	230	245	240	255	24.1	25.5	86	94
FXD380	380	390	250	265	260	275	26.9	28.2	99	107
FXD480	370	380	270	280	305	320	25.5	26.8	113	122
FXD580	375	385	290	300	350	360	26.2	27.6	131	139
FXD300	390	400	145	160	150	165	28.0	29.5	59	66
FXD400	400	410	250	265	260	275	29.8	31.3	104	113
FXD500 (note) 1	390	400	285	295	320	330	29.8	30.5	124	130
FXD520	420	425	240	250	250	260	32.8	33.6	105	111

Note

1. Tentative data

c.g.s.

MATERIAL DESIGNATION	REMANENCE		COERCIVITY		POLARIZATION COERCIVITY		MAX. BH PRODUCT		$B_r \times H_{cJ}$	
	B_r (Gs)		H_{cB} (Oe)		H_{cJ} (Oe)		$(BH)_{max}$ (MGsOe)		(MGsOe)	
	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.
RARE - EARTH (sintered)										
ANISOTROPIC										
RES190	8700	8900	7790	8420	13820	15080	18.1	19.4	-	-
RES195	8700	8900	8170	8480	17590	20105	18.1	19.4	-	-
RES230 (note) 1	9500	10000	6910	8170	8170	9425	20.1	23.2	-	-
RES270	10500	11000	8795	9425	9425	12565	-	27.0	-	-
RES300 (note) 2	11000	11500	9425	10055	9425	12565	-	30.2	-	-
RES350 (note) 2	11500	12000	10055	10680	9425	12565	-	35.2	-	-
RES255	10000	10500	8800	9425	15080	18850	-	25.1	-	-
RES275 (note) 2	10500	11000	9425	10055	15080	18850	-	27.0	-	-
RES305 (note) 2	11000	11500	10055	10680	15080	18850	-	30.2	-	-
RES257	9500	10000	8800	9425	22620	23875	-	23.6	-	-

Notes

1. Tentative data.
2. Special pressing process.

c.g.s.

MATERIAL DESIGNATION	REMANENCE		COERCIVITY		POLARIZATION COERCIVITY		MAX. BH PRODUCT		$B_r \times H_{cJ}$	
	B_r (Gs)		H_{cB} (Oe)		H_{cJ} (Oe)		$(BH)_{max}$ (MGsOe)		(MGsOe)	
	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.
FERROXDURE (plastic bonded)										
ISOTROPIC										
FXD SP02	90	100	-	-	-	-	-	-	-	-
FXD SP10	750	800	679	729	-	2390	0.10	0.11	-	-
FXD P30	1150	1250	1050	1110	-	2390	0.30	0.35	-	-
FXD P40B	1350	1450	1110	1210	-	2390	0.40	0.45	-	-
ANISOTROPIC										
FXD SP160	2350	2450	2010	2260	-	3270	1.4	1.5	-	-
FXD SP170	2600	2700	2360	2460	-	3270	1.6	1.8	-	-

c.g.s.

MATERIAL DESIGNATION	REMANENCE		COERCIVITY		POLARIZATION COERCIVITY		MAX. BH PRODUCT		$B_r \times H_{cJ}$	
	B_r (Gs)		H_{cB} (Oe)		H_{cJ} (Oe)		$(BH)_{max}$ (MGsOe)		(MGsOe)	
	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.
FERROXDURE (sintered)										
ANISOTROPIC										
FXD330	3600	3700	2900	3100	3000	3200	3.0	3.2	10.8	11.8
FXD380	3800	3900	3100	3300	3300	3500	3.4	3.6	12.4	13.4
FXD480	3700	3800	3400	3500	3800	4000	3.2	3.4	14.2	15.3
FXD580	3750	3850	3640	3770	4400	4520	3.3	3.5	16.5	17.5
FXD300	3900	4000	1800	2000	1850	2050	3.5	3.7	7.4	8.3
FXD400	4000	4100	3100	3300	3300	3500	3.7	3.9	13.1	14.2
FXD500 (note) 1	3900	4000	3600	3700	4020	4150	3.7	3.8	15.6	16.3
FXD520	4200	4250	3000	3100	3100	3300	4.1	4.2	13.0	13.9

Note

1. Tentative data

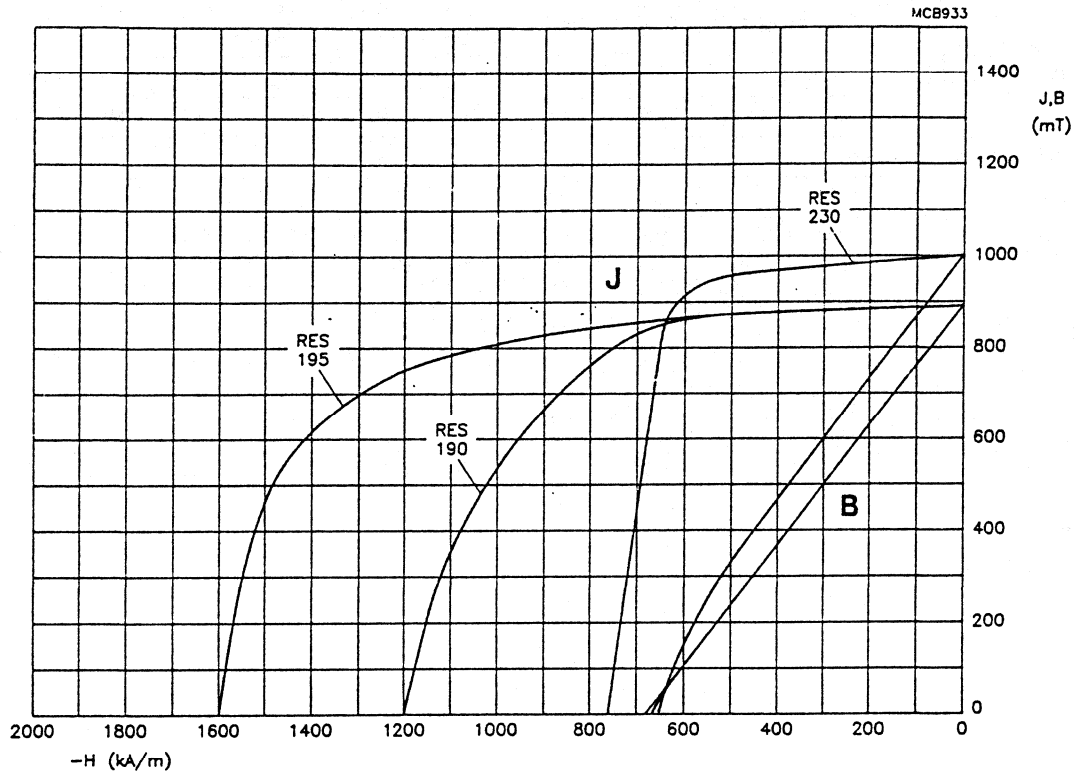


Fig.2 Typical demagnetization curves, Samarium Cobalt grades.

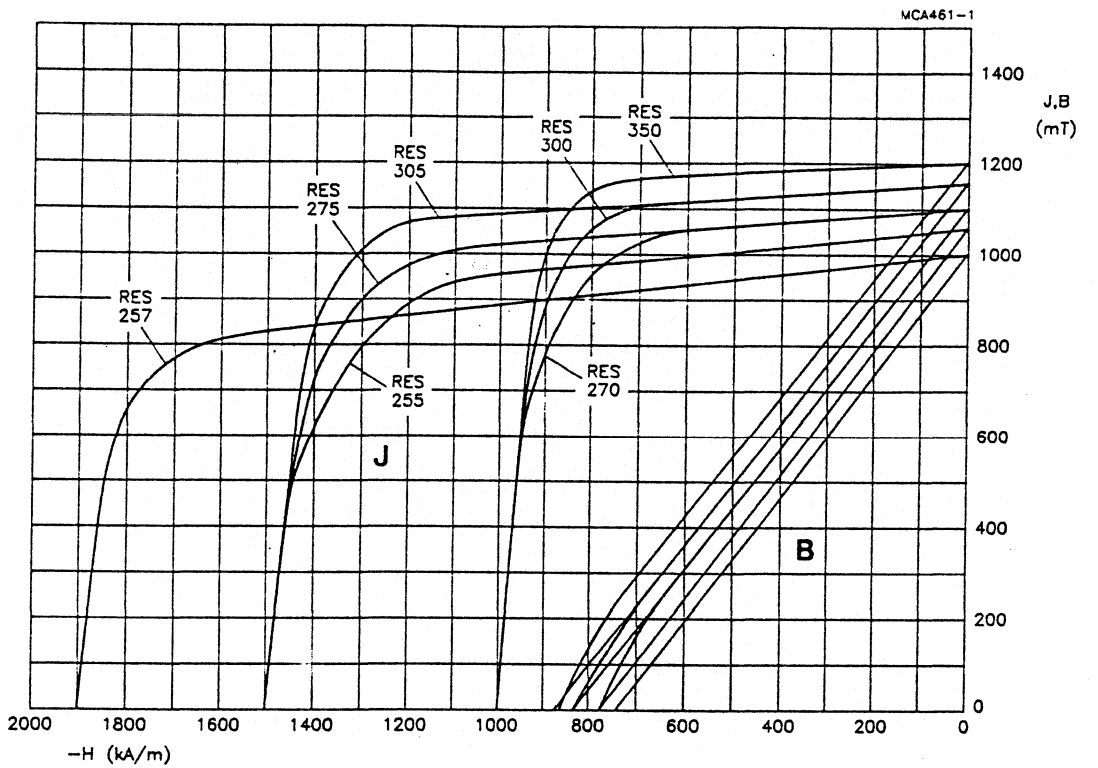


Fig.3 Typical demagnetization curves, Neodure grades.

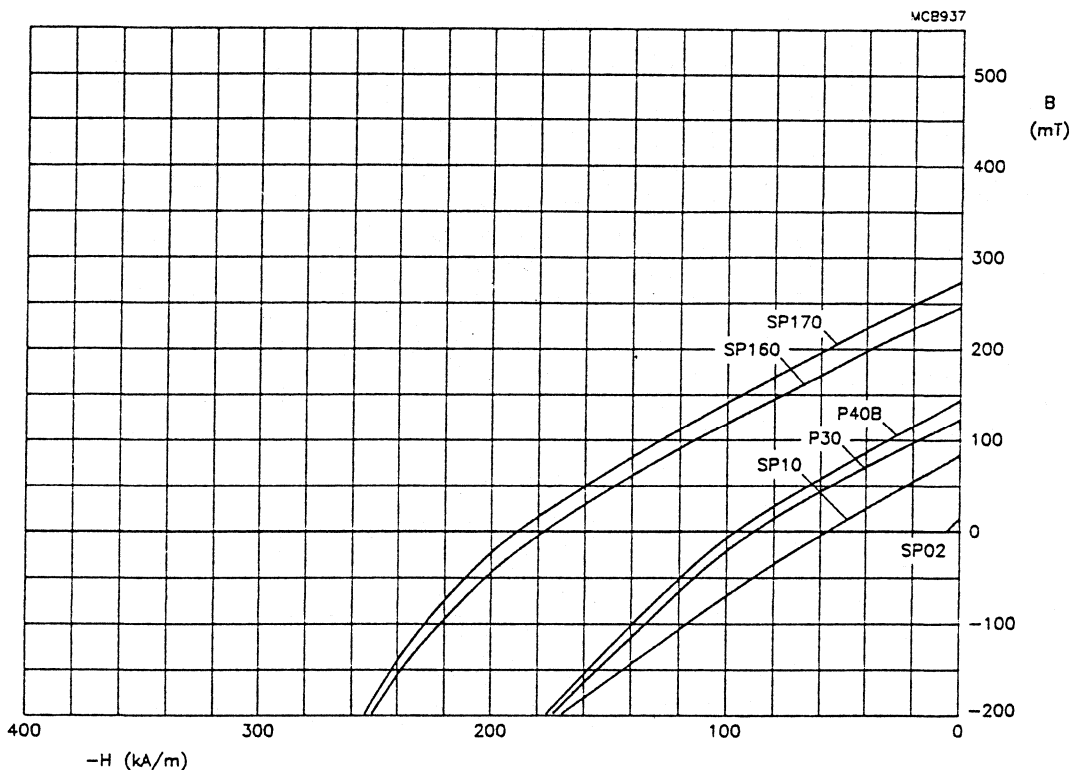


Fig.4 Typical demagnetization curves, Plastic-bonded ferroxdure.

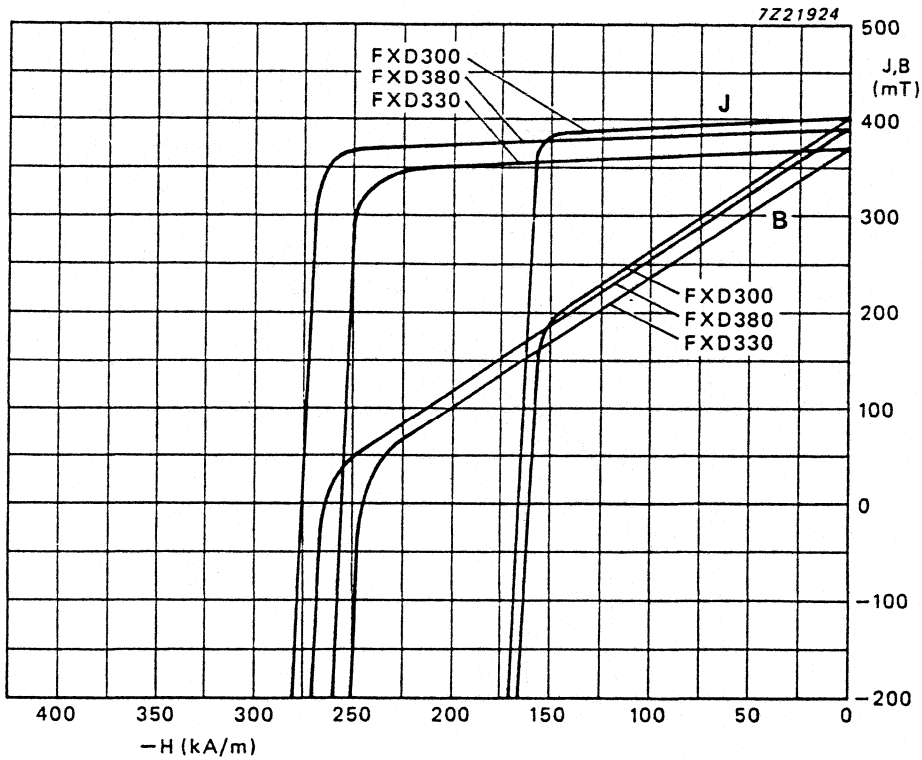


Fig.5 Typical demagnetization curves, Ferroxdure 300 series.

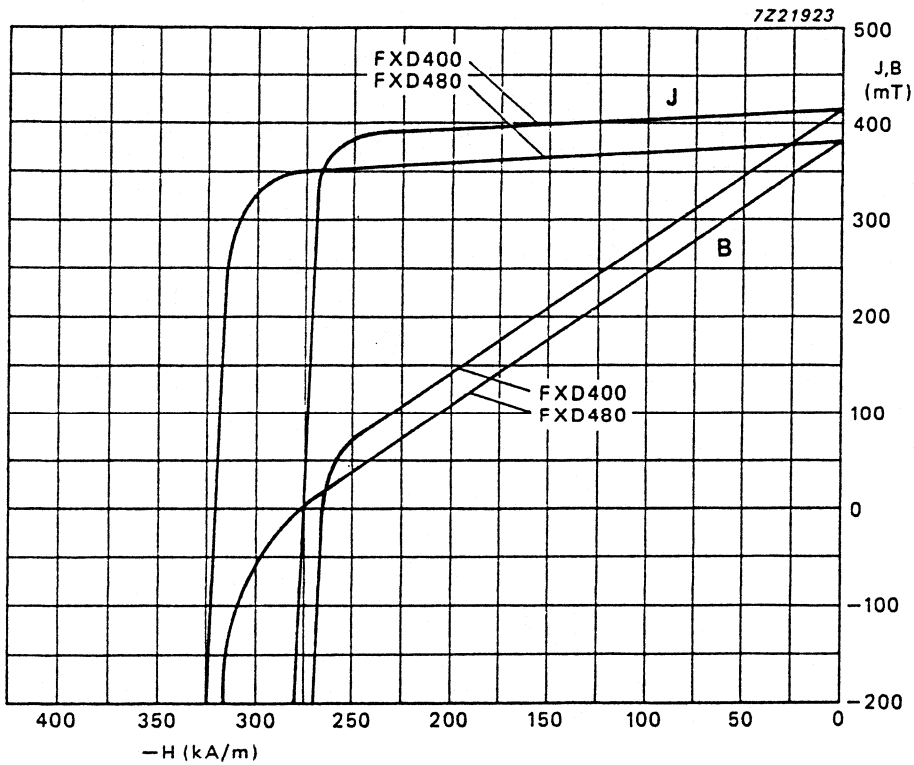


Fig.6 Typical demagnetization curves, Ferroxdure 400 series.

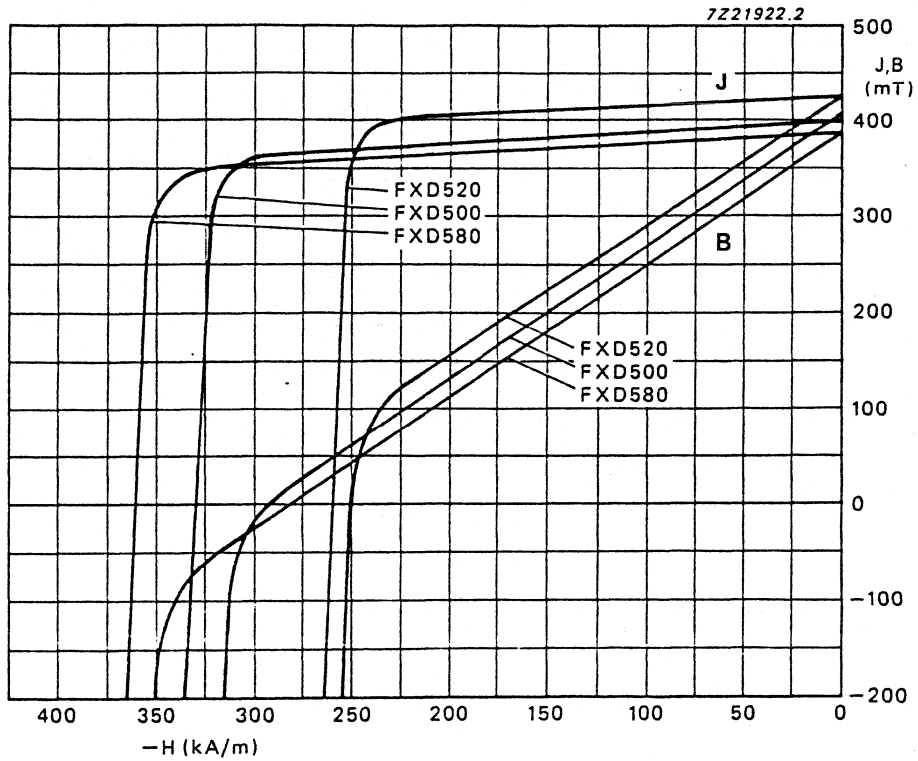


Fig.7 Typical demagnetization curves, Ferroxdure 500 series.

Magnetization

RECOMMENDATIONS FOR MAGNETIZATION AND DEMAGNETIZATION

Magnets are usually supplied unmagnetized, and are magnetized by the user during system assembly. This simplifies handling and manufacture considerably.

Most magnets can, however, be premagnetized, but this may result in some loss, the extent depending upon the relative recoil permeability of the material. This should be determined at the working point (i.e. the point on the hysteresis loop) corresponding to the highest demagnetizing field experienced by the magnet before assembly. For a magnet working under open-circuit conditions, the area in the middle of the pole-faces normally experiences a higher demagnetizing effect than the periphery. The working point under these conditions is determined by the size and shape of the magnet. In computing these losses, the minimum values for the characteristics at the lowest storage temperature should be assumed. For most currently used shapes, the expected losses (computed values) are available.

Note: some Ferroxdure and rare-earth cobalt materials have relative recoil permeabilities close to unity through a substantial part of the second quadrant of their hysteresis characteristics. Such materials show little loss when premagnetized.

Magnetization

A magnet is magnetized instantaneously by exposing it to an external unidirectional field, produced by a permanent magnet or, more usually, by a direct current (or pulsed current) flowing though a coil. The magnetizing field must not be less than the saturation field H_{sat} for the material, otherwise the full properties will not be obtained.

In some systems the requirement is not clear, for example the magnet may be shielded by other magnetic materials which then must also be saturated. In practice the magnetizing field should be increased until no further increase in magnet flux can be measured. For magnetizers using steel poles, saturation of the equipment could occur before the magnets are fully saturated. An alternative can be to use ironless coils correctly positioned. Advice where required should be sought.

The required magnetizing current can be obtained from many alternative DC sources. Apart from obtaining the correct magnetizing field strength, the choice will depend on possible size of coil, temperature rise of conductors, repetition rate and other production circumstances. Where heat dissipation can be a problem with small coils, pulsed currents derived from discharging capacitors or other current sources is a solution. There are suppliers of power supplies for magnetizing equipment.

After magnetizing it is possible to equalize the performance of magnetic systems by partial demagnetization of the magnets. This can be done by applying an increasing DC field in the reverse direction until the magnetization falls to the required level, the field preferably being controlled by some means with the facility to measure the instantaneous magnetic flux density.

Demagnetization

Modern magnetic materials have a high resistance to demagnetization, and complete demagnetization is usually difficult if not impossible. Sintered Ferroxdure magnets are best demagnetized by heating them above their Curie point (about 450 °C). Bonded or metal magnets need a magnetic field to demagnetize them, usually a gradually diminishing AC field whose initial value is great enough to force the magnet through its hysteresis cycle. For larger magnets, complete demagnetization is usually impossible.

Magnetic axis

Permanent Magnets Magnetic Axis

SPECIFYING THE MAGNETIC AXIS AND DIRECTION OF MAGNETIZATION

Drawing symbols and terminology

It is recommended that the magnetic axis, or the direction of magnetization be indicated on drawings by means of the following symbols:

For the magnetic axis, or the preferred direction of magnetization in unmagnetized anisotropic magnets: the symbol ← – MA – →.

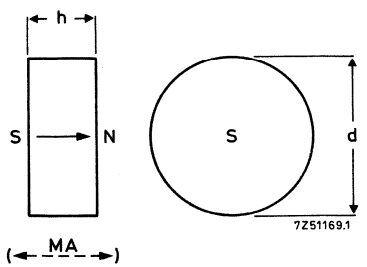
For the direction of magnetization in magnetized magnets: the symbol S → N.

The recommended method of showing the magnetic axis or the direction(s) of magnetization is shown in the following examples:

For unmagnetized magnets: the symbol U.

Orientation of unmagnetized anisotropic magnets can be indicated by the prefix U, e.g.: orientation UB.

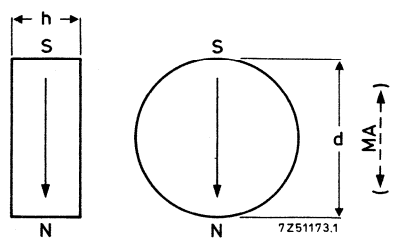
Magnetization for isotropic and anisotropic magnets



A

Also to be used for rings and cylinders.

Fig.1 Axial.

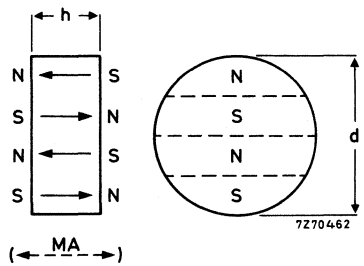


B

Also to be used for rings and cylinders.

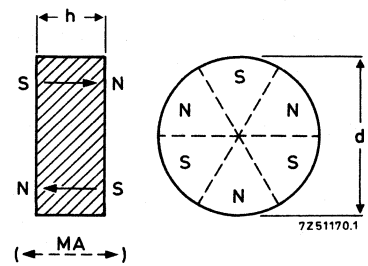
Fig.2 Diametrical.

Magnetization for isotropic and anisotropic magnets



C

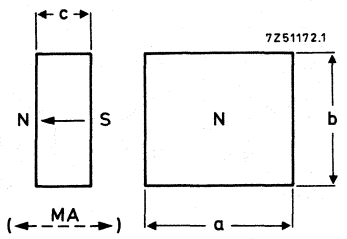
Fig.3 Axial, n-poles, neutral zones parallel (in this example n = 4).



D

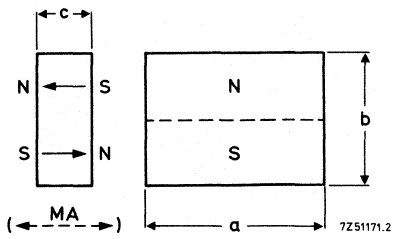
Fig.4 Axial, n-poles, neutral zones radial (in this example n = 6).

Magnetization for isotropic and anisotropic magnets



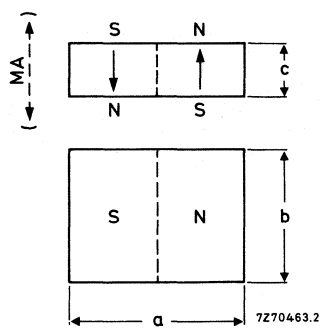
E

Fig.5 Perpendicular to a x b.



F

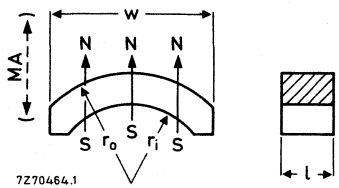
Fig.6 Perpendicular to a x b, n-poles, neutral zone parallel to side a (in this example n = 2).



G

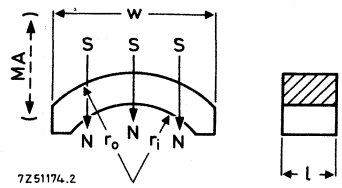
Fig.7 Perpendicular to a x b, n-poles, neutral zone parallel to side b (in this example n = 2).

Magnetization for isotropic and anisotropic magnets



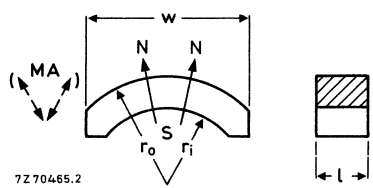
H

Fig.8 Parallel (also called diametrical), S-pole inside.



J

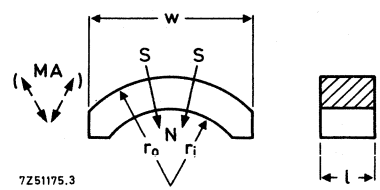
Fig.9 Parallel (also called diametrical), N-pole inside.



K

Multipole magnetization on both sides is possible, to be specified by user.

Fig.10 Radial, S-pole inside.

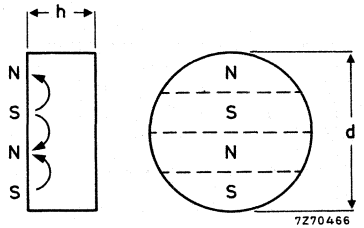


L

Multipole magnetization on both sides is possible, to be specified by user.

Fig.11 Radial, N-pole inside.

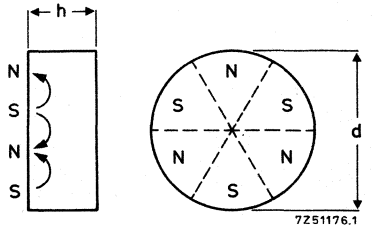
Magnetization for isotropic magnets only



M

Magnetization can also be applied to both faces. When magnetization is required with an odd number of poles the polarity of the centre pole should be specified (eg: N, S, or "don't care").

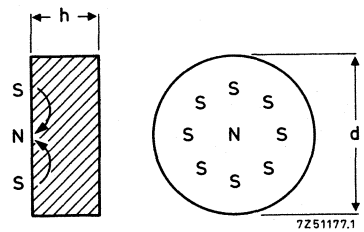
Fig.12 Lateral, n parallel poles on one face only, (in this example n = 4).



N

Magnetization can also be applied to both faces.

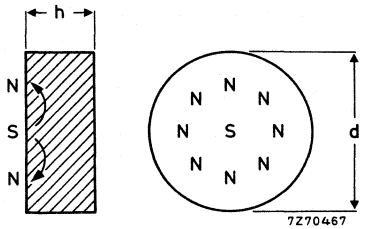
Fig.13 Lateral, n-pole sectors on one face only, (in this example n = 6).



O

Magnetization can also be applied to both faces.

Fig.14 Lateral, 2-poles on one face only, centred N-pole with concentric S-pole.

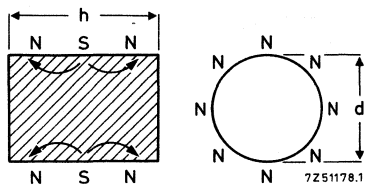


P

Magnetization can also be applied to both faces.

Fig.15 Lateral, 2-poles on one face only, centred S-pole with concentric N-pole.

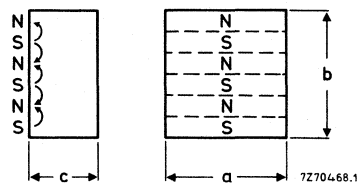
Magnetization for isotropic magnets only



Q

When magnetization is required with an odd number of poles the polarity of the centre pole should be specified (eg: N, S, or "don't care").

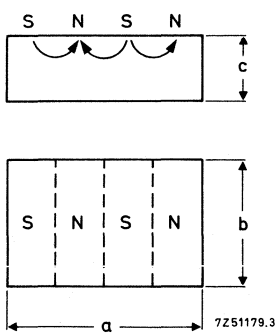
Fig.16 Lateral, n annular poles (in this example n = 3).



R

Magnetization can also be applied to both faces. When magnetization is required with an odd number of poles the polarity of the centre pole should be specified (eg: N, S, or "don't care").

Fig.17 Lateral, n-poles on one a x b face, poles parallel to side a (in this example n = 6).

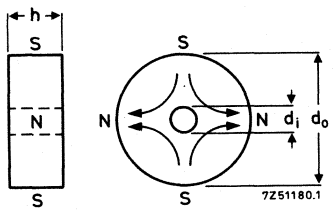


S

Magnetization can also be applied to both faces. When magnetization is required with an odd number of poles the polarity of the centre pole should be specified (eg: N, S, or "don't care").

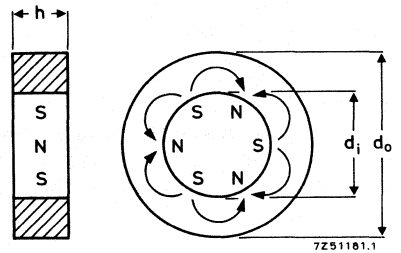
Fig.18 Lateral, n-poles on one a x b face, poles parallel to side b (in this example n = 4).

Magnetization for isotropic magnets only



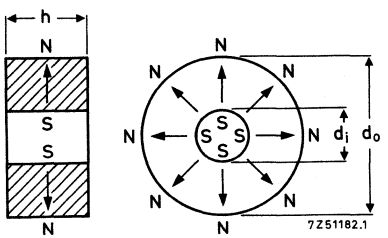
T

Fig.19 Lateral, n-poles on outer circumference, neutral zones axial (in this example n = 4).



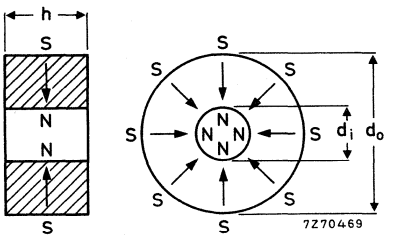
W

Fig.20 Lateral, n-poles on inner circumference, neutral zones axial (in this example n = 6).



X

Fig.21 Radial, S-pole inside.



Y

Fig.22 Radial, N-pole inside.

Marking of permanent magnets

If it is required to identify magnetized magnets of the same outline but with different directions of magnetization, a colour code is recommended.

The poles can then marked by spots of paint or some other identification mark,

either:	South pole yellow
or:	North pole red
or:	neutral zone white.

If it is necessary to indicate the position of poles more accurately than may be obtained by spots of paint, another method, e.g. grooves, may be used.
The method of marking, if required, should be shown on the magnet drawing.

Conversion of units

CONVERSION OF UNITS

SI units →	c.g.s. units
1 T = 1 Wb/m^2 = 1 Vs/m^2	= 10^4 Gs = 10 kGs
1 mT	= 10 Gs
1 A/m	= $4\pi \times 10^{-3}$ Oe = 0.01257 Oe
1 kA/m	= 4π Oe = 12.57 Oe
1 Wb = 1 Vs = 1 Tm^2	= 10^8 Mx
1 μWb	= 100 Mx
$\mu_o = 4\pi \times 10^{-7}$ H/m = 1.257 mTm/kA	μ_o can be replaced by 1 Gs/Oe
1 H/m = 1 Vs/Am	
1 J/m^3 = 1 TA/m	= 4π x 10 GsOe = 125.7 GsOe
1 kJ/m^3 = 1 mJ/cm^3	= $4\pi \times 10^{-2}$ MGsOe = 0.1257 MGsOe
1 J = Ws = 1 Nm	= 10^7 erg
1 N = 1 kgm/s^2 = 0.1019 kilogramme-force	= 10^5 dynes
SI units ←	**c.g.s. units**
10^{-4} = 0.1 mT	= 1 Gs (gauss)
0.1 T = 100 mT	= 1 kGs
$10^3/(4\pi)$ A/m = $1/(4\pi)$ kA/m = 0.07958 kA/m	= 1 Oe (oersted)
0.01 μWb	= 1 Mx (maxwell)
10 μWb	= 1000 Mx
$10^2/(4\pi)$ mJ/m^3 = 7.958 mJ/m^3	= 1 GsOe
$10^2/(4\pi)$ mJ/m^3 = 7.958 mJ/m^3	= 1 MGsOe
10^{-7} J	= 1 erg
Energy in the field external to the magnetic material, per unit volume of the permanent magnet. SI system: BH/2	Energy in the field external to the magnetic material, per unit volume of the permanent magnet. c.g.s. system: $BH/8\pi$

Quality

QUALITY

Permanent magnets are produced to meet constantly high quality standards. High quality in mass production requires advanced production techniques as well as background knowledge of the product itself.

1. Quality policy

Our policy is:

- to meet in full the requirements of our customers,
- to continuously improve all operations,
- to maintain a Quality Assurance System in accordance with ISO9001,
- to build in product quality by process control,
- to maintain a high level of quality awareness amongst all personnel.

2. Product quality

For each product, specification agreements are defined in a Quality Description Sheet (Q.D.S.) outlining clearly the drawing specifications, control methods, control plan and quality assurance.
These Q.D.S. should be agreed between customer and the supplier.
The quality of our permanent magnets is guaranteed either on a PPM defect level or an AQL limit for parameters as specified in the Q.D.S.
When AQL limits are applied in conformity with MIL-STD 105D, following values are laid down, unless otherwise specified.

ATTRIBUTES	AQL	INSPECTION LEVEL
Visual	0.65%	II
Dimensions	0.65%	II
Magnetic values	0.65%	II

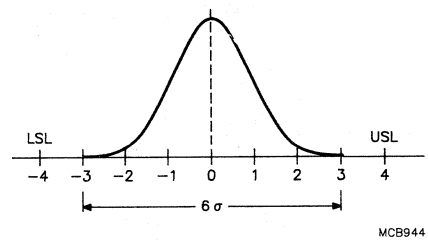
For the attributes, reference is made to the magnet specifications concerned.
When the PPM defect level is specified in the Q.D.S.,it is in correlation with a capability index, result of a SPC procedure applied at the final step of the manufacturing process.

3. Quality by process capability and control

In terms of product quality our aim is to deliver products manufactured from processes which are capable and in control.

Capability

The matching of process capability with customer requirements is fundamental to the achievement of low defect rates. This obviously requires an open supplier - customer relationship. The program of continuous improvement ensures that process capability are suitable for the demands of the market. Process capability is measured by comparing the process spread with the specified tolerances and expressed as an index, Cp.



$$Cp = \frac{\text{total tolerance}}{6\sigma} = \frac{USL-LSL}{6\sigma}$$

Fig.1 Process spread.

Process and specification are not considered compatible unless a Cp of 1.33 or greater is achievable, i.e. 8 standard deviations can be contained within the specified tolerances.

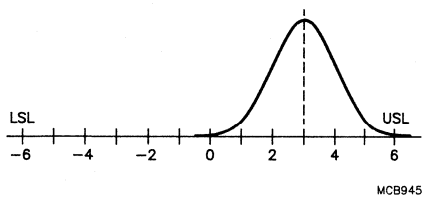
Cp of 1.33 is the minimum target for supplier and customer to pursue if low defect rates are to be achieved.

Specification agreements are defined in Quality Description Sheets unique to a product type and outlining clearly the specifications and control methods.

Control

Processes must not only be capable but also controlled. Only by focussing on defect prevention can effective control be achieved. Defect prevention methods including Statistical Process Control and Failure Mode Effect Analysis.

The effectiveness of control by prevention is measured by comparing both the process spread and mean with the specified tolerances and expressed as an index, Cpk.



$$Cpk = minimum\ of \frac{USL - \bar{X}}{3\sigma} \text{ or } \frac{\bar{X} - LSL}{3\sigma}$$

Fig.2 Process spread.

For processes proven capable, control is not considered to be successful in defect prevention unless a Cpk of 1.00 or greater is achieved.

Cpk of 1.00 = 1350 defects per million

Again the continuous improvement policy plays a role by driving defect rates down with the ultimate goal of zero.

4. Control methods

MAGNET INSPECTION

Full determination of the magnetic properties of each magnet is too expensive for mass production inspection. It has therefore, become normal practice to perform comparison tests against a "minimum standard magnet", copies of which are supplied on request. The control plan, detailed in the Q.D.S. gives the inspection frequencies.

The minimum standard magnet may have either:

- minimum remanence (B_r), a "minimum flux standard", or
- minimum coercivity (H_{cB}), a "minimum coercivity standard.

These magnets will have the following dimensions:

- Blocs, segments and axially magnetized cylinders, discs and rings:
  Perpendicular to M.A.: bottom line dimensions.
  Parallel to M.A.: midlimit (nominal) dimensions.
- Diametrically magnetized cylinders and discs:
  bottom limit diameter and height.
- Diametrically magnetized rings:
  bottom limit diameters, wall thickness and height.

VISUAL INSPECTION

The visual standards required are set by means of sketches in a visual aspect specification, which is detailed in each Q.D.S. It gives the acceptable limits of visual defects in accordance with the fitness for use of the application.

Material Specification Sintered Rare-Earth

RES 190, SAMARIUM COBALT MATERIAL ($SmCo_5$)

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 25 mm x 5 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	870	890	mT	8700	8900	Gs
H_{cB}	Coercivity	620	670	kA/m	7790	8420	Oe
H_{cJ}	Polarization coercivity	1100	1200	kA/m	13820	15080	Oe
$(BH)_{max}$	Maximum BH product	144	154	kJ/m^3	18.1	19.4	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	440	mT	-	4400	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	350	kA/m	-	4400	Oe
μ_{rec}	Recoil permeability	-	1.05	-	-	1.05	-
-	Temperature coefficient of B_r (–60 to +180 °C)	-	–0.05	%/K	-	–0.05	%/°C
-	Temperature coefficient of H_{cJ} (20 to 150 °C)	-	–0.3	%/K	-	–0.3	%/°C
H_{sat}	Recommended initial magnetizing field static	1800	-	kA/m	22600	-	Oe
ρ	Resistivity	-	5×10^{-7}	Ωm	-	5×10^{-5}	Ωcm
-	Curie point	-	720	°C	-	720	°C

RES 190, Physical properties

PARAMETER	VALUE
Maximum continuous operating temperature	250 °C
Density	8.3×10^3 kg/m³ (8.3 g/cm³)
Hardness (Vickers)	500
Young's modulus	1.5×10^5 N/mm²
Coefficient of linear expansion parallel to magnetic axis normal to magnetic axis	 6×10^{-6}/K 12×10^{-6}/K
Thermal conductivity	10 W/mK
Bending strength	120 N/mm²
Compressive strength	900 N/mm²

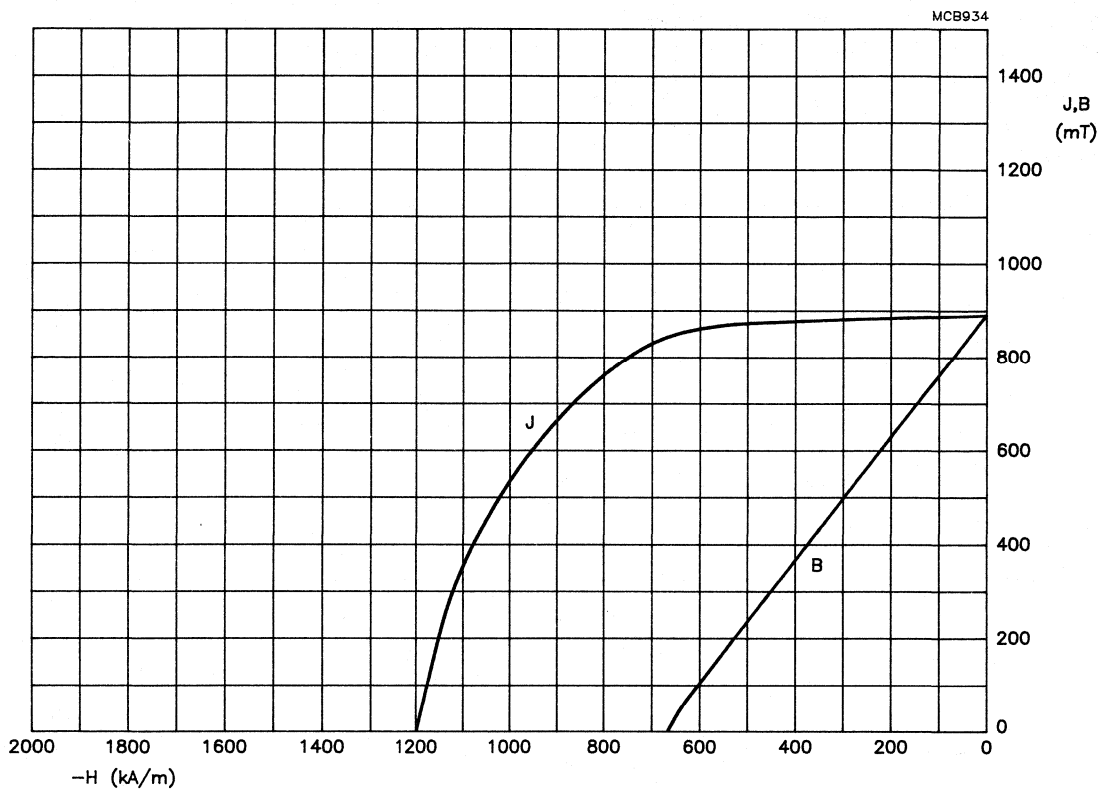


Fig.1 Typical demagnetization curve (20 °C) for RES 190.

Magnetization

The figures quoted for minimum magnetizing field strength relate to magnets that have not been magnetized after the final production heat treatment. Subsequent magnetizing operations require much stronger fields than used in the initial magnetization (up to three times as strong). The next two figures (2 and 3) show the effect of an increasing magnetic field on the properties of a magnet.

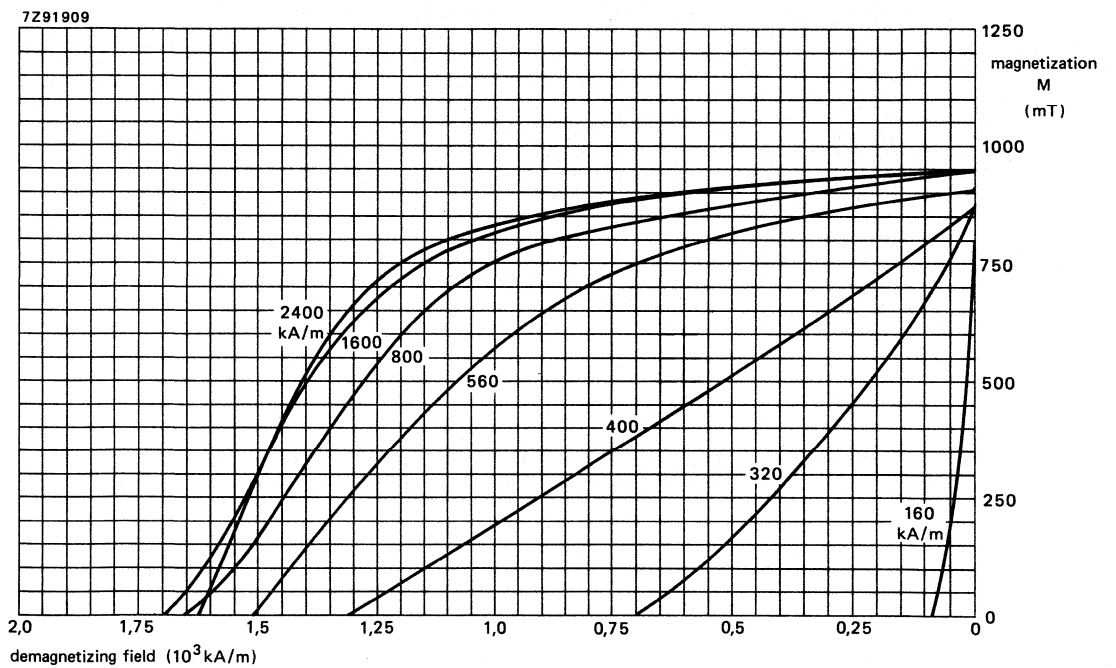


Fig.2 Thermally demagnetized RES 190 magnets; dependence of coercivity on initial magnetizing field.

Material Specification Sintered Rare-Earth

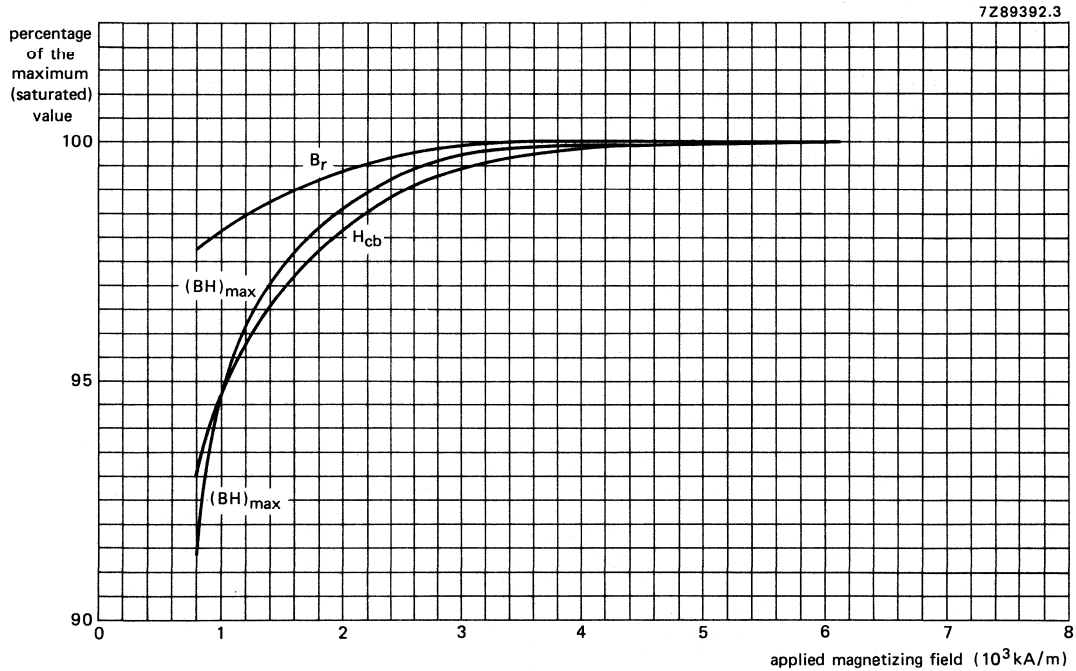


Fig.3 B_r,H_{cB} and $(BH)_{max}$ as a percentage of the maximum obtained (saturated) value as a function of magnetizing field strength. Values are typical for a RES 190 magnet not previously magnetized.

Effect of temperature on magnetic properties

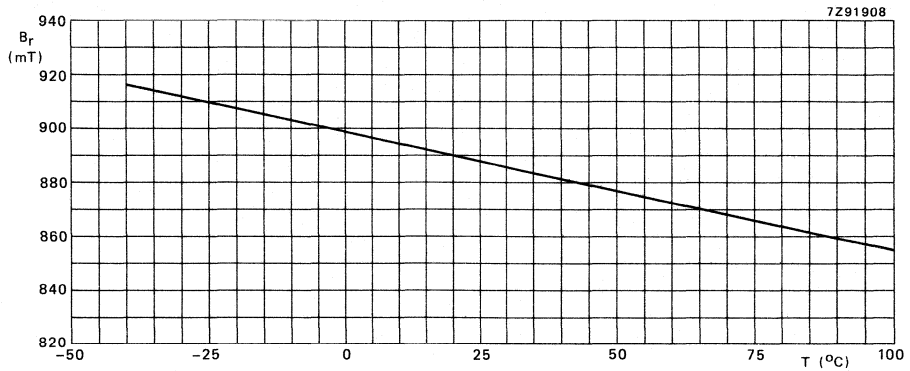


Fig.4 Typical reversible losses for RES 190. B_r as a function of temperature.

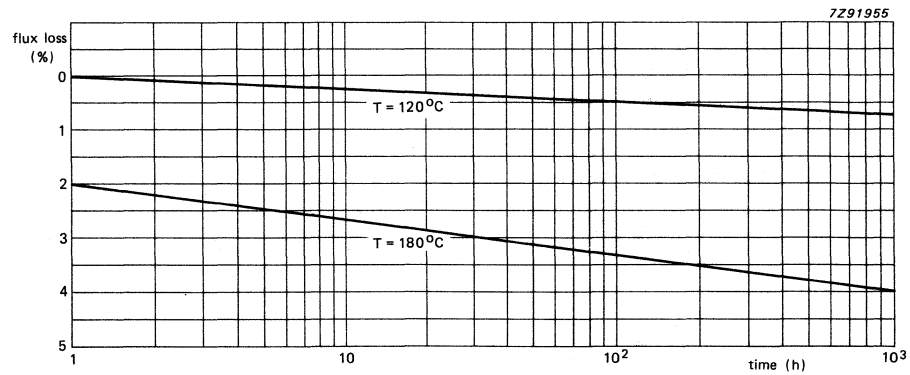


Fig.5 Irreversible flux losses measured on a disc sample with $B/\mu_o H = 1.5$ for RES 190.

Material Specification — Sintered Rare-Earth

RES 195, SAMARIUM COBALT MATERIAL ($SmCo_5$)

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 25 mm x 5 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C, unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	870	890	mT	8700	8900	Gs
H_{cB}	Coercivity	650	675	kA/m	8170	8480	Oe
H_{cJ}	Polarization coercivity	1400	1600	kA/m	17590	20105	Oe
$(BH)_{max}$	Maximum BH product	144	154	kJ/m^3	18.1	19.4	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	-	mT	-	-	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	-	kA/m	-	-	Oe
μ_{rec}	Recoil permeability	-	1.05	-	-	1.05	-
-	Temperature coefficient of B_r (–60 to +180 °C)	-	–0.05	%/K	-	–0.05	%/°C
-	Temperature coefficient of H_{cJ} (20 to 150 °C)	-	–0.3	%/K	-	–0.3	%/°C
H_{sat}	Recommended initial magnetizing field static	1800	-	kA/m	22600	-	Oe
ρ	Resistivity	-	5×10^{-7}	Ωm	-	5×10^{-5}	Ωcm
-	Curie point	-	720	°C	-	720	°C

RES 195, Physical properties

PARAMETER	VALUE
Maximum continuous operating temperature	250 °C
Density	8.3×10^3 kg/m³ (8.3 g/cm³)
Hardness (Vickers)	500
Young's modulus	1.5×10^5 N/mm²
Coefficient of linear expansion parallel to magnetic axis normal to magnetic axis	 6×10^{-6}/K 12×10^{-6}/K
Thermal conductivity	10 W/mK
Bending strength	120 N/mm²
Compressive strength	900 N/mm²

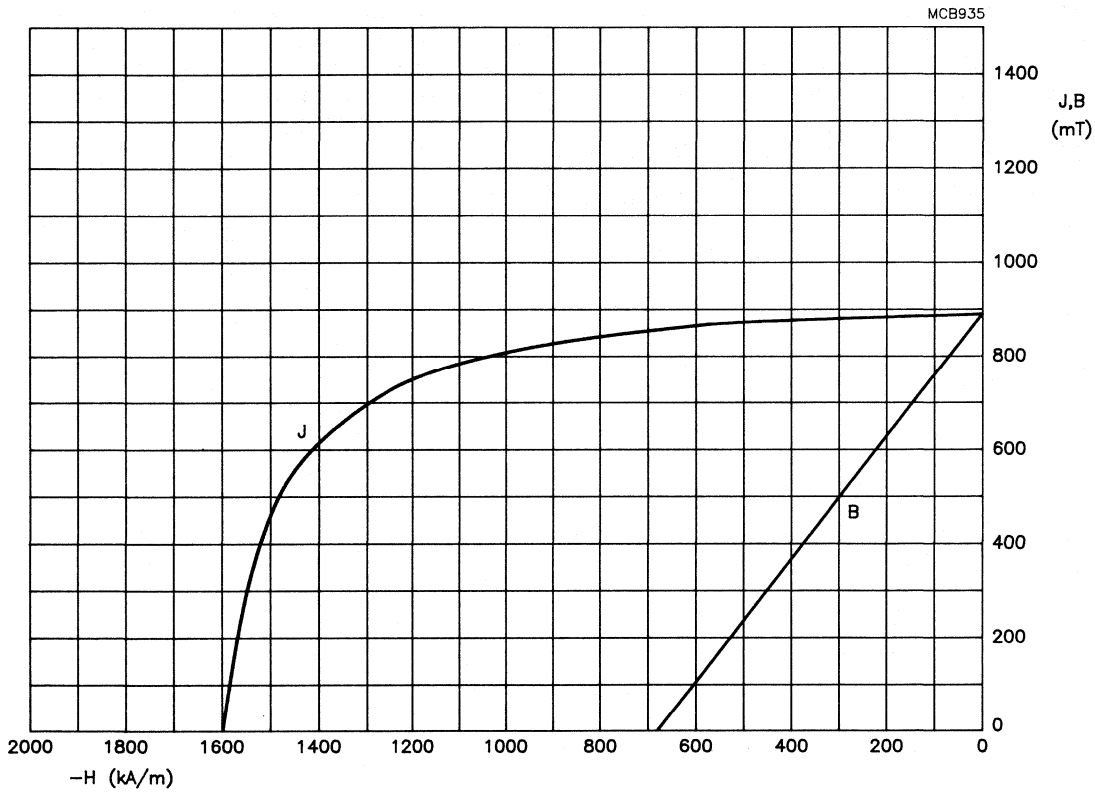


Fig.1 Typical demagnetization curve (20 °C) for RES 195.

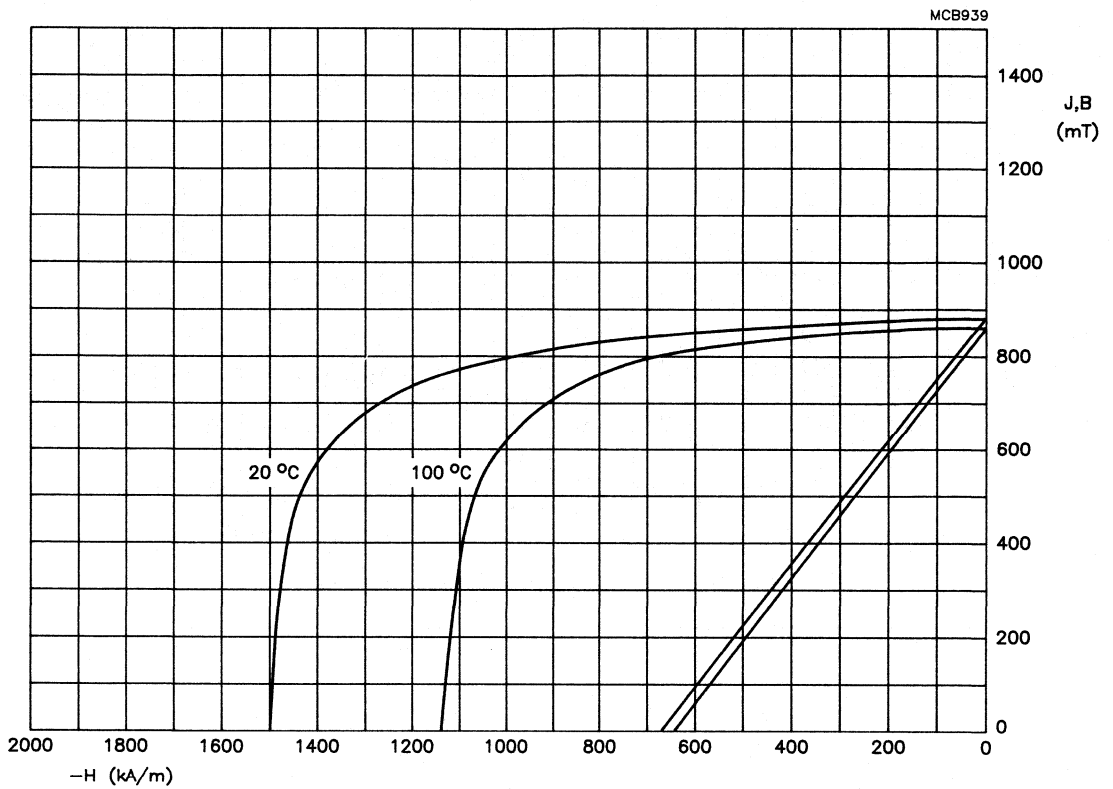


Fig.2 Demagnetization curves for RES 195 at several temperatures.

Material Specification Sintered Rare-Earth

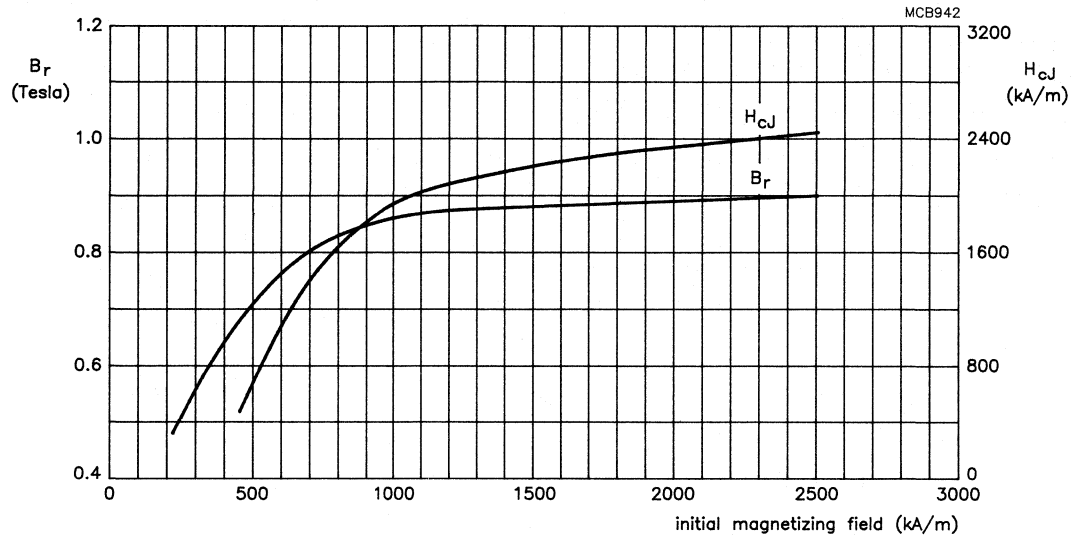


Fig.3 Magnetizing field dependance of RES 195.

Material Specification Sintered Rare-Earth

RES 230, SAMARIUM COBALT MATERIAL (Sm_2Co_{17})

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately Ø 25 mm x 5 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Magnetic and electrical properties of the test piece

Tentative data
Temperature of the test piece is 20 ±2 °C, unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	950	1000	mT	9500	10000	Gs
H_{cB}	Coercivity	550	650	kA/m	6910	8170	Oe
H_{cJ}	Polarization coercivity	650	750	kA/m	8170	9425	Oe
$(BH)_{max}$	Maximum BH product	160	185	kJ/m^3	20.1	23.2	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	-	mT	-	-	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	-	kA/m	-	-	Oe
μ_{rec}	Recoil permeability	-	1.05	-	-	1.05	-
-	Temperature coefficient of B_r (–60 to +180 °C)	-	–0.03	%/K	-	–0.03	%/°C
-	Temperature coefficient of H_{cJ} (20 to 150 °C)	-	–0.25	%/K	-	–0.25	%/°C
H_{sat}	Recommended initial magnetizing field static pulse	 1800 2500	 - -	 kA/m kA/m	 22600 31400	 - -	 Oe Oe
ρ	Resistivity	-	8×10^{-7}	Ωm	-	8×10^{-5}	Ωcm
-	Curie point	-	850	°C	-	850	°C

RES 230, Physical properties

PARAMETER	VALUE
Maximum continuous operating temperature	350 °C
Density	8.4×10^3 kg/m³ (8.4 g/cm³)
Hardness (Vickers)	550
Young's modulus	1.5×10^5 N/mm²
Coefficient of linear expansion parallel to magnetic axis normal to magnetic axis	 8×10^{-6}/K 12×10^{-6}/K
Thermal conductivity	15 W/mK
Bending strength	120 N/mm²
Compressive strength	800 N/mm²

Material Specification Sintered Rare-Earth

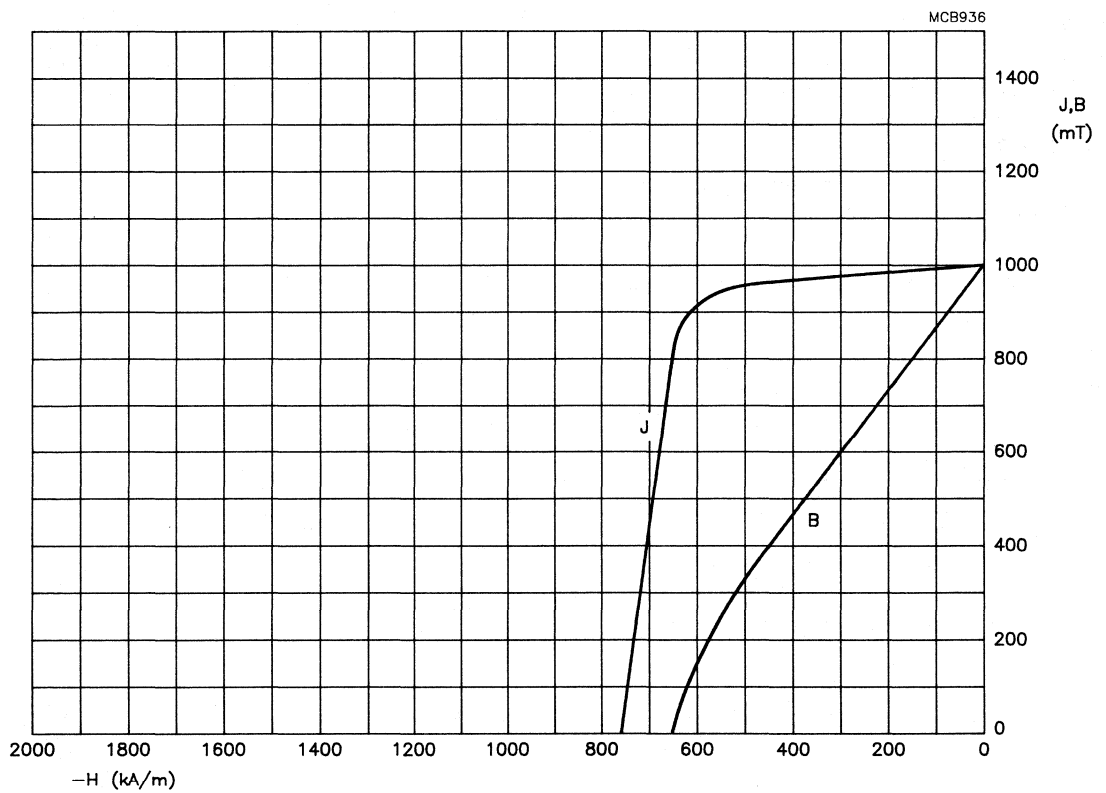


Fig.1 Typical demagnetization curve (20 °C) for RES 230.

Material Specification Sintered Rare-Earth

RES 270, NEODYMIUM IRON BORON MATERIAL (NdFeB)

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 25 mm x 5 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C, unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	1050	1100	mT	10500	11000	Gs
H_{cB}	Coercivity	700	750	kA/m	8795	9425	Oe
H_{cJ}	Polarization coercivity	750	1000	kA/m	9425	12565	Oe
$(BH)_{max}$	Maximum BH product	-	215	kJ/m^3	-	27.0	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	520	mT	-	5200	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	413	kA/m	-	5200	Oe
μ_{rec}	Recoil permeability	-	1.05	-	-	1.05	-
-	Temperature coefficient of B_r (20 to 150 °C)	-	–0.13	%/K	-	–0.13	%/°C
-	Temperature coefficient of H_{cJ} (20 to 150 °C)	-	–0.6	%/K	-	–0.6	%/°C
H_{sat}	Recommended initial magnetizing field static	1800	–	kA/m	22600	-	Oe
ρ	Resistivity	-	1.4×10^{-6}	Ωm	-	1.4×10^{-4}	Ωcm
-	Curie point	-	310	°C	-	310	°C

RES 270, Physical properties

PARAMETER	VALUE
Maximum continuous operating temperature	120 °C
Density	7.4×10^3 kg/m³ (7.4 g/cm³)
Hardness (Vickers)	500
Young's modulus	-
Coefficient of linear expansion parallel to magnetic axis normal to magnetic axis	 5.7×10^{-6}/K -0.5×10^{-6}/K
Thermal conductivity	6.5 W/mK
Bending strength	280 N/mm²
Compressive strength	940 N/mm²

Material Specification Sintered Rare-Earth

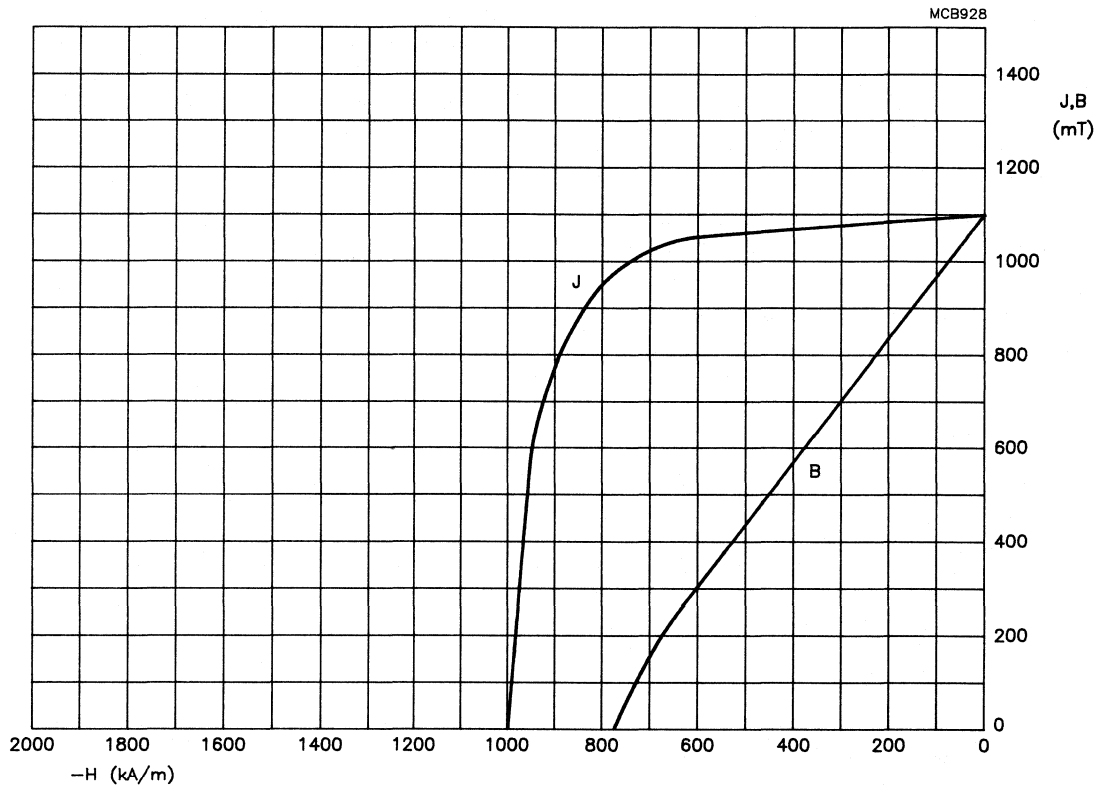


Fig.1 Typical demagnetization curve (20 °C) for RES 270.

Material Specification Sintered Rare-Earth

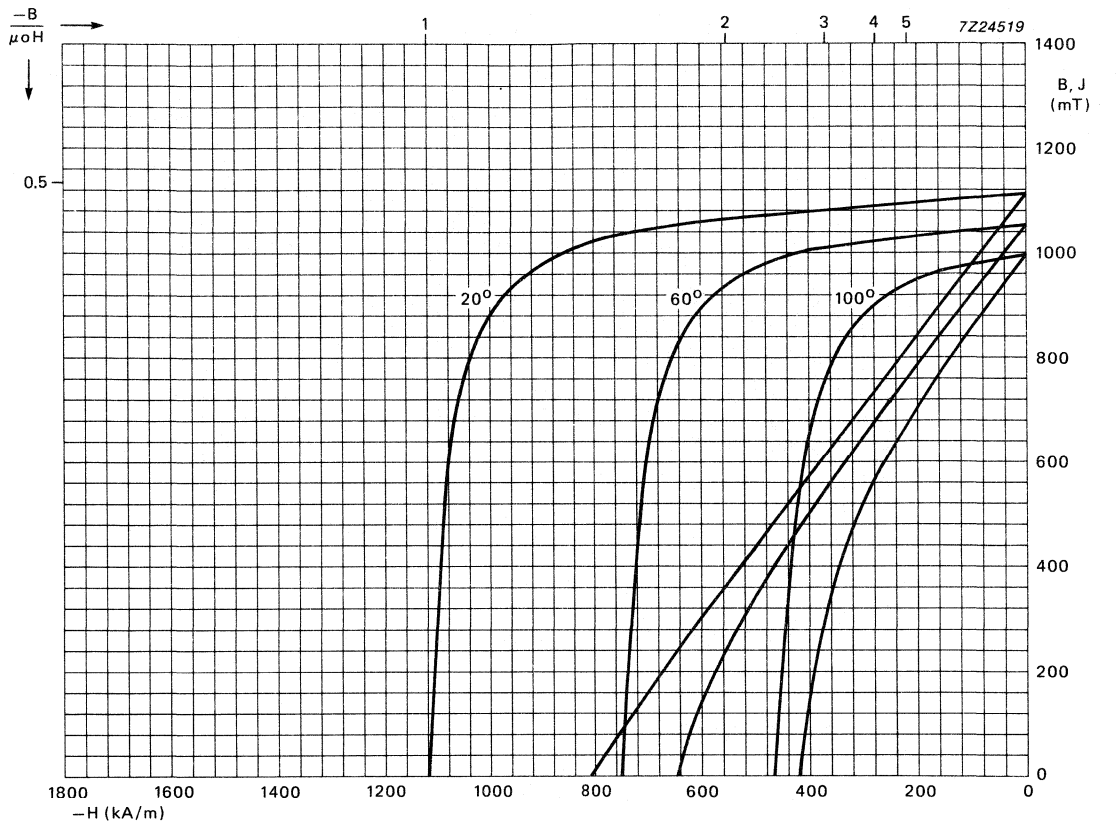


Fig.2 Demagnetization curves for RES 270 at several temperatures.

Magnetization

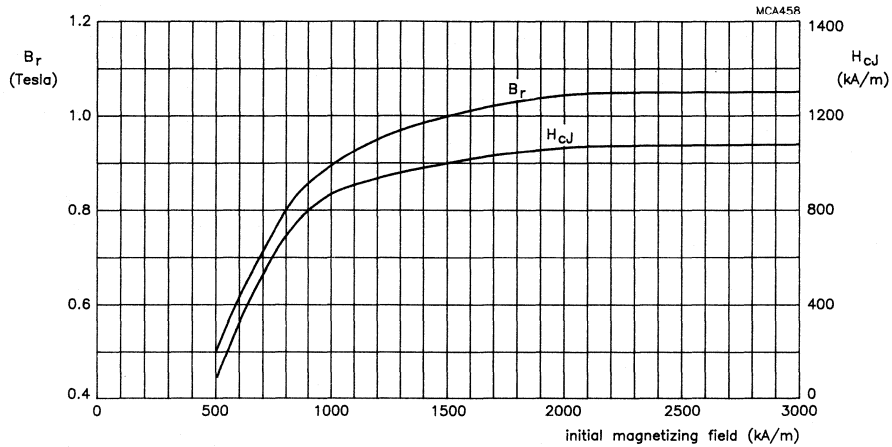


Fig.3 Magnetizing field dependance of Neodure RES 270.

Effect of temperature on magnetic properties

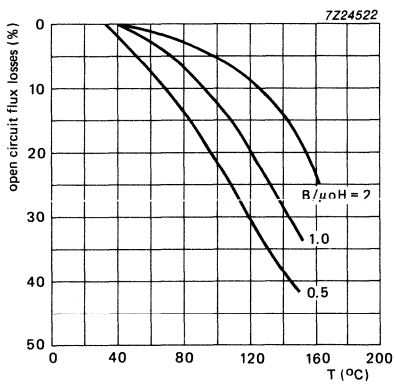


Fig.4 Open circuit irreversible losses as a function of temperature for RES 270.

Material Specification Sintered Rare-Earth

RES 300, NEODYMIUM IRON BORON MATERIAL (NdFeB)

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 25 mm x 5 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C, unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	1100	1150	mT	11000	11500	Gs
H_{cB}	Coercivity	750	800	kA/m	9425	10055	Oe
H_{cJ}	Polarization coercivity	750	1000	kA/m	9425	12565	Oe
$(BH)_{max}$	Maximum BH product	-	240	kJ/m^3	-	30.2	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	550	mT	-	5500	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	436	kA/m	-	5500	Oe
μ_{rec}	Recoil permeability	-	1.05	-	-	1.05	-
-	Temperature coefficient of B_r (20 to 150 °C)	-	–0.13	%/K	-	–0.13	%/°C
-	Temperature coefficient of H_{cJ} (20 to 150 °C)	-	–0.6	%/K	-	–0.6	%/°C
H_{sat}	Recommended initial magnetizing field static	1800	-	kA/m	22600	-	Oe
ρ	Resistivity	-	1.4×10^{-6}	Ωm	-	1.4×10^{-4}	Ωcm
-	Curie point	-	310	°C	-	310	°C

RES 300, Physical properties

PARAMETER	VALUE
Maximum continuous operating temperature	120 °C
Density	7.4×10^3 kg/m³ (7.4 g/cm³)
Hardness (Vickers)	500
Young's modulus	-
Coefficient of linear expansion parallel to magnetic axis normal to magnetic axis	 5.7×10^{-6}/K -0.5×10^{-6}/K
Thermal conductivity	6.5 W/mK
Bending strength	280 N/mm²
Compressive strength	940 N/mm²

Material Specification Sintered Rare-Earth

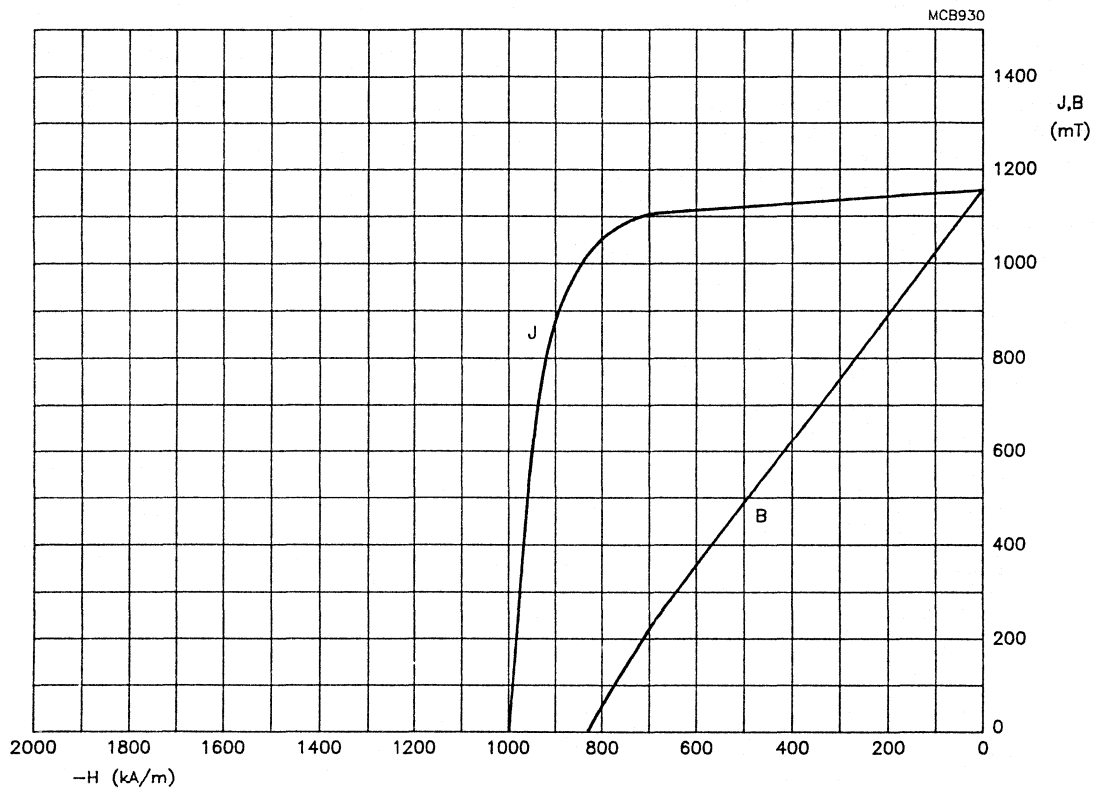


Fig.1 Typical demagnetization curve (20 °C) for RES 300.

Material Specification Sintered Rare-Earth

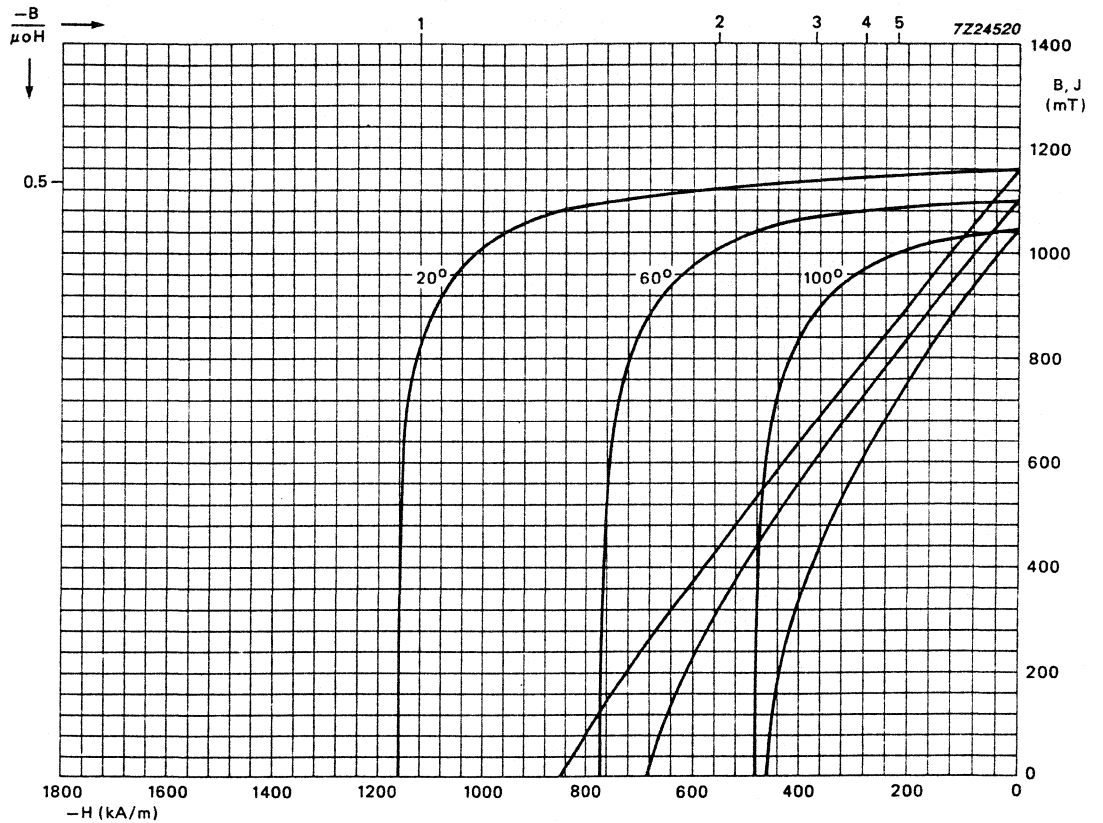


Fig.2 Demagnetization curves for RES 300 at several temperatures.

Effect of temperature on magnetic properties

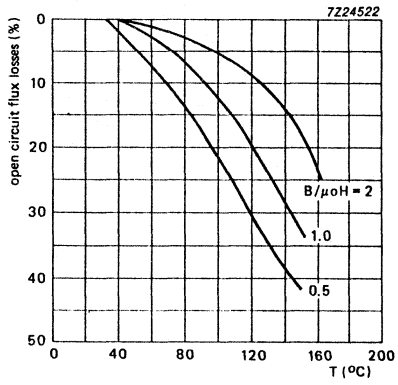


Fig.3 Open circuit irreversible losses as a function of temperature for RES 300.

Material Specification — Sintered Rare-Earth

RES 350, NEODYMIUM IRON BORON MATERIAL (NdFeB)

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 25 mm x 5 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C, unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYPE.	UNIT	MIN.	TYPE.	UNIT
B_r	Remanence	1150	1200	mT	11500	12000	Gs
H_{cB}	Coercivity	800	850	kA/m	10055	10680	Oe
H_{cJ}	Polarization coercivity	750	1000	kA/m	9425	12565	Oe
$(BH)_{max}$	Maximum BH product	-	280	kJ/m^3	-	35.2	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	570	mT	-	5700	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	491	kA/m	-	6200	Oe
μ_{rec}	Recoil permeability	-	1.05	-	-	1.05	-
-	Temperature coefficient of B_r (20 to 150 °C)	-	–0.13	%/K	-	–0.13	%/°C
-	Temperature coefficient of H_{cJ} (20 to 150 °C)	-	–0.6	%/K	-	–0.6	%/°C
H_{sat}	Recommended initial magnetizing field static	1800	-	kA/m	22600	-	Oe
ρ	Resistivity	-	1.4×10^{-6}	Ωm	-	1.4×10^{-4}	Ωcm
-	Curie point	-	310	°C	-	310	°C

RES 350, Physical properties

PARAMETER	VALUE
Maximum continuous operating temperature	120 °C
Density	7.4×10^3 kg/m³ (7.4 g/cm³)
Hardness (Vickers)	500
Young's modulus	-
Coefficient of linear expansion parallel to magnetic axis normal to magnetic axis	 5.7×10^{-6}/K -0.5×10^{-6}/K
Thermal conductivity	6.5 W/mK
Bending strength	280 N/mm²
Compressive strength	940 N/mm²

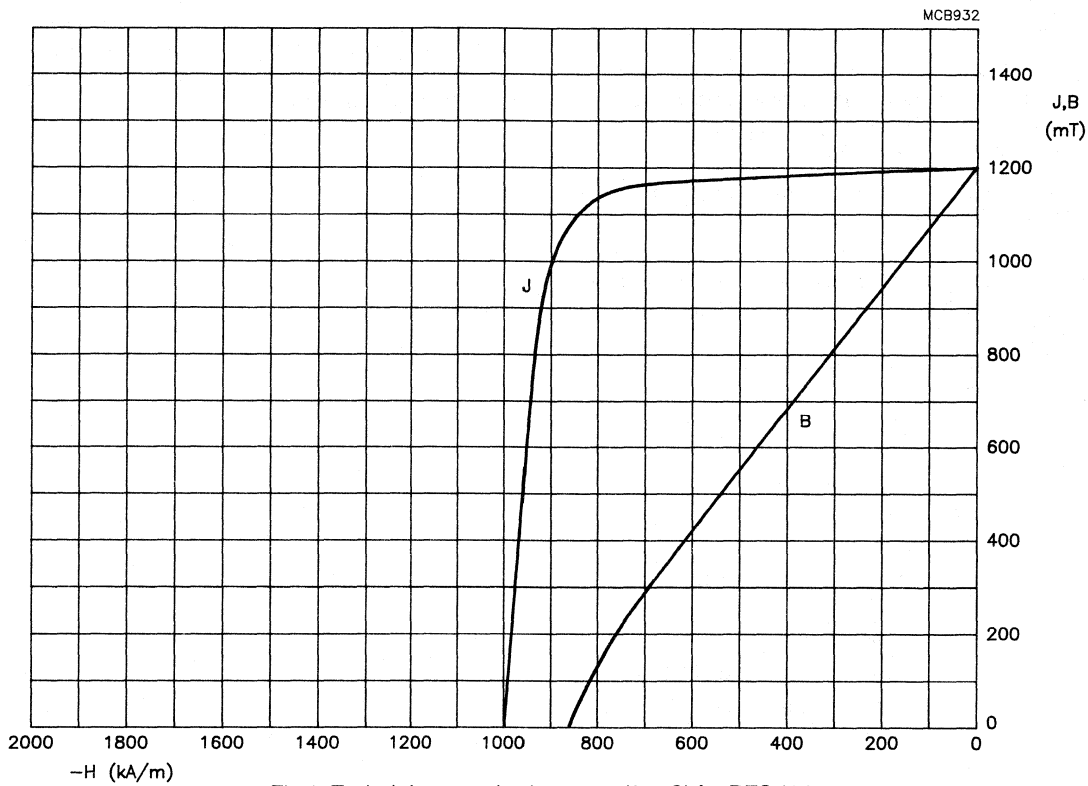


Fig.1 Typical demagnetization curve (20 °C) for RES 350.

Material Specification Sintered Rare-Earth

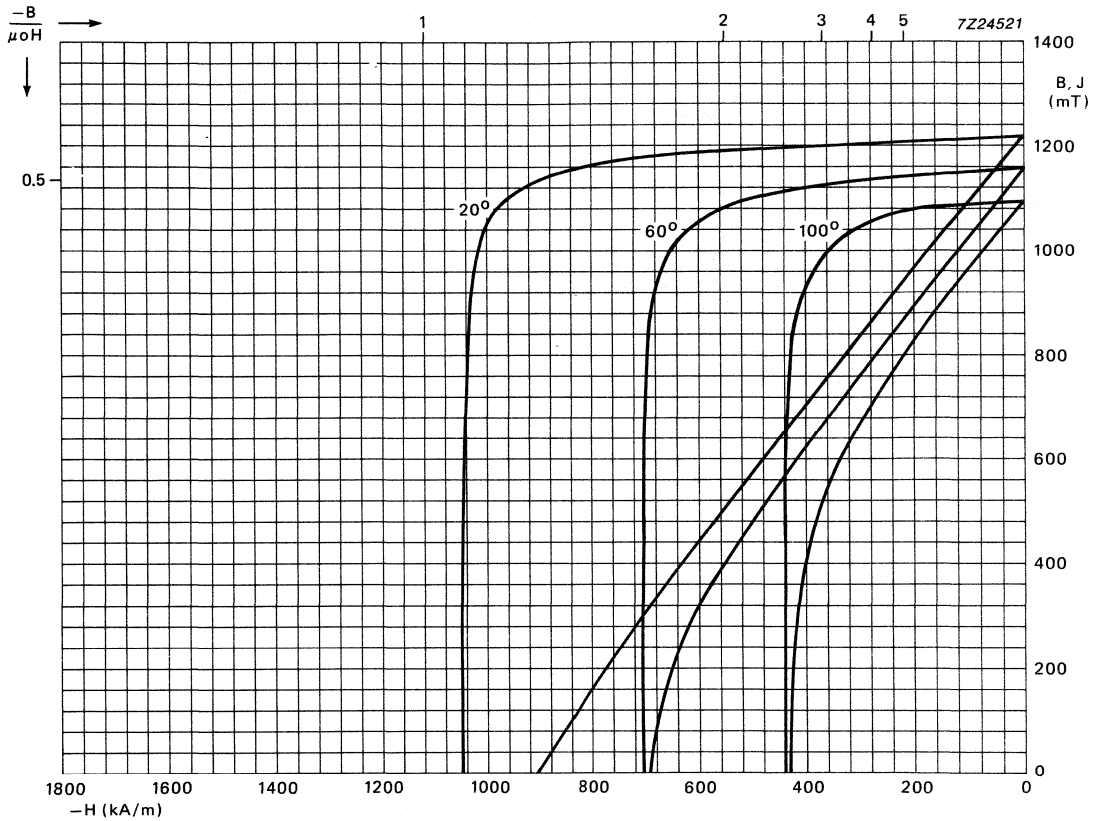


Fig.2 Demagnetization curves for RES 350 at several temperatures.

Effect of temperature on magnetic properties

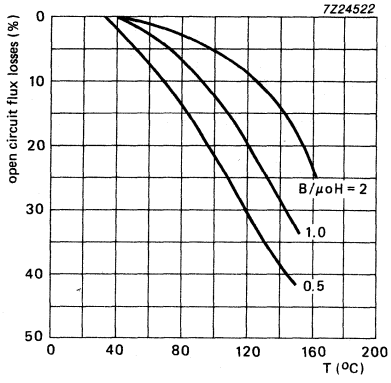


Fig.3 Open circuit irreversible losses as a function of temperature for RES 350.

Material Specification — Sintered Rare-Earth

RES 255, NEODYMIUM IRON BORON MATERIAL (NdFeB)

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 25 mm x 5 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C, unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYPE.	UNIT	MIN.	TYPE.	UNIT
B_r	Remanence	1000	1050	mT	10000	10500	Gs
H_{cB}	Coercivity	700	750	kA/m	8800	9425	Oe
H_{cJ}	Polarization coercivity	1200	1500	kA/m	15080	18850	Oe
$(BH)_{max}$	Maximum BH product	-	200	kJ/m^3	-	25.1	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	500	mT	-	5000	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	400	kA/m	-	5000	Oe
μ_{rec}	Recoil permeability	-	1.05	-	-	1.05	-
-	Temperature coefficient of B_r (20 to 150 °C)	-	–0.13	%/K	-	–0.13	%/°C
-	Temperature coefficient of H_{cJ} (20 to 150 °C)	-	–0.6	%/K	-	–0.6	%/°C
H_{sat}	Recommended initial magnetizing field static	1800	-	kA/m	22600	-	Oe
ρ	Resistivity	-	1.4×10^{-6}	Ωm	-	1.4×10^{-4}	Ωcm
-	Curie point	-	310	°C	-	310	°C

RES 255, Physical properties

PARAMETER	VALUE
Maximum continuous operating temperature	140 °C
Density	7.4×10^3 kg/m³ (7.4 g/cm³)
Hardness (Vickers)	500
Young's modulus	-
Coefficient of linear expansion parallel to magnetic axis normal to magnetic axis	 5.7×10^{-6}/K -0.5×10^{-6}/K
Thermal conductivity	6.5 W/mK
Bending strength	280 N/mm²
Compressive strength	940 N/mm²

Material Specification Sintered Rare-Earth

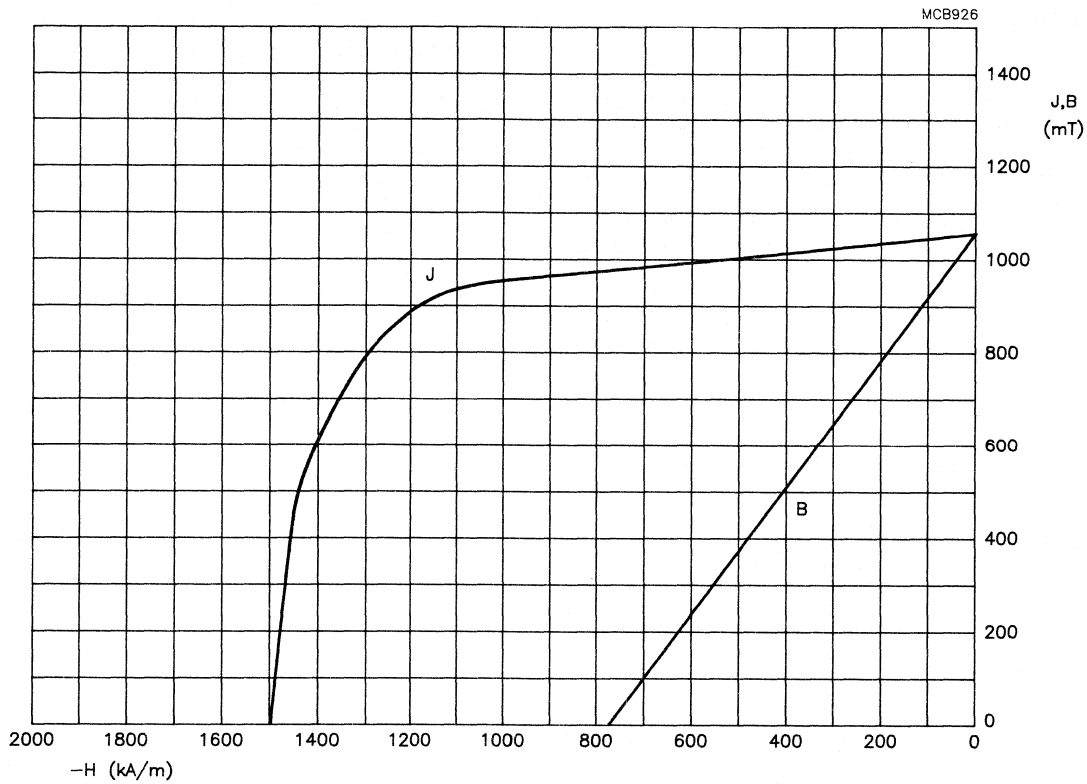


Fig.1 Typical demagnetization curve (20 °C) for RES 255.

Material Specification Sintered Rare-Earth

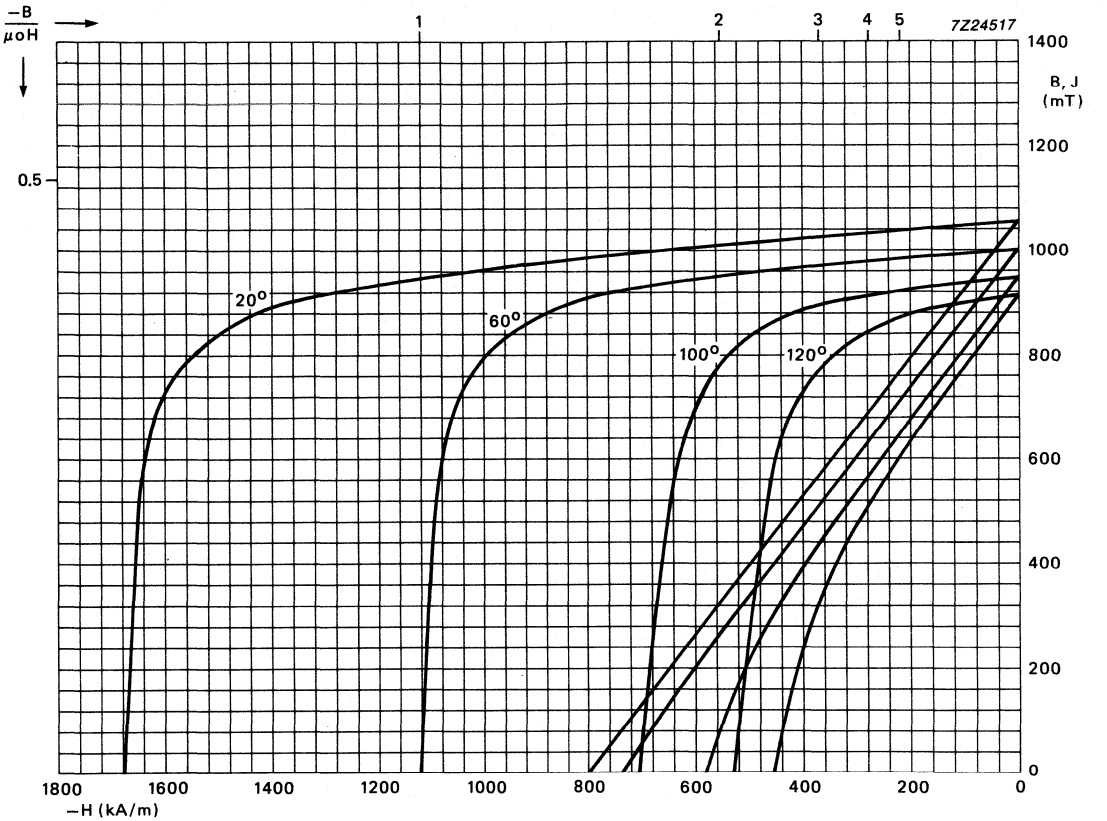


Fig.2 Demagnetization curves for Neodure RES 255 at several temperatures.

Effect of temperature on magnetic properties

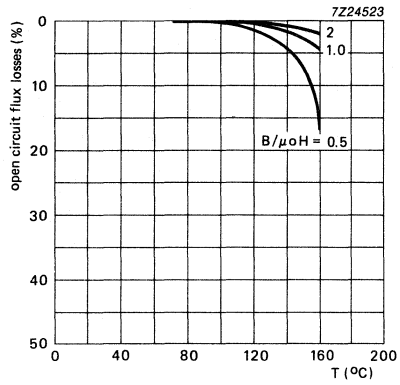


Fig.3 Open circuit irreversible losses as a function of temperature for RES 255.

Material Specification Sintered Rare-Earth

RES 275, NEODYMIUM IRON BORON MATERIAL (NdFeB)

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 25 mm x 5 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C, unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYPE.	UNIT	MIN.	TYPE.	UNIT
B_r	Remanence	1050	1100	mT	10500	11000	Gs
H_{cB}	Coercivity	750	800	kA/m	9425	10055	Oe
H_{cJ}	Polarization coercivity	1200	1500	kA/m	15080	18850	Oe
$(BH)_{max}$	Maximum BH product	-	215	kJ/m^3	-	27.0	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	520	mT	-	5200	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	413	kA/m	-	5200	Oe
μ_{rec}	Recoil permeability	-	1.05	-	-	1.05	-
-	Temperature coefficient of B_r (20 to 150 °C)	-	–0.13	%/K	-	–0.13	%/°C
-	Temperature coefficient of H_{cJ} (20 to 150 °C)	-	–0.6	%/K	-	–0.6	%/°C
H_{sat}	Recommended initial magnetizing field static	1800	-	kA/m	22600	-	Oe
ρ	Resistivity	-	1.4×10^{-6}	Ωm	-	1.4×10^{-4}	Ωcm
-	Curie point	-	310	°C	-	310	°C

RES 275, Physical properties

PARAMETER	VALUE
Maximum continuous operating temperature	140 °C
Density	7.4×10^3 kg/m³ (7.4 g/cm³)
Hardness (Vickers)	500
Young's modulus	-
Coefficient of linear expansion parallel to magnetic axis normal to magnetic axis	 5.7×10^{-6}/K -0.5×10^{-6}/K
Thermal conductivity	6.5 W/mK
Bending strength	280 N/mm²
Compressive strength	940 N/mm²

Material Specification Sintered Rare-Earth

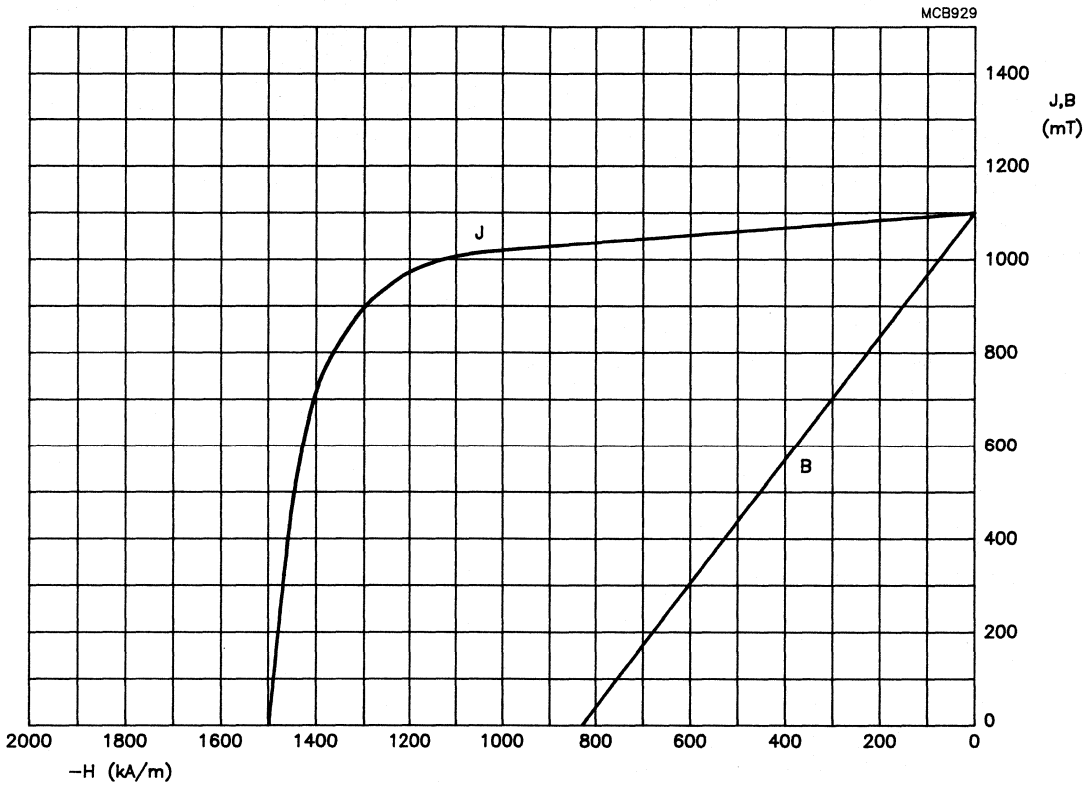


Fig.1 Typical demagnetization curve (20 °C) for RES 275.

Material Specification Sintered Rare-Earth

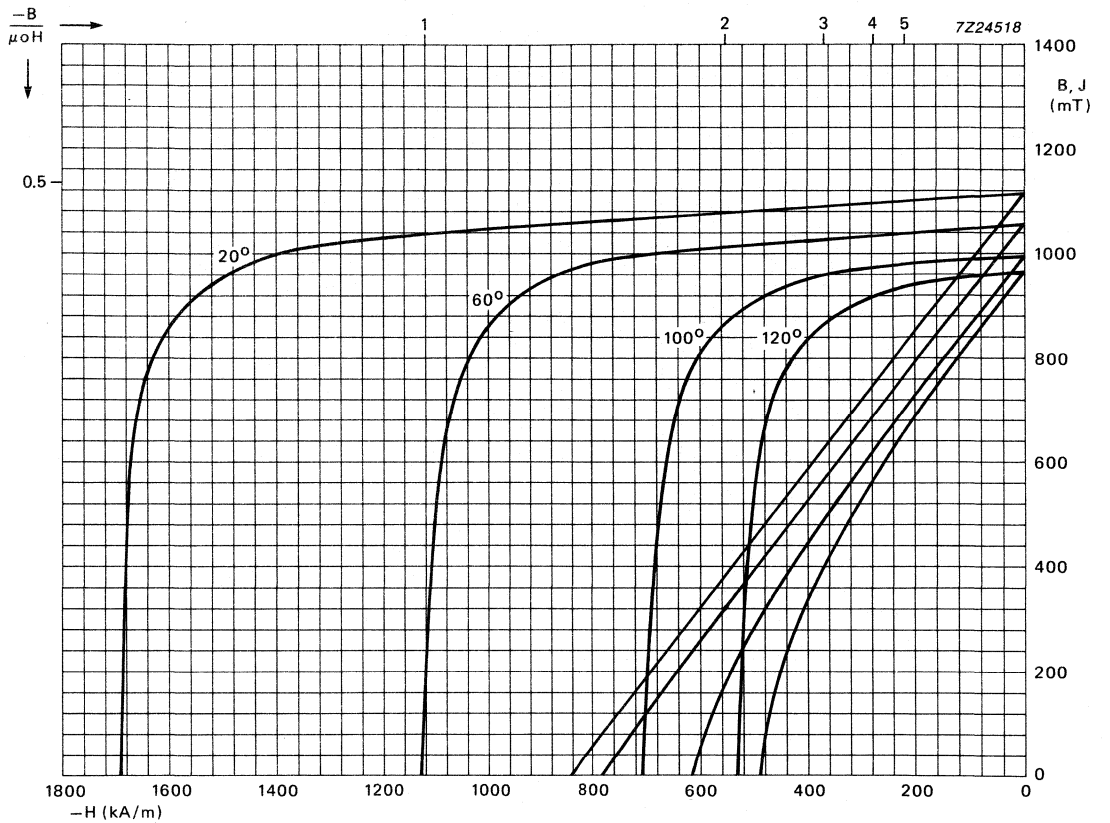


Fig.2 Demagnetization curves for Neodure RES 275 at several temperatures.

Effect of temperature on magnetic properties

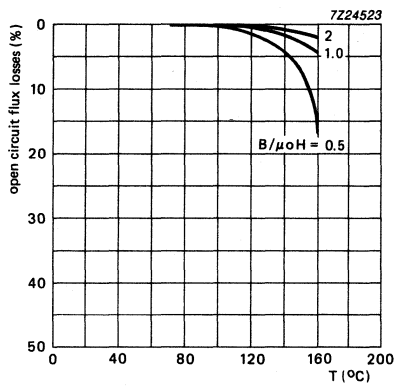


Fig.3 Open circuit irreversible losses as a function of temperature for RES 275.

Material Specification Sintered Rare-Earth

RES 305, NEODYMIUM IRON BORON MATERIAL (NdFeB)

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately Ø 25 mm x 5 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C, unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYPE.	UNIT	MIN.	TYPE.	UNIT
B_r	Remanence	1100	1150	mT	11000	11500	Gs
H_{cB}	Coercivity	800	850	kA/m	10055	10680	Oe
H_{cJ}	Polarization coercivity	1200	1500	kA/m	15080	18850	Oe
$(BH)_{max}$	Maximum BH product	-	240	kJ/m^3	-	30.2	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	550	mT	-	5500	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	436	kA/m	-	5500	Oe
μ_{rec}	Recoil permeability	-	1.05	-	-	1.05	-
-	Temperature coefficient of B_r (20 to 150 °C)	-	–0.13	%/K	-	–0.13	%/°C
-	Temperature coefficient of H_{cJ} (20 to 150 °C)	-	–0.6	%/K	-	–0.6	%/°C
H_{sat}	Recommended initial magnetizing field static	1800	-	kA/m	22600	-	Oe
ρ	Resistivity	-	1.4×10^{-6}	Ωm	-	1.4×10^{-4}	Ωcm
-	Curie point	-	310	°C	-	310	°C

RES 305, Physical properties

PARAMETER	VALUE
Maximum continuous operating temperature	140 °C
Density	7.4×10^3 kg/m³ (7.4 g/cm³)
Hardness (Vickers)	500
Young's modulus	-
Coefficient of linear expansion parallel to magnetic axis normal to magnetic axis	 5.7×10^{-6}/K -0.5×10^{-6}/K
Thermal conductivity	6.5 W/mK
Bending strength	280 N/mm²
Compressive strength	940 N/mm²

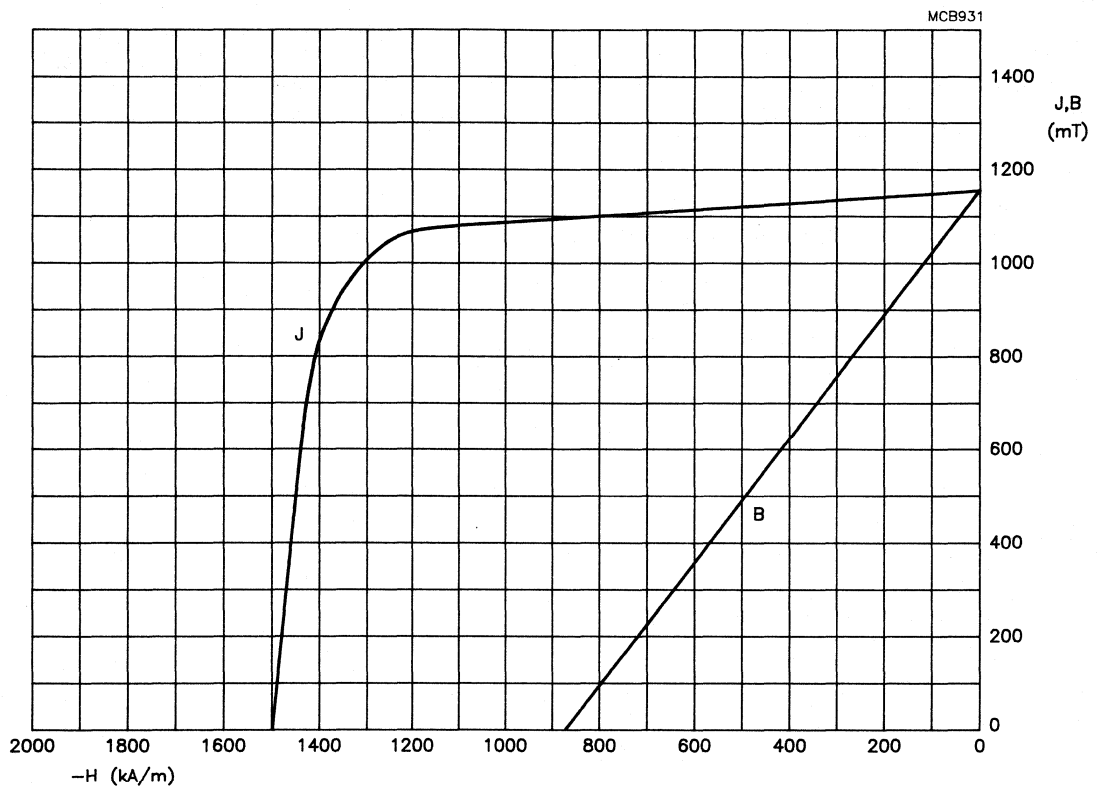


Fig.1 Typical demagnetization curve (20 °C) for RES 305.

Material Specification Sintered Rare-Earth

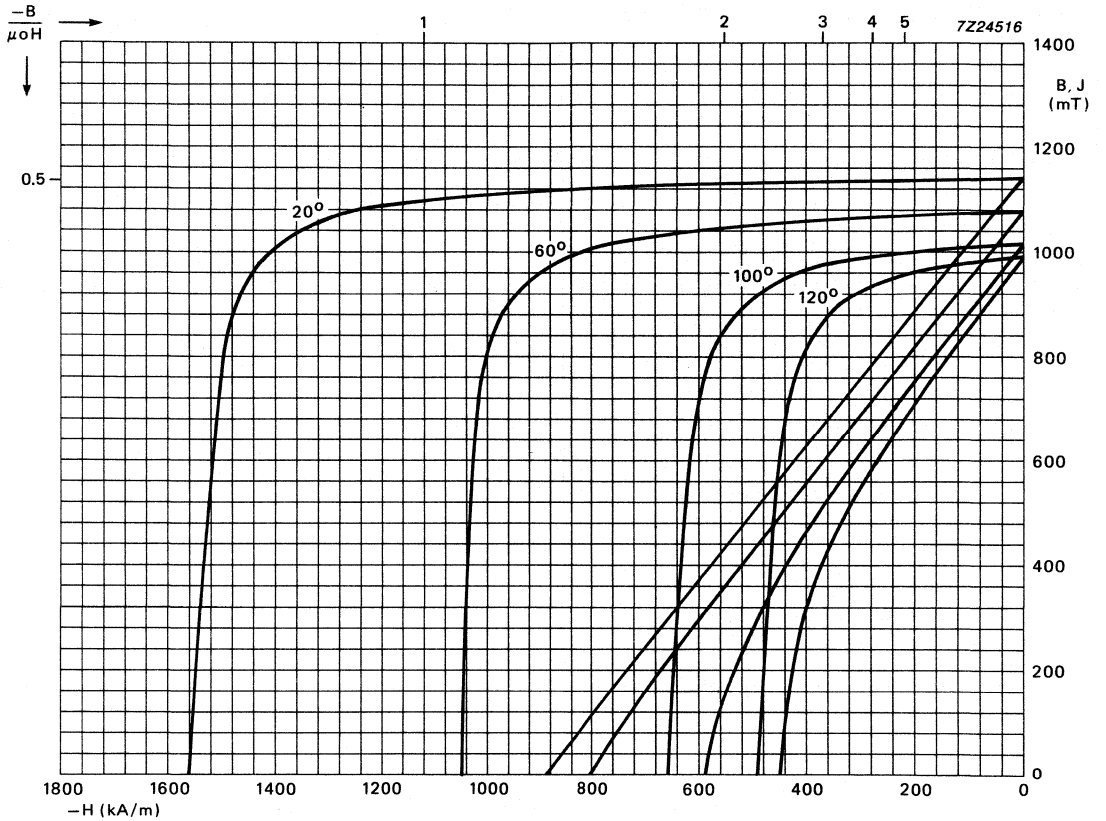


Fig.2 Demagnetization curves for Neodure RES 305 at several temperatures.

Effect of temperature on magnetic properties

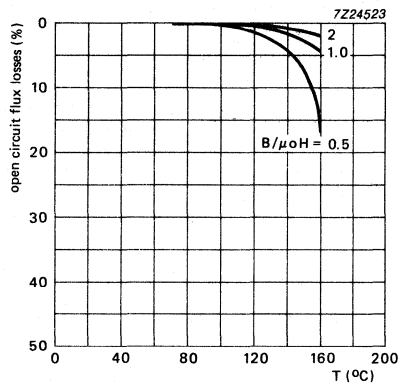


Fig.3 Open circuit irreversible losses as a function of temperature for RES 305.

Material Specification Sintered Rare-Earth

RES 257, NEODYMIUM IRON BORON MATERIAL (NdFeB)

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 25 mm x 5 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C, unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYPE.	UNIT	MIN.	TYPE.	UNIT
B_r	Remanence	950	1000	mT	9500	10000	Gs
H_{cB}	Coercivity	700	750	kA/m	8800	9425	Oe
H_{cJ}	Polarization coercivity	1800	1900	kA/m	22600	23875	Oe
$(BH)_{max}$	Maximum BH product	-	188	kJ/m^3	-	23.6	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	490	mT	-	4900	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	384	kA/m	-	4850	Oe
μ_{rec}	Recoil permeability	-	1.05	-	-	1.05	-
-	Temperature coefficient of B_r (20 to 150 °C)	-	–0.12	%/K	-	–0.12	%/°C
-	Temperature coefficient of H_{cJ} (20 to 150 °C)	-	–0.55	%/K	-	–0.55	%/°C
H_{sat}	Recommended initial magnetizing field static	1800	-	kA/m	22600	-	Oe
ρ	Resistivity	-	1.4×10^{-6}	Ωm	-	1.4×10^{-4}	Ωcm
-	Curie point	-	310	°C	-	310	°C

RES 257, Physical properties

PARAMETER	VALUE
Maximum continuous operating temperature	150 °C
Density	7.4×10^3 kg/m³ (7.4 g/cm³)
Hardness (Vickers)	500
Young's modulus	-
Coefficient of linear expansion parallel to magnetic axis normal to magnetic axis	 5.7×10^{-6}/K -0.5×10^{-6}/K
Thermal conductivity	6.5 W/mK
Bending strength	280 N/mm²
Compressive strength	940 N/mm²

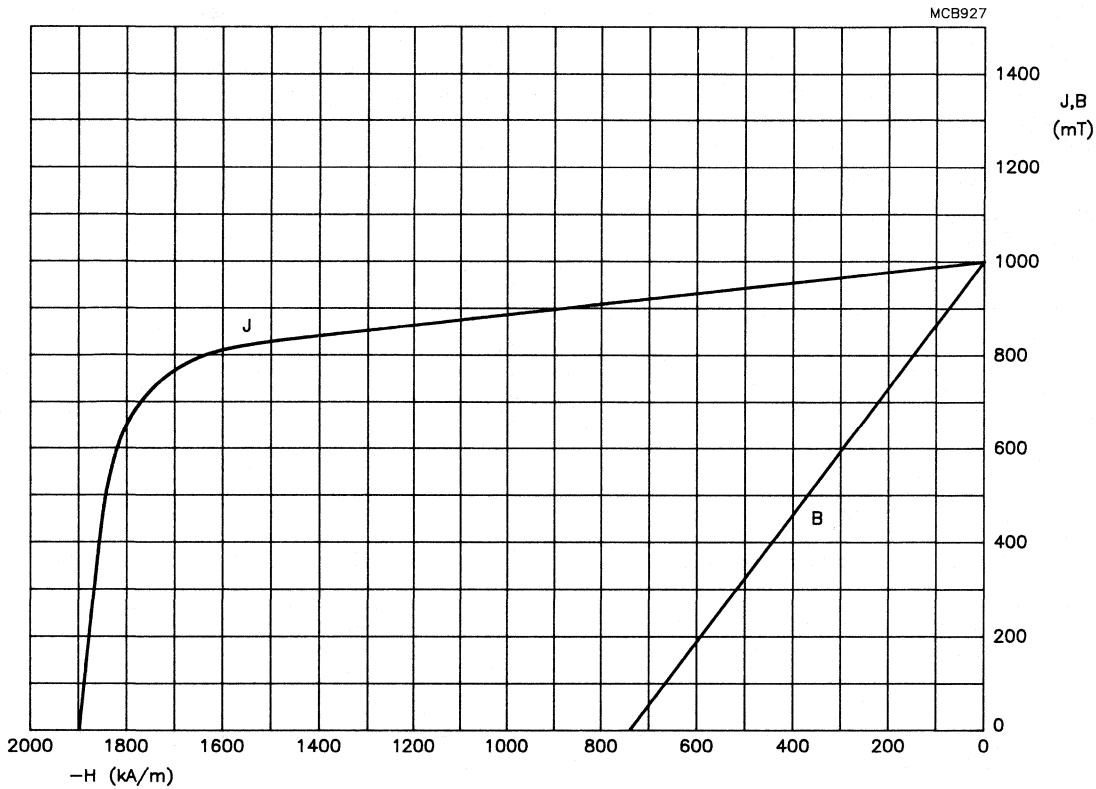


Fig.1 Typical demagnetization curve (20 °C) for RES 257.

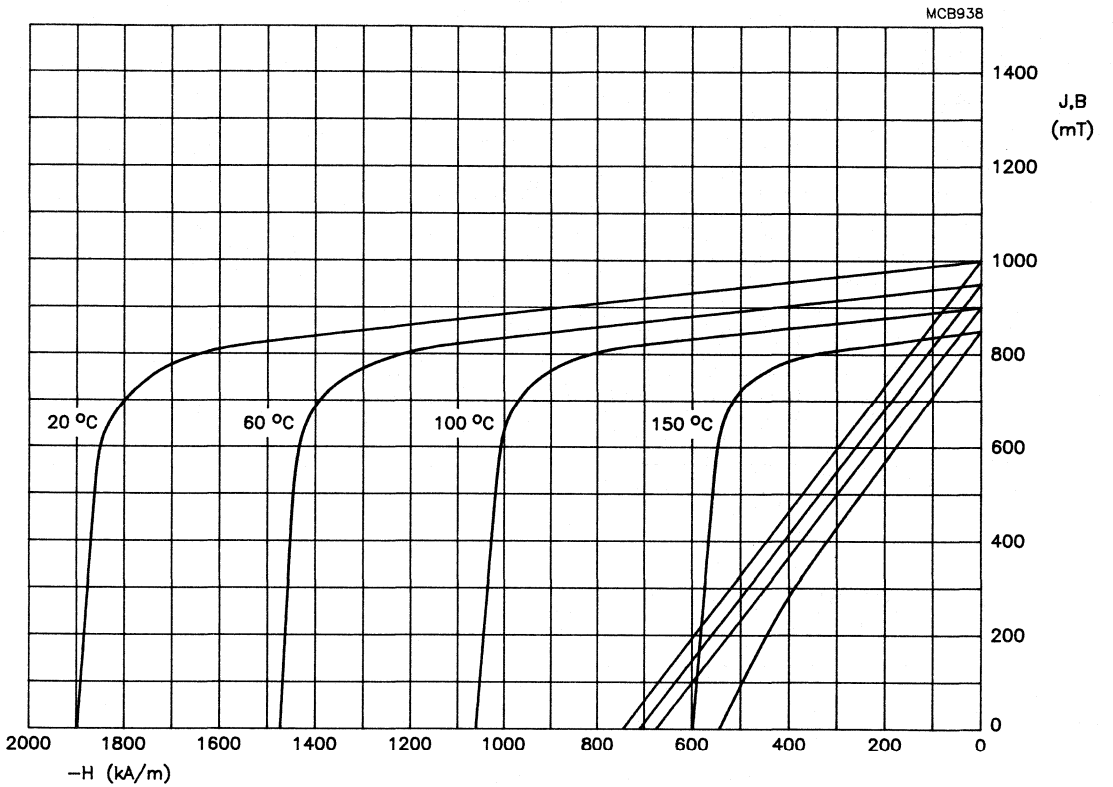


Fig.2 Demagnetization curves for Neodure RES 257 at several temperatures.

Effect of temperature on magnetic properties

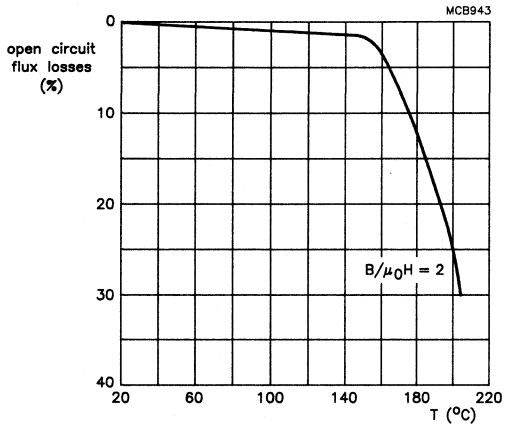


Fig.3 Open circuit irreversible losses as a function of temperature for RES 257.

Magnet type list Sintered Rare-Earth

ANISOTROPIC SINTERED RARE-EARTH

The magnet type list gives initial information on the main dimensions etc, of types for which tooling already exists. Choice of a type from this list eliminate the need for new tools and consequent delay in delivery. It is important to check with the supplier if the data is still valid. Frequent additions, eliminations or changes may render the survey in this data handbook outdated. In that case, an updated list should be consulted.

The exact mechanical and magnetic data and the correct code number (last digit) have been laid down in the magnet specifications, which exist for each type, and which will be sent on request.

For anisotropic sintered rare-earth some shapes can be supplied in another material grade than that listed.

For optimum results, supply of pre-magnetized magnets is not always advisable because self-demagnetization may occur due to unfavourable combinations of grade, the ratio of magnetic area to magnetic length and temperature variation.

Permanent magnets can also be ordered to your own design (within the limits of the material and manufacturing techniques). Our technical assistance on the design and application of permanent magnets is always at your disposal.

The magnet type list of rare-earth products is divided into 3 different shapes:

For anisotropic sintered rare-earth

- Blocks
- Discs
- Rings

Magnet type list Sintered Rare-Earth

Blocks in RES 190

Orientation: perpendicular to a x b

E = Magnetized perpendicular to a x b

U = Unmagnetized

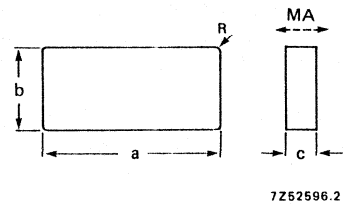


Fig.1 Blocks in RES 190.

Magnet type list: Blocks in RES 190

TYPE DESCRIPTION	a (mm)	b (mm)	c (mm)	COATING	MAGN ACC	RES	MASS (gr)	ORDERING CODE
B..3..2..1R190E.0.0.	+0.1 3.0 −0.1	+0.1 2.0 −0.1	+0.1 1.0 −0.1	-	E	190	0.05	4313 059 68081
B..3..3..1R190E.0.1.	+0.1 3.0 −0.1	+0.1 3.0 −0.1	+0.1 1.0 −0.1	-	E	190	0.07	4313 059 68141
B..4..4..2R190E.0.3.	+0.1 4.0 −0.1	+0.1 4.0 −0.1	+0.15 2.0 −0.15	-	E	190	0.27	4313 059 68331
B..5..5..2R190E.0.3.	+0.1 5.0 −0.1	+0.1 5.0 −0.1	+0.1 1.5 −0.1	-	E	190	0.31	4313 059 68541
B..5..5..3R190E.0.6.	+0.1 5.0 −0.1	+0.1 5.0 −0.1	+0.1 3.0 −0.1	-	E	190	0.62	4313 059 66031
B..8..5..3R190E.1.0.	+0.2 8.0 −0.2	+0.2 5.0 −0.2	+0.1 3.0 −0.1	-	E	190	1.00	4313 059 68351
B.13..7..2R190U.1.9. B.13..7..2R190E.1.9.	+0.2 13.0 −0.2	+0.2 7.0 −0.2	+0.1 2.5 −0.1	-	U E	190	1.89	4313 059 68201 4313 059 68371
B.18..8..4R190E.5.5.	+0.4 18.5 −0.4	+0.3 8.3 −0.3	+0.05 4.3 −0.05	-	E	190	5.48	4313 059 68381
B.30..8..2R190E.4.2M	+0.7 30.0 −0.7	+0.05 8.5 −0.05	+0.05 2.0 −0.05	-	E	190	4.23	4313 059 68401
B.42.42.10R190U.146.	+1.5 42.0 −1.5	+1.5 42.0 −1.5	+0.1 10.0 −0.1	-	U	190	146.4	4313 059 68301

Magnet type list Sintered Rare-Earth

Magnet type list: Blocks in RES 190

TYPE DESCRIPTION	a (mm)	b (mm)	c (mm)	COATING	MAGN ACC	RES	MASS (gr)	ORDERING CODE
B.46.11..4R190E..15M	+0.7 46.0 –0.7	+0.05 10.6 –0.05	+0.05 3.8 –0.05	-	E	190	15.38	4313 059 68451
B.52.48.10R190U.207.	+1.5 52.0 –1.5	+1.5 48.0 –1.5	+0.1 10.0 –0.1	-	U	190	207.2	4313 059 68501
B.68.36.10R190U.188.	+1.5 68.0 –1.5	+1.5 36.0 –1.5	+0.1 10.0 –0.1	-	U	190	188.2	4313 059 68271

Magnet type list Sintered Rare-Earth

Discs in RES 190

Orientation: axial

A = Magnetized axially

U = Unmagnetized

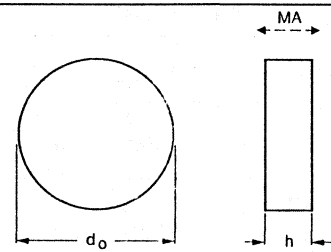


Fig.2 Discs in RES 190. MBA375

Magnet type list: Discs in RES 190

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	h (mm)	COATING	MAGN ACC	RES	MASS (gr)	ORDERING CODE
D..5.....2R190A.0.2.	+0.15 5.0 −0.15	-	+0.05 1.5 −0.05	-	A	190	0.25	4313 059 66042
D..5.....2R190A.0.3.	+0.15 5.0 −0.15	-	+0.05 2.0 −0.05	-	A	190	0.33	4313 059 66072
D..6.....4R190A.1.0.	+0.2 6.0 −0.2	-	+0.2 4.0 −0.2	-	A	190	0.95	4313 059 66001
D..8.....5R190A.2.1.	+0.05 8.0 −0.05	-	+0.1 5.0 −0.1	-	A	190	2.11	4313 059 66191
D.10.....1R190A.1.1.	+0.0 10.5 −0.5	-	+0.0 1.5 −0.1	-	A	190	1.09	4313 059 66031
D.10.....3R190A.2.0.	+0.2 10.0 −0.2	-	+0.1 3.0 −0.1	-	A	190	1.98	4313 059 66211
D.10.....4R190A.2.6.	+0.2 10.0 −0.2	-	+0.2 4.0 −0.2	-	A	190	2.64	4313 059 66021
D.14.....4R190A.5.2.	+0.2 14.0 −0.2	-	+0.2 4.0 −0.2	-	A	190	5.17	4313 059 66011
D.14.....8R190A..10.	+0.1 14.0 −0.1	-	+0.1 8.0 −0.1	-	A	190	10.3	4313 059 66231
D.18.....2R190U.5.0.	+0.5 17.5 −0.5	-	+0.05 2.5 −0.05	-	U	190	5.05	4313 059 66101
D.24....10R190A..38.	+0.1 24.0 −0.1	-	+0.05 10.0 −0.05	-	A	190	38.0	4313 059 66202

Magnet type list Sintered Rare-Earth

Rings in RES 190

Orientation: axial

A = Magnetized axially

U = Unmagnetized

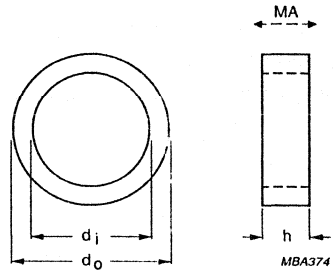


Fig.3 Rings in RES 190.

Magnet type list: Rings in RES 190

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	h (mm)	COATING	MAGN ACC	RES	MASS (gr)	ORDERING CODE
R.12..5..1R190U.1.0.	+0.2 11.95 –0.2	+0.15 5.35 –0.15	+0.1 1.35 –0.1	-	U	190	1.02	4313 059 67001
R.14.13..3R190U.0.5.	≤ 14.1	≥ 13.1	+0.0 2.7 –0.1	-	U	190	0.48	4313 059 67061
R.72.38..4R190U..99.	+0.2 72.0 –0.2	+0.3 38.0 –0.3	+0.1 4.0 –0.1	-	U	190	98.7	4313 059 67031

Magnet type list Sintered Rare-Earth

Blocks in RES 270

Orientation: perpendicular to a x b

E = Magnetized perpendicular to a x b

U = Unmagnetized

Al = Aluminium coated

CEP = Cathodic electro paint (epoxy)

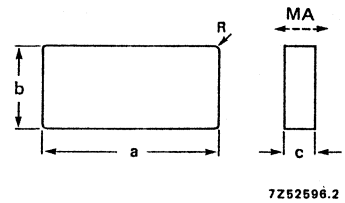


Fig.4 Blocks in RES 270.

Magnet type list: Blocks in RES 270

TYPE DESCRIPTION	a (mm)	b (mm)	c (mm)	COATING	MAGN ACC	RES	MASS (gr)	ORDERING CODE
B..5..5..2R270E.0.3A	+0.1 5.0 −0.1	+0.1 5.0 −0.1	+0.1 1.5 −0.1	Al	E	270	0.28	4313 059 68641
B..5..5..3R270E.0.6A	+0.1 5.0 −0.1	+0.1 5.0 −0.1	+0.1 3.0 −0.1	Al	E	270	0.56	4313 059 68651
B..8..5..3R270E.0.9A	+0.2 8.0 −0.2	+0.2 5.0 −0.2	+0.1 3.0 −0.1	Al	E	270	0.89	4313 059 68661
B.13..7..2R270E.1.7A	+0.2 13.0 −0.2	+0.2 7.0 −0.2	+0.1 2.5 −0.1	Al	E	270	1.68	4313 059 68561
B.18..8..4R270E.4.9E	+0.4 18.5 −0.4	+0.3 8.3 −0.3	+0.05 4.3 −0.05	CEP	E	270	4.89	4313 059 68671
B.30..8..2R270E.3.8E	+0.7 30.0 −0.7	+0.05 8.5 −0.05	+0.05 2.0 −0.05	CEP	E	270	3.77	4313 059 68681
B.42.42.10R270U.130.	+1.5 42.0 −1.5	+1.5 42.0 −1.5	+0.1 10.0 −0.1	NOT	U	270	130.5	8213 142 06201
B.63.36.10R270E.168.	+1.5 63.0 −1.5	+1.5 36.0 −1.5	+0.1 10.0 −0.1	NOT	E	270	167.8	8213 142 06181

Magnet type list Sintered Rare-Earth

Discs in RES 270

Orientation: axial

A = Magnetized axially

U = Unmagnetized

Al = Aluminium coated

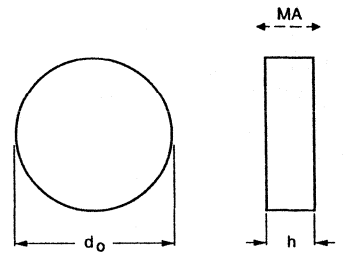


Fig.5 Discs in RES 270.

Magnet type list: Discs in RES 270

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	h (mm)	COATING	MAGN ACC	RES	MASS (gr)	ORDERING CODE
D..5.....2R270U.0.2A D..5.....2R270A.0.2A	+0.15 5.0 –0.15	-	+0.05 1.5 –0.05	Al Al	U A	270	0.22	4313 059 66391 4313 059 66281
D..5.....2R270A.0.3A	+0.15 5.0 –0.15	-	+0.05 2.0 –0.05	Al	A	270	0.29	4313 059 66331
D..8.....4R270U.1.5.	+0.1 8.0 –0.1	-	+0.05 4.0 –0.05	NOT	U	270	1.49	4313 059 66251
D..8.....5R270A.1.9A	+0.05 8.0 –0.05	-	+0.1 5.0 –0.1	Al	A	270	1.86	4313 059 66341
D.10.....2R270A.1.0A	+0.0 10.5 –0.5	-	+0.0 1.5 –0.1	Al	A	270	0.96	4313 059 66351
D.10.....4R270A.2.3A	+0.2 10.0 –0.2	-	+0.2 4.0 –0.2	Al	A	270	2.32	4313 059 66361
D.14.....4R270A.4.6A	+0.2 14.0 –0.2	-	+0.2 4.0 –0.2	Al	A	270	4.56	4313 059 66371
D.15.....8R270A..10A	+0.1 15.0 –0.1	-	+0.05 8.0 –0.05	Al	A	270	10.5	4313 059 66321
D.24....10R270A..33A	+0.1 24.0 –0.1	-	+0.05 10.0 –0.05	Al	A	270	33.5	4313 059 66271

Magnet type list Sintered Rare-Earth

Rings in RES 270

Orientation: axial

A = Magnetized axially

U = Unmagnetized

Al = Aluminium coated

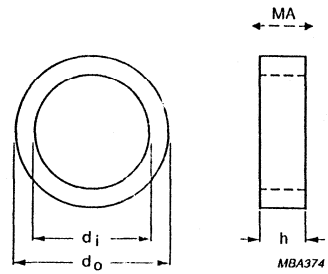


Fig.6 Rings in RES 270.

Magnet type list: Rings in RES 270

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	h (mm)	COATING	MAGN ACC	RES	MASS (gr)	ORDERING CODE
R..8..4..2R270A.0.5A	+0.0 7.6 −0.1	+0.15 4.35 −0.15	+0.05 2.3 −0.05	Al	A	270	0.51	3104 101 18055
R.12..4..2R270U.1.2.	+0.3 11.8 −0.3	+0.2 3.5 −0.2	+0.03 1.7 −0.03	NOT	U	270	1.25	4313 059 67141
R.12..5..1R270U.0.9A	+0.2 11.5 −0.2	+0.3 5.17 −0.0	+0.1 1.35 −0.1	Al	U	270	0.91	4313 059 67131
R.18..8..3R270U.4.2A	+0.0 17.5 −0.5	+0.6 8.3 −0.0	+0.05 3.05 −0.05	Al	U	270	4.21	4313 059 67081

Material Specification — Sintered Ferroxdure

FXD 300, ANISOTROPIC CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 20 mm x 10 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure 300 is a barium ferrite, the main constituent being $BaFe_{12}O_{19}$

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	390	400	mT	3900	4000	Gs
H_{cB}	Coercivity	145	160	kA/m	1800	2000	Oe
H_{cJ}	Polarization coercivity	150	165	kA/m	1850	2050	Oe
$(BH)_{max}$	Maximum BH product	28.0	29.5	kJ/m^3	3.5	3.7	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	220	mT	-	2200	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	135	kA/m	-	1700	Oe
μ_{rec}	Recoil permeability	-	1.1	-	-	1.1	-
-	Temperature coefficient of B_r (–40 to +200 °C)	-	–0.2	%/K	-	–0.2	%/°C
-	Temperature coefficient of H_{cJ} (–40 to +200 °C)	-	≈0.8	kA/m/K	-	≈10	Oe/°C
H_{sat}	Saturation field strength	560	-	kA/m	-	7000	Oe
ρ	Resistivity	-	10^4	Ωm	-	10^6	Ωcm
-	Curie point	-	450	°C	-	450	°C

Physical properties

PARAMETER	VALUES
Density	(typical) 4.9 x 10^3 kg/m^3 (4.9 g/cm^3)
Coefficient of linear expansion (20 to 300 °C)	⊥ MA 8 and // MA 13 x 10^{-6}/K
Hardness (Moh's scale)	(typical) 6.5

Material Specification Sintered Ferroxdure

Direction of magnetization

Ferroxdure 300 is an anisotropic material and has therefore a preferred direction of magnetization (magnetic axis), which must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

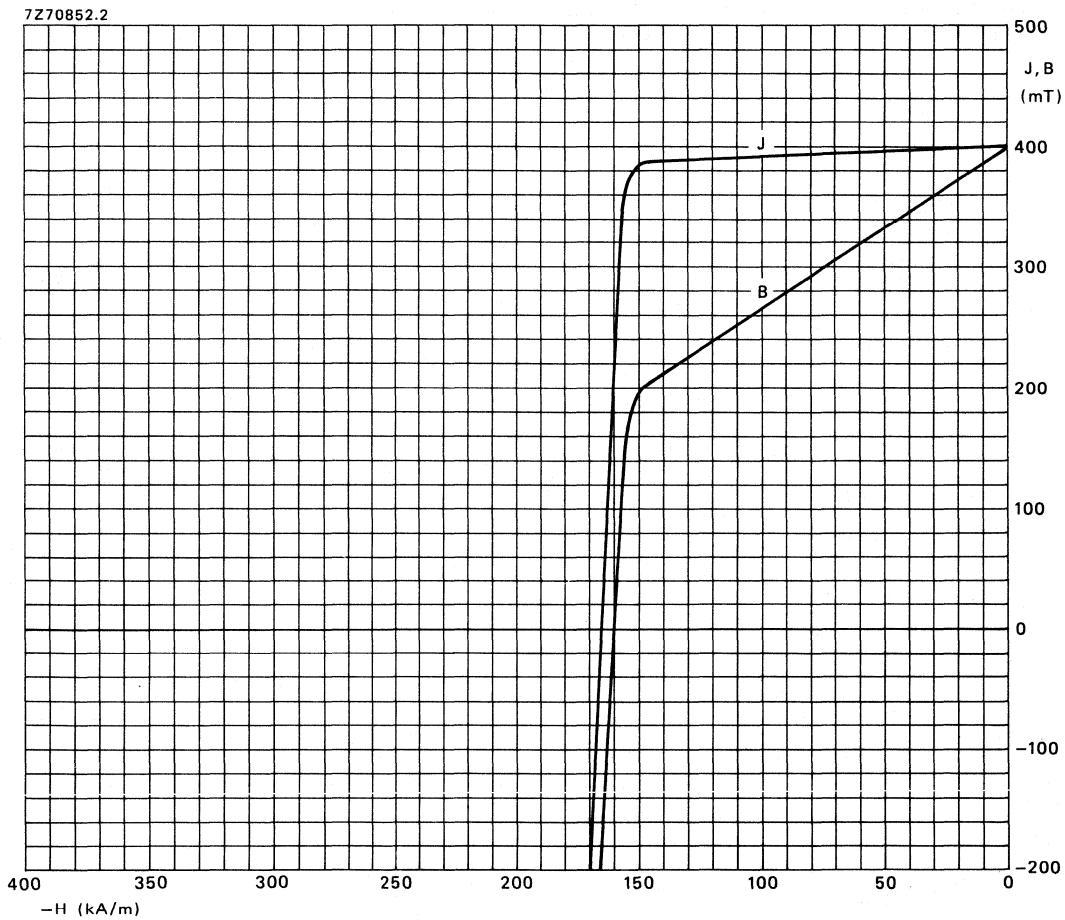


Fig.1 Typical demagnetization curve (20 °C) FXD 300.

Material Specification — Sintered Ferroxdure

FXD 330, ANISOTROPIC CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 20 mm x 10 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure 330 is a strontium ferrite, the main constituent being $SrFe_{12}O_{19}$.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	360	370	mT	3600	3700	Gs
H_{cB}	Coercivity	230	245	kA/m	2900	3100	Oe
H_{cJ}	Polarization coercivity	240	255	kA/m	3000	3200	Oe
$(BH)_{max}$	Maximum BH product	24.1	25.5	kJ/m^3	3.0	3.2	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	180	mT	-	1800	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	140	kA/m	-	1750	Oe
μ_{rec}	Recoil permeability	-	1.1	-	-	1.1	-
-	Temperature coefficient of B_r (–40 to +200 °C)	-	–0.2	%/K	-	–0.2	%/°C
-	Temperature coefficient of H_{cJ} (–40 to +200 °C)	-	≈0.95	kA/m/K	-	≈12	Oe/°C
H_{sat}	Saturation field strength	875	-	kA/m	11000	-	Oe
ρ	Resistivity	-	10^4	Ωm	-	10^6	Ωcm
-	Curie point	-	450	°C	-	450	°C

Physical properties

PARAMETER	VALUES
Density	(typical) 4.65 x 10^3 kg/m^3 (4.65 g/cm^3)
Coefficient of linear expansion (20 to 300 °C)	⊥ MA 8 and // MA 13 x 10^{-6}/K
Hardness (Moh's scale)	(typical) 6.5

Material Specification Sintered Ferroxdure

Direction of magnetization

Ferroxdure 330 is an anisotropic material and has therefore a preferred direction of magnetization (magnetic axis), which must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

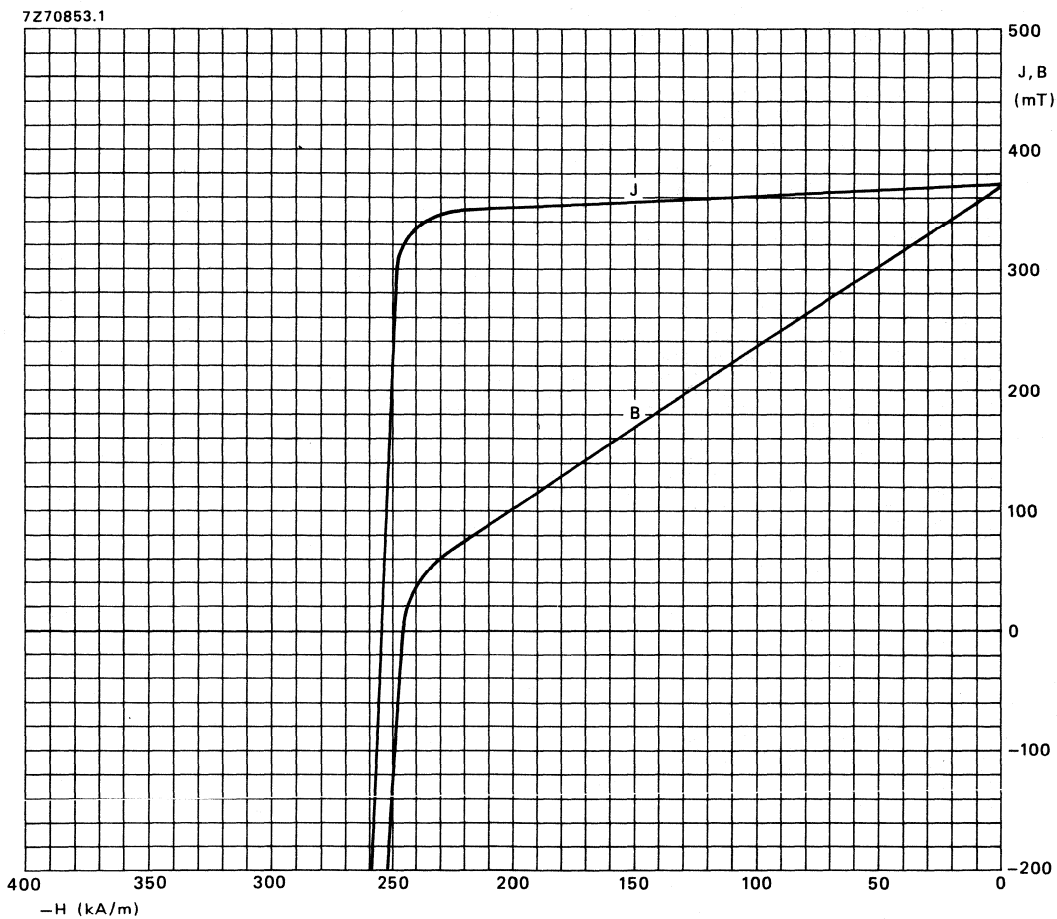


Fig.1 Typical demagnetization curve (20 °C) FXD 330.

Material Specification — Sintered Ferroxdure

FXD 380, ANISOTROPIC CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 20 mm x 10 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure 380 is a strontium ferrite, the main constituent being $SrFe_{12}O_{19}$.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	380	390	mT	3800	3900	Gs
H_{cB}	Coercivity	250	265	kA/m	3100	3300	Oe
H_{cJ}	Polarization coercivity	260	275	kA/m	3300	3500	Oe
$(BH)_{max}$	Maximum BH product	26.9	28.2	kJ/m^3	3.4	3.6	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	190	mT	-	1900	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	150	kA/m	-	1850	Oe
μ_{rec}	Recoil permeability	-	1.1	-	-	1.1	-
-	Temperature coefficient of B_r (–40 to +200 °C)	-	–0.2	%/K	-	–0.2	%/°C
-	Temperature coefficient of H_{cJ} (–40 to +200 °C)	-	≈0.95	kA/m/K	-	≈12	Oe/°C
H_{sat}	Saturation field strength	955	-	kA/m	12000	-	Oe
ρ	Resistivity	-	10^4	Ωm	-	10^6	Ωcm
-	Curie point	-	450	°C	-	450	°C

Physical properties

PARAMETER	VALUES
Density	(typical) 4.75 x 10^3 kg/m^3 (4.75 g/cm^3)
Coefficient of linear expansion (20 to 300 °C)	⊥ MA 8 and // MA 13 x 10^{-6}/K
Hardness (Moh's scale)	(typical) 6.5

Material Specification — Sintered Ferroxdure

Direction of magnetization

Ferroxdure 380 is an anisotropic material and has therefore a preferred direction of magnetization (magnetic axis), which must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

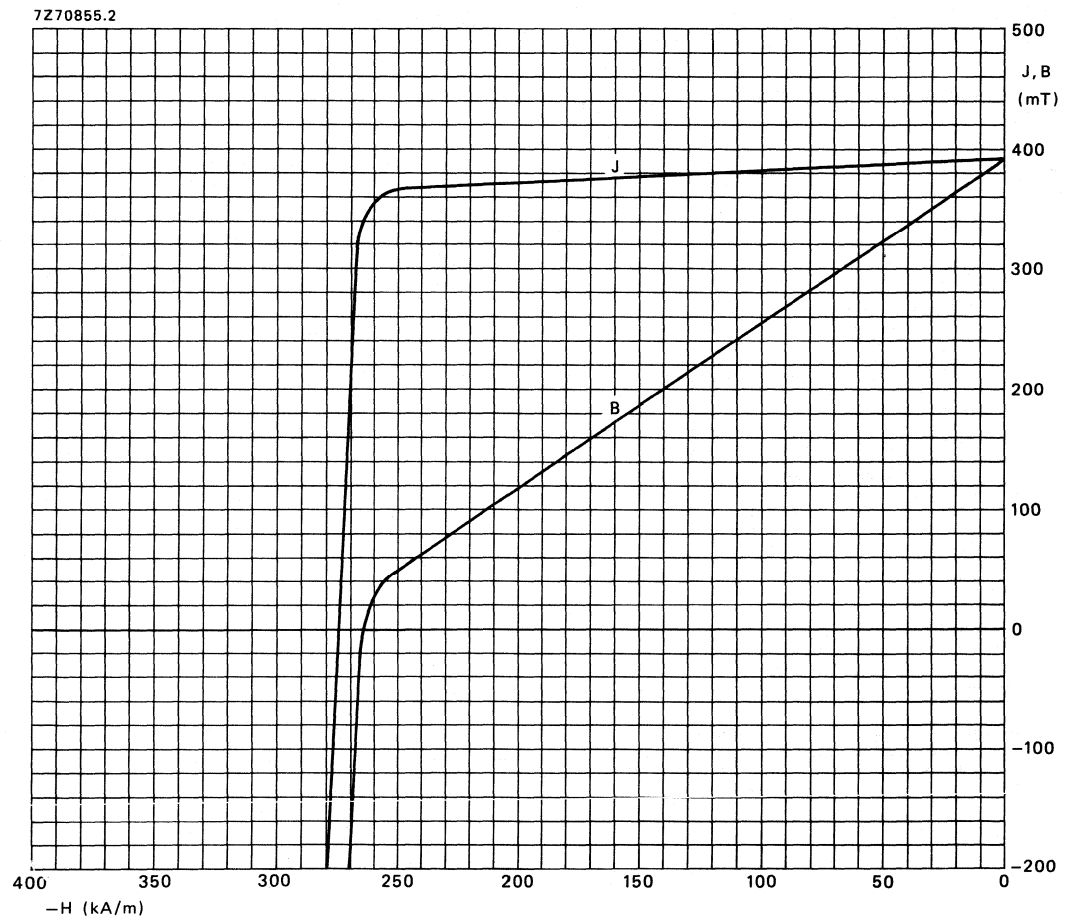


Fig.1 Typical demagnetization curve (20 °C) FXD 380.

Material Specification — Sintered Ferroxdure

FXD 400, ANISOTROPIC CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately Ø 20 mm x 10 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure 400 is a strontium ferrite, the main constituent being $SrFe_{12}O_{19}$.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	400	410	mT	4000	4100	Gs
H_{cB}	Coercivity	250	265	kA/m	3100	3300	Oe
H_{cJ}	Polarization coercivity	260	275	kA/m	3300	3500	Oe
$(BH)_{max}$	Maximum BH product	29.8	31.3	kJ/m^3	3.7	3.9	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	200	mT	-	2000	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	155	kA/m	-	1950	Oe
μ_{rec}	Recoil permeability	-	1.1	-	-	1.1	-
-	Temperature coefficient of B_r (–40 to +200 °C)	-	–0.2	%/K	-	–0.2	%/°C
-	Temperature coefficient of H_{cJ} (–40 to +200 °C)	-	≈0.95	kA/m/K	-	≈12	Oe/°C
H_{sat}	Saturation field strength	955	-	kA/m	12000	-	Oe
ρ	Resistivity	-	10^4	Ωm	-	10^6	Ωcm
-	Curie point	-	450	°C	-	450	°C

Physical properties

PARAMETER	VALUES
Density	(typical) 4.8 x 10^3 kg/m^3 (4.8 g/cm^3)
Coefficient of linear expansion (20 to 300 °C)	⊥ MA 8 and // MA 13 x 10^{-6}/K
Hardness (Moh's scale)	(typical) 6.5

Material Specification — Sintered Ferroxdure

Direction of magnetization

Ferroxdure 400 is an anisotropic material and has therefore a preferred direction of magnetization (magnetic axis), which must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

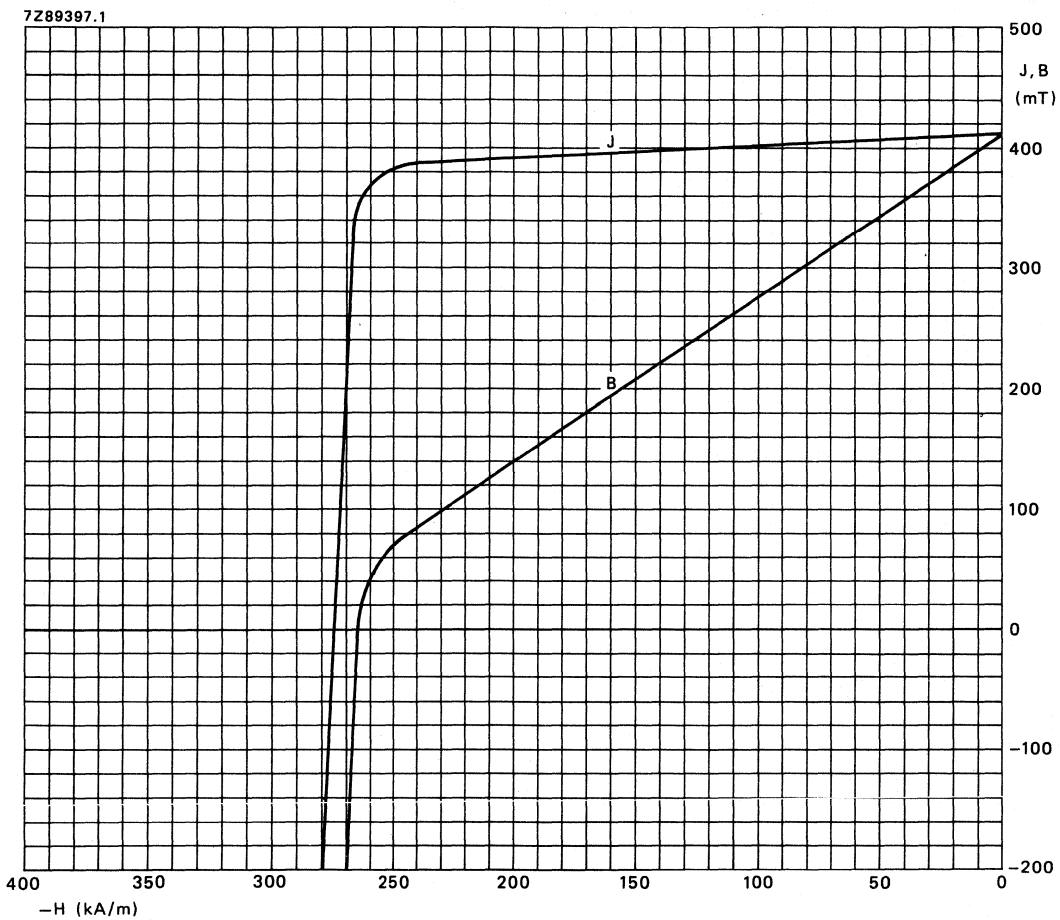


Fig.1 Typical demagnetization curve (20 °C) FXD 400.

Material Specification Sintered Ferroxdure

FXD 480, ANISOTROPIC CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately Ø 20 mm x 10 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure 480 is a strontium ferrite, the main constituent being $SrFe_{12}O_{19}$.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	370	380	mT	3700	3800	Gs
H_{cB}	Coercivity	270	280	kA/m	3400	3500	Oe
H_{cJ}	Polarization coercivity	305	320	kA/m	3800	4000	Oe
$(BH)_{max}$	Maximum BH product	25.5	26.8	kJ/m^3	3.2	3.4	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	190	mT	-	1900	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	140	kA/m	-	1750	Oe
μ_{rec}	Recoil permeability	-	1.1	-	-	1.1	-
-	Temperature coefficient of B_r (–40 to +200 °C)	-	–0.2	%/K	-	–0.2	%/°C
-	Temperature coefficient of H_{cJ} (–40 to +200 °C)	-	≈0.95	kA/m/K	-	≈12	Oe/°C
H_{sat}	Saturation field strength	1115	-	kA/m	14000	-	Oe
ρ	Resistivity	-	10^4	Ωm	-	10^6	Ωcm
-	Curie point	-	450	°C	-	450	°C

Physical properties

PARAMETER	VALUES
Density	(typical) 4.7 x 10^3 kg/m^3 (4.7 g/cm^3)
Coefficient of linear expansion (20 to 300 °C)	⊥ MA 8 and // MA 13 x 10^{-6}/K
Hardness (Moh's scale)	(typical) 6.5

Material Specification — Sintered Ferroxdure

Direction of magnetization

Ferroxdure 480 is an anisotropic material and has therefore a preferred direction of magnetization (magnetic axis), which must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

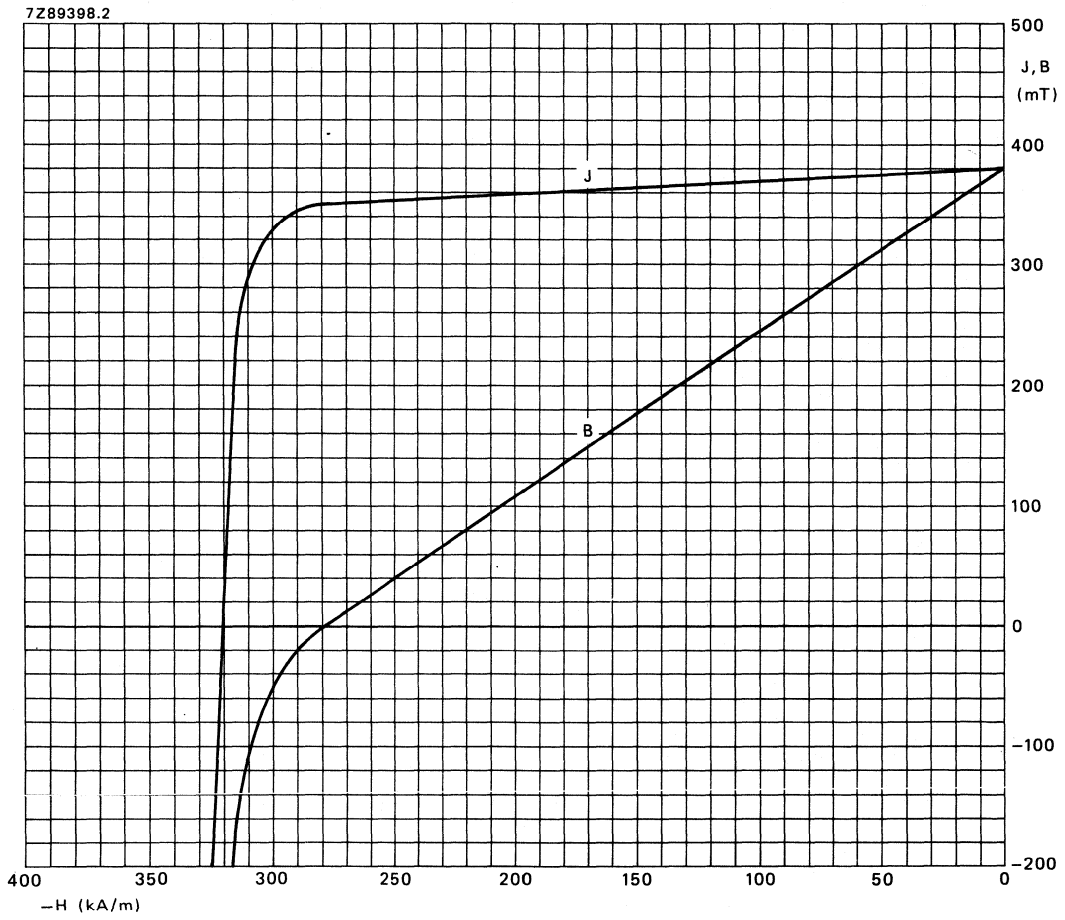


Fig.1 Typical demagnetization curve (20 °C) FXD 480.

Material Specification — Sintered Ferroxdure

FXD 500, ANISOTROPIC CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 20 mm x 10 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure 500 is a strontium ferrite, the main constituent being $SrFe_{12}O_{19}$.

Magnetic and electrical properties of the test piece

Tentative data
Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	390	400	mT	3900	4000	Gs
H_{cB}	Coercivity	285	295	kA/m	3600	3700	Oe
H_{cJ}	Polarization coercivity	320	330	kA/m	4020	4150	Oe
$(BH)_{max}$	Maximum BH product	29.8	30.5	kJ/m^3	3.7	3.8	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	200	mT	-	2000	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	150	kA/m	-	1900	Oe
μ_{rec}	Recoil permeability	-	1.1	-	-	1.1	-
-	Temperature coefficient of B_r (–40 to +200 °C)	-	–0.2	%/K	-	–0.2	%/°C
-	Temperature coefficient of H_{cJ} (–40 to +200 °C)	-	≈0.95	kA/m/K	-	≈12	Oe/°C
H_{sat}	Saturation field strength	1100	-	kA/m	14000	-	Oe
ρ	Resistivity	-	10^4	Ωm	-	10^6	Ωcm
-	Curie point	-	450	°C	-	450	°C

Physical properties

PARAMETER	VALUES
Density	(typical) 4.85 x 10^3 kg/m^3 (4.85 g/cm^3)
Coefficient of linear expansion (20 to 300 °C)	⊥ MA 8 and // MA 13 x 10^{-6}/K
Hardness (Moh's scale)	(typical) 6.5

Material Specification Sintered Ferroxdure

Direction of magnetization

Ferroxdure 500 is an anisotropic material and has therefore a preferred direction of magnetization (magnetic axis), which must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

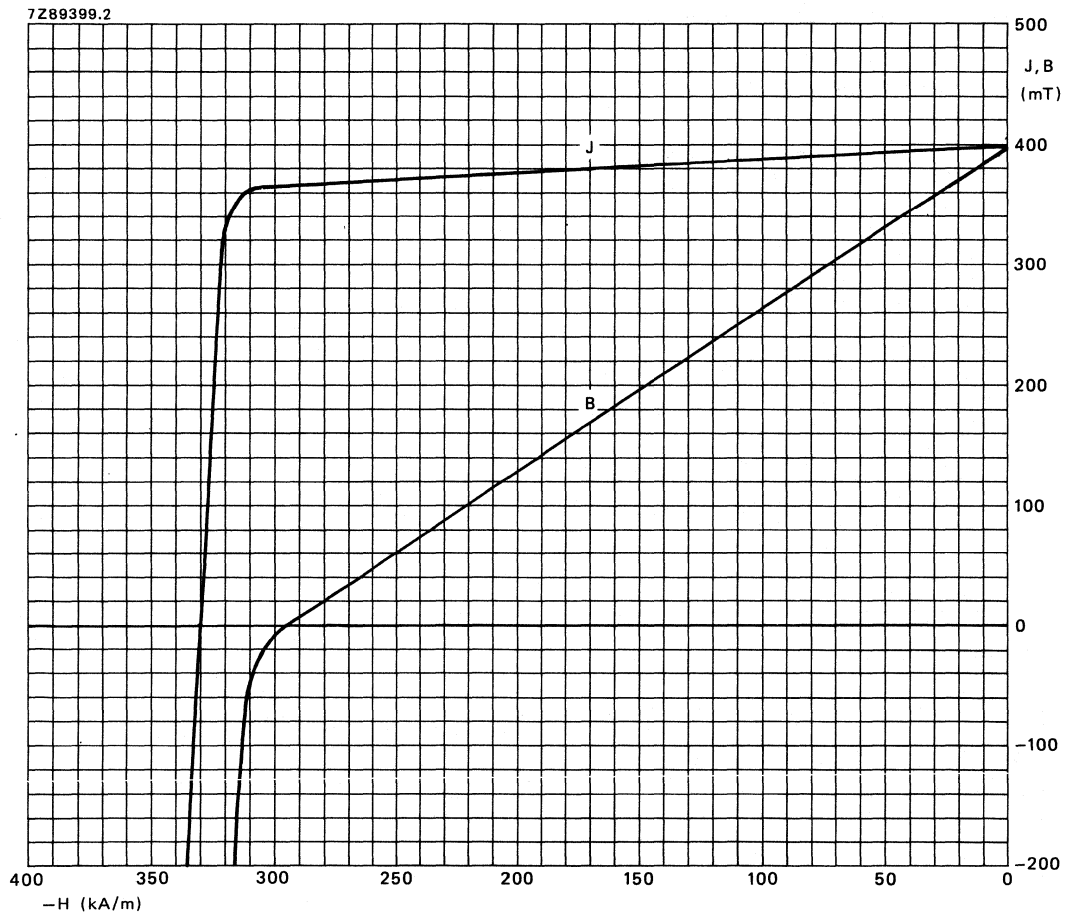


Fig.1 Typical demagnetization curve (20 °C) FXD 500.

Material Specification — Sintered Ferroxdure

FXD 520, ANISOTROPIC CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 20 mm x 10 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure 520 is a strontium ferrite, the main constituent being $SrFe_{12}O_{19}$.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	420	425	mT	4200	4250	Gs
H_{cB}	Coercivity	240	250	kA/m	3000	3100	Oe
H_{cJ}	Polarization coercivity	250	260	kA/m	3100	3300	Oe
$(BH)_{max}$	Maximum BH product	32.8	33.6	kJ/m^3	4.1	4.2	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	210	mT	-	2100	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	160	kA/m	-	2000	Oe
μ_{rec}	Recoil permeability	-	1.1	-	-	1.1	-
-	Temperature coefficient of B_r (–40 to +200 °C)	-	–0.2	%/K	-	–0.2	%/°C
-	Temperature coefficient of H_{cJ} (–40 to +200 °C)	-	≈0.95	kA/m/K	-	≈12	Oe/°C
H_{sat}	Saturation field strength	955	-	kA/m	12000	-	Oe
ρ	Resistivity	-	10^4	Ωm	-	10^6	Ωcm
-	Curie point	-	450	°C	-	450	°C

Physical properties

PARAMETER	VALUES
Density	(typical) 4.9 x 10^3 kg/m^3 (4.9 g/cm^3)
Coefficient of linear expansion (20 to 300 °C)	⊥ MA 8 and // MA 13 x 10^{-6}/K
Hardness (Moh's scale)	(typical) 6.5

Material Specification — Sintered Ferroxdure

Direction of magnetization

Ferroxdure 520 is an anisotropic material and has therefore a preferred direction of magnetization (magnetic axis), which must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

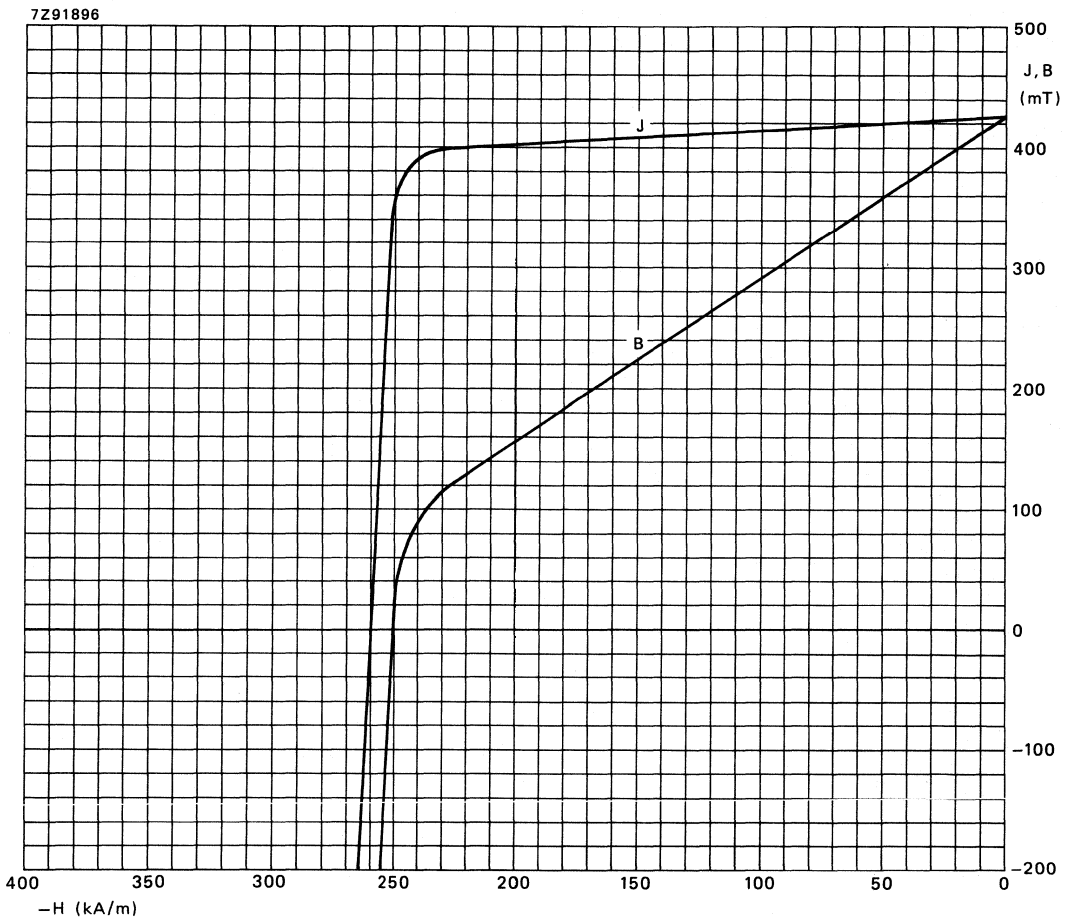


Fig.1 Typical demagnetization curve (20 °C) FXD 520.

Material Specification — Sintered Ferroxdure

FXD 580, ANISOTROPIC CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately ∅ 20 mm x 10 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure 580 is a strontium ferrite, the main constituent being $SrFe_{12}O_{19}$.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	375	385	mT	3750	3850	Gs
H_{cB}	Coercivity	290	300	kA/m	3640	3770	Oe
H_{cJ}	Polarization coercivity	350	360	kA/m	4400	4520	Oe
$(BH)_{max}$	Maximum BH product	26.2	27.6	kJ/m^3	3.3	3.5	MGsOe
B_d	Magnetic flux density corresponding to $(BH)_{max}$	-	190	mT	-	1900	Gs
H_d	Magnetic field strength corresponding to $(BH)_{max}$	-	145	kA/m	-	1800	Oe
μ_{rec}	Recoil permeability	-	1.1	-	-	1.1	-
-	Temperature coefficient of B_r (–40 to +200 °C)	-	–0.2	%/K	-	–0.2	%/°C
-	Temperature coefficient of H_{cJ} (–40 to +200 °C)	-	≈0.95	kA/m/K	-	≈12	Oe/°C
H_{sat}	Saturation field strength	1200	-	kA/m	15000	-	Oe
ρ	Resistivity	-	10^4	Ωm	-	10^6	Ωcm
-	Curie point	-	450	°C	-	450	°C

Physical properties

PARAMETER	VALUES
Density	(typical) 4.85 x 10^3 kg/m^3 (4.85 g/cm^3)
Coefficient of linear expansion (20 to 300 °C)	⊥ MA 8 and // MA 13 x 10^{-6}/K
Hardness (Moh's scale)	(typical) 6.5

Material Specification Sintered Ferroxdure

Direction of magnetization

Ferroxdure 580 is an anisotropic material and has therefore a preferred direction of magnetization (magnetic axis), which must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

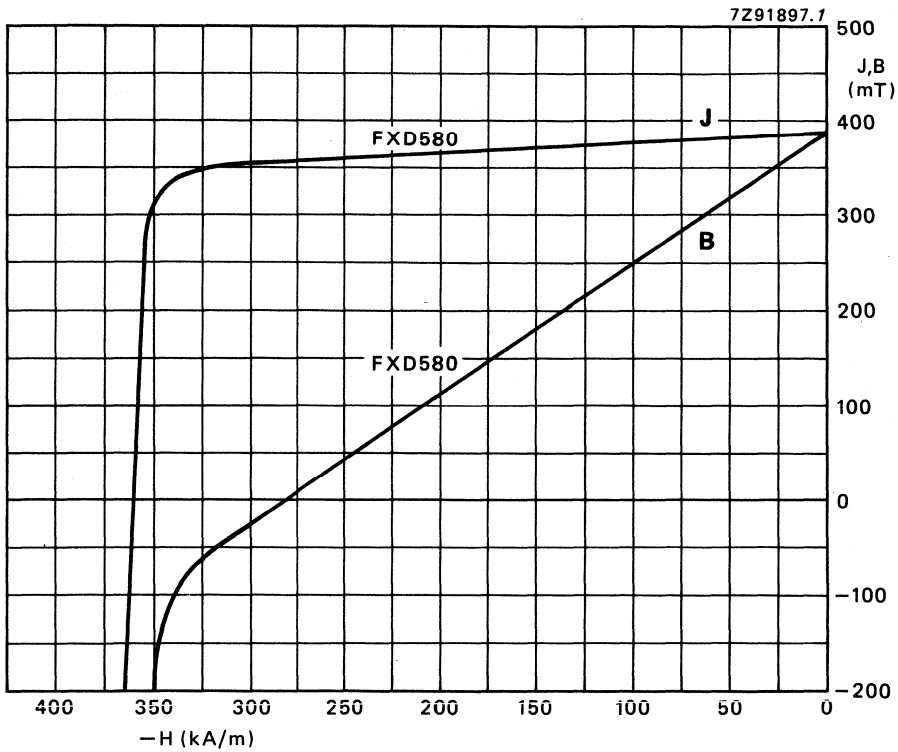


Fig.1 Typical demagnetization curve (20 °C) FXD 580.

Magnet Type List Sintered Ferroxdure

ANISOTROPIC SINTERED FERROXDURE

The magnet type list gives initial information on the main dimensions etc, of types for which tooling already exists. Choice of a type from this list eliminates the need for new tools and consequent delay in delivery. It is important to check with the supplier if the data is still valid. Frequent additions, eliminations or changes may render the survey in this data handbook outdated. In that case, an updated list should be consulted.

The exact mechanical and magnetic data and the correct code number (last digit) have been laid down in the magnet specifications, which exist for each type, and which will be sent on request.

For anisotropic sintered ferroxdure, most shapes can be supplied in another material grade than that listed, however, due to different shrinkage properties, some differences in dimensions may be expected.

For optimum results, supply of pre-magnetized magnets is not always advisable because self-demagnetization may occur due to unfavourable combinations of grade, the ratio of magnetic area to magnetic length and temperature variation.

Permanent magnets can also be ordered to your own design (within the limits of the material and manufacturing techniques). Our technical assistance on the design and application of permanent magnets is always at your disposal.

The indication S, in some cases placed after the material grade, means that the product in question has magnetic properties which deviate slightly from the basic properties of that material grade.

The magnet type list of ferroxdure products is divided into 5 different shapes:

For anisotropic sintered ferroxdure

- Blocks
- Discs and rods (axially oriented)
- Cylinders (diametrically oriented)
- Rings (axially oriented)
- Segments

Magnet Type List — Sintered Ferroxdure

Blocks

Orientation: perpendicular to a x b

E = Magnetized perpendicular to a x b

U = Unmagnetized

Where more than one ordering code number is mentioned in the table, the first is of an unmagnetized product (U), the second is of a magnetized product (E).

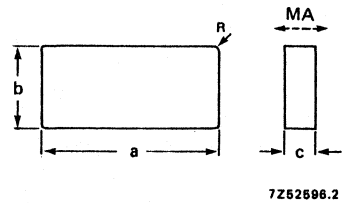


Fig.1 Blocks.

Magnet type list: Blocks

TYPE DESCRIPTION	a (mm)	b (mm)	c (mm)	FXD	MASS (gr)	ORDERING CODE
B.12..8..7F330E.3.2.	+0.1 12.0 −0.5	+3.0 8.0 −0.3	+0.3 7.0 −0.0	330	3.2	4311 021 31221
B.12.11..7F330U.4.6. B.12.11..7F330E.4.6.	+0.1 12.0 −0.5	+0.0 11.0 −0.6	+0.1 7.0 −0.1	330	4.6	4311 021 30152 4311 021 31291
B.13.10..5F330E.3.1.	+0.3 13.0 −0.3	+0.3 10.0 −0.3	+0.4 5.0 −0.4	330	3.1	4311 021 32681
B.17.10..5F330E.4.3.	+0.4 17.0 −0.4	+0.3 10.0 −0.3	+0.4 5.0 −0.4	330	4.3	4311 021 30981
B.18.15..9F330E..11.	+0.0 18.0 −0.9	+0.0 15.0 −0.7	+0.0 9.0 −0.1	330	10.8	4311 021 31922
B.20.10..5F330E.4.6.	+0.5 20.0 −0.5	+0.3 10.0 −0.3	+0.4 5.0 −0.4	330	4.6	4311 021 30721
B.25.11..6F330U.7.2.	+0.5 25.0 −0.5	+0.3 11.0 −0.3	+0.5 5.6 −0.5	330	7.2	4311 021 35071
B.30.30..8F380U..36.	+0.7 30.0 −0.7	+0.7 30.0 −0.7	+0.05 8.0 −0.05	380 S	35.5	4322 020 67352
B.40.21.10F330E..41.	+1.0 40.0 −1.0	+0.5 21.0 −0.5	+0.05 10.0 −0.05	330	41	4311 021 30263
B.40.25.10F330U..46. B.40.25.10F330E..46.	+1.0 40.0 −1.0	+0.75 25.0 −0.75	+0.1 10.0 −0.1	330	46	4322 020 62301 4322 020 62181
B.43.26..9F300U..48.	+1.6 42.5 −0.0	+1.2 25.2 −0.0	+0.05 8.8 −0.05	300 S	48	4311 021 37802

Magnet Type List — Sintered Ferroxdure

TYPE DESCRIPTION	a (mm)	b (mm)	c (mm)	FXD	MASS (gr)	ORDERING CODE
B.43.26..9F330U..46.	+1.6 42.5 –0.0	+1.2 25.2 –0.0	+0.05 8.8 –0.05	330	46	4311 021 34563
B.49.49..4F330U..54.	+1.2 49.2 –1.2	+1.2 49.2 –1.2	+0.5 4.5 –0.5	330	53.5	4311 021 33631
B.50.19..5F330U..21. B.50.19..5F330E..21.	+1.3 50.0 –1.3	+0.5 19.0 –0.5	+0.0 4.9 –0.25	330	21	4322 020 62221 4322 020 62271
B.50.19..6F330U..26. B.50.19..6F330E..26.	+1.3 50.0 –1.3	+0.5 19.0 –0.5	+0.1 6.1 –0.1	330	26	4322 020 62191 4322 020 62212
B.50.19..5F380U..21.	+1.3 50.0 –1.3	+0.5 19.0 –0.5	+0.0 4.9 –0.25	380	21	4322 021 37821
B.53.53..8F330U.123.	+3.0 51.5 –0.0	+3.0 51.5 –0.0	+0.05 8.4 –0.05	330 S	123	4322 020 67332
B.60.20.15F330E..85R	+1.5 60.0 –1.5	+0.6 20.0 –0.6	+0.5 15.0 –0.5	330	85	4311 021 35881
B.64.32.20F330U.192.	+1.5 64.0 –1.5	+0.7 32.0 –0.7	+0.1 20.0 –0.1	330	192	4311 021 36051
B.75.50.20F330U.353. B.75.50.20F330E.353.	+2.0 75.0 –2.0	+1.5 50.0 –1.5	+0.1 19.9 –0.1	330	353	4322 020 62311 4322 020 62321
B100.75.25F330U.900. B100.75.25F330E.900.	+2.5 100.0 –2.5	+1.9 75.0 –1.9	+0.2 25.4 –0.2	330	900	4311 021 32331 4311 020 32911
B131.51.15F330U.460.	+3.0 131.0 –3.0	+1.5 51.0 –1.5	+0.2 15.0 –0.2	330	460	4322 020 62471
B131.51.17F330U.550. B131.51.17F330E.550.	+3.0 131.0 –3.0	+1.5 51.0 –1.5	+0.2 17.5 –0.2	330	550	4322 020 62142 4322 020 62481
B150100.25F330U1800. B150100.25F330E1800.	+3.7 150.0 –3.7	+2.5 100.0 –2.5	+0.2 25.4 –0.2	330	1800	4322 020 62332 4322 020 62342

Magnet Type List — Sintered Ferroxdure

Discs and rods

Orientation: axial (A)

Where more than one ordering code number is mentioned, the first is of an unmagnetized product (U), the second is of a magnetized one (A).

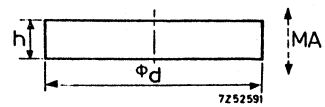


Fig.2 Discs and rods.

Magnet type list: Discs and rods

TYPE DESCRIPTION	d (mm)	h (mm)	FXD	MASS (gr)	ORDERING CODE
D.12.....6F330U.3.3. D.12.....6F330A.3.3.	+0.3 12.0 −0.3	+0.4 6.0 −0.4	330 S	3.3	4311 021 38151 4311 021 33692
D.29.....7F330A..23.	+0.75 29.25 −0.75	+0.2 7.2 −0.2	330	22.6	4311 021 31391
D.29....10F330A..33.	+0.75 29.25 −0.75	+0.5 10.5 −0.5	330	33	4311 021 32571
D.39.....7F300U..39.	+1.0 39.0 −1.0	+0.1 7.0 −0.1	300	39.5	4311 021 34711
D.45.....9F330U..68.	+1.0 45.0 −1.0	+0.1 9.0 −0.1	330	67.7	4311 021 34871
D.53.....9F300U..94.	+1.3 53.0 −1.3	+0.1 9.0 −0.1	300	94	4311 021 34721

Magnet Type List Sintered Ferroxdure

Cylinders

Orientation: diametrical

Where more than one ordering code number is mentioned, the first is of an unmagnetized product (U), the second is of a magnetized one.

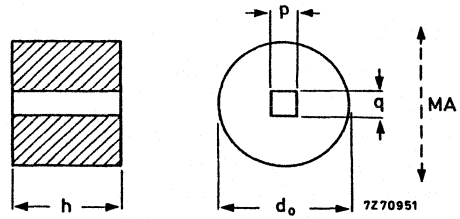


Fig.3 Cylinders.

Magnet type list: Cylinders

TYPE DESCRIPTION	d_o (mm)	p x q (mm)	h (mm)	FXD	MASS (gr)	ORDERING CODE
C.15..4..8F380U.6.2.	+0.03 14.7 –0.03	4.5 ±0.3 x 3.9 ±0.3	+0.1 8.0 –0.1	380 S	6.2	4203 014 80280

Magnet Type List Sintered Ferroxdure

Rings

Orientation: axial (A)

These are mainly for loudspeakers.

Unmagnetized versions only are listed, magnetized products from this range are also available. Some loss of performance can be expected when using pre-magnetized rings. The extent of this is dependent on dimensions and storage conditions. Please ask for details.

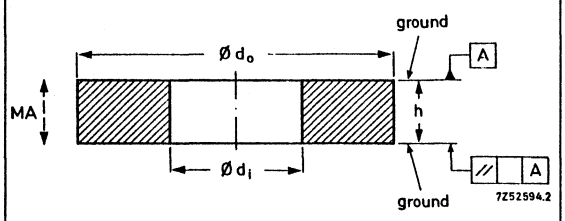


Fig.4 Rings.

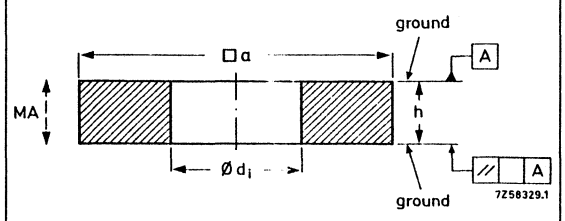


Fig.5 Rings.

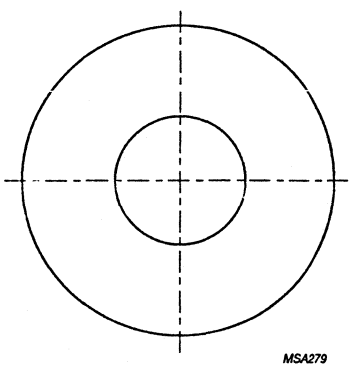


Fig.6 Rings.

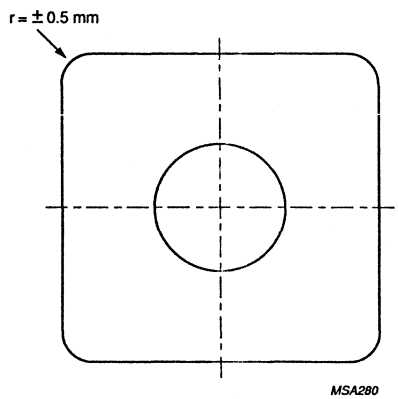


Fig.7 Rings.

Magnet Type List — Sintered Ferroxdure

Magnet type list: Rings

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	h (mm)	FXD	MASS (gr)	ORDERING CODE
R.26.13..4F300U.7.3.	+0.5 25.7 –0.5	+0.5 12.8 –0.5	+0.05 3.8 –0.05	300	7.3	4311 021 37522
P.28.13..5F300U..17.	+0.7 28.5 –0.7	+0.4 12.9 –0.4	+0.15 5.0 –0.15	300	17	4311 021 35001
R.30.16..5F300U..12.	+0.75 30.0 –0.75	+0.4 16.0 –0.4	+0.1 5.0 –0.1	300	12.4	4311 021 37271
R.36.18..6F300U..23.	+0.8 36.0 –0.8	+0.5 18.0 –0.5	+0.1 6.0 –0.1	300	23	4311 021 35211
R.36.18..8F300U..30.	+0.8 36.0 –0.8	+0.5 18.0 –0.5	+0.1 8.0 –0.1	300	30	4311 021 36841
R.40.22..9F300U..39.	+1.3 40.0 –0.7	+0.5 22.0 –0.5	+0.1 9.0 –0.1	300	39	4311 021 36611
R.45.22..8F300U..47.	+1.0 45.0 –1.0	+0.6 22.0 –0.6	+0.1 8.0 –0.1	300	47	4311 021 35221
R.45.22..9F300U..53.	+1.0 45.0 –1.0	+0.6 22.0 –0.6	+0.1 9.0 –0.1	300	53	4311 021 36621
R.51.24..9F300U..70.	+1.2 51.0 –1.2	+0.6 24.0 –0.6	+0.1 9.0 –0.1	300	70	4311 021 36651
R.55.24..8F300U..75.	+1.2 55.0 –1.2	+0.6 24.0 –0.6	+0.1 8.0 –0.1	300	75	4311 021 36671
R.55.24.12F300U.113.	+1.2 55.0 –1.2	+0.6 24.0 –0.6	+0.1 12.0 –0.1	300	113	4311 021 35911
R.60.24..9F300U.105.	+1.5 60.0 –1.5	+0.6 24.0 –0.6	+0.1 9.0 –0.1	300	105	4311 021 35921
R.60.24.13F300U.151.	+1.5 60.0 –1.5	+0.6 24.0 –0.6	+0.1 13.0 –0.1	300	151	4311 021 36731
R.60.30.10F300U.104.	+1.5 60.0 –1.5	+0.7 30.0 –0.7	+0.1 10.0 –0.1	300	104	4311 021 36761

Magnet Type List — Sintered Ferroxdure

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	h (mm)	FXD	MASS (gr)	ORDERING CODE
R.60.30.13F300U.136.	+1.5 60.0 −1.5	+0.7 30.0 −0.7	+0.1 13.0 −0.1	300	136	4311 021 36771
R.72.32.10F380U.160.	+1.5 72.0 −1.5	+0.7 32.0 −0.7	+0.1 10.0 −0.1	380	160	4322 020 60622
R.72.32.12F300U.192.	+1.5 72.0 −1.5	+0.7 32.0 −0.7	+0.1 12.0 −0.1	300	192	4311 021 35761
R.72.32.15F300U.240.	+1.5 72.0 −1.5	+0.7 32.0 −0.7	+0.1 15.0 −0.1	300	240	4322 020 60243
R.72.32.18F300U.288.	+1.5 72.0 −1.5	+0.7 32.0 −0.7	+0.1 18.0 −0.1	300	288	4311 021 32881
R.72.32.20F300U.320.	+1.5 72.0 −1.5	+0.7 32.0 −0.7	+0.1 20.0 −0.1	300	320	4311 021 35771
R.84.32.15F300U.345.	+1.8 84.0 −1.8	+0.9 32.0 −0.9	+0.1 15.0 −0.1	300	345	4322 020 60271
R.84.42.15F300U.306.	+2.1 84.0 −2.1	+1.1 42.0 −1.1	+0.15 15.0 −0.15	300	306	4322 020 60981
R.90.36.17F300U.448.	+1.8 90.0 −1.8	+0.9 36.0 −0.9	+0.15 17.0 −0.15	300	448	4322 020 60281
R.90.42.17F300U.415.	+1.8 90.0 −1.8	+1.1 42.0 −1.1	+0.15 17.0 −0.15	300	415	4322 020 60751
R100.45.18F300U.552.	+2.5 100.0 −2.5	+1.1 45.0 −1.1	+0.15 18.0 −0.15	300	552	4311 021 35231
R102.51.14F300U.420.	+3.0 102.0 −3.0	+1.5 51.0 −1.5	+0.15 14.0 −0.15	300	420	4322 020 60311
R102.51.18F300U.540.	+3.0 102.0 −3.0	+1.5 51.0 −1.5	+0.15 18.0 −0.15	300	540	4311 021 33901
R102.51.20F300U.600.	+3.0 102.0 −3.0	+1.5 51.0 −1.5	+0.2 20.0 −0.2	300	600	4311 021 35791
R102.57.12F300U.330.	+3.0 102.0 −3.0	+1.5 57.0 −1.5	+0.15 12.0 −0.15	300	330	4322 020 60791

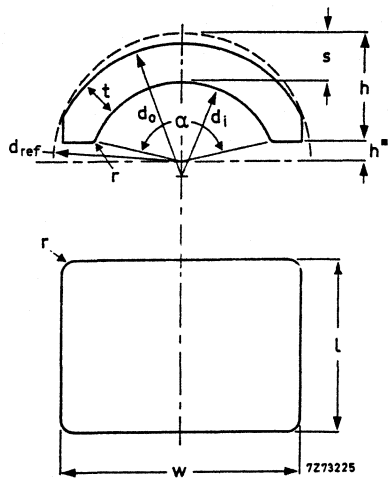
Magnet Type List — Sintered Ferroxdure

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	h (mm)	FXD	MASS (gr)	ORDERING CODE
R102.57.15F300U.415.	+3.0 102.0 –3.0	+1.5 57.0 –1.5	+0.15 15.0 –0.15	300	415	4322 020 60961
R102.57.17F300U.470.	+3.0 102.0 –3.0	+1.5 57.0 –1.5	+0.15 17.0 –0.15	300	470	4322 020 60931
R110.45.18F300U.698.	+3.0 110.0 –3.0	+1.1 45.0 –1.1	+0.15 18.0 –0.15	300	698	4311 021 35801
R110.57.20F300U.681.	+3.0 110.0 –3.0	+1.5 57.0 –1.5	+0.15 20.0 –0.15	300	681	4311 021 35811
R121.42.20F300U.991.	+3.6 121.0 –3.6	+1.1 42.0 –1.1	+0:15 20.0 –0.15	300	991	4311 021 35821
R121.57.12F300U.527.	+3.6 121.0 –3.6	+1.7 57.0 –1.7	+0.2 12.0 –0.2	300	527	4322 020 60321
R121.57.17F300U.767.	+3.6 121.0 –3.6	+1.7 57.0 –1.7	+0.2 17.5 –0.2	300	767	4322 020 60571
R121.57.20F300U.876.	+3.6 121.0 –3.6	+1.7 57.0 –1.7	+0.15 20.0 –0.15	300	876	4311 021 35831
R121.57.22F300U.965.	+3.6 121.0 –3.6	+1.7 57.0 –1.7	+0.2 22.0 –0.2	300	965	4311 021 37761
R121.57.24F300U1052.	+3.6 121.0 –3.6	+1.7 57.0 –1.7	+0.2 24.0 –0.2	300	1052	4311 021 36781
R121.64.20F300U.811.	+3.6 121.0 –3.6	+1.7 64.0 –1.7	+0.2 20.0 –0.2	300	811	4322 020 60901
R134.57.20F300U1132.	+4.0 134.0 –4.0	+1.7 57.0 –1.7	+0.2 20.0 –0.2	300	1132	4322 020 60021
R184.73.18F300U2032.	+5.5 184.0 –5.5	+2.2 73.0 –2.2	+0.2 18.5 –0.2	300	2032	4322 020 60351
R224122.23F300U3124.	+5.0 224.0 –5.0	+3.0 122.0 –3.0	+0.2 23.0 –0.2	300	3124	4311 021 35841

Magnet Type List Sintered Ferroxdure

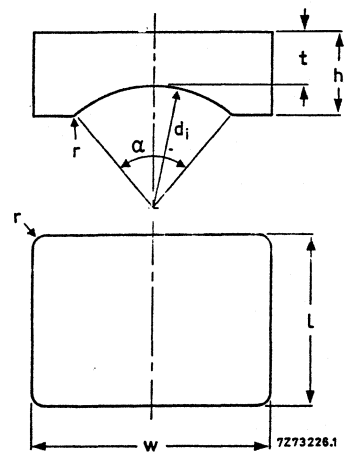
Segments for motors

Basic shapes (A,B and C)



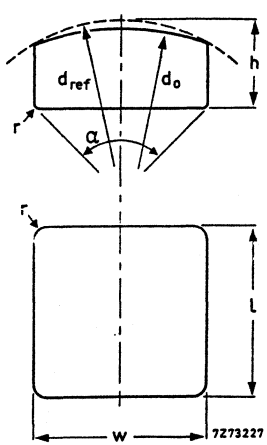
A

Fig.8 Concave-convex.



B

Fig.9 Flat-concave.



C

Fig.10 Flat-convex.

Magnet Type List Sintered Ferroxdure

The diameter d_{ref} corresponds with the maximum internal diameter of the stator housing. Most segments have an outer diameter $\geq d_{ref}$. In this way, two-point contact with the stator housing is obtained, avoiding rocking of the segment.

Variants on the feet of shapes A and B.

Fig.11 Variants on the feet.

Variants on the inner radii of shapes A and B.

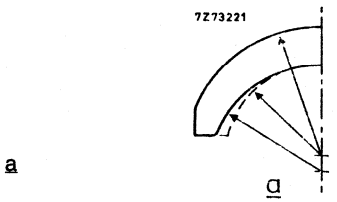


Fig.12 Divergence.

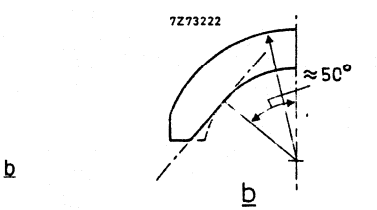


Fig.13 Tangential flats inside.

Variants on the outer radii of shapes A and C.

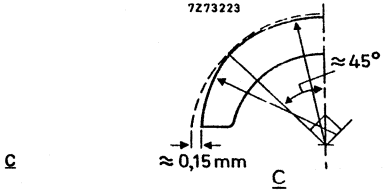


Fig.14 Contact point within 90 °C.

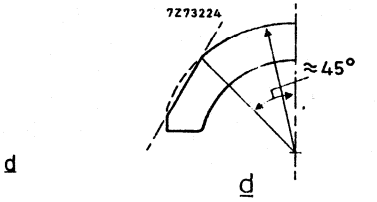


Fig.15 Outside flats.

Magnet Type List — Sintered Ferroxdure

In the ordering code column, the first number is for an unmagnetized segment (U), the second is for a magnetized segment. S pole inside (K), the third is for a magnetized segment, N pole inside (L).

Magnet type list: Concave-convex segments

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	l (mm)	w (mm)	h (mm)	s (mm)	α °	FXD	MASS (gr)	ORDERING CODE
S.24.18.14F330U.4.3.	≥ 23.8	≥ 17.6	+0.4 14.0 −0.4	+0.0 19.5 −0.7	+0.3 7.0 −0.3	≤ 3.1	120	330	4.3	4222 017 20251
S.28.20.15F330U.7.3.	≥ 28.0	≥ 20.2	+0.4 15.0 −0.4	+0.5 24.0 −0.5	10.2	≤ 3.9	140	330	7.3	4311 021 35112
S.28.20.24F330U..12. S.28.20.24F330K..12M S.28.20.24F330L..12.	≥ 28.0	≥ 20.2	+0.4 24.0 −0.6	+0.5 24.0 −0.5	10.2	≤ 3.9	140	330	11.7	4311 021 33502 4311 021 37562 4311 021 37572
S.28.22.18F330U.6.3.	≥ 28.0	≥ 21.8	+0.5 18.0 −0.5	+0.3 23.0 −0.3	+0.4 8.5 −0.4	≤ 3.1	120	330	6.3	4313 020 72962
S.30.22.18F330U.9.1.	+0.3 30.0 −0.0	≥ 21.8	+0.5 18.0 −0.5	+0.6 25.8 −0.6	+0.2 8.5 −0.2	≤ 4.1	120	330	9.1	4311 021 32053
S.30.22.20F330U..13.	≥ 30.0	≥ 21.8	+0.5 20.0 −0.5	+0.6 28.0 −0.6	+0.4 12.1 −0.4	≤ 4.1	150	330	12.6	4311 021 37541
S.30.22.26F330U..16.	≥ 30.0	≥ 21.8	+0.65 26.0 −0.65	+0.6 28.0 −0.6	+0.4 12.1 −0.4	≤ 4.1	150	330	16.0	4311 021 37591
S.32.24.20F330U..12.	≥ 31.9	≥ 24.0	+0.5 20.0 −0.5	+0.5 29.0 −0.5	+0.3 11.6 −0.3	≤ 4.0	140	330	11.9	4311 021 34421
S.36.24.30F400U..29.	≥ 36.0	≥ 24.0	+0.75 30.0 −0.75	+0.7 30.0 −0.7	+0.2 12.0 −0.2	≤ 6.1	130	400 S	29.0	4311 021 37244
S.36.28.26F400U..38.	≥ 36.2	≥ 27.9	+0.5 25.5 −0.5	+0.6 33.5 −0.6	+0.4 13.3 −0.4	≤ 4.1	140	400	38.0	4311 021 37882
S.37.27.30F330U..23.	≥ 37.0	≥ 27.0	+0.7 30.0 −0.7	+0.5 30.0 −0.5	+0.4 11.8 −0.4	≤ 4.9	125	330	22.5	4311 021 33511
S.38.29.25F380U..21.	≥ 38.2	≥ 29.1	+0.6 25.0 −0.6	+0.4 34.0 −0.3	+0.2 13.4 −0.2	≤ 4.5	135	380	21.0	4311 021 37921
S.38.29.25F400U..21.	≥ 38.2	≥ 29.1	+0.6 25.0 −0.6	+0.4 34.0 −0.3	+0.2 13.4 −0.2	≤ 4.5	135	400	21.0	4311 021 37652

Magnet Type List — Sintered Ferroxdure

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	l (mm)	w (mm)	h (mm)	s (mm)	α °	FXD	MASS (gr)	ORDERING CODE
S.38.29.40F330U..32.	≥ 38.1	≥ 28.8	+0.0 40.6 −2.0	+0.5 34.0 −0.5	+0.0 13.3 −0.5	≤ 4.5	135	330	32.1	4311 021 32506
S.38.29.41F330U..32.	≥ 38.1	≥ 28.8	+0.0 40.6 −2.0	+0.5 34.0 −0.5	+0.0 13.3 −0.5	≤ 4.55	135	330	32.0	4311 021 38201
S.38.30.40F400U..32.	≥ 38.1	+1.0 30.0 −0.0	+0.5 40.0 −1.1	+0.6 34.0 −0.6	+0.4 13.4 −0.4	≤ 4.5	133	400	32.0	4311 021 38361
S.38.30.40F400U..32.	≥ 38.1	+1.0 30.0 −0.0	+0.5 40.0 −1.1	+0.6 34.0 −0.6	+0.4 13.4 −0.4	≤ 4.5	135	400	32.0	4311 021 34624
S.38.29.22F380U..20.	≥ 38.1	≥ 28.8	+0.6 22.0 −0.6	+1.0 33.5 −0.0	+0.2 13.4 −0.2	≤ 4.6	135	380	20.0	4313 020 72932
S.41.31.31F400U..32.	≥ 41.0	≥ 31.2	+0.7 31.0 −0.7	+0.6 37.5 −0.6	+0.3 16.5 −0.3	≤ 4.8	150	400 S	32.0	4322 010 88482
S.43.33.32F330U..35.	≥ 42.8	≥ 32.8	+0.8 32.0 −0.8	+0.6 39.0 −0.6	+0.0 16.0 −1.0	≤ 5.2	140	330	35.0	4311 021 32151
S.44.33.37F380U..34.	≥ 44.3	+0.8 32.6 −0.0	+0.8 36.7 −0.8	+0.8 32.5 −0.0	+0.2 11.3 −0.2	≤ 5.8	100	380 S	34.0	4311 021 37384
S.44.33.47F380U..43.	≥ 44.3	+0.8 32.6 −0.0	+1.0 47.0 −1.0	+0.8 32.5 −0.0	+0.2 11.1 −0.2	≤ 5.8	100	380 S	43.0	4311 021 35586
S.44.33.29F330U..34.	≥ 44.1	+0.8 32.6 −0.0	+0.7 28.7 −0.7	+0.5 38.5 −0.5	+0.5 15.7 −0.5	≤ 5.7	140	330	33.5	4311 021 32462
S.46.34.33F520U..34.	≥ 46.2	≥ 34.5	+0.0 33.0 −1.3	+0.5 33.1 −0.5	+0.5 12.7 −0.5	≤ 6.5	105	520	34.0	4311 021 37891
S.46.39.45F380U..42.	≥ 46.2	≥ 38.8	+0.0 45.0 −1.8	+0.6 33.0 −0.6	+0.4 11.0 −0.4	≤ 6.4	95	380 S	41.5	4311 021 34472
S.46.36.29F380U..35.	≥ 46.2	≥ 36.0	+0.7 29.4 −0.7	+0.6 40.0 −0.6	+0.4 15.8 −0.4	≤ 5.8	130	380 S	35.0	4311 021 35201
S.46.33.45F380U..63.	≥ 46.0	≥ 33.2	+0.0 45.0 −1.8	+1.0 40.0 −1.0	+0.2 16.4 −0.2	≤ 6.2	135	380	63.0	4311 021 38211
S.46.34.35F380U..45.	≥ 46.4	≥ 34.3	+0.6 35.0 −1.0	+1.0 39.4 −0.0	+0.0 16.0 −0.4	≤ 6.0	130	380	45.0	4311 021 33706

Magnet Type List — Sintered Ferroxdure

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	l (mm)	w (mm)	h (mm)	s (mm)	α °	FXD	MASS (gr)	ORDERING CODE
S.49.36.22F330U..26.	≥ 49.0	≥ 35.8	+1.0 22.0 −1.0	+1.0 36.0 −1.0	+0.5 13.5 −0.5	≤ 6.6	105	330	26.5	4311 021 33281
S.53.40.44F380U..68.	+0.6 53.1 −0.0	+0.5 40.4 −0.5	+0.0 45.0 −2.0	+0.5 47.5 −0.5	+0.0 18.7 −0.5	≤ 6.3	135	380	68.5	4311 021 35444
S.53.43.45F520U..64.	≥ 53.2	≥ 42.6	+1.0 45.0 −1.0	+0.9 46.0 −0.9	+0.3 18.0 −0.3	≤ 5.9	130	400 S	63.5	4311 021 37863
S.53.43.45F480U..64.	≥ 53.2	≥ 42.6	+1.0 45.0 −1.0	+0.9 46.0 −0.9	+0.3 18.0 −0.3	≤ 5.9	130	480 S	63.5	4311 021 37051
S.53.41.35F380U..49R	≥ 53.2	≥ 41.0	+0.6 35.0 −1.0	+0.9 46.0 −0.9	+0.4 16.3 −0.4	≤ 6.0	120	380	49.0	4311 021 33574
S.53.41.45F330U..65.	≥ 53.4	≥ 41.2	+0.2 44.0 −0.0	+2.0 45.0 −0.0	-	≤ 6.2	120	330	64.6	4313 020 72671
S.54.39.46F400U..83.	≥ 53.5	≥ 39.0	+0.9 46.0 −0.9	+0.5 48.0 −0.5	+0.2 17.8 −0.2	≤ 7.1	135	400	83.0	4311 021 37872
S.54.39.46F380U..83.	≥ 53.5	≥ 39.0	+0.9 46.0 −0.9	+0.5 48.0 −0.5	+0.2 17.8 −0.2	≤ 7.1	135	380 S	83.0	4311 021 37622
S.55.44.35F380U..53.	≥ 55.2	≥ 43.6	+0.9 35.0 −0.9	+1.5 50.0 −0.0	+0.2 18.5 −0.2	≤ 5.8	130	380	53.0	4311 021 38221
S.55.44.37F380U..69.	≥ 55.1	+1.0 44.0 −0.0	+1.0 37.0 −1.0	+1.5 51.0 −1.0	+0.2 19.2 −0.2	≤ 7.1	135	380 S	69.0	4311 021 37221
S.55.44.45F400U..85. S.55.44.45F400K..85. S.55.44.45F400L..85.	≥ 55.1	+1.0 44.0 −0.0	+0.5 45.0 −1.1	+0.0 51.0 −1.5	+0.2 19.2 −0.2	≤ 7.1	135	400	85.0	4311 021 37232 4311 021 38111 4311 021 38121
S.55.44.40F480U..60.	≥ 55.2	≥ 43.6	+1.0 40.0 −1.0	+1.5 50.0 −0.0	+0.2 18.7 −0.2	≤ 5.8	130	480 S	60.0	4311 021 37343
S.55.44.50F480U..75.	≥ 55.2	≥ 43.6	+1.0 50.0 −1.0	+1.5 49.5 −0.0	+0.2 18.7 −0.2	≤ 5.8	130	480 S	75.0	4311 021 37332
S.55.44.40F380U..60.	≥ 55.2	≥ 43.6	+1.0 40.0 −1.0	+1.5 50.0 −0.0	+0.2 18.7 −0.2	≤ 5.7	130	380	60.0	4311 021 38241
S.55.44.50F380U..75.	≥ 55.2	≥ 43.6	+1.0 50.0 −1.0	+1.5 50.0 −0.0	+0.2 18.7 −0.2	≤ 5.7	130	380	75.0	4311 021 38351

Magnet Type List — Sintered Ferroxdure

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	l (mm)	w (mm)	h (mm)	s (mm)	α °	FXD	MASS (gr)	ORDERING CODE
S.56.44.38F480U..58.	≥ 55.7	≥ 44.1	+1.9 37.1 −0.0	≥ 50.0	-	≤ 5.8	135	480 S	58.0	4311 021 34403
S.56.44.39F380U..64.	≥ 56.0	≥ 43.6	+2.0 38.0 −0.0	+2.0 47.0 −0.0	-	≤ 6.3	130	380	64.0	4313 020 72793
S.56.44.28F330U..45.	≥ 56.2	≥ 43.6	+0.8 27.5 −0.8	+1.2 48.2 −1.2	+0.5 19.0 −0.5	≤ 6.3	125	330	45.0	4313 020 73021
S.56.44.35F330U..59.	≥ 56.2	≥ 43.6	+0.7 35.0 −0.7	+1.0 50.0 −1.0	+0.2 19.0 −0.2	≤ 6.3	130	330	59.0	4311 021 31885
S.57.41.21F330K..37M	+0.6 57.0 −0.0	+0.6 40.6 −0.0	+0.5 21.0 −0.5	+1.0 44.0 −1.0	+0.5 16.0 −0.5	≤ 9.0	90	330	37.0	4311 021 31952
S.57.41.21F330L..37.										4311 021 31962
S.58.46.31F380U..55.	+0.6 58.0 −0.0	≥ 45.7	+2.0 30.0 −0.0	+1.0 54.0 −1.0	+0.0 22.0 −1.0	≤ 6.0	145	380	55.0	4311 021 37103
S.58.41.31F330U..70.	+0.6 58.0 −0.0	+2.0 40.4 −0.0	+0.7 31.0 −0.7	+1.0 51.0 −1.0	+0.0 20.3 −1.0	≤ 8.7	125	330	70.0	4311 021 34645
S.58.41.31F330K..70.										4311 021 35033
S.58.41.31F330L..70.										4311 021 35043
S.58.41.40F370U..92.	+0.6 58.0 −0.0	+1.0 40.4 −0.0	+1.0 40.0 −1.0	+0.5 52.0 −0.5	+0.0 20.3 −0.5	≤ 8.7	125	330	92.0	4311 021 34215
S.58.41.40F370K..92M										4311 021 34185
S.58.41.40F370L..92.										4311 021 34195
S.58.41.21F330U..37.	≥ 58.0	+0.6 40.6 −0.0	+0.5 21.0 −0.5	+1.0 44.0 −1.0	+0.5 16.0 −0.5	≤ 8.7	90	330	37.0	4311 021 33881
S.58.41.21F330K..37.										4311 021 33591
S.58.41.21F330L..37.										4311 021 33601
S.58.45.35F380U..70.	≥ 58.0	≥ 45.2	+1.5 35.0 −1.5	+1.5 55.0 −1.5	+0.3 22.8 −0.3	≤ 6.4	145	380	70.5	4313 020 73011
S.59.41.21F330U..37.	+0.6 58.3 −0.0	≥ 40.6	+0.5 21.0 −0.5	+1.0 44.0 −1.0	+0.5 16.0 −0.5	≤ 8.7	90	330	37.0	4311 021 34753
S.59.41.21F330K..37M										4311 021 34673
S.59.41.21F330L..37.										4311 021 34683
S.59.43.31F330U..70.	+0.4 58.5 −0.0	nom 42.6	+1.6 29.8 −0.0	+3.3 50.4 −0.0	-	≤ 8.1	140	330	70.0	4313 020 72463
S.59.43.30F380U..62.	≥ 58.5	≥ 42.6	+1.0 30.0 −0.6	+0.5 51.6 −1.0	+0.0 21.5 −0.6	≤ 8.1	135	380	62.5	4311 021 37353
S.59.43.30F380K..62.										4313 020 73091
S.59.43.30F380L..62M										4313 020 73101
S.59.43.36F380U..75.	≥ 58.5	≥ 42.6	+1.0 36.0 −0.6	+0.5 51.6 −1.0	+0.0 21.5 −0.6	≤ 8.1	135	380	75.0	4313 020 73051
S.59.43.36F380L..75.										4313 020 73111
S.59.43.36F380K..75M										4313 020 73121
S.58.45.42F400U..80.	≥ 58.4	≥ 44.6	+2.0 40.8 −0.0	+2.0 53.0 −0.0	+1.0 21.2 −0.0	≤ 7.2	140	400 S	80.0	4304 170 05092

Magnet Type List — Sintered Ferroxdure

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	l (mm)	w (mm)	h (mm)	s (mm)	α °	FXD	MASS (gr)	ORDERING CODE
S.64.51.28F330U..53.	≥ 63.5	≥ 51.0	+1.6 27.2 −0.0	+1.0 56.5 −0.0	+1.0 21.0 −0.0	≤ 6.4	140	330	53.0	4322 020 61633
S.65.52.40F380U..88.	+0.6 65.1 −0.0	+1.0 52.0 −0.0	+1.1 40.0 −1.1	+0.5 60.0 −0.5	+0.0 25.0 −0.5	≤ 6.8	145	380	88.0	4311 021 37991
S.65.52.38F400U..78.	≥ 65.2	≥ 52.4	+1.0 38.0 −1.0	+1.5 57.5 −1.5	+0.6 22.0 −0.6	≤ 8.5	133	400	78.0	4311 021 38021
S.70.56.42F580U..33.	≥ 70.2	≥ 56.5	+1.0 42.0 −1.0	+0.5 25.0 −0.5	+0.2 6.6 −0.2	≤ 7.0	55	580	33.0	4311 021 37843
S.70.54.35F380U..92.	≥ 70.2	≥ 53.7	+0.8 35.0 −0.8	+1.5 60.0 −1.5	+0.7 24.0 −0.7	≤ 8.2	130	380 S	92.0	4311 021 33962
S.70.54.40F330U.100.	≥ 70.2	≥ 53.7	+1.0 40.0 −1.0	+2.5 60.0 −0.0	+0.3 24.0 −0.3	≤ 8.2	130	330	100.0	4311 021 32064
S.70.54.50F330U.123.	≥ 70.2	≥ 53.7	+1.0 50.0 −1.0	+1.5 60.0 −1.5	+0.7 24.0 −0.7	≤ 8.2	130	330	125.0	4311 021 31943
S.70.56.38F330U..90.	≥ 70.3	≥ 55.6	+2.0 36.7 −0.0	+2.6 62.3 −0.0	-	≤ 7.5	130	330	90.0	4313 020 72761
S.70.56.45F330U.107.	≥ 70.3	≥ 55.6	+2.0 44.0 −0.0	+2.6 62.3 −0.0	-	≤ 7.5	130	330	107.0	4313 020 72801
S.70.56.49F400U.121.	≥ 70.2	≥ 55.7	+1.0 49.4 −1.0	+1.5 61.8 −1.5	+0.6 22.0 −0.6	≤ 7.6	120	400	121.0	4311 021 37781
S.70.58.42F330U..88.	≥ 70.2	≥ 57.5	+1.0 41.6 −1.0	+1.2 64.0 −1.2	-	≤ 6.6	140	330	88.5	4313 020 72346
S.71.56.17F330U..33.	≥ 70.8	≥ 55.9	+1.4 16.3 −0.0	+4.4 55.2 −0.0	-	≤ 7.4	110	330	33.0	4313 020 72415
S.71.56.26F330U..62.	≥ 70.8	≥ 55.9	+1.3 25.4 −0.0	+4.2 60.8 −0.0	+0.8 13.8 −0.0	≤ 7.4	120	330	62.0	4313 020 72383
S.71.56.36F330U..86.	≥ 70.8	+1.0 55.9 −0.0	+1.8 35.1 −0.0	+0.2 61.4 −0.2	-	≤ 7.4	120	330	85.6	4313 020 73061
S.71.56.36F330U..86.	≥ 70.8	+1.0 55.9 −0.0	+1.8 35.1 −0.0	+4.2 60.8 −0.0	-	≤ 7.4	120	330	85.6	4313 020 72581

Magnet Type List — Sintered Ferroxdure

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	l (mm)	w (mm)	h (mm)	s (mm)	α °	FXD	MASS (gr)	ORDERING CODE
S.71.56.40F380U..50.	≥ 71.2	≥ 56.0	+1.0 40.0 −1.0	+0.5 36.0 −0.5	-	≤ 7.6	100	380	50.0	4311 021 38031
S.71.56.49F380U.121.	≥ 71.2	≥ 55.7	+1.0 49.4 −1.0	+1.5 61.8 −1.5	+0.6 22.0 −0.6	≤ 7.6	120	380	121.0	4313 020 72992
S.71.57.39F330U..85. S.71.57.39F330K..85. S.71.57.39F330L..85.	≥ 71.1	≥ 57.0	+1.0 39.4 −1.0	+3.0 60.3 −0.0	+0.0 21.4 −1.2	≤ 7.3	120	330	85.0	4311 021 32591 4311 021 32601 4311 021 32611
S.71.57.39F380U..86.	≥ 71.1	≥ 57.0	+1.0 39.4 −1.0	+3.0 60.3 −0.0	+0.0 21.4 −1.2	≤ 7.3	120	380	86.0	4313 020 72913
S.71.57.49F380U.108.	≥ 71.1	≥ 57.0	+1.0 49.4 −1.0	+3.0 60.3 −0.0	+0.0 21.4 −1.2	≤ 7.3	120	380	108.0	4322 020 66111
S.71.61.38F380U.101.	≥ 71.2	≥ 61.0	+1.8 37.1 −0.0	+3.2 64.4 −0.0	+1.2 24.4 −0.0	≤ 7.1	120	380	101.0	4322 020 66101
S.72.58.27F330U..62.	nom 72.1	nom 57.9	+0.4 27.2 −0.4	≥ 62.7	+0.4 21.8 −0.4	≤ 7.4	120	330	62.5	4313 020 72254
S.86.70.50F330U.173.	≥ 86.2	≥ 69.7	+1.0 50.0 −1.0	+3.0 78.5 −0.0	+0.5 30.0 −0.5	≤ 8.2	140	330 S	173.0	4313 020 72981
S.86.70.60F330U.203.	≥ 86.2	≥ 69.7	+3.0 58.0 −0.0	+1.5 78.5 −1.5	+1.6 29.2 −0.0	8.2	140	330	203.0	4313 020 72881
S.95.78.55F330U.225.	+0.0 95.0 −0.2	+1.4 77.0 −0.0	+2.2 54.0 −0.0	+1.0 85.0 −1.0	+0.0 33.0 −1.6	≤ 9.0	135	330 S	225.0	4311 021 37901
S.95.78.74F480U.300.	+0.0 95.0 −0.2	+1.4 77.0 −0.0	+3.6 72.0 −0.0	+1.0 85.0 −1.0	+0.0 33.0 −1.6	-	135	480	300.0	4311 021 38061
S.95.78.74F330U.300.	+0.0 95.0 −0.2	+1.4 77.0 −0.0	+3.6 72.0 −0.0	+1.0 85.0 −0.0	+0.0 33.0 −1.6	≤ 9.0	135	330	300.0	4311 021 35371
S.95.82.25F330U..42. S.95.82.25F330K..42M S.95.82.25F330L..42.	+0.3 95.0 −0.0	+2.0 81.2 −0.0	+0.6 25.0 −0.6	+1.0 52.0 −1.0	+0.5 13.0 −0.5	≤ 6.9	65	330	42.0	4311 021 33452 4311 021 33002 4311 021 33012
S.96.81.23F400U..47.	≥ 96.4	≥ 81.0	+0.6 22.9 −0.6	+1.5 55.4 −1.5	+0.4 14.6 −0.4	≤ 7.7	70	400	47.0	4311 021 37971
S.96.81.29F400U..60.	≥ 96.4	≥ 81.0	+0.7 29.2 −0.7	+1.5 55.4 −1.5	+0.4 14.6 −0.4	≤ 7.7	70	400	60.0	4311 021 37981

Magnet Type List — Sintered Ferroxdure

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	l (mm)	w (mm)	h (mm)	s (mm)	α °	FXD	MASS (gr)	ORDERING CODE
S108.93.26F380U..83.	≥ 107.7	≥ 93.3	+0.6 26.5 −0.6	+0.0 85.0 −3.0	+0.6 23.8 −0.6	≤ 6.9	100	380	83.0	4311 021 35194
S113.83.67F330U.276.	≥ 113.0	≥ 83.0	+2.6 66.0 −0.0	+1.0 60.0 −1.0	+0.6 23.0 −0.6	≤ 15	70	330	276.0	4322 020 66302
S116.91.39F330U..96.	+0.6 116.0 −0.0	≥ 91.0	+1.0 39.0 −1.0	+1.0 41.5 −1.0	+0.5 15.7 −0.5	≤ 12.5	45	330	96.0	4311 021 36971
S126.96127F380U.540.	≥ 126.5	≥ 96.4	+3.1 127 −3.1	+1.5 59.5 −1.5	+0.6 20.3 −0.6	-	60	380	540.0	4311 021 38041
S130.96127F380U.603.	≥ 130.2	≥ 95.8	+3.1 127 −3.1	+1.5 59.5 −1.5	+1.2 22.2 −1.2	≤ 17.4	60	380	603.0	4311 021 35611
S161135.72F380U.450.	≥ 161.0	≥ 135	+1.3 71.6 −1.3	+1.0 102 −1.0	+0.9 28.0 −0.9	≤ 12.8	85	380	450.0	4311 021 36092
S222159102F380U1211.	+0.0 224.0 −4.0	+4.0 157 −0.0	+4.0 100 −0.0	+4.0 76.0 −0.0	+0.8 37.0 −0.8	≤ 31.1	50	380 S	1211	4311 021 35591

Magnet type list: Flat-Concave segments

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	l (mm)	w (mm)	h (mm)	s (mm)	α °	FXD	MASS (gr)	ORDERING CODE
S999.31.54F330U..64.		+0.6	+1.0	+0.8	+0.5	+0.0				4311 021 32743
S999.31.54F330K..64.	-	31.0	54.0	28.6	10.5	6.8	80	330	64.5	4311 021 32094
S999.31.54F330L..64.		−0.0	−0.2	−0.8	−0.5	−0.3				4311 021 32104

Magnet type list: Flat-Convex segments

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	l (mm)	w (mm)	h (mm)	s (mm)	α °	FXD	MASS (gr)	ORDERING CODE
S114999.25F330U..39.	+0.2 114.0 −0.2	-	+0.5 25.0 −0.5	+0.8 39.5 −0.8	+0.2 9.5 −0.2	-	40	330	39.5	4311 021 30132
	+4.0		+0.6	+1.0	+0.2					
S148999.27F330K..87.	148.0	-	27.0	40.5	15.0	-	30	330	87.5	4311 021 34501
S148999.27F330L..87.	−4.0		−0.6	−1.0	−0.2					4311 021 34511

Material Specification Plastic-bonded ferroxdure

SP02, ISOTROPIC PLASTIC-BONDED CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately 6 mm x 12 mm x 20 mm for magnetic and electrical tests and 6 mm x 4 mm x 55 mm for mechanical and thermal tests.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure SP02 is a ferrite, the main constituent being 75% (by weight) iron oxide (Fe_2O_3) and 7% (by weight) $BaFe_{12}O_{19}$ with thermoplastic material added.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	9	10	mT	90	100	Gs
H_{cB}	Coercivity	7	8	kA/m	88	101	Oe
H_{cJ}	Polarization coercivity	-	130	kA/m	-	1634	Oe
$(BH)_{max}$	Maximum BH product	-	0.02	kJ/m³	-	0.0025	MGsOe
-	Temperature coefficient of B_r (–20 to +100 °C)	-	–0.2	%/K	-	–0.2	%/°C
H_{sat}	Saturation field strength	-	800	kA/m	-	10000	Oe
ρ	Resistivity	10^8	-	Ωm	10^{10}	-	Ωcm

After storage of the magnetized test piece for 48 hours at –30 °C and 48 hours at +80 °C the changes in its magnetic properties do not exceed ±3% of the initial values.

Material Specification Plastic-bonded ferroxdure

SP02, Physical properties

PARAMETER	VALUES
Density	(typical) 2.65 x 10^3 kg/m^3 (2.65 g/cm^3)
Coefficient of linear expansion (20 to 90 °C)	(typical) 7.5 x 10^{-3}/K
Maximum permissible temperature continuous short periods	 100 °C 120 °C
Test piece 6 mm x 4 mm x 55 mm produced by injection moulding	
Linear shrinkage after 100 hours at 90 °C	(approx) 0.3%
Flame retardance of SP02	to UL94-HB
Flexural strength test	
Rate of crosshead motion	50 mm/min
Length of span	40 mm
Flexural strength after 100 hours at 20 ±3 °C at 100 ±3 °C	 (typical) 200 N/cm^2 (typical) 200 N/cm^2
Impact strength test (pendulum type)	
Striker: 50 Ncm, length of span 40 mm	
Impact strength after 100 hours at 20 ±3 °C at 100 ±3 °C	 (typical) 0.4 J/cm^2 (typical) 0.3 J/cm^2

Material Specification Plastic-bonded ferroxdure

SP02, Chemical resistance

SUBSTANCE	25 °C		70 °C	
	UP TO 5 HOURS	LIFE TEST	UP TO 5 HOURS	LIFE TEST
Water	+	+	+	+
Diluted acids	+	+	+	-
Concentrated acids	+	+	+	-
Basic solutions 10%	+	+	+	+
Basic solutions 40%	+	+	+	+
Acetic acid 10% (note 1)	-	-	-	-
Mineral oil	+	+	+	+
Light petrol 100/140 °C	+	+	+	-
Spirit (note 1)	-	-	-	-
Ethyl alcohol (note 1)	-	-	-	-
Ethyl glycol	+	+	+	+
Acetone	+	+	+	-
Butyl acetate	+	+	+	-
Toluol	+	+	+	-
Carbon tetrachloride	+	-	-	-

Note

1. Not tested.

A "+" means that in the chemical resistance test, the specimens show no visible change (in appearance) and no change in weight exceeding ±1%.
Life test duration, 170 hours. (During the test specimens are completely immersed).

Manufacture of magnets

Magnets are produced by injection moulding. Turning and milling with special (steel) tools is possible.

Material Specification Plastic-bonded ferroxdure

Direction of magnetization

Ferroxdure SP02 is an isotropic material and may therefore be magnetized in any direction. Where magnets are to be supplied magnetized, the pole pattern must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

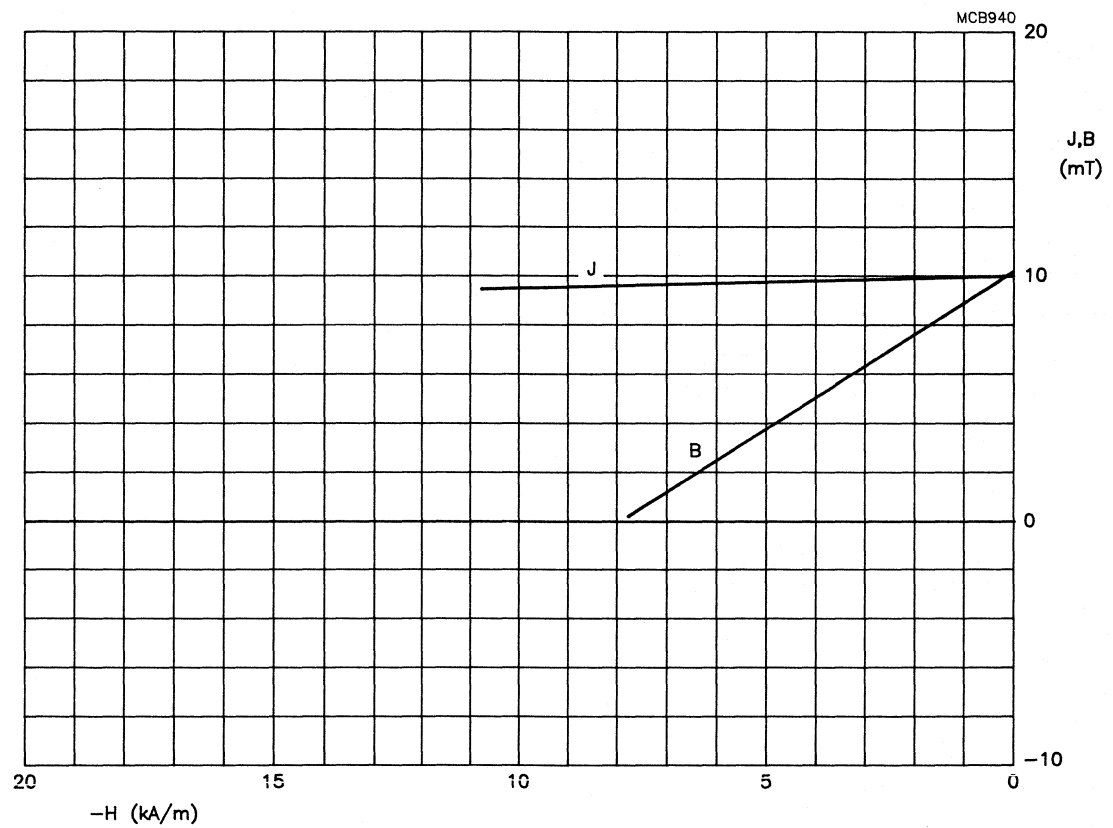


Fig.1 Typical demagnetization curve (20 °C) for SP02.

Material Specification — Plastic-bonded ferroxdure

SP10, ISOTROPIC PLASTIC-BONDED CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately 6 mm x 12 mm x 20 mm for magnetic and electrical tests and 6 mm x 4 mm x 55 mm for mechanical and thermal tests.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure SP10 is a ferrite, the main constituent being 75% (by weight) $BaFe_{12}O_{19}$ / $SrFe_{12}O_{19}$ with thermoplastic material added.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	75	80	mT	750	800	Gs
H_{cB}	Coercivity	54	58	kA/m	679	729	Oe
H_{cJ}	Polarization coercivity	-	190	kA/m	-	2390	Oe
$(BH)_{max}$	Maximum BH product	0.8	0.9	kJ/m^3	0.1	0.11	MGsOe
-	Temperature coefficient of B_r (–20 to +100 °C)	-	–0.2	%/K	-	–0.2	%/°C
H_{sat}	Saturation field strength	-	800	kA/m	-	10000	Oe
ρ	Resistivity	10^8	-	Ωm	10^{10}	-	Ωcm

After storage of the magnetized test piece for 48 hours at –30 °C and 48 hours at +80 °C the changes in its magnetic properties do not exceed ±3% of the initial values.

Material Specification Plastic-bonded ferroxdure

SP10, Physical properties

PARAMETER	VALUES
Density	(typical) 2.5 x 10^3 kg/m^3 (2.5 g/cm^3)
Coefficient of linear expansion (20 to 90 °C)	(typical) 5 x 10^{-6}/K
Maximum permissible temperature continuous short periods	 100 °C 120 °C
Test piece 6 mm x 4 mm x 55 mm produced by injection moulding	
Linear shrinkage after 100 hours at 90 °C	≤ 0.25%
Moisture absorption during storage in water	≤ 0.25% (by weight)
Flame retardance of SP10	to UL94-HB
Flexural strength test	
Rate of crosshead motion	50 mm/min
Length of span	40 mm
Flexural strength after 100 hours at 20 ±3 °C at 100 ±3 °C	 (typical) 200 N/cm^2 (typical) 200 N/cm^2
Impact strength test (pendulum type)	
Striker: 50 Ncm, length of span 40 mm	
Impact strength after 100 hours at 20 ±3 °C at 100 ±3 °C	 (typical) 0.4 J/cm^2 (typical) 0.4 J/cm^2

Material Specification — Plastic-bonded ferroxdure

SP10, Chemical resistance

SUBSTANCE	20 °C		70 °C	
	UP TO 5 HOURS	LIFE TEST	UP TO 5 HOURS	LIFE TEST
Water	+	+	+	+
Thinned acids	+	-	-	-
Concentrated acids (except HCl)	-	-	-	-
Concentrated HCl	-	-	-	-
Thinned lyes	+	+	+	-
Concentrated lyes	+	+	+	-
Acetic acid 10%	+	+	+	+
Mineral oil	+	+	+	-
Petrol	+	-	-	-
Ethyl alcohol	+	+	+	+
Ethyl glycol (note 1)	-	-	-	-
Acetone	+	-	-	-
Butyl acetate	+	-	-	-
Toluol	+	-	-	-
Carbon tetrachloride	-	-	-	-

Note

1. Not tested.

A "+" means that in the chemical resistance test, the specimens show no visible change in appearance and no change in weight exceeding ±1%.
Life test duration, 170 hours. (During the test specimens are completely immersed).

Manufacture of magnets

Magnets are produced by injection moulding. Turning and milling with special (steel) tools is possible.

Material Specification — Plastic-bonded ferroxdure

Direction of magnetization

Ferroxdure SP10 is an isotropic material and may therefore be magnetized in any direction. Where magnets are to be supplied magnetized, the pole pattern must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

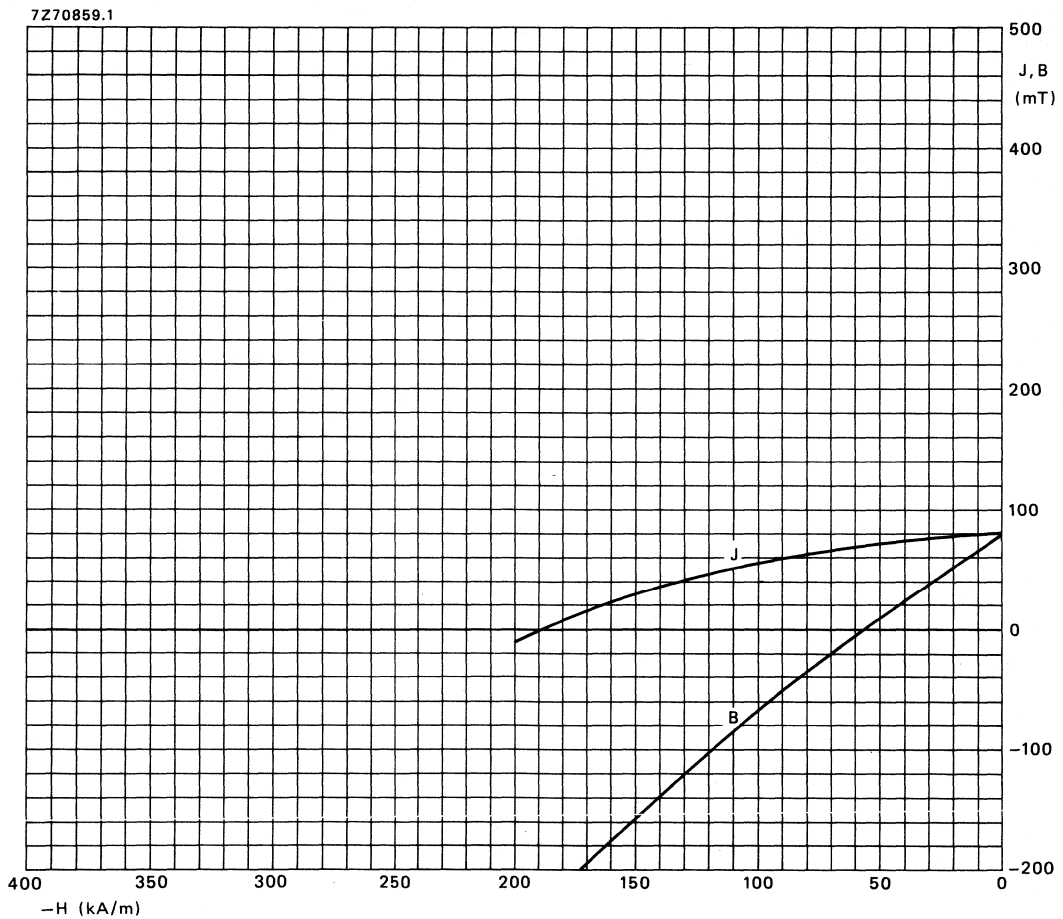


Fig.1 Typical demagnetization curve (20 °C) for SP10.

Material Specification — Plastic-bonded ferroxdure

P30, ISOTROPIC PLASTIC-BONDED CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece is an extruded strip with a cross-section of approximately 11 mm x 3 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure P30 is a ferrite, the main constituent being 85% (by weight) $BaFe_{12}O_{19}$ / $SrFe_{12}O_{19}$ with elastomeric material added.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	115	125	mT	1150	1250	Gs
H_{cB}	Coercivity	84	88	kA/m	1050	1110	Oe
H_{cJ}	Polarization coercivity	-	190	kA/m	-	2390	Oe
$(BH)_{max}$	Maximum BH product	2.4	2.8	kJ/m^3	0.3	0.35	MGsOe
-	Temperature coefficient of B_r (–20 to +90 °C)	-	–0.2	%/K	-	–0.2	%/°C
H_{sat}	Saturation field strength	-	800	kA/m	-	10000	Oe
ρ	Resistivity	10^7	-	Ωm	10^9	-	Ωcm

After storage of the magnetized test piece for 48 hours at –30 °C and 48 hours at +90 °C the changes in its magnetic properties do not exceed ±3% of the initial values.

Material Specification — Plastic-bonded ferroxdure

P30, Physical properties

PARAMETERS	VALUES		
Density	(typical) 3.1 x 10^3 kg/m^3 (3.1 g/cm^3)		
Maximum temperature range (continuous)	–50 to +90 °C		
Flame retardance of P30	to UL 94-HB		
	Typical values at ambient temperature after 100 hours storage at:		
	–50 ±2 °C	20 ±2 °C	70 ±2°C
Shore C hardness after 10 s	55 ±10	55 ±10	70 ±10
Tensile strength at uniform speed of 50 mm/min	200	200	250 N/cm^2
Diameter of mandrel around which the test piece can be bent without cracking or breaking; broad face in contact with mandrel	10	10	15 mm
Linear shrinkage	0.25	0.25	2%

Material Specification Plastic-bonded ferroxdure

P30, Chemical resistance

SUBSTANCE	20 °C		70 °C	
	UP TO 5 HOURS	LIFE TEST	UP TO 5 HOURS	LIFE TEST
Water	+	+	+	+
Thinned acids	+	-	+	-
Concentrated acids	-	-	-	-
Thinned lyes	+	+	+	+
Concentrated lyes	+	-	+	-
Acetic acid 10%	+	-	-	-
Mineral oil	-	-	-	-
Light petrol	-	-	-	-
Ethyl alcohol	+	+	+	-
Acetone	-	-	-	-
Butyl acetate	-	-	-	-
Toluol	-	-	-	-
Carbon tetrachloride	-	-	-	-

A "+" means that in the chemical resistance test, the specimens show no visible change in appearance and no change in weight exceeding ±3%.
Life test duration, 170 hours. (During the test the specimens are completely immersed).

Manufacture of magnets

Magnets are produced by rolling, calendering, transfer-moulding or extrusion, after which the magnets may be further processed by cutting tools, die-cutting machines, shears and high-speed diamond cutting wheels.

Material Specification Plastic-bonded ferroxdure

Direction of magnetization

Ferroxdure P30 is an isotropic material and may therefore be magnetized in any direction. Where magnets are to be supplied magnetized, the pole pattern must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

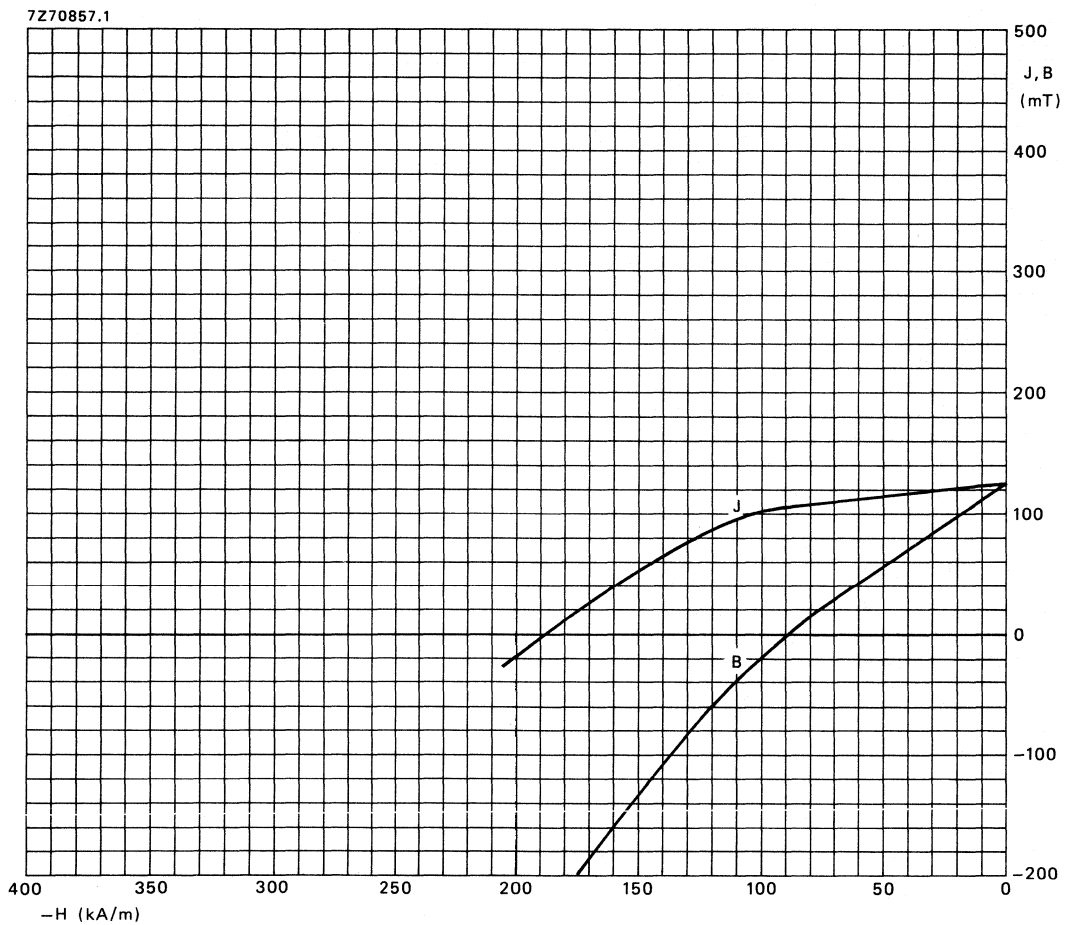


Fig.1 Typical demagnetization curve (20 °C) for P30.

Material Specification — Plastic-bonded ferroxdure

P40B, ISOTROPIC PLASTIC-BONDED CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece is an extruded strip with a cross-section of approximately 11 mm x 3 mm.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure P40B is a ferrite, the main constituent being 90% (by weight) $BaFe_{12}O_{19}$ / $SrFe_{12}O_{19}$ with elastomeric material added.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	135	145	mT	1350	1450	Gs
H_{cB}	Coercivity	88	96	kA/m	1110	1210	Oe
H_{cJ}	Polarization coercivity	-	190	kA/m	-	2390	Oe
$(BH)_{max}$	Maximum BH product	3.2	3.6	kJ/m^3	0.4	0.45	MGsOe
-	Temperature coefficient of B_r (–20 to +90 °C)	-	–0.2	%/K	-	–0.2	%/°C
H_{sat}	Saturation field strength	-	800	kA/m	-	10000	Oe
ρ	Resistivity	10^6	-	Ωm	10^8	-	Ωcm

After storage of the magnetized test piece for 48 hours at –30 °C and 48 hours at +90 °C the changes in its magnetic properties do not exceed ±3% of the initial values.

Material Specification — Plastic-bonded ferroxdure

P40B, Physical properties

PARAMETERS		VALUES		
Density		(typical) 3.7 x 10^3 kg/m^3 (3.7 g/cm^3)		
Maximum temperature range (continuous)		–50 to +90 °C		
Flame retardance of P40B		to UL 94-HB		
		Typical values at ambient temperature after 100 hours storage at:		
		–50 ±2 °C	20 ±2 °C	70 ±2°C
Shore C hardness after 10 s	P40	80 ±10	80 ±10	90 ±10
	P40F	90 ±10	90 ±1-	90 ±10
Tensile strength at uniform speed of 50 mm/min	P40	400	350	500 N/cm^2
	P40F	800	800	950 N/cm^2
Diameter of mandrel around which the test piece can be bent without cracking or breaking; broad face in contact with mandrel	P40	15	15	25 mm
	P40F	20	20	25 mm
Linear shrinkage	-	0.25	0.25	2%

Material Specification — Plastic-bonded ferroxdure

P40B, Chemical resistance

SUBSTANCE	20 °C		70 °C	
	UP TO 5 HOURS	LIFE TEST	UP TO 5 HOURS	LIFE TEST
Water	+	+	+	+
Thinned acids	+	-	+	-
Concentrated acids	-	-	-	-
Thinned lyes	+	+	+	-
Concentrated lyes	+	-	+	-
Acetic acid 10%	+	-	-	-
Mineral oil	+	-	-	-
Light petrol	-	-	-	-
Ethyl alcohol	+	+	+	+
Acetone	+	-	-	-
Butyl acetate	-	-	-	-
Toluol	-	-	-	-
Carbon tetrachloride	-	-	-	-

A "+" means that in the chemical resistance test, the specimens show no visible change in appearance and no change in weight exceeding ±3%.
Life test duration, 170 hours. (During the test specimens are completely immersed).

Manufacture of magnets

Magnets are produced by rolling, calendering, transfer-moulding or extrusion, after which the magnets may be further processed by cutting tools, die-cutting machines, shears and high-speed diamond cutting wheels.

Material Specification Plastic-bonded ferroxdure

Direction of magnetization

Ferroxdure P40B is an isotropic material and may therefore be magnetized in any direction. Where magnets are to be supplied magnetized, the pole pattern must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

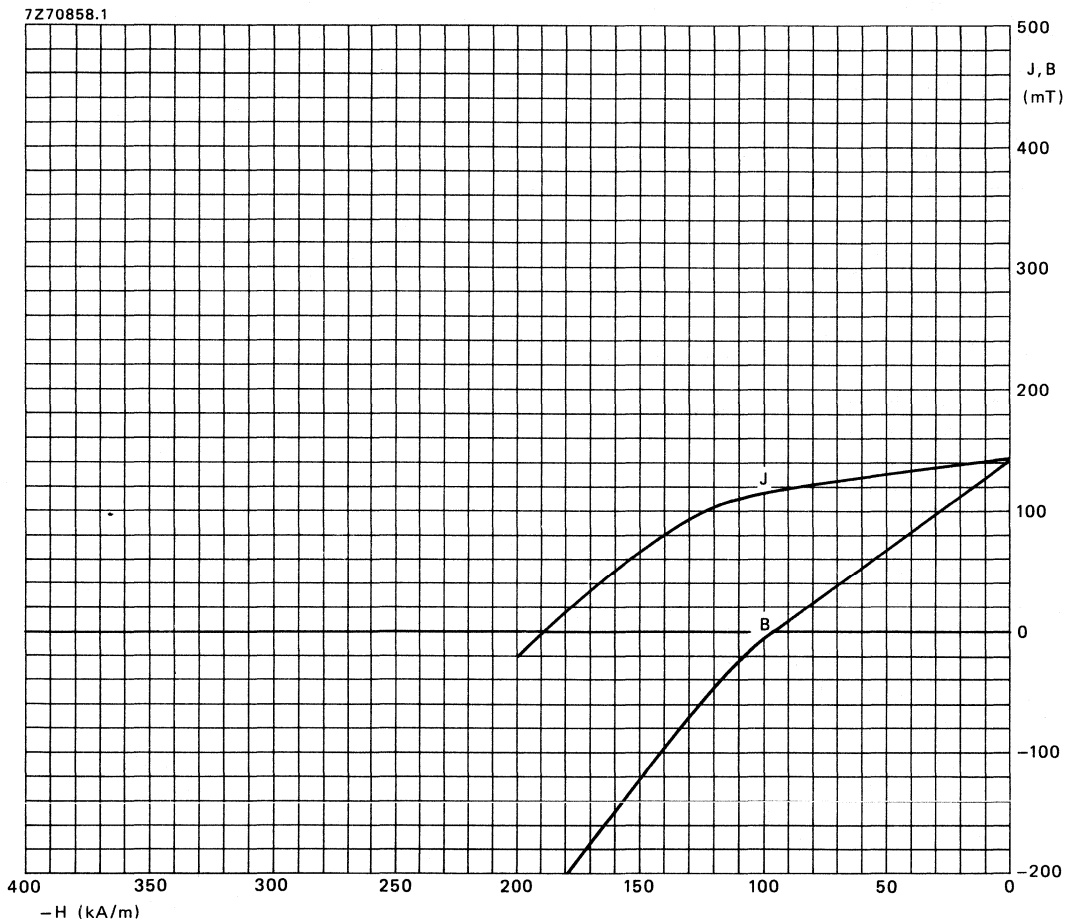


Fig.1 Typical demagnetization curve (20 °C) for P40B.

Material Specification — Plastic-bonded ferroxdure

SP160, ANISOTROPIC PLASTIC-BONDED CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately 6 mm x 12 mm x 20 mm for magnetic and electrical tests and 6 mm x 4 mm x 55 mm for mechanical and thermal tests. The preferred direction of magnetization parallel to the 6 mm dimension.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure SP160 is a ferrite, the main constituent being 90% (by weight) $SrFe_{12}O_{19}$ with thermoplastic material added.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	235	245	mT	2350	2450	Gs
H_{cB}	Coercivity	160	180	kA/m	2010	2260	Oe
H_{cJ}	Polarization coercivity	-	260	kA/m	-	3270	Oe
$(BH)_{max}$	Maximum BH product	11	12	kJ/m^3	1.4	1.5	MGsOe
-	Temperature coefficient of B_r (–20 to +100 °C)	-	–0.2	%/K	-	–0.2	%/°C
H_{sat}	Saturation field strength	-	800	kA/m	-	10000	Oe
ρ	Resistivity	10^5	-	Ωm	10^7	-	Ωcm

After storage of the magnetized test piece for 48 hours at –30 °C and 48 hours at +90 °C the changes in its magnetic properties do not exceed ±5% of the initial values.

Material Specification Plastic-bonded ferroxdure

SP160, Physical properties

PARAMETER	VALUES
Density	(typical) 3.5 x 10^3 kg/m^3 (3.5 g/cm^3)
Coefficient of linear expansion (20 to 90 °C)	(typical) 15 x 10^{-6}/K
Maximum permissible temperature continuous short periods	 100 °C 120 °C
Test piece 6 mm x 4 mm x 55 mm produced by injection moulding	
Linear shrinkage after 24 hours at 125 °C	≤ 0.1%
Moisture absorption during storage in water	≤ 0.05% (by weight)
Impact strength test (pendulum type)	
Striker: 50 Ncm, length of span 40 mm	
Impact strength after 100 hours at 20 ±3 °C at 100 ±3 °C	 (typical) 0.3 J/cm^2 (typical) 0.3 J/cm^2

Material Specification Plastic-bonded ferroxdure

SP160, Chemical resistance

SUBSTANCE	20 °C		70 °C	
	UP TO 5 HOURS	LIFE TEST	UP TO 5 HOURS	LIFE TEST
Water	+	+	+	+
Thinned acids	+	-	-	-
Concentrated acids	-	-	-	-
Thinned lyes	+	+	+	-
Concentrated lyes	+	+	+	-
Acetic acid 10%	+	+	+	+
Mineral oil	+	+	+	-
Light petrol	+	-	-	-
Ethyl alcohol	+	+	+	-
Acetone	+	-	-	-
Butyl acetate	+	-	-	-
Toluol	+	-	-	-
Carbon tetrachloride	+	-	-	-

A "+" means that in the chemical resistance test, the specimens show no visible change in appearance and no change in weight exceeding ±1%.
Life test duration, 170 hours. (During the test specimens are completely immersed).

Manufacture of magnets

Magnets are produced by injection moulding, afterwards the products may be machined by turning and milling with special (steel) tools, by grinding using diamond tools and also by vibro-finishing.

Material Specification — Plastic-bonded ferroxdure

Direction of magnetization

Ferroxdure SP160 is an anisotropic material, and has therefore a preferred direction of magnetization (magnetic axis), which must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

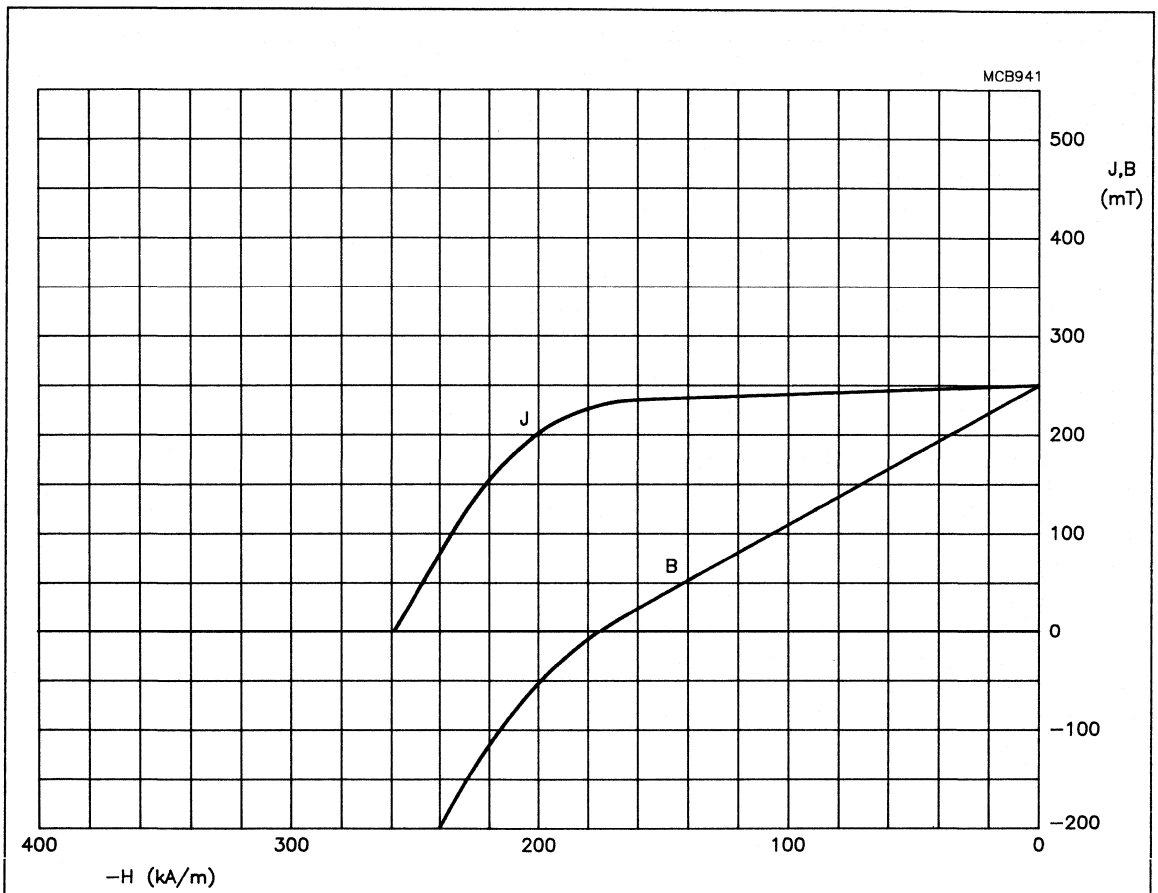


Fig.1 Typical demagnetization curve (20 °C) for SP160.

Material Specification — Plastic-bonded ferroxdure

SP170, ANISOTROPIC PLASTIC-BONDED CERAMIC MATERIAL

General

This specification relates to tests carried out on test pieces made from each batch of material taken from normal production. The test piece has dimensions of approximately 6 mm x 12 mm x 20 mm for magnetic and electrical tests and 6 mm x 4 mm x 55 mm for mechanical and thermal tests. Preferred direction of magnetization parallel to the 6 mm dimension.

Magnets manufactured from this material conform generally to this specification but, owing to the method of manufacture and to the variation in size and shape, some limits cannot always be realized, or indeed checked by measurement on the magnet. However, a minimum-flux test or similar test described in each magnet specification can be used as a basis for performance guarantees.

Composition

Ferroxdure SP170 is a ferrite, the main constituent being 93% (by weight) $SrFe_{12}O_{19}$ with thermoplastic material added.

Magnetic and electrical properties of the test piece

Temperature of the test piece is 20 ±2 °C unless otherwise specified.

SYMBOL	PARAMETER	MIN.	TYP.	UNIT	MIN.	TYP.	UNIT
B_r	Remanence	260	270	mT	2600	2700	Gs
H_{cB}	Coercivity	188	196	kA/m	2360	2460	Oe
H_{cJ}	Polarization coercivity	-	260	kA/m	-	3270	Oe
$(BH)_{max}$	Maximum BH product	13	14	kJ/m^3	1.6	1.75	MGsOe
-	Temperature coefficient of B_r (–20 to +100 °C)	-	–0.2	%/K	-	–0.2	%/°C
H_{sat}	Saturation field strength	-	800	kA/m	-	10000	Oe
ρ	Resistivity	10^5	-	Ωm	10^7	-	Ωcm

After storage of the magnetized test piece for 48 hours at –30 °C and 48 hours at +90 °C the changes in its magnetic properties do not exceed ±5% of the initial values.

Material Specification — Plastic-bonded ferroxdure

SP170, Physical properties

PARAMETER	VALUES
Density	(typical) 3.9 x 10^3 kg/m^3 (3.9 g/cm^3)
Coefficient of linear expansion (20 to 90 °C)	(typical) 15 x 10^{-6}/K
Maximum permissible temperature continuous short periods	 100 °C 120 °C
Test piece 6 mm x 4 mm x 55 mm produced by injection moulding	
Linear shrinkage after 24 hours at 125 °C	≤ 0.1%
Moisture absorption during storage in water	≤ 0.05% (by weight)
Flexural strength test	
Rate of crosshead motion	20 mm/min
Length of span	40 mm
Flexural strength after 100 hours at 20 ±3 °C at 100 ±3 °C	 (typical) 30 N/cm^2 (typical) 40 N/cm^2
Impact strength test (pendulum type)	
Striker: 50 Ncm, length of span 40 mm	
Impact strength after 100 hours at 25 ±3 °C at 100 ±3 °C	 (typical) 0.08 J/cm^2 (typical) 0.08 J/cm^2

Material Specification Plastic-bonded ferroxdure

SP170, Chemical resistance

SUBSTANCE	20 °C		70 °C	
	UP TO 5 HOURS	LIFE TEST	UP TO 5 HOURS	LIFE TEST
Water	+	+	+	+
Thinned acids	+	-	-	-
Concentrated acids	-	-	-	-
Thinned lyes	+	+	+	-
Concentrated lyes	+	+	+	-
Acetic acid 10%	+	+	+	+
Mineral oil	+	+	+	-
Light petrol	+	-	-	-
Ethyl alcohol	+	+	+	-
Acetone	+	-	-	-
Butyl acetate	+	-	-	-
Toluol	+	-	-	-
Carbon tetrachloride	+	-	-	-

A "+" means that in the chemical resistance test, the specimens show no visible change in appearance and no change in weight exceeding ±1%.
Life test duration, 170 hours. (During the test specimens are completely immersed).

Manufacture of magnets

Magnets are produced by injection moulding. After complete demagnetization the products may be machined by turning and milling with special (steel) tools or by grinding using diamond tools.

Material Specification — Plastic-bonded ferroxdure

Direction of magnetization

Ferroxdure SP170 is an anisotropic material, and has therefore a preferred direction of magnetization (magnetic axis), which must be shown on the magnet drawing.

Quality and finish

The material allows magnets to be produced, having a good clean finish and appearance according to the appropriate visual limit samples.

Application

Where high-coercivity permanent magnets are required.

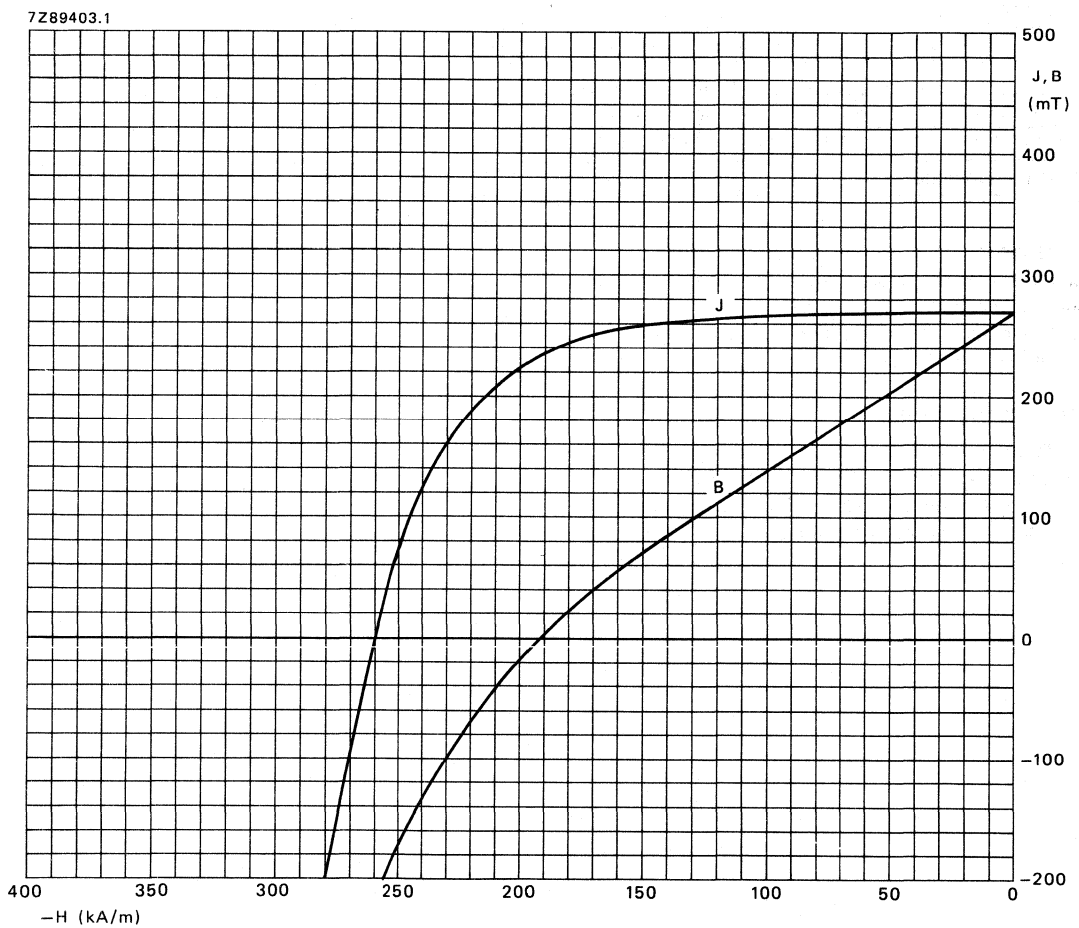


Fig.1 Typical demagnetization curve (20 °C) for SP170.

Magnet type list Plastic-Bonded Ferroxdure

PLASTIC-BONDED FERROXDURE

The magnet type list gives initial information on the main dimensions etc, of types for which tooling already exists. Choice of a type from this list eliminate the need for new tools and consequent delay in delivery. It is important to check with the supplier if the data is still valid. Frequent additions, eliminations or changes may render the survey in this data handbook outdated. In that case, an updated list should be consulted.

The exact mechanical and magnetic data and the correct code number (last digit) have been laid down in the magnet specifications, which exist for each type, and which will be sent on request.

For plastic-bonded ferroxdure, all shapes can be supplied with different pole patterns than those listed.

For optimum results, supply of pre-magnetized magnets is not always advisable because self-demagnetization may occur due to unfavourable combinations of grade, the ratio of magnetic area to magnetic length and temperature variation.

Permanent magnets can also be ordered to your own design (within the limits of the material and manufacturing techniques). Our technical assistance on the design and application of permanent magnets is always at your disposal.

The magnet type list of plastic-bonded products is divided into various shapes:

For plastic-bonded ferroxdure

- Blocks, strips and rolls
- Discs and rods
- Rings and cylinders
- U-shaped segments
- Plates with holes, slots
- Rings with ears

Magnet type list Plastic-Bonded Ferroxdure

Blocks, strips, rolls (isotropic)

E = Magnetized perpendicular to a x b.

Rn = Magnetized laterally, n poles on one a x b face, poles parallel to side a.

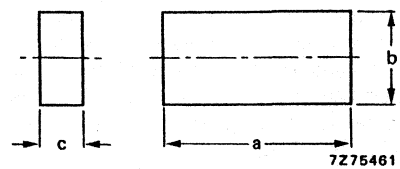


Fig.1 Blocks, Strips, Rolls (isotropic).

Magnet Type List: Blocks, strips, rolls (isotropic)

TYPE DESCRIPTION	a (mm)	b (mm)	c (mm)	MAGN ACC	REMARKS	FXD	MASS (gr)	ORDERING CODE
T999..9..3P.40R....S	150 m	+0.1 9.0 −0.3	+0.1 3.0 −0.1	R2	sticking force 0.25 N (d = 0.5)	P40B	-	4312 020 70021
T.10..6.40P.40E.8.9P	+0.2 10.0 −0.2	+0.15 6.0 −0.15	+0.6 40.0 −0.6	E	-	P40B	8.9	3122 134 91892
T..6..6.40P.40E.5.3P	+0.15 6.0 −0.15	+0.15 6.0 −0.15	+0.6 40.0 −0.6	E	-	P40B	5.3	3122 134 92095
T..6..6.70P.40E.9.3P	+0.15 6.0 −0.15	+0.15 6.0 −0.15	+0.6 70.0 −0.6	E	-	P40B	9.3	3122 134 92085

Magnet type list Plastic-Bonded Ferroxdure

Discs, rods (isotropic)

A = Magnetized axially.

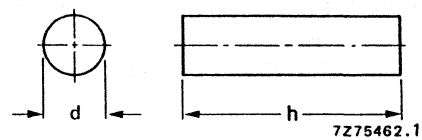


Fig.2 Discs, Rods (isotropic).

Magnet Type List: Discs, rods (isotropic)

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	h (mm)	MAGN ACC	REMARKS	FXD	MASS (gr)	ORDERING CODE
D..5....30P.40A.2.1P	+0.2 5.0 −0.2	-	+0.0 30.0 −1.0	A	pole marking	P40B	2.1	3122 104 94981
D..5....40P.40A.2.8P	+0.2 5.0 −0.2	-	+0.0 40.0 −1.0	A	pole marking	P40B	2.8	3122 104 90363

Magnet type list — Plastic-Bonded Ferroxdure

Rings, cylinders (isotropic and anisotropic)

B = Magnetized diametrically.

Wn = Magnetized laterally,
n poles on inner circumference,
neutral zones axial.

Y = Magnetized radially, N pole inside.

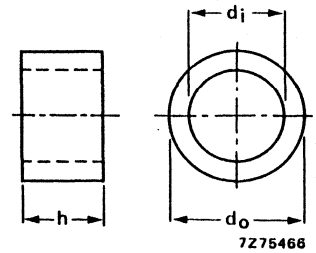


Fig.3 Rings, cylinders (isotropic and anisotropic).

Magnet Type List: Rings, cylinders (isotropic and anisotropic)

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	h (mm)	MAGN ACC	REMARKS	FXD	MASS (gr)	ORDERING CODE
C.12..3..3P.30B.1.0P	+0.6 12.0 –0.0	+0.15 3.35 –0.15	+0.4 3.0 –0.4	B	isotropic	P30	1.0	4312 020 72024
C.15..4.26S170B..17P	+0.0 14.7 –0.1	+0.0 4.1 –0.2	+0.1 25.5 –0.1	B	anisotropic square hole	SP170	17.0	4203 014 80021
C.12..5..7P.40Y.2.5P	+0.0 12.4 –0.4	+0.2 5.5 –0.2	+0.5 7.0 –0.0	Y	isotropic special hole	P40B	2.5	3122 104 93533
R.28.23.26S170W..20P	+0.1 28.0 –0.1	+0.2 23.0 –0.2	+0.2 25.5 –0.2	W2	anisotropic	SP170	19.7	4304 099 10065

Magnet type list Plastic-Bonded Ferroxdure

U-Shaped segment (isotropic)

X = Magnetized radially, S-pole inside.

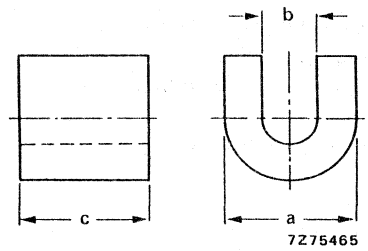


Fig.4 U-Shaped segment (isotropic).

Magnet Type List: U-Shaped segment (isotropic)

TYPE DESCRIPTION	a (mm)	b (mm)	c (mm)	MAGN ACC	REMARKS	FXD	MASS (gr)	ORDERING CODE
X.12..5.12P.40X.2.9P	+0.6 12.0 −0.0	+0.1 5.2 −0.1	+0.3 12.0 −0.3	X	-	P40B	2.9	3122 104 93771

Magnet type list Plastic-Bonded Ferroxdure

Plates with holes (isotropic)

E = Magnetized perpendicular to a x b.

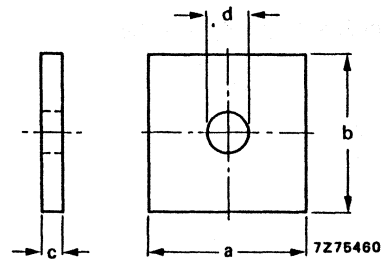


Fig.5 Plates with holes (isotropic).

Magnet Type List: Plates with holes (isotropic)

TYPE DESCRIPTION	a (mm)	b (mm)	c (mm)	d (mm)	MAGNE ACC	REMARKS	FXD	MASS (gr)	ORDERING CODE
P.13..3.13P.30E.1.6P	+0.6 13.0 −0.0	+0.15 3.0 −0.15	+0.6 13.0 −0.0	+0.0 3.0 −0.3	E	-	P30	1.6	4312 020 76991
P.13..3.40P.40E.6.0P	+0.6 13.0 −0.0	+0.15 3.0 −0.15	+0.0 40.0 −1.0	+0.0 3.0 −1.0	E	hole not in centre	P40B	6.0	3122 104 95004

Magnet type list — Plastic-Bonded Ferroxdure

Plates with slots (isotropic)

E = Magnetized perpendicular to a x b.

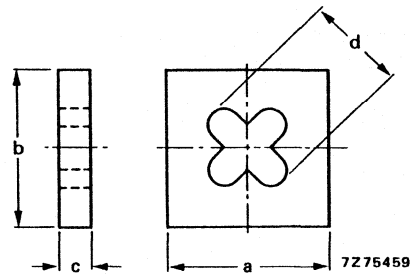


Fig.6 Plates with slots (isotropic).

Magnet Type List: Plates with slots (isotropic)

TYPE DESCRIPTION	a (mm)	b (mm)	c (mm)	d (mm)	MAGN ACC	REMARKS	FXD	MASS (gr)	ORDERING CODE
P..8..3..8P.30E.0.5P	+0.0 8.4 −0.6	+0.0 8.4 −0.6	+0.15 3.0 −0.15	+0.5 5.8 −0.0	E	-	P30	0.5	3122 104 94121
P.11..3.11P.30E.0.6P	+0.0 10.6 −0.6	+0.0 10.6 −0.6	+0.15 3.0 −0.15	9.0	E	-	P30	0.6	3122 104 93542
P.11.11..3P.30E.1.1P	+0.6 11.0 −0.0	+0.6 11.0 −0.0	+0.15 3.0 −0.15	+0.5 6.5 −0.0	E	-	P30	1.1	3122 104 02724

Magnet type list Plastic-Bonded Ferroxdure

Rings with ears (isotropic)

W2 = Magnetized laterally,
2 poles on inner circumference,
neutral zones axial.

B = Magnetized diametrically.

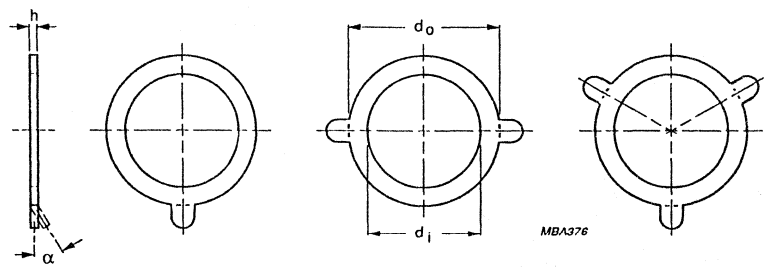


Fig.7 Rings with ears (isotropic).

Magnet Type List: Rings with ears (isotropic)

TYPE DESCRIPTION	d_o (mm)	d_i (mm)	h (mm)	α (°)	MAGN ACC	REMARKS	FXD	MASS (gr)	ORDERING CODE
R.39.27..2S.10W.3.3P	+0.5 39.0 −0.0	+0.4 27.0 −0.0	+0.1 1.50 −0.1	30	W2	3 ears	SP10	3.3	3122 134 91291
R.50.36..2S.10W.5.1P R.50.36..2S.10B.5.1P	+0.0 50.0 −0.5	+0.2 35.6 −0.0	+0.2 1.7 −0.0	30	W2 B	2 ears	SP10	5.1	3122 104 93986 3122 134 91873
R.55.44..2S.02W.3.5P R.55.44..2S.02W.3.5S	+0.3 55.0 −0.3	+0.12 44.1 −0.12	+0.0 1.7 −0.2	20	W4	1 ear 1 ear	SP02	3.5	3322 600 01341 3322 600 01351
R.55.44..2S.02W.3.5P R.55.44..2S.02W.3.5S	+0.3 55.0 −0.3	+0.12 44.1 −0.12	+0.0 1.7 −0.2	20	W6	1 ear 1 ear	SP02	3.5	3322 600 01361 3322 600 01371

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