Section 3

Materials

MATERIALS

Magnetics has developed and produces leading MnZn ferrite materials for a variety of applications.

POWER MATERIALS

Three low loss materials are engineered for optimum frequency and temperature performance in power applications. Magnetics' R, P and F materials provide superior saturation, high temperature performance, low losses and product consistency.

SHAPES: E cores, Planar E cores, ETD, EC, U cores, I cores, PQ, Planar PQ, RM, Toroids (2mm to 86mm), Pot cores, RS (round-slab), DS (double slab), EP, Special Shapes.

APPLICATIONS: Telecomm Power Supplies, Computer Power Supplies, Commercial Power Supplies, Consumer Power Supplies, Automotive, DC-DC Converters, Telecomm Data Interfaces, Impedance Matching Transformers, Handheld Devices, High power control (gate drive), Computer Servers, Distributed Power (DC-DC), EMI Filters, Aerospace, Medical.

HIGH PERMEABILITY MATERIALS

Three high permeablility materials (5000μ J material, 10000μ W material and 15000μ H material) are engineered for optimum frequency and impedance performance in signal, choke and filter applications. These Magnetics' materials provide superior loss factor, frequency response, temperature performance, and product consistency.

SHAPES: Toroids (2 mm to 86 mm), E cores, U cores, RM, Pot cores, RS (round-slab), DS (double slab), EP, Special Shapes.

APPLICATIONS: Common Mode Chokes, EMI Filters, Other Filters, Current Sensors, Telecomm Data Interfaces, Impedance matching interfaces, Handheld devices, Spike Suppression, Gate Drive Transformers.

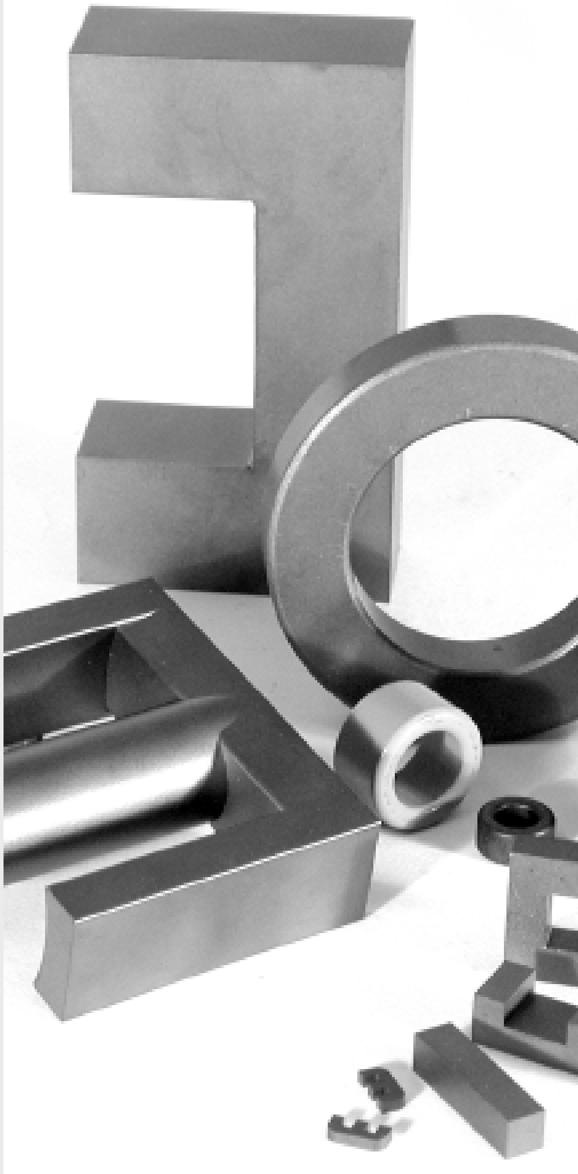
SPECIAL MATERIALS

A number of special materials are engineered for specific performance results, including frequency response, temperature factor, Curie temperature, permeability across temperature for GFCI and telecomm performance, and loss factor. Magnetics' special materials provide outstanding performance, customization options and superior product consistency.

SHAPES: E cores, Planar E cores, ETD, EC, U cores, I cores, PQ, Planar PQ, RM, Toroids (2mm to 86mm), Pot cores, RS (round-slab), DS (double slab), EP, Special Shapes.

APPLICATIONS: EMI Filters, Current sensors, Chokes, Tuned Filters, Data interfaces, Special temperature requirements, Other Special Requirements.

Contact Magnetics' Application Engineering for additional information.



Materials

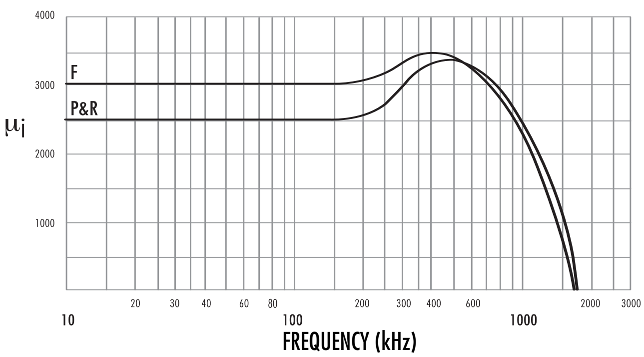
Characteristics

			INDUCTORS & POWER TRANSFORMERS			EMI/RFI FILTERS & BROADBAND TRANSFORMERS		
			R	P	F	J	W	H
Initial Permeability	μ_i	—	2,300 ± 25%	2,500 ± 25%	3,000 ± 20%	5,000 ± 20%	10,000 ± 30%	15,000 ± 30%
Maximum Usable Frequency (50% roll-off)	f	MHz	<1.5	<1.2	<1.3	<1	<0.25	<0.15
Relative Loss Factor	$\frac{\tan\delta}{\mu_{iac}}$	10^{-6}			<8 (100kHz)	<20 (100kHz)	<7 (10kHz)	<15 (10kHz)
*Curie Temperature	T_c	°C	>230	>230	>250	>140	>125	>120
* Relative Temp. Factor -30°C to +20°C +20°C to 70°C	/°C	10^{-6}/°C						
* Flux Density @ 1,194 A/m (15 Oe)	B_m	G mT	5,000 500	5,000 500	4,900 490	4,300 430	4,300 430	4,200 420
* Remanence	B_r	G mT	1,100 110	1,100 110	1,200 120	1,000 100	800 80	800 80
* Coercivity	Hc	Oe A/m	0.18 14	0.18 14	0.2 16	0.1 8	0.04 3	0.04 3
Disaccommodation Factor	D_F	10^{-6}				<3	<3	<2.5
* Resistivity	ρ	Ω-m	6	5	2	1	0.15	0.1
* Density	δ	g/cm^3	4.8	4.8	4.8	4.8	4.8	4.9
Power Loss (P_L) Sine Wave, in mW/cm^3 (typical)	25kHz 200mT (2,000G)	@25°C @60°C @100°C @120°C	130 85 70 85	120 90 95 130	90 160 240			
	100kHz 100mT (1,000G)	@25°C @60°C @100°C @120°C	140 100 70 90	125 90 125 165	100 180 225			
	500kHz 50mT (500G)	@25°C @60°C @100°C @120°C	375 300 250 300	300 250 275 350				
	700kHz 50mT (500G)	@25°C @60°C @100°C @120°C						
Available In:	Pot Cores		X	X	X	X	X	
	RS Cores		X	X	X	X	X	
	DS Cores		X	X	X	X	X	
	RM Cores		X	X	X	X	X	
	EP Cores		X	X	X	X	X	
	E, U Cores		X	X	X	X	X	
	EC, ETD Cores		X	X	X			
	PQ Cores		X	X	X			
	Toroids		X	X	X	X	X	X
	Blocks					X		

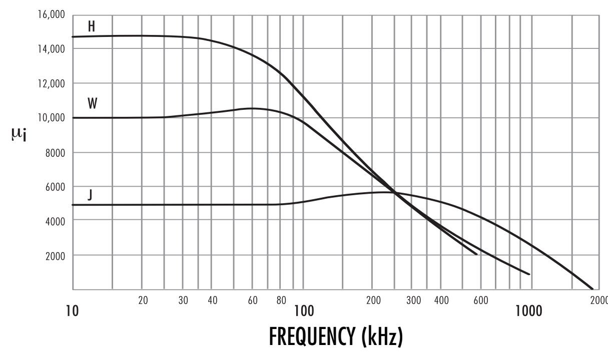
Note: These characteristics are typical for a 42206 size (22.09mm O.D.) toroid. Specific core data will usually differ from these numbers due to the influence of geometry and size. Characteristics with a * are typical.

Material Curves

GRAPH 1 - FREQUENCY RESPONSE CURVES



GRAPH 2 - FREQUENCY RESPONSE CURVES



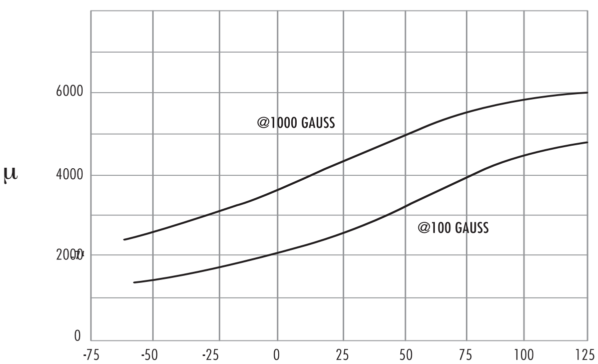
R Material

Saturation Flux Density - gausses 5,000 (at 15 oersted, 25˚C) (500 mT)
Coercive Force - oersted 0.18 (14A/m)
Curie Temperature . . . . 230˚C

μ_i 2,300 ±25%

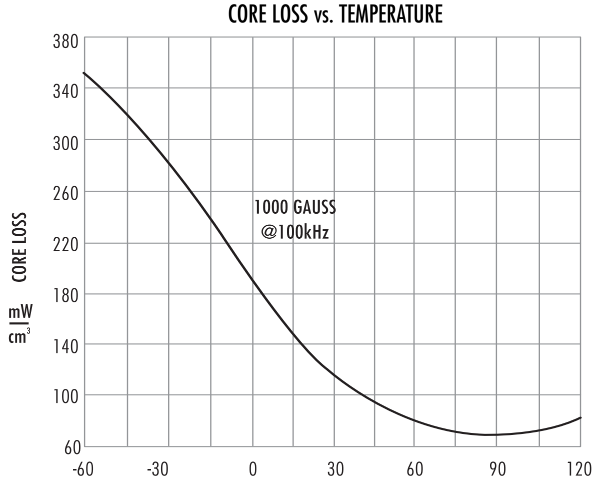
NOTE: The core loss curves are developed from empirical data. For best results and highest accuracy, use them. The formula on page 3.10 yields a fair approximation and can be useful in computer programs.

PERMEABILITY vs. TEMPERATURE



TEMPERATURE ˚C

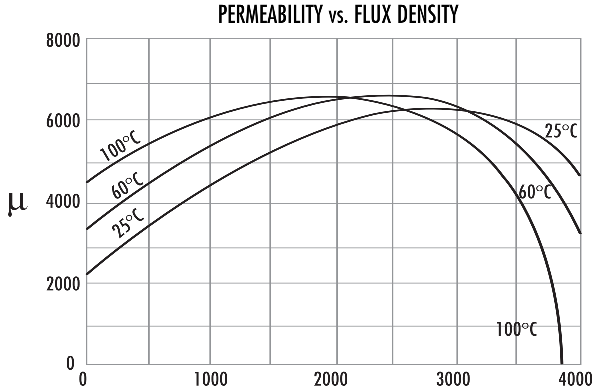
CORE LOSS vs. TEMPERATURE



TEMPERATURE ˚C

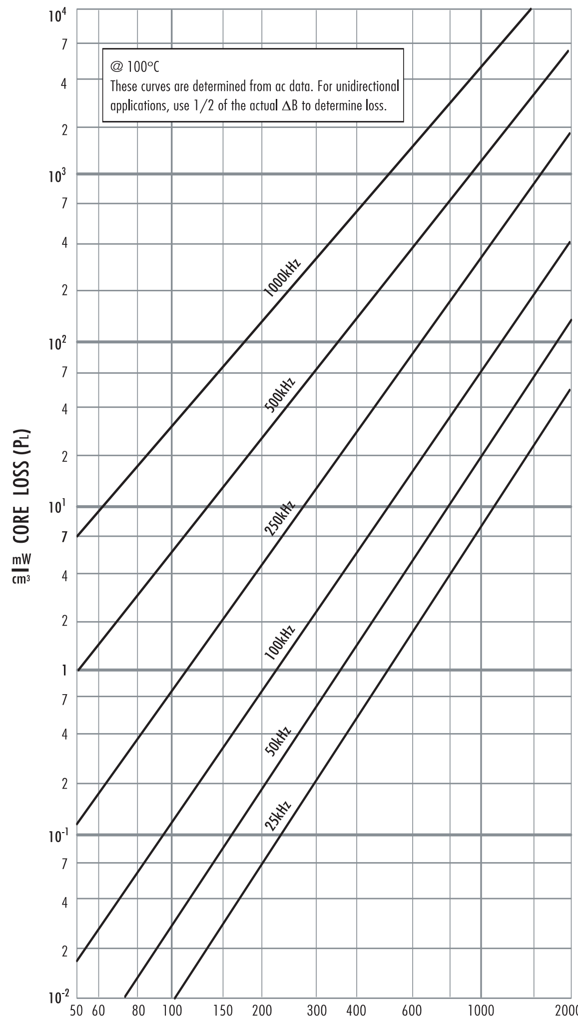
FLUX DENSITY GAUSS

PERMEABILITY vs. FLUX DENSITY



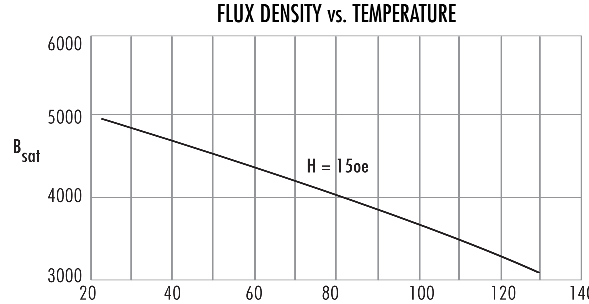
FLUX DENSITY GAUSS

CORE LOSS vs. FLUX DENSITY



FLUX DENSITY GAUSS

FLUX DENSITY vs. TEMPERATURE



TEMPERATURE ˚C

See Page 3.11 for B-H Data

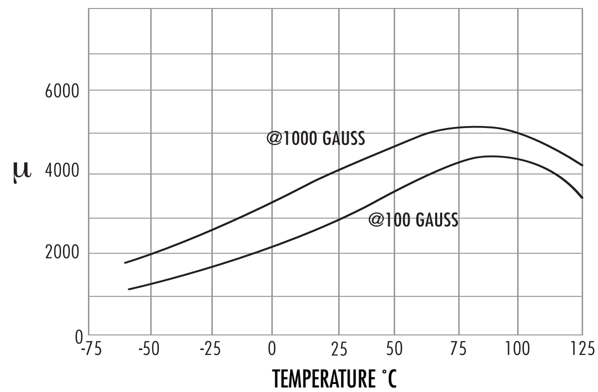
P Material

Saturation Flux Density - gausses 5,000 (at 15 oersted, 25˚C) (500 mT)
Coercive Force - oersted. 0.18 (14A/m)
Curie Temperature. . . . . 230˚C

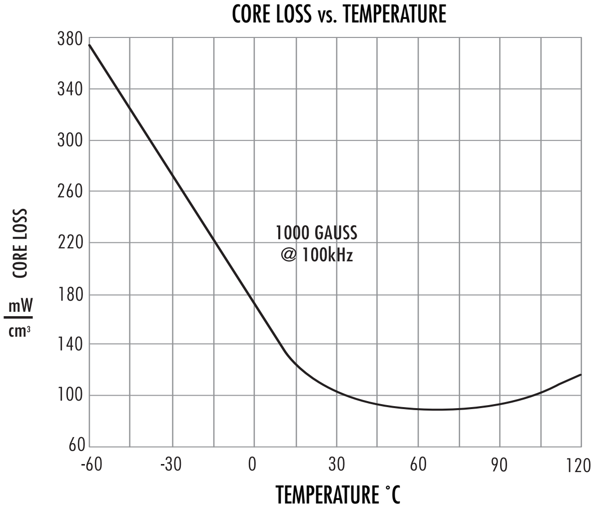
NOTE: The core loss curves are developed from empirical data.
For best results and highest accuracy, use them. The formula on page 3.10 yields a fair approximation and can be useful in computer programs.

μ_i 2,500 ±25%

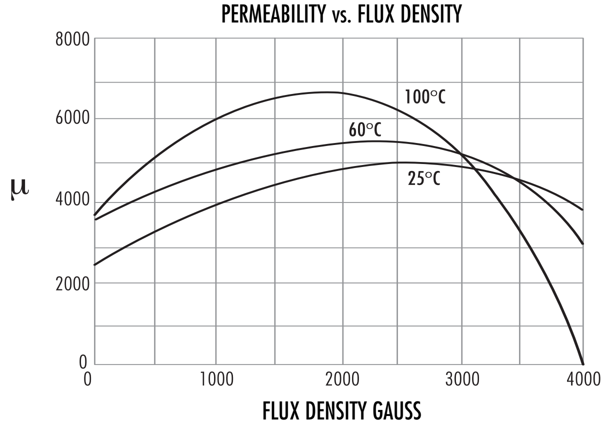
PERMEABILITY vs. TEMPERATURE



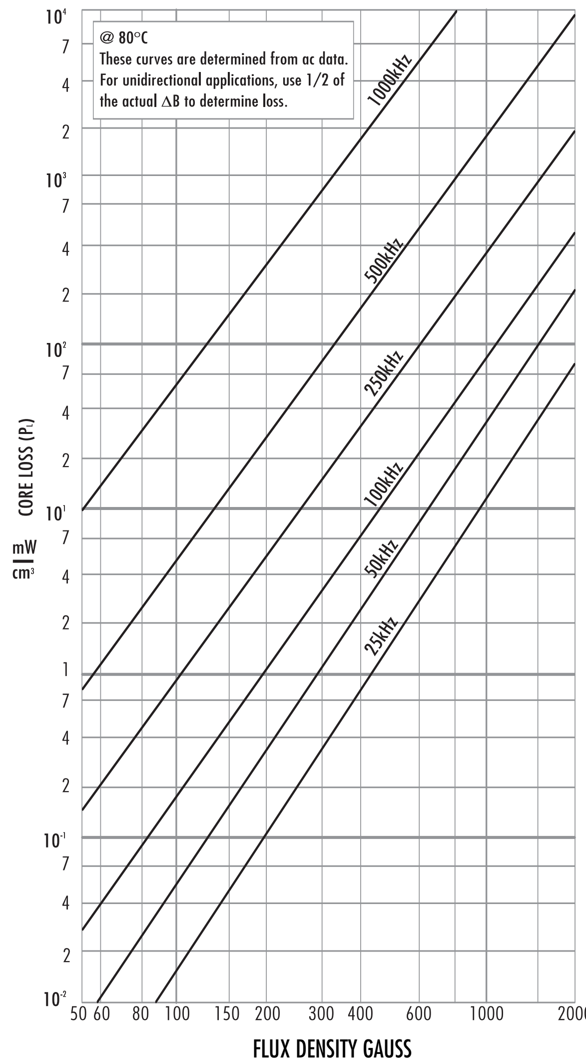
CORE LOSS vs. TEMPERATURE



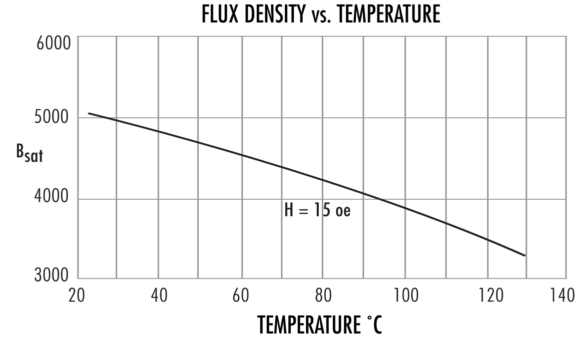
PERMEABILITY vs. FLUX DENSITY



CORE LOSS vs. FLUX DENSITY



FLUX DENSITY vs. TEMPERATURE



See Page 3.11 for B-H Data

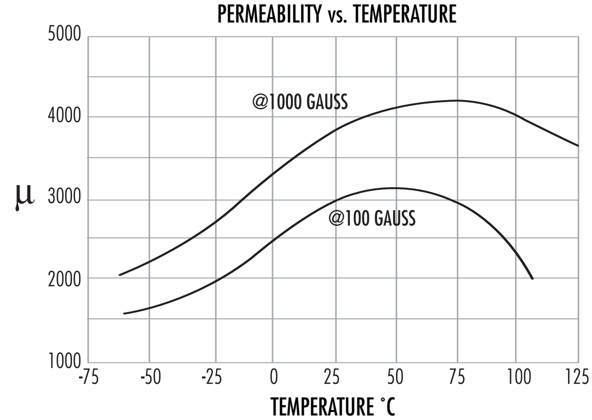
F Material

Saturation Flux Density - gausses 4,900 (at 15 oersted, 25°C) (490 mT)
Coercive Force - oersted 0.20 (16A/m)
Curie Temperature. . . . . 250°C

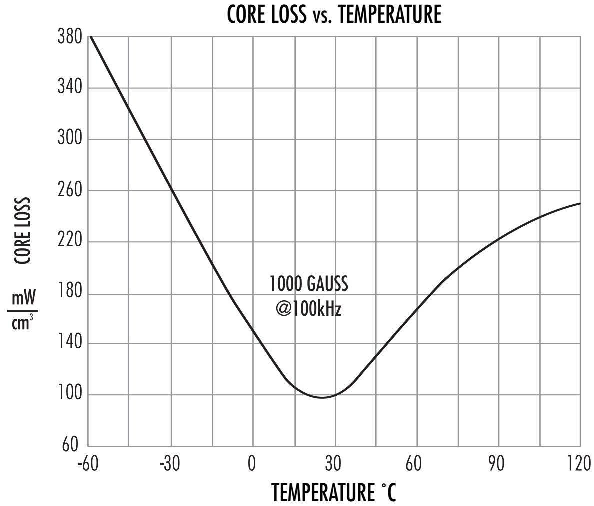
μ_i 3,000 ±20%

NOTE: The core loss curves are developed from empirical data. For best results and highest accuracy, use them. The formula on page 3.10 yields a fair approximation and can be useful in computer programs.

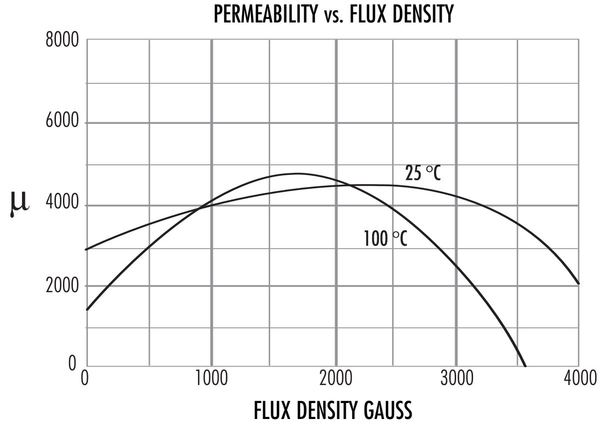
PERMEABILITY vs. TEMPERATURE



CORE LOSS vs. TEMPERATURE

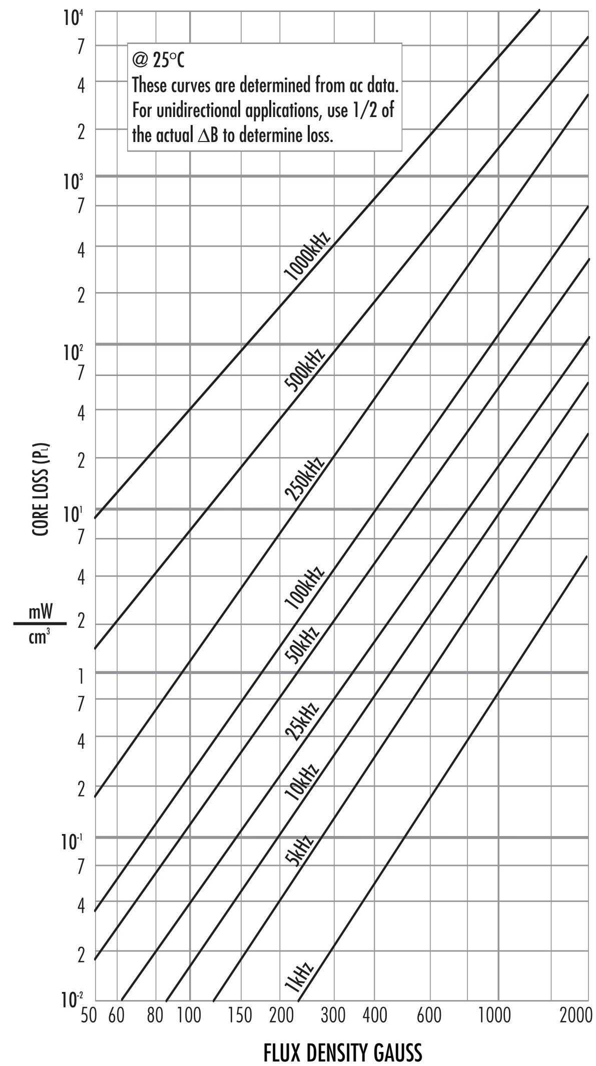


PERMEABILITY vs. FLUX DENSITY

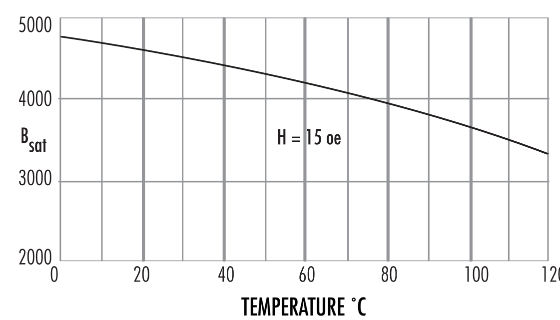


See Page 3.11 for B-H Data

CORE LOSS vs. FLUX DENSITY



FLUX DENSITY vs. TEMPERATURE



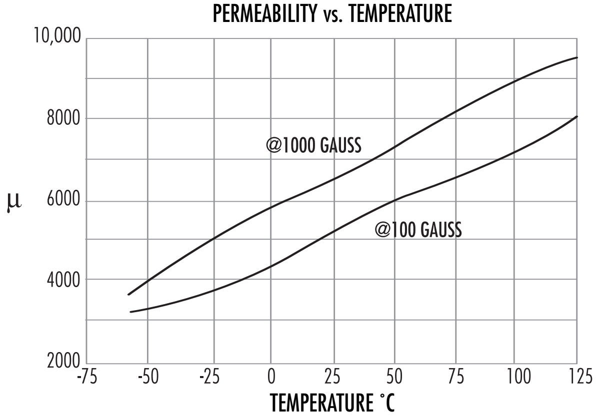
Saturation Flux Density - gausses 4,300 (at 15 oersted, 25˚C) (430 mT)
Coercive Force - oersted 0.1 (8A/m)
Curie Temperature . . . . 140˚C
Disaccomadation Factor . . . . $<3.0 \times 10^{-6}$

NOTE: The core loss curves are developed from empirical data.
For best results and highest accuracy, use them. The formula on page 3.10 yields a fair approximation and can be useful in computer programs.

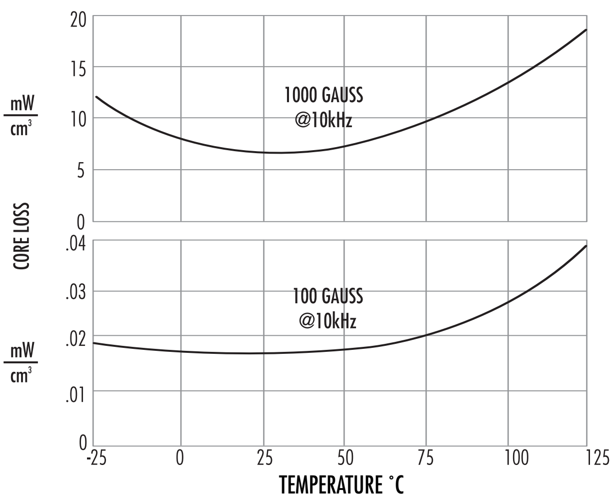
μi 5,000 ±20%

J Material

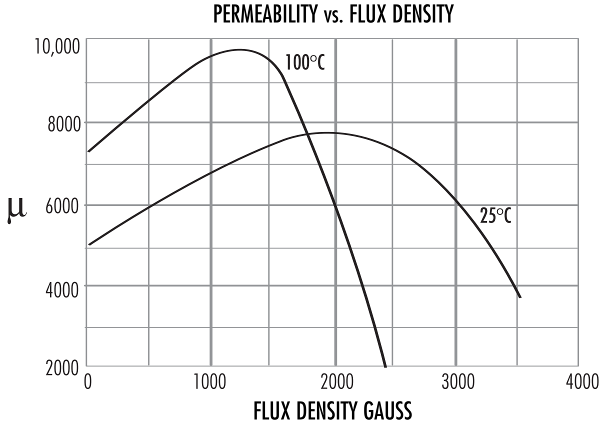
PERMEABILITY vs. TEMPERATURE



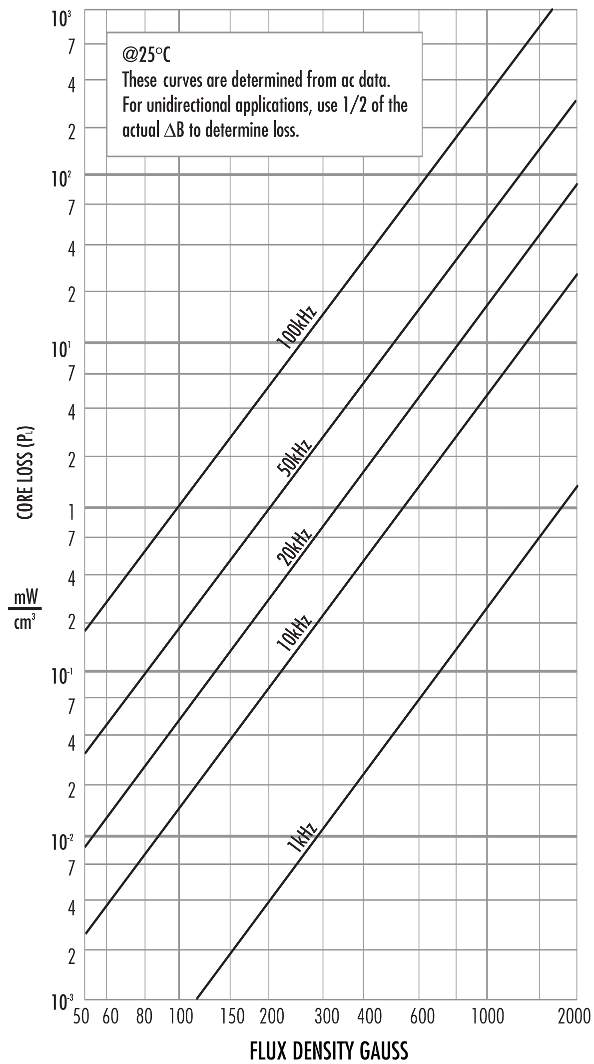
CORE LOSS vs. TEMPERATURE



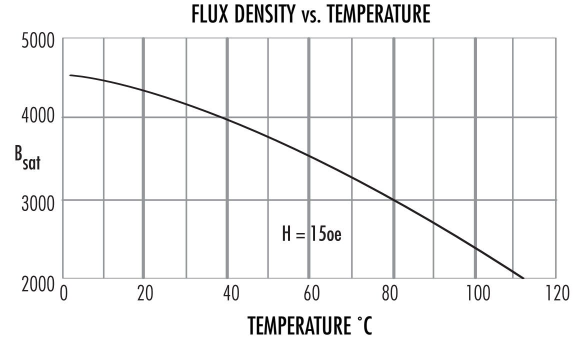
PERMEABILITY vs. FLUX DENSITY



CORE LOSS vs. FLUX DENSITY



FLUX DENSITY vs. TEMPERATURE



See Page 3.11 for B-H Data

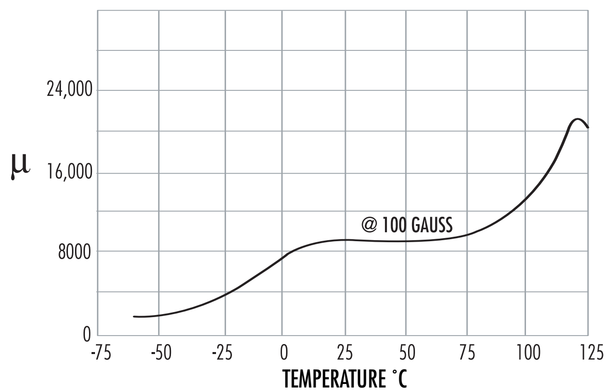
W Material

Saturation Flux Density - gausses 4,300 (at 15 oersted, 25˚C) (430 mT)
Coercive Force - oersted. 0.04 (3A/m)
Curie Temperature . . . . 125˚C
Disaccomadation factor. . . . . <3 x 10^{-6}

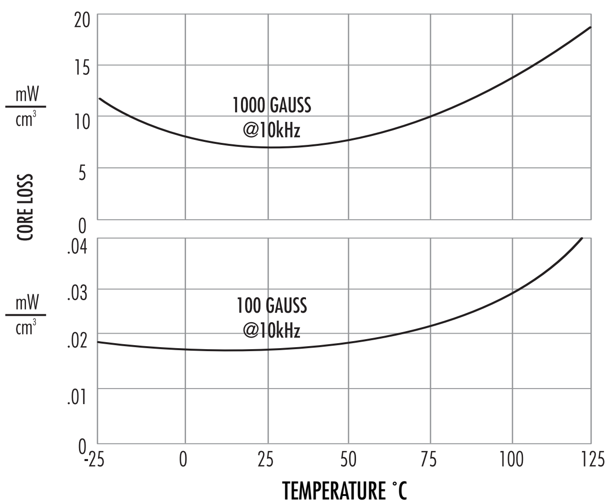
μ_i 10,000 ±30% at 10kHz

NOTE: The core loss curves are developed from empirical data. For best results and highest accuracy, use them. The formula on page 3.10 yields a fair approximation and can be useful in computer programs.

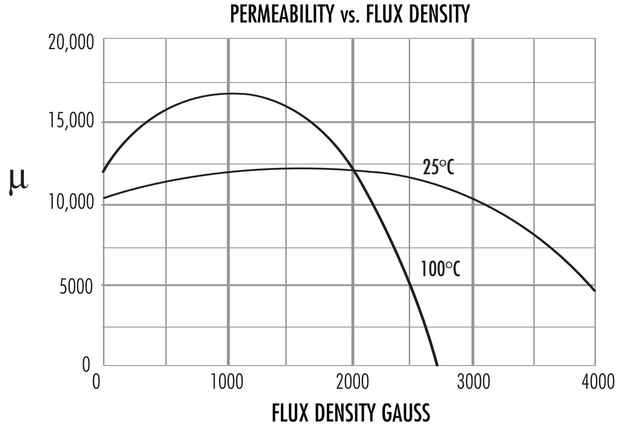
PERMEABILITY vs. TEMPERATURE



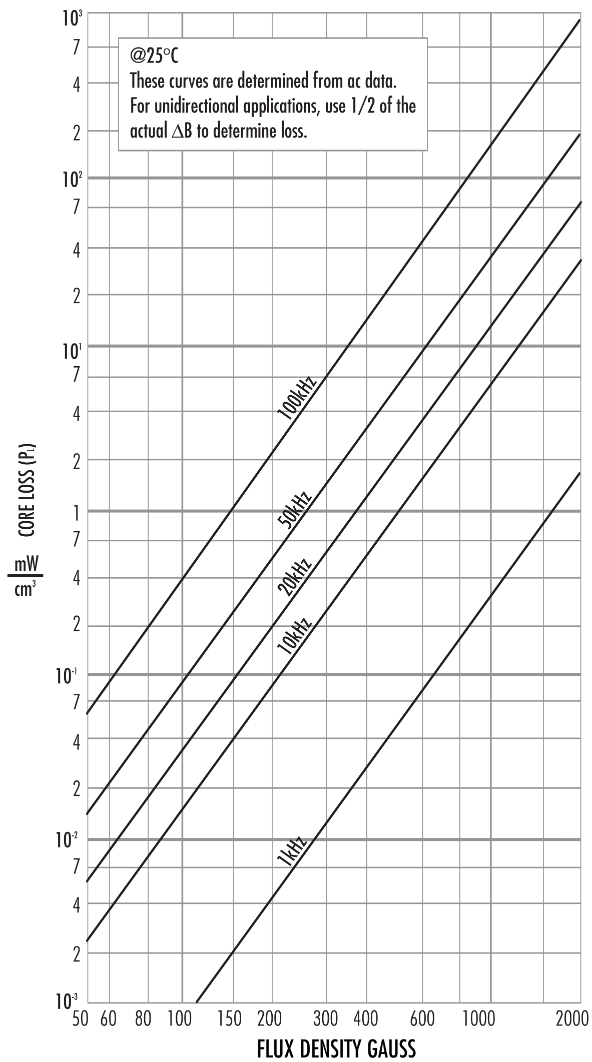
CORE LOSS vs. TEMPERATURE



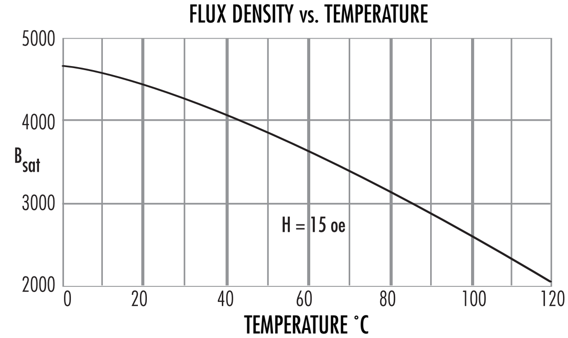
PERMEABILITY vs. FLUX DENSITY



CORE LOSS vs. FLUX DENSITY



FLUX DENSITY vs. TEMPERATURE



See Page 3.11 for B-H Data

Core Loss Equation

Included on pages Pages 3.4-3.9 are material characteristics for the various Magnetics power and inductor materials. For computer programming purposes, the core loss curves can be represented by the equation below.

The factors indicated in the chart are split into discrete frequency ranges, so that the equation offers a close approximation to the core loss curves on the above pages.

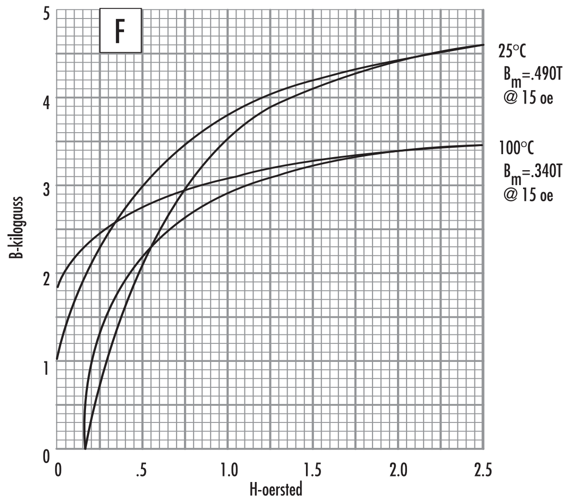
$$\text{CORE LOSS EQUATION: } P_L = af^cB^d$$

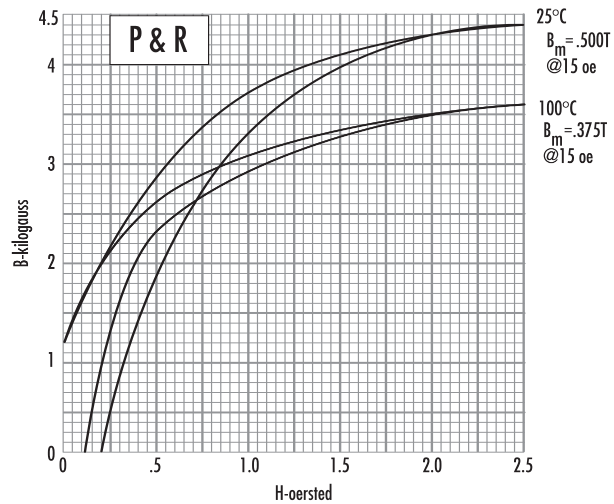
P is in mW/cm^3
B is in kG
f is in kHz

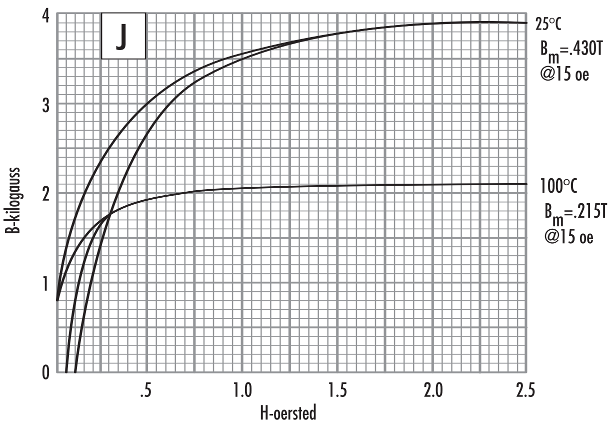
FACTORS APPLIED TO THE ABOVE FORMULA

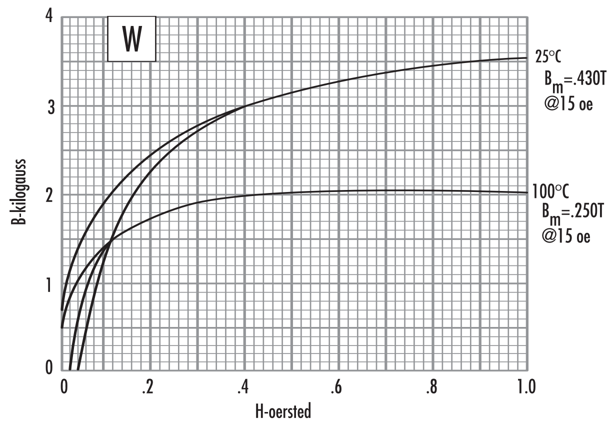
		a	c	d
R Material	f<100 kHz	0.074	1.43	2.85
	100 kHz ≤f<500 kHz	0.036	1.64	2.68
	f≥500 kHz	0.014	1.84	2.28
P Material	f<100 kHz	0.158	1.36	2.86
	100 kHz≤f<500 kHz	0.0434	1.63	2.62
	f≥500 kHz	$7.36*10^{-7}$	3.47	2.54
F Material	f<10 kHz	0.790	1.06	2.85
	10 kHz≤f<100 kHz	0.0717	1.72	2.66
	100 kHz≤f<500 kHz	0.0573	1.66	2.68
	f≥500 kHz	0.0126	1.88	2.29
J Material	f≤20 kHz	0.245	1.39	2.50
	f>20 kHz	0.00458	2.42	2.50
W Material	f≤20 kHz	0.300	1.26	2.60
	f>20 kHz	0.00382	2.32	2.62
H Material	f≤20 kHz	0.148	1.50	2.25
	f>20 kHz	0.135	1.62	2.15

B vs. H Curves (dc)









CONVERSION TABLE

MULTIPLY NUMBER OF	BY	TO OBTAIN
Oersteds	79.5	A/m
Oersteds	0.795	A/cm
Gausses	0.100	milli Teslas
Gausses	10^{-4}	Teslas
Teslas	10^{4}	Gausses

Ferrite Blocks

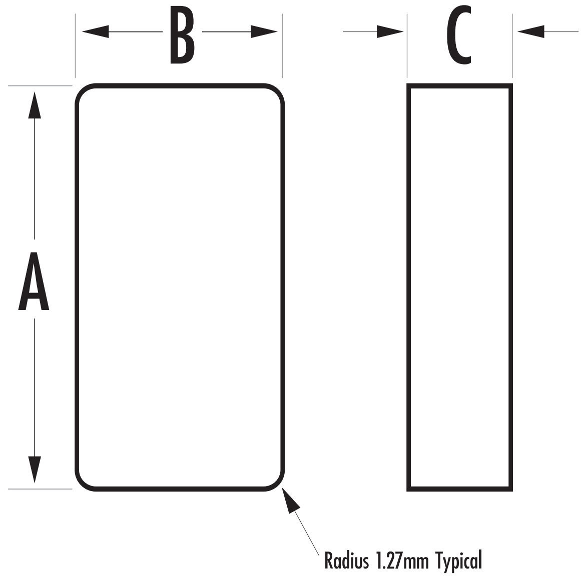
FEATURES OF MAGENTICS FERRITE BLOCKS

- LOW POROSITY
- EXTREME HARDNESS
- UNIFORM PHYSICAL PROPERTIES
- HIGH DENSITY
- EASE OF MACHINING

Ferrites can be pressed in block form and then machined into intricate shapes. Where large sizes are required, it is possible to assemble them from two or more smaller machined or pressed sections; the variety of sizes and shapes becomes limitless.

Without sacrificing magnetic properties, many manufacturing operations can be performed on ferrites, providing strict dimensional or mechanical tolerances:

Surface grinding
Cutting, slicing, slotting
ID and OD machining
Hole drilling
Special machining
Assembly of smaller parts



MATERIAL SELECTION

J material offers high permeability, see page 3.7.
R material is suitable for power applications, see page 3.4.

STANDARD BLOCKS and HOW TO ORDER

PART NUMBER	Dimensions (mm)			Wt.	Vol.
	A	B	C	(gms)	(cm^3)
J42500FB	63.5	2.54	12.7	98.3	20.5
J46213FB	62.23	49.53	12.7	188	39.2
R42500FB	63.5	25.4	12.7	98.3	20.5
R46213FB	62.23	49.53	12.7	188	39.2