Specification for Soft Magnetic Material

kOr 120 / kOr 120HF / kOr 120LP

Material selection (first block in part number, see page 2)

120: standard material for transformers, common mode chokes (CMC), RCD cores, CT cores without DC tolerance available with linear flat hysteresis loop (F-loop), round loop (R-loop), rectangular loop (Z-loop)

120HF: optimised for transformers for f > 30 kHz and CMCs with improved high frequency impedance

120LP: high linearity / low permeability version for DC tolerant CT cores

Nominal data

	Symbol	Unit	Value	Conditions	
General material data					
Chemical composition		at%	$Fe_{73,5}Cu_1Nb_3Si_{15,5}B_7$		
Saturation flux density (saturation induction)	B_{sat}	mT	1200 1120	H > 100 A/m H > 100 A/m	25°C 100°C
Curie temperature	T_c	°C	600		
Resistance	ρ	µΩm	1,15		
Density	d	g / cm^3	7,35	annealed	
Saturation magnetostriction	λ_S	ppm	<1	annealed	
Tape thickness[2)]	d	µm	20 16	kOr 120, kOr 120LP kOr 120HF	
Tape width	b	mm	3 - 50		
Filling factor (stacking factor)	FF	%	>80 >76	kOr 120: b ≤ 25 mm kOr 120: b>25 mm; all kOr 120HF	
recommended max. operational temperature		°C	120 - 200	depending on specification and operational conditions	
For kOr 120 / kOr 120HF with flat hysteresis loop (nominal values, cores in protection case or Epoxy coated):					
Initial permeability	μ_i'		20.000 - 200.000	adjustable[1)]	25°C
Nominal permeability	μ'		30.000 - 120.000	adjustable[1)]	10 kHz
Remanence	B_r	mT	50 150	µ = 30.000, 50 Hz µ = 100.000, 50 Hz	
Power losses (in protection case)	P_{Fe}	W/kg	4,5 60 40	10 kHz / 0,6 T 100 kHz / 0,3 T (kOr 120) 100 kHz / 0,3 T (kOr 120HF)	
For kOr 120 with round hysteresis loop (in protection case):					
Initial permeability	μ_i'		100.000 - 250.000		25°C
Maximum permeability	μ'_{max}		150.000 - 500.000	adjustable[1)]	50 Hz
Remanence	B_r	mT	500 - 900		
For kOr 120LP with high linear flat hysteresis loop (in protection case or Epoxy coated):					
Initial permeability	μ_i'		1000 - 2500	adjustable[1)]	25°C
permeability decay at 0,9 T		%	6 - 10		50 Hz

Remarks:

1) Permeability μ can be adjusted.

A_L-values are calculated according to $A_L = \mu_r \mu_0 \frac{A_{Fe}}{l_{Fe}}$

(A_L in mH, effective cross section A_{Fe} in mm^2, magnetic path length l_{Fe} in mm, $\mu_0 = 4\pi \cdot 10^{-7}$ Vs/Am)
μ_r in this formula is identical with μ' in this document.
A_{Fe} and l_{Fe} depend on the core dimensions and are indicated in the core datasheets.

2) Effective tape thickness, calculated from length, width and density of a tape sample.
Geometrical tape thickness (measured with a tape stack using a gauge) is higher by 10% - 15% due to roughness.

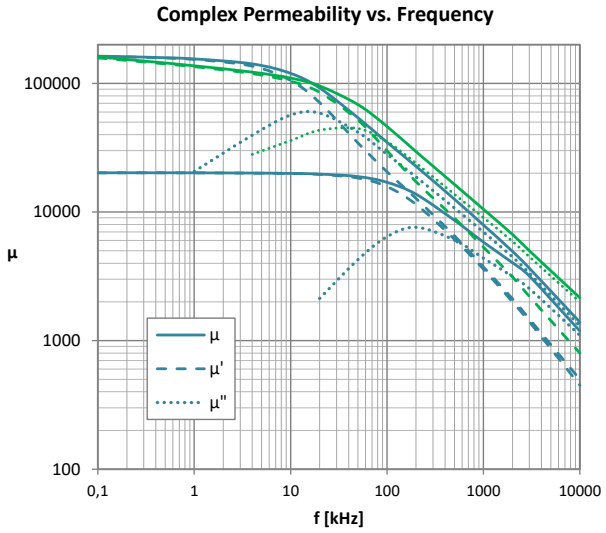
Material data of specific product specifications may differ due to geometry and dimension.

Part number system:

	material	-	shape	finish	-	size	-	perm./cuts	-version
example:	120HF	-	T	B	-	252010	-	70	-1
	120	-	R	I	-	016A	-	2C	-2

material:	number denotes B_S in 10 mT; available materials see page 1
shape:	T = toroid, R = rectangular, O = oval, E = E-shape, U = U-shape, I = bar
finish:	B = protection box (usually plastic case), E = Epoxy coating, I = Epoxy impregnation, EI = impregnation + coating, V = sprayed varnish, S = soft impregnation + glass fiber wrapped
size:	toroid: OD ID H; rectangular: standard number or B C H; bar: A B C
permeability:	for non-cut cores of kOr 120 and kOr 120HF: minimum permeability in 1000 for non-cut cores of kOr 120LP: minimum permeability for cores with rectangular hysteresis loop (Z-loop): "Z"
cuts:	for cut cores: number of cuts + "C" for bars: empty
version:	version number (e.g. different coatings). This is not the revision state!

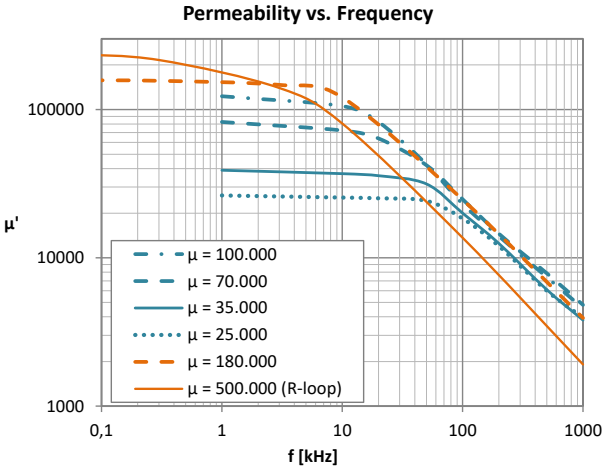
Data for toroidal cores of kOr 120 in protection case



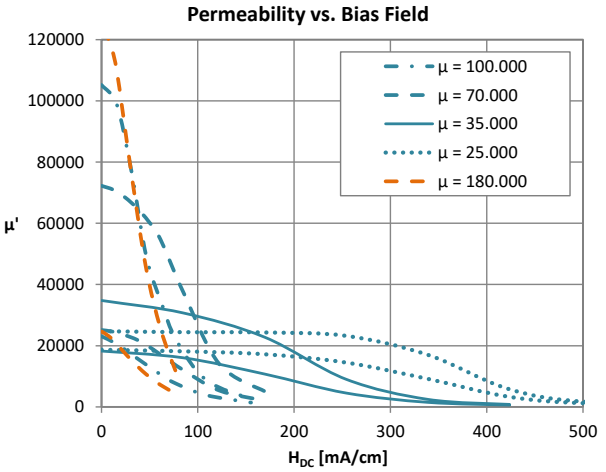
Notes:

Typical curves are given for cores with nominal permeability (10 kHz) of 20.000 and 100.000. Data for other permeabilities may be approximated using these data.
Green curves are for kOr 120HF with nominal permeability (10 kHz) of 100.000.

N = 1, H = 10 mA/cm



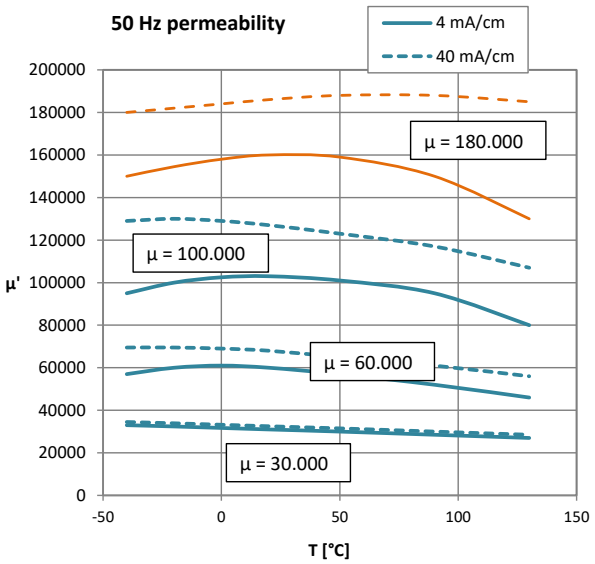
Typical curves.
Blue curves:
Nominal permeability refers to 10 kHz value.
Orange curves (highest permeabilities):
Nominal permeability refers to μ_{max} at 50 Hz, curves are measured at H_{AC} = 4 mA/cm.

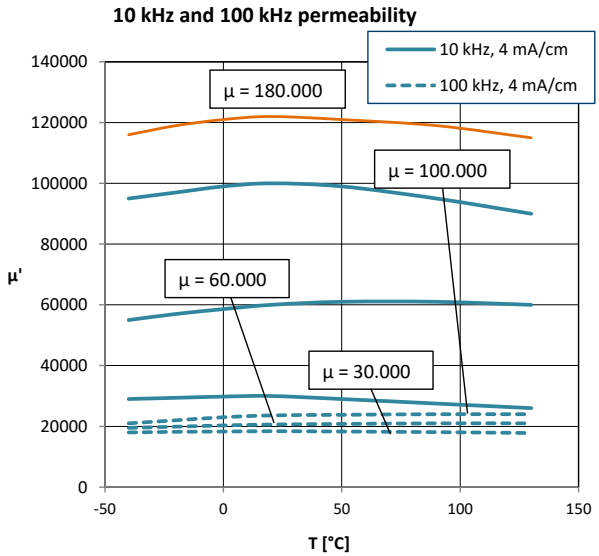


Typical curves.
Upper curve: 10 kHz
Lower curve: 100 kHz
Blue curves:
Nominal permeability refers to 10 kHz value.
orange curves:
Nominal permeability refers to μ_{max} at 50 Hz, curves are measured at H_{AC} = 4 mA/cm.

$$I_{DC} = H_{DC} \cdot l_{Fe}$$

Temperature dependence of permeability





Notes:

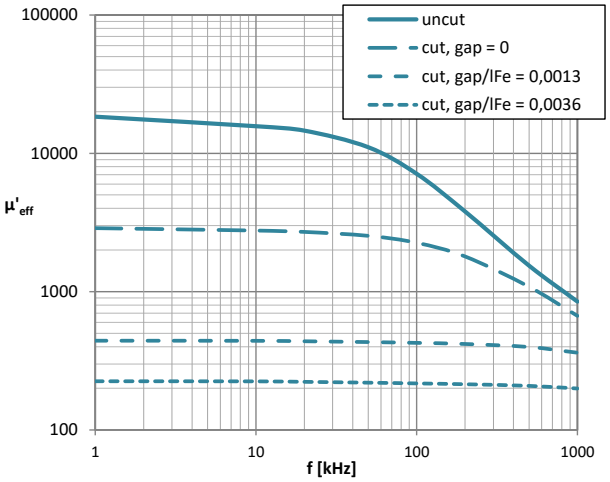
Typical curves for cores without or with low residual stress, for example in protection case fixed with some silicone glue or foam rings.

Permeability of Epoxy coated cores decreases in relation to shown curves below 50°C.

Blue curves:
Nominal permeability refers to 10 kHz value.
Orange curves:
Nominal permeability refers to μ_{max} at 50 Hz.

Data for impregnated uncut and single cut cores of kOr 120, standard quality

Effective Permeability vs. Frequency



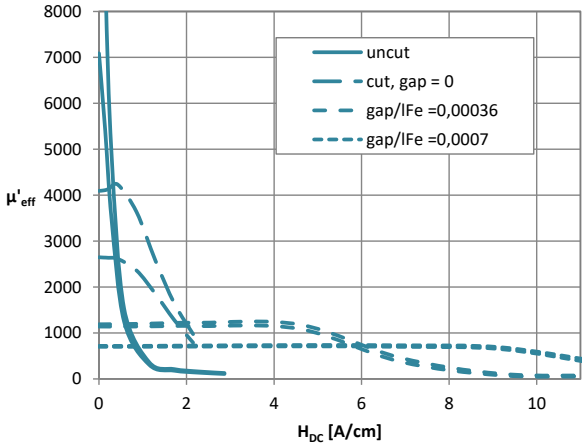
Notes:
Cores are impregnated with Epoxy.
Typical curves are shown.

gap/lFe denotes single gap width in relation to mean path length l_{Fe} for l_{Fe} = 100 - 500 mm

N = 1, U_{eff} = 100 mV

Nominal / minimum permeability for
single cut cores without additional gap:
10 kHz: 2500 / 1600
100 kHz: 1900 / 1200
Nominal permeability at 10 kHz up to 10.000 is possible with special cut quality on request.

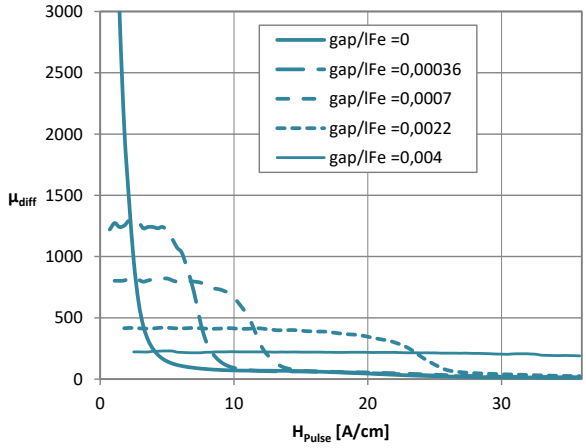
Effective Permeability vs. Bias Field



N = 1, U_{eff} = 100 mV
Upper curves: 10 kHz; lower curves: 100 kHz

$$I_{DC} = H_{DC} \cdot l_{Fe}$$

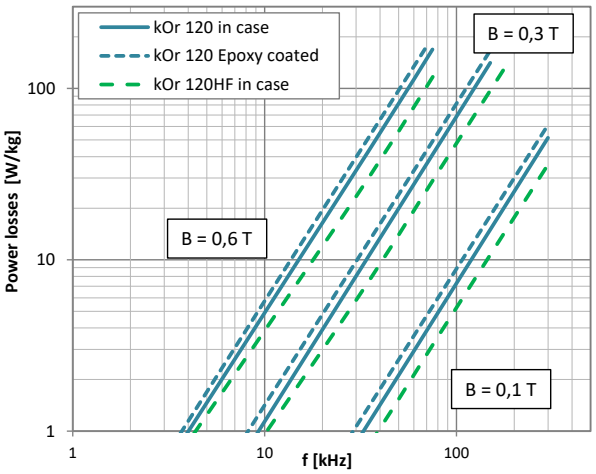
Differential Permeability vs. Pulse Field

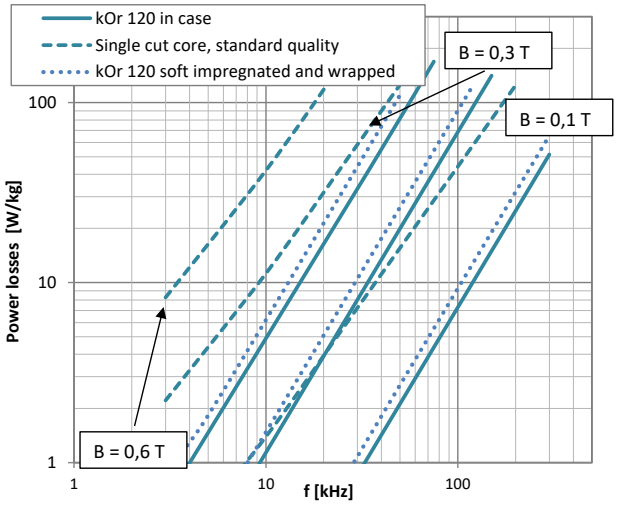


μ_{diff} monitored during pulse

Nominal power loss data

Power Losses vs. Frequency and Induction Amplitude





Notes:

Excitation with sinusoidal voltage of an amplitude corresponding to the indicated peak induction.

Power losses of cores in plastic cases decrease with increasing temperature.

Power losses of coated cores converge towards those of cores in cases between 80 and 130°C.

Losses of cut cores refer to rectangular shape (not E-shaped cores or other shapes) with path length l_{Fe} of 50 - 500 mm and effective cross section A_{Fe} of 100 - 3000 mm^2 with standard quality, without additional gap. Losses vary with gap width and number of cuts.

Core losses are affected by forces, i.e. by assembly and fixation technologies.

Actual losses may vary in a wide range.

Soft impregnation and wrapped:
Cores are impregnated with soft Epoxy resin, and wrapped with glasfiber or Polyimide foil. They can be wire wound directly.

Steinmetz-coefficients (nominal data):

$$P_{Fe} = k\, f^{a} \hat{B}^{b}$$

P_{Fe} in W/kg, f in kHz, B in T

Valid for room temperature.

Valid for B ≤ 0,6 T, f = 10 … 150 kHz; losses are higher for f < 10 kHz and nominal B > 0,6 T.

	Part Number	k	a	b
kOr 120 in protection case, μ_{nom} > 45.000	120-TB-…->30-…	0,23	1,74	2,02
kOr 120 in protection case, μ_{nom} < 45.000	120-TB-…-≤30-…	0,22	1,82	2,05
kOr 120 Epoxy coated, μ_{nom} > 45.000	120-TE-…->30-…	0,34	1,70	2,06
kOr 120 Epoxy coated, μ_{nom} < 45.000	120-TE-…-≤30-…	0,36	1,70	2,08
kOr 120 soft impregnated, wrapped	120-TS-…	0,3	1,78	2,07
kOr 120HF in protection case	120HF-TB-…	0,18	1,75	2,01
kOr 120 cut core standard quality	120-RI-…	4	1,5	2,0