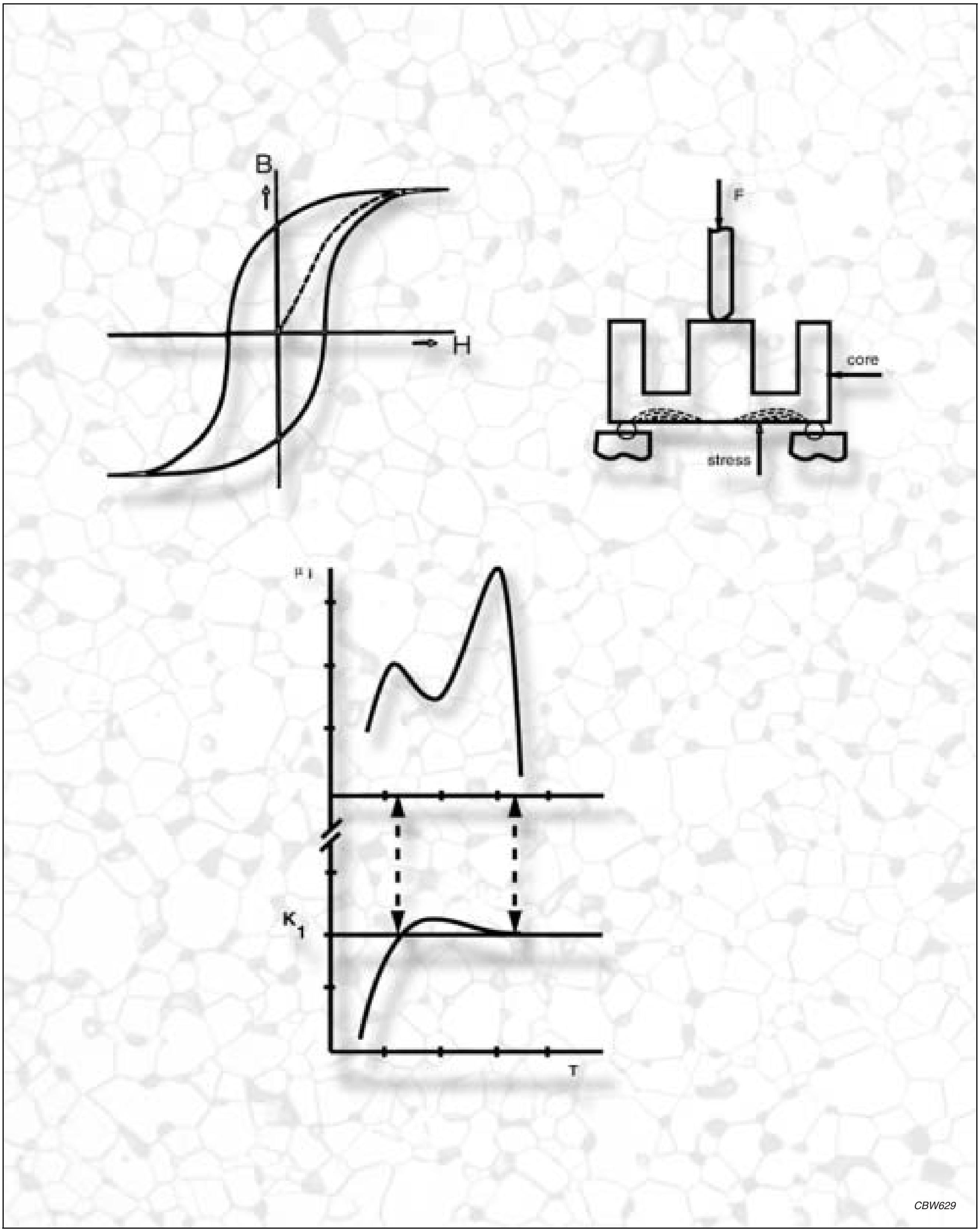
B
H
F
core
stress
K1
T
CBW629

Properties specified in this section are related to room temperature (25 °C) unless otherwise stated.
They have been measured on sintered, non ground ring cores of dimensions ∅25 × ∅15 × 10 mm which are not subjected to external stresses. Products generally comply with the material specification. However, deviations may occur due to shape, size and grinding operations etc. Specified product properties are given in the data sheets or product drawings.

Ferrite material survey

MAIN APPLICATION AREA	FREQUENCY RANGE (MHZ)	MATERIAL	μ_i at 25 °C	B_{sat} (mT) at 25 °C (1200 A/m)	T_C (°C)	ρ (Ωm)	FERRITE TYPE	AVAILABLE CORE SHAPES
Telecom filters Proximity sensors		3B46	3800	≈ 545	≥ 255	≈ 10	MnZn	RM, P, PT, PTS, EP, E, Planar ER, RM/I, RM/ILP, PH
	< 0.1	3B7	2300	≈ 440	≥ 170	≈ 1	MnZn	
	0.2 – 2	3D3	750	≈ 380	≥ 200	≈ 2	MnZn	
	< 0.2	3H3	2000	≈ 360	≥ 160	≈ 2	MnZn	
Wideband signal transformers Pulse transformers Delay lines		3E27	6000	≈ 430	≥ 150	≈ 0.5	MnZn	RM, P, PT, PTS, EP, EP/LP, EPX, E, Planar ER, RM/I, RM/ILP, Toroids
		3E28	4000	≈ 440	≥ 145	≈ 1	MnZn	
		3E5	10000	≈ 380	≥ 125	≈ 0.5	MnZn	
		3E55	10000	≈ 370	≥ 100	≈ 0.1	MnZn	
		3E6	12000	≈ 390	≥ 130	≈ 0.1	MnZn	
		3E7	15000	≈ 390	≥ 130	≈ 0.1	MnZn	Toroids
		3E8	18000	≈ 380	≥ 100	≈ 0.1	MnZn	
		3E9	20000	≈ 380	≥ 100	≈ 0.1	MnZn	
Line output transformers (LOT)	< 0.2	3C30	2100	≈ 500	≥ 240	≈ 2	MnZn	UR
	< 0.3	3C34	2100	≈ 500	≥ 240	≈ 5	MnZn	
Power transformers Power inductors General purpose transformers and inductors	< 0.2	3C81	2700	≈ 450	≥ 210	≈ 1	MnZn	E, EI, Planar E, EC, EFD, EP, ETD, ER, Planar ER, U, RM/I, RM/ILP, P, P/I, PT, PTS, PM, PQ, Toroids (gapped), Bobbin cores
	< 0.2	3C90	2300	≈ 470	≥ 220	≈ 5	MnZn	
	< 0.3	3C91	3000	≈ 470	≥ 220	≈ 5	MnZn	
	< 0.2	3C92	1500	≈ 520	≥ 280	≈ 5	MnZn	
	< 0.3	3C93	1800	≈ 500	≥ 240	≈ 5	MnZn	
	< 0.3	3C94	2300	≈ 470	≥ 220	≈ 5	MnZn	
	< 0.3	3C95	3000	≈ 530	≥ 215	≈ 5	MnZn	
	< 0.4	3C96	2000	≈ 500	≥ 240	≈ 5	MnZn	
	0.2 – 0.5	3F3	2000	≈ 440	≥ 200	≈ 2	MnZn	
	0.5 – 1	3F35	1400	≈ 500	≥ 240	≈ 10	MnZn	
	1 – 2	3F4	900	≈ 410	≥ 220	≈ 10	MnZn	
	1 – 2	3F45	900	≈ 420	≥ 300	≈ 10	MnZn	
	2 – 4	3F5	650	≈ 380	≥ 300	≈ 10	MnZn	
	4 – 10	4F1	80	≈ 320(1)	≥ 260	$\approx 10^5$	NiZn	
Wideband EMI-suppression Wideband transformers Balun transformers	10 – 100	3B1	900	≈ 380	≥ 150	≈ 0.2	MnZn	BD, BDW, BDS, MLS, CMS, Cable shields, Rods, Toroids, WBS, WBC
	1 – 30	3S1	4000	≈ 400	≥ 125	≈ 1	MnZn	
	30 – 1000	3S3	350	≈ 320	≥ 225	$\approx 10^4$	MnZn	
	10 – 300	3S4	1700	≈ 320	≥ 110	$\approx 10^3$	MnZn	
	1 – 30	3S5	3800	≈ 545	≥ 255	≈ 10	MnZn	
	30 – 1000	4A11	850	≈ 340	≥ 125	$\approx 10^5$	NiZn	
	10 – 300	4A15	1200	≈ 350	≥ 125	$\approx 10^5$	NiZn	
	10 – 300	4A20	2000	≈ 260	≥ 100	$\approx 10^5$	NiZn	
	30 – 1000	4B1	250	≈ 360(1)	≥ 250	$\approx 10^5$	NiZn	
	50 – 1000	4C65	125	≈ 380(1)	≥ 350	$\approx 10^5$	NiZn	
	30 – 1000	4S2	850	≈ 340	≥ 125	$\approx 10^5$	NiZn	
	30 – 1000	4S3	250	≈ 360(1)	≥ 250	$\approx 10^5$	NiZn	

MAIN APPLICATION AREA	FREQUENCY RANGE (MHZ)	MATERIAL	μ_i at 25 °C	B_{sat} (mT) at 25 °C (1200 A/m)	T_C (°C)	ρ (Ωm)	FERRITE TYPE	AVAILABLE CORE SHAPES
EMI-filters Current compensated chokes		3C11	4300	≈ 390	≥ 125	≈ 1	MnZn	Toroids E, EI, U
		3E25	6000	≈ 390	≥ 125	≈ 0.5	MnZn	
		3E26	7000	≈ 430	≥ 155	≈ 0.5	MnZn	
		3E5	10000	≈ 380	≥ 125	≈ 0.5	MnZn	
		3E6	12000	≈ 390	≥ 130	≈ 0.1	MnZn	
		4A11	850	≈ 340	≥ 125	≈ 10^5	NiZn	
HF Tuning	< 1	3B1	900	≈ 380	≥ 150	≈ 0.2	MnZn	Rods, Tubes, Wideband chokes
	< 2	3D3	750	≈ 380	≥ 200	≈ 2	MnZn	
	< 5	4B1	250	≈ 360(1)	≥ 250	≈ 10^5	NiZn	
	< 5	4B2	250	≈ 360(1)	≥ 335	≈ 10^5	NiZn	
	< 20	4C65	125	≈ 380(1)	≥ 350	≈ 10^5	NiZn	
	< 50	4D2	60	≈ 250(2)	≥ 400	≈ 10^5	NiZn	
	< 200	4E1	15	≈ 220(3)	≥ 500	≈ 10^5	NiZn	
magnetic regulators	< 0.2	3R1	800	≈ 410	≥ 230	≈ 10^3	MnZn	Toroids
absorber tiles	< 1000	4S60	2000	≈ 260	≥ 100	≈ 10^5	NiZn	Tiles
scientific particle accelerators	< 10	4B3	300	≈ 420(1)	≥ 250	≈ 10^5	NiZn	Large toroids Machined ferrite products
	< 100	4E2	25	≈ 350(2)	≥ 400	≈ 10^5	NiZn	
	< 10	4M2	140	≈ 310(1)	≥ 200	≈ 10^5	NiZn	
	< 1	8C11	1200	≈ 310	≥ 125	≈ 10^5	NiZn	
	< 10	8C12	900	≈ 260	≥ 125	≈ 10^5	NiZn	

1. At 3000 A/m
2. At 10 kA/m
3. At 20 kA/m

Iron powder material grade survey

IRON POWDER MATERIAL	μ_i at 25 °C	B_{sat} (mT) at 25 °C (3000 A/m)	MAXIMUM OPERATING TEMPERATURE (°C)	MAIN APPLICATION AREA	AVAILABLE CORE SHAPES
2P40	40	950	140	EMI-suppression Output inductors	Toroids
2P50	50	1000	140		
2P65	65	1150	140		
2P80	80	1400	140		
2P90	90	1600	140		

Typical mechanical and thermal properties

PROPERTY	MnZn FERRITE	NiZn FERRITE	UNIT
Young’s modules	(90 to 150) × 10^3	(80 to 150) × 10^3	N/mm^2
Ultimate compressive strength	200 to 600	200 to 700	N/mm^2
Ultimate tensile strength	20 to 65	30 to 60	N/mm^2
Vickers hardness	600 to 700	800 to 900	N/mm^2
Linear expansion coefficient	(10 to 12) × 10^{-6}	(7 to 8) × 10^{-6}	K^{-1}
Specific heat	700 to 800	750	$Jkg^{-1} \times K^{-1}$
Heat conductivity	(3.5 to 5.0) × 10^{-3}	(3.5 to 5.0) × 10^{-3}	$Jmm^{-1}s^{-1} \times K^{-1}$

RESISTIVITY

Ferrite is a semiconductor with a DC resistivity in the crystallites of the order of 10^{-3} Ωm for a MnZn type ferrite, and about 30 Ωm for a NiZn ferrite.

Since there is an isolating layer between the crystals, the bulk resistivity is much higher: 0.1 to 10 Ωm for MnZn ferrites and 10^4 to 10^6 Ωm for NiZn and MgZn ferrites.

This resistivity depends on temperature and measuring frequency, which is clearly demonstrated in Tables 1 and 2 which show resistivity as a function of temperature for different materials.

Table 1 Resistivity as a function of temperature of a MnZn-ferrite (3C94)

TEMPERATURE (°C)	RESISTIVITY (Ωm)
−20	≈10
0	≈7
20	≈4
50	≈2
100	≈1

Table 2 Resistivity as a function of temperature of a NiZn-ferrite (4C65)

TEMPERATURE (°C)	RESISTIVITY (Ωm)
0	$\approx 5.10^7$
20	$\approx 10^7$
60	$\approx 10^6$
100	$\approx 10^5$

At higher frequencies the crystal boundaries are more or less short-circuited by heir capacitance and the measured resistivity decreases, as shown in Tables 3 and 4.

Table 3 Resistivity as function of frequency for MnZn ferrites

FREQUENCY (MHz)	RESISTIVITY (Ωm)
0.1	≈2
1	≈0.5
10	≈0.1
100	≈0.01

Table 4 Resistivity as function of frequency for NiZn ferrites

FREQUENCY (MHz)	RESISTIVITY (Ωm)
0.1	$\approx 10^5$
1	$\approx 5.10^4$
10	$\approx 10^4$
100	$\approx 10^3$

PERMITTIVITY

The basic permittivity of all ferrites is of the order of 10. This is valid for MnZn and NiZn materials. The isolating material on the grain boundaries also has a permittivity of approximately 10. However, if the bulk permittivity of a ferrite is measured, very different values of apparent permittivity result. This is caused by the conductivity inside the crystallites. The complicated network of more or less leaky capacitors also shows a strong frequency dependence.

Tables 5 and 6 show the relationship between permittivity and frequency for both MnZn and NiZn ferrites.

Table 5 Permittivity as a function of frequency for MnZn ferrites

FREQUENCY (MHz)	PERMITTIVITY (ε_r)
0.1	$\approx 2.10^5$
1	$\approx 10^5$
10	$\approx 5.10^4$
100	$\approx 10^4$

Table 6 Permittivity as a function of frequency for NiZn ferrites

FREQUENCY (MHz)	PERMITTIVITY (ε_r)
0.001	≈100
0.01	≈50
1	≈25
10	≈15
100	≈12