Ferrite for Switching Power Supplies

Summary

Issue date: June 2012

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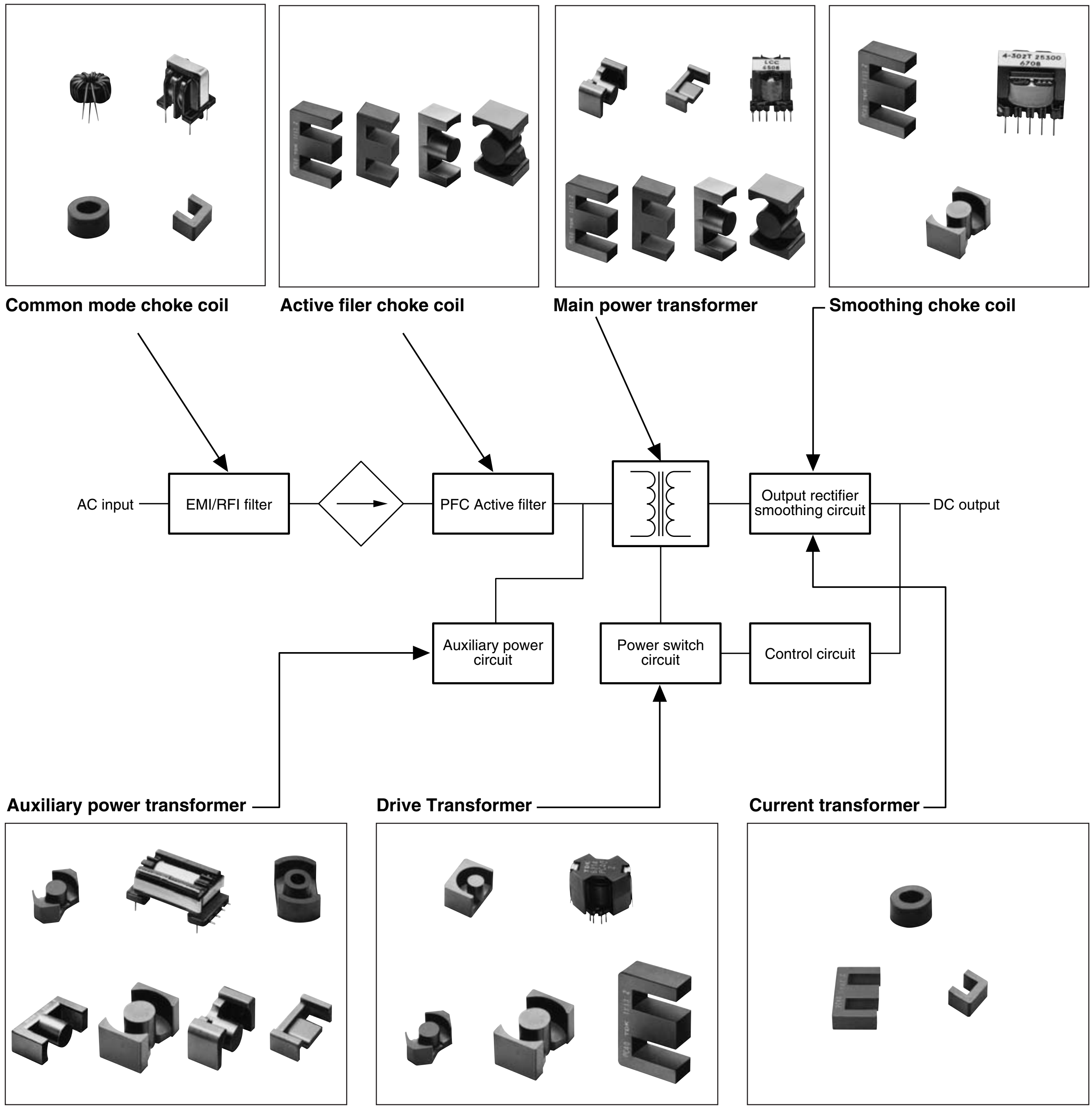
Our foremost mission is to develop unique and advanced electronics technologies. As such, ever since TDK was founded in 1935 when its researchers invented ferrite, we have been involved in a wide range of technological and product development efforts. Particularly, our high-performance ferrite elements, which result from our accumulated expertise and excellent microstructure control technologies, have become essential in reducing the weight and improving the performance of advanced electronic devices that are transforming the world around us.
As a result of pursuing the numerous potentials of these ferrite elements, we have been able to develop high-frequency power ferrite material that deliver among the world's highest levels of reliability and magnetic properties. These products include PC90 and PC47. They contribute to achieving even greater size reductions and performance improvements of high-performance switching power supplies and DC to DC converters -- products considered to constitute the heart of microelectronic devices. We have also developed the PC95 which delivers low loss characteristics in a wide temperature range. This materials is expected to improve the efficiency of power supplies in DC to DC converters used in electric vehicles.
Additionally, we have been conducting research in ferrite that delivers permeability close to the theoretical limit in high frequency ranges. These ferrite materials are designed for EMC solutions. The materials HS72, HS10 and HS12 deliver frequency responses with excellent permeability - a prerequisite for EMC magnetic material such as EMI filters and common mode choke coils - and higher impedance compared to existing material in the high frequency ranges.
In parallel with material development, we have been working to reduce sizes and improve the performance of our switching power supplies and DC to DC converters. To this end, we have been developing optimum core shape designs and creating an extensive line up of these products to accommodate a wide range of specific needs.

CIRCUIT EXAMPLE

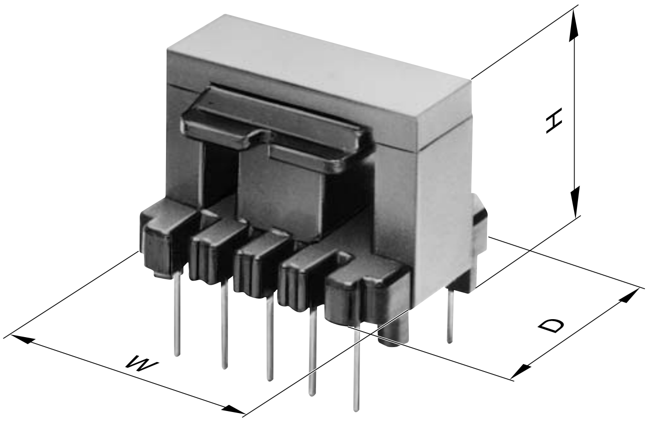
SINGLE FORWARD CONVERTER

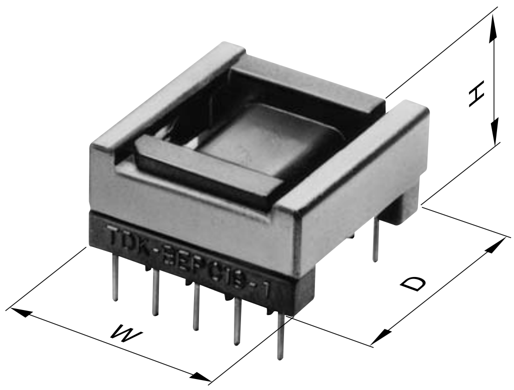


Notes:
- LP and EPC cores are ideal for use in thin transformers.
- LP cores are available in .5 and .7 inches in height (when mounted).
- EP cores are available in .5 and .65 inches in height (when mounted).

SELECTED ITEMS OF LEGEND

$C_1 = \sum \frac{\ell}{A}$	Core constant mm^{-1}
Ae	Effective cross-sectional area, mm^2
ℓe	Effective magnetic path length, mm
Ve	Effective core volume mm^3
Acp	Cross-sectional center leg/pole area, mm^2
Acp min.	Minimum cross-sectional center pole area, mm^2
Acw	Cross-sectional winding area of core, mm^2
Aw	Cross-sectional winding area of bobbin, mm^2
ℓw	Average length of turns around bobbin, mm
t	Minimum thickness of bobbin inside which core is placed, including flanges, mm
W	Bobbin-core assembly dimensions
D	Bobbin-core assembly dimensions
H	Bobbin-core assembly dimensions





MATERIAL CHARACTERISTICS

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For Transformer and Choke

Material					PC47	PC90	PC95
Initial permeability	μi				2500±25%	2200±25%	3300±25%
Amplitude permeability	μa						
Core loss volume density (Core loss)* [B=200mT]	Pcv	kW/m^3	100kHz sine wave	25°C	600	680	350
				60°C	400	470	
				100°C	250	320	290
				120°C	360	460	350
Saturation magnetic flux density* [H=1194A/m]	Bs	mT		25°C	530	540	530
				60°C	480	500	480
				100°C	420	450	410
				120°C	390	420	380
Remanent flux density*	Br	mT		25°C	180	170	85
				60°C	100	95	70
				100°C	60	60	60
				120°C	60	65	55
Coercive force*	Hc	A/m		25°C	13	13	9.5
				60°C	9	9	7.5
				100°C	6	6.5	6.5
				120°C	7	7	6.0
Curie temperature	Tc	°C			>230	>250	>215
Density*	db	kg/m^3			4.9×10^3	4.9×10^3	4.9×10^3
Electrical resistivity*	ρv	Ω • m			4.0	4.0	6.0

For Common Mode Choke

Material				HS72	HS10	HS12
Initial permeability	μi			7500±25% (2000min. at 500kHz)	10000±25%	12000±25% (at 150kHz)
Relative loss factor*	tanδ/μi	$\times10^{-6}$		30(100kHz)	30(100kHz)	20(100kHz)
Saturation magnetic flux density* [H=1194A/m]	Bs	mT	25°C	410	380	430
Remanent flux density*	Br	mT	25°C	80	120	80
Coercive force*	Hc	A/m	25°C	6	5	6
Curie temperature	Tc	°C		>130	>120	>130
Density*	db	kg/m^3		4.9×10^3	4.9×10^3	4.9×10^3
Electrical resistivity*	ρv	Ω • m		0.2	0.2	0.5

* Average value
** 500kHz, 50mT

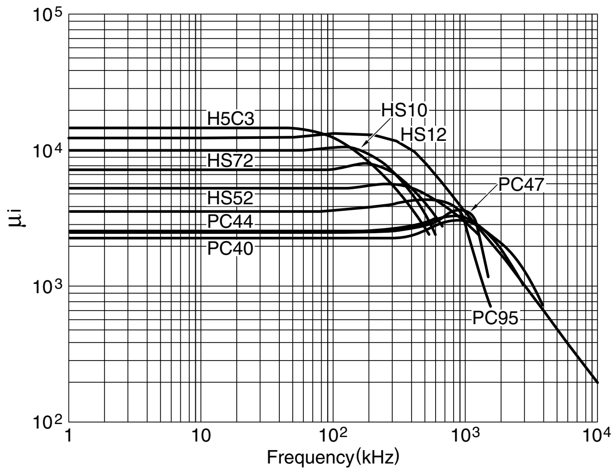
For Telecommunication

Material				H5A	H5B2	H5C2	H5C3
Initial permeability	μi			$3300^{+40\%}_{-0\%}$	7500±25%	10000±30%	15000±30%
Relative loss factor	tanδ/μi	×10–6		<2.5(10kHz) <10(100kHz)	<6.5(10kHz)	<7.0(10kHz)	<7.0(10kHz)
Temperature factor of initial permeability	αμir	×10–6	–30 to +20°C 0 to 20°C 20 to 70°C	–0.5 to 2.0 –0.5 to 2.0	0 to 1.8 0 to 1.8	–0.5 to 1.5 –0.5 to 1.5	–0.5 to 1.5 –0.5 to 1.5
Saturation magnetic flux density* [H=1194A/m]	Bs	mT	25°C	410	420	400	360
Remanent flux density*	Br	mT	25°C	100	40	90	105
Coercive force*	Hc	A/m	25°C	8.0	5.6	7.2	4.4
Curie temperature	Tc	°C		>130	>130	>120	>105
Hysteresis material constant	ηB	$\frac{10^{-6}}{mT}$		<0.8	<1.0	<1.4	<0.5
Disaccommodation factor	DF	×10–6		<3	<3	<2	<2
Density*	db	kg/m3		4.8×10³	4.9×10³	4.9×10³	4.95×10³
Electrical resistivity*	ρv	Ω • m		1	0.1	0.15	0.15

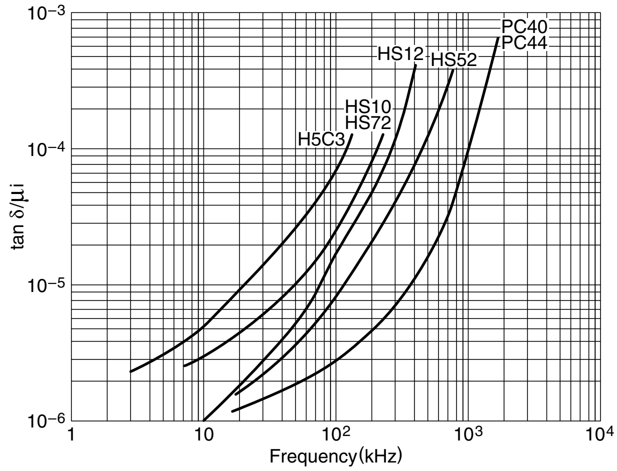
Material				H5C4	HP5	DNW45	DN70
Initial permeability	μi			12000±30% ≧9000(–20°C)	5000±20%	4200±25%	7500±25%
Relative loss factor	tanδ/μi	×10–6	25°C, 10kHz	<8(10kHz)	<3.5	<3.5	<2.0
Temperature factor of initial permeability	αμir	×10–6	–30 to +20°C 0 to 20°C 20 to 70°C		 ±12.5% ±12.5%		–0.5 to 1.5 –0.5 to 1.5
Saturation magnetic flux density* [H=1194A/m]	Bs	mT	25°C	380	400	450	390
Remanent flux density*	Br	mT	25°C	100	65	50	45
Coercive force*	Hc	A/m	25°C	4.4	7.2	6.5	3.5
Curie temperature	Tc	°C		>110	>140	>150	>105
Hysteresis material constant	ηB	$\frac{10^{-6}}{mT}$		<2.8	<0.4	<0.8	<0.2
Disaccommodation factor	DF	×10–6		<3	<3	<3	<2.5
Density*	db	kg/m3		4.95×10³	4.8×10³	4.85×10³	5.0×10³
Electrical resistivity*	ρv	Ω • m		0.15	0.15	0.65	0.3

* Average value

μi vs. Frequency Characteristics

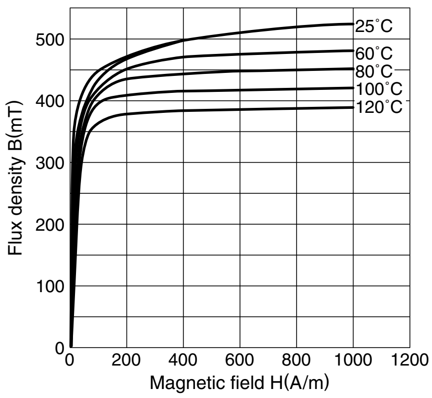


tanδ/μi vs. Frequency Characteristics

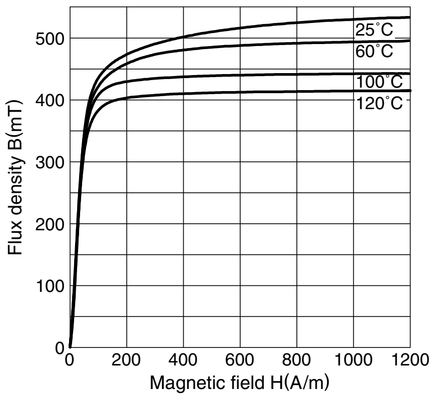


Magnetization Curves (Typical)

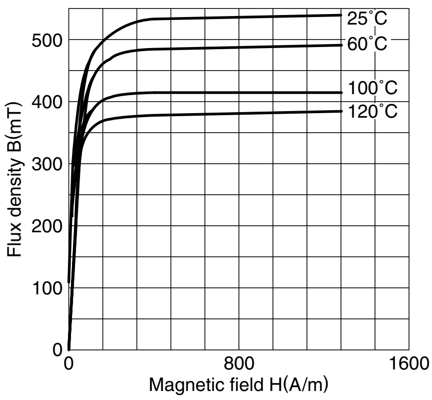
Material: PC47



Material: PC90



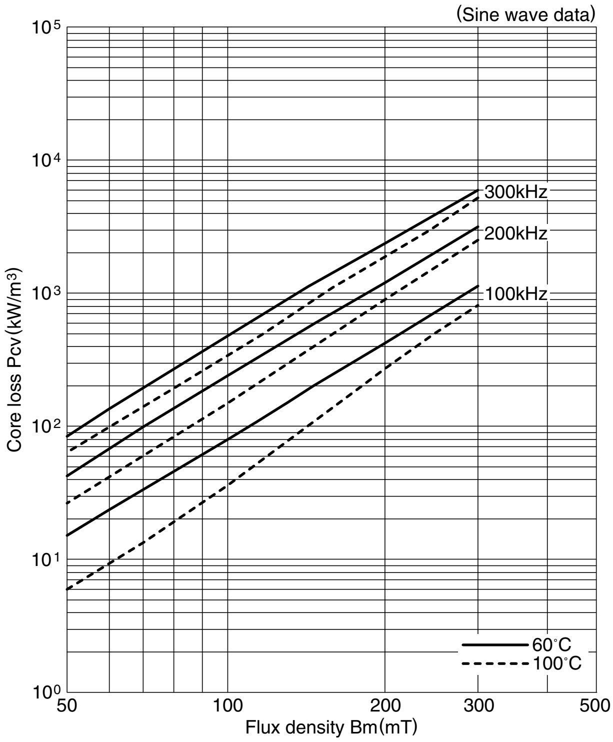
Material: PC95



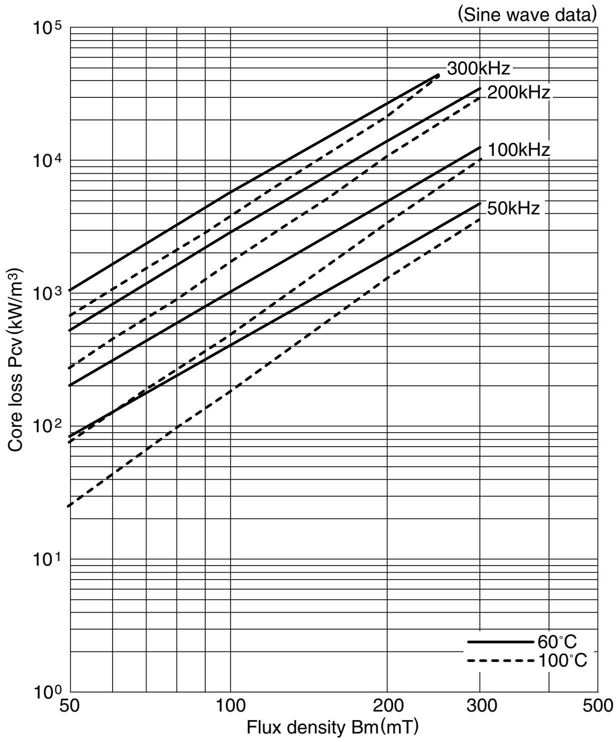
TDK

Core Loss (Typical)

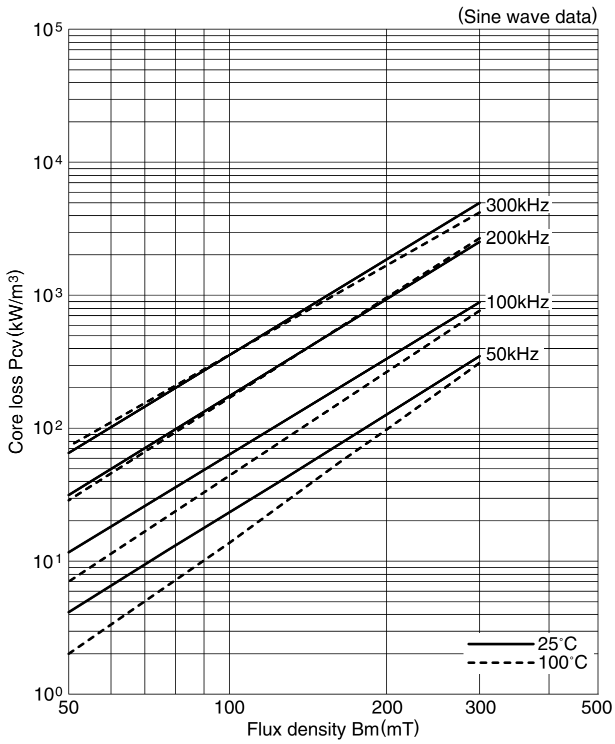
Material: PC47



Material: PC90

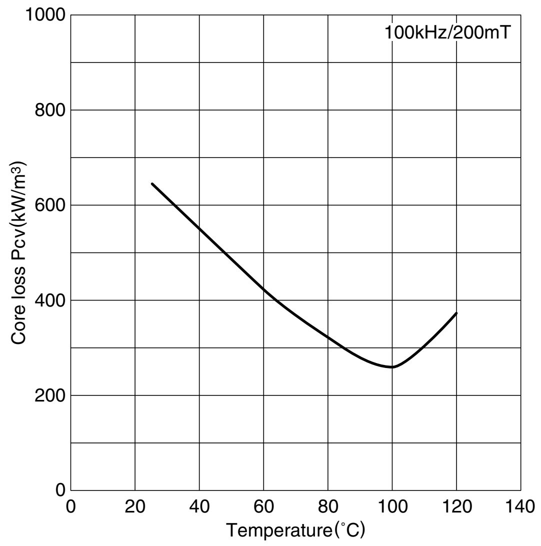


Material: PC95

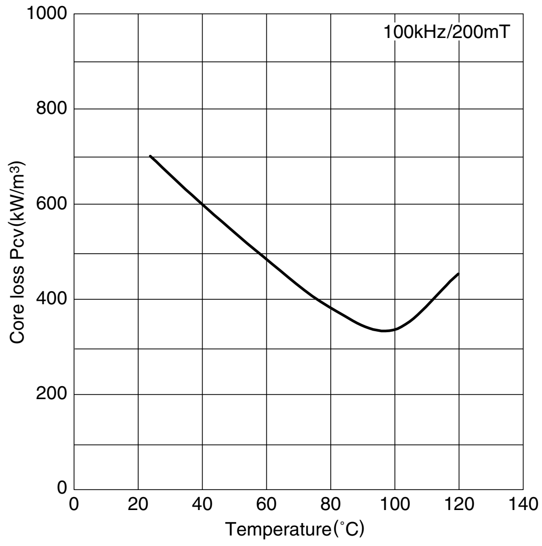


Temperature Dependence of Core Loss (Typical)

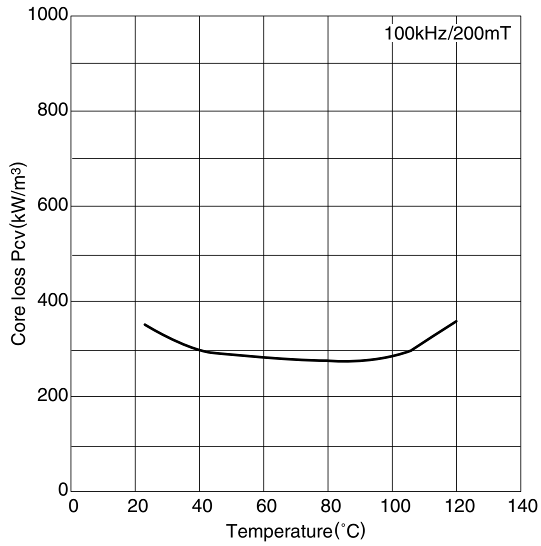
Material: PC47



Material: PC90

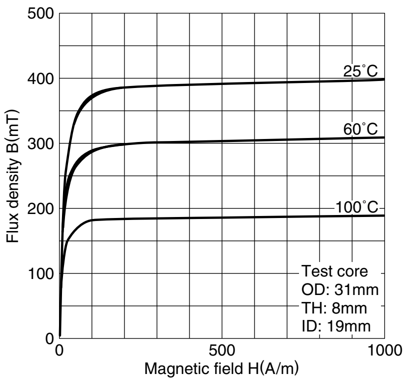


Material: PC95

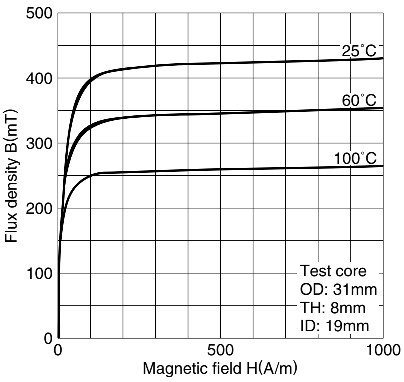


Magnetization Curves (Typical)

HS72

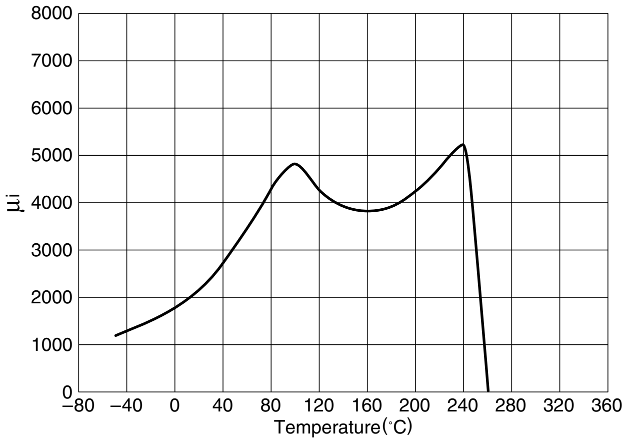


HS10

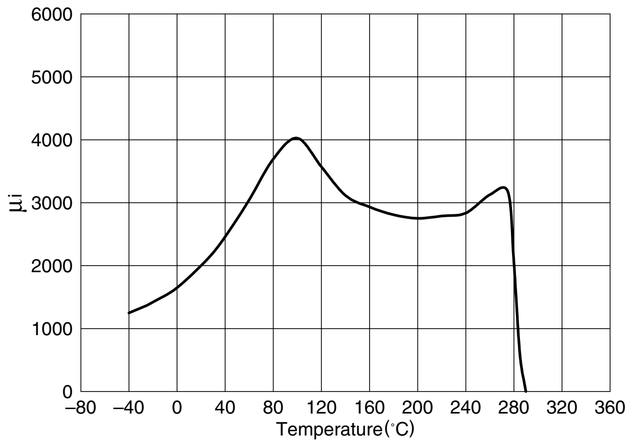


μi vs. Temperature Characteristics (Typical)

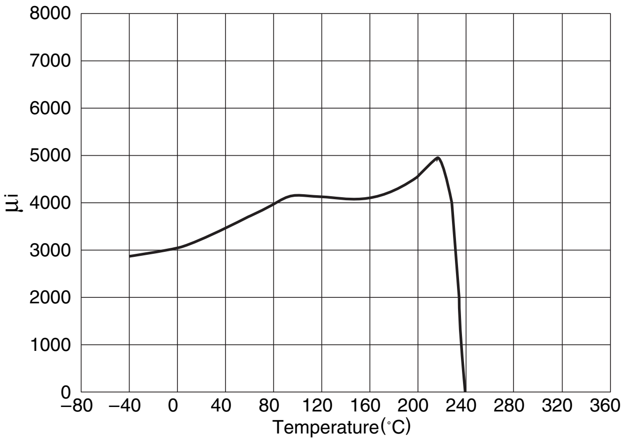
PC47



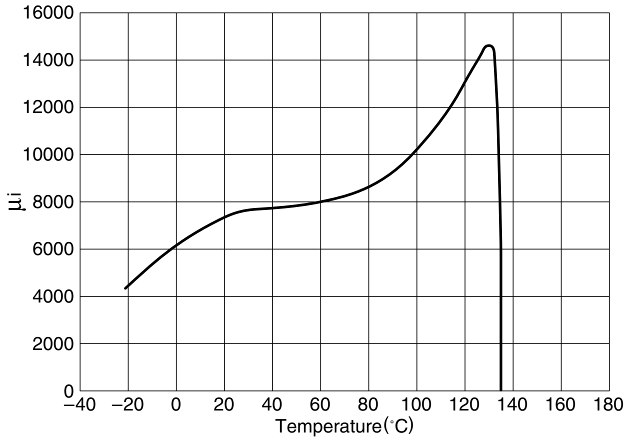
PC90



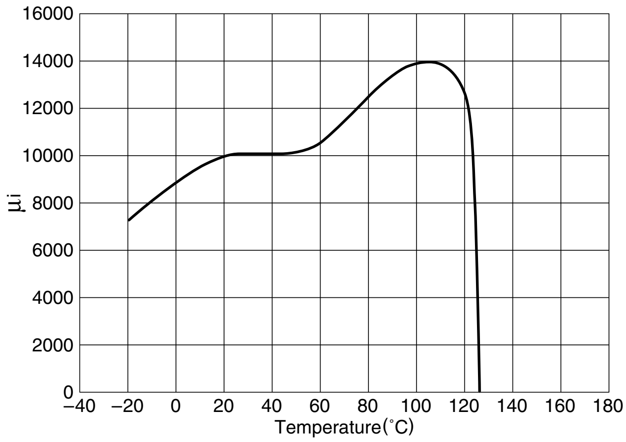
PC95



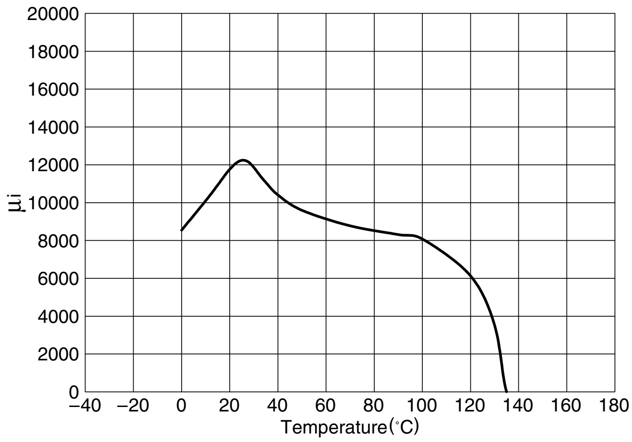
HS72



HS10



HS12



Test core: OD=31mm
TH=8mm
ID=19mm

- All specifications are subject to change without notice.