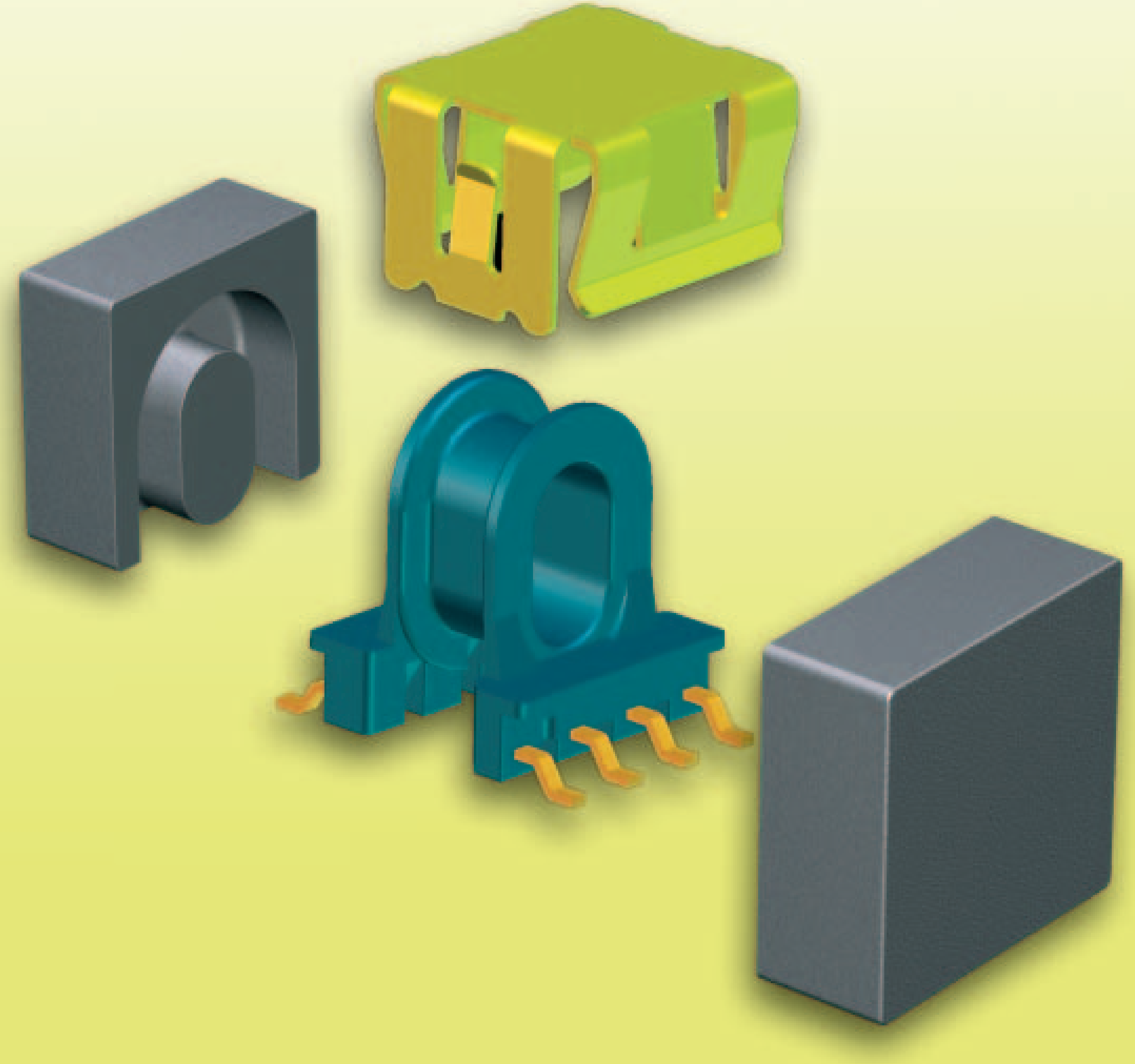
EPX

a new telecom core range



FERROXCUBE
A YAGEO COMPANY

EPX - a new telecom core shape

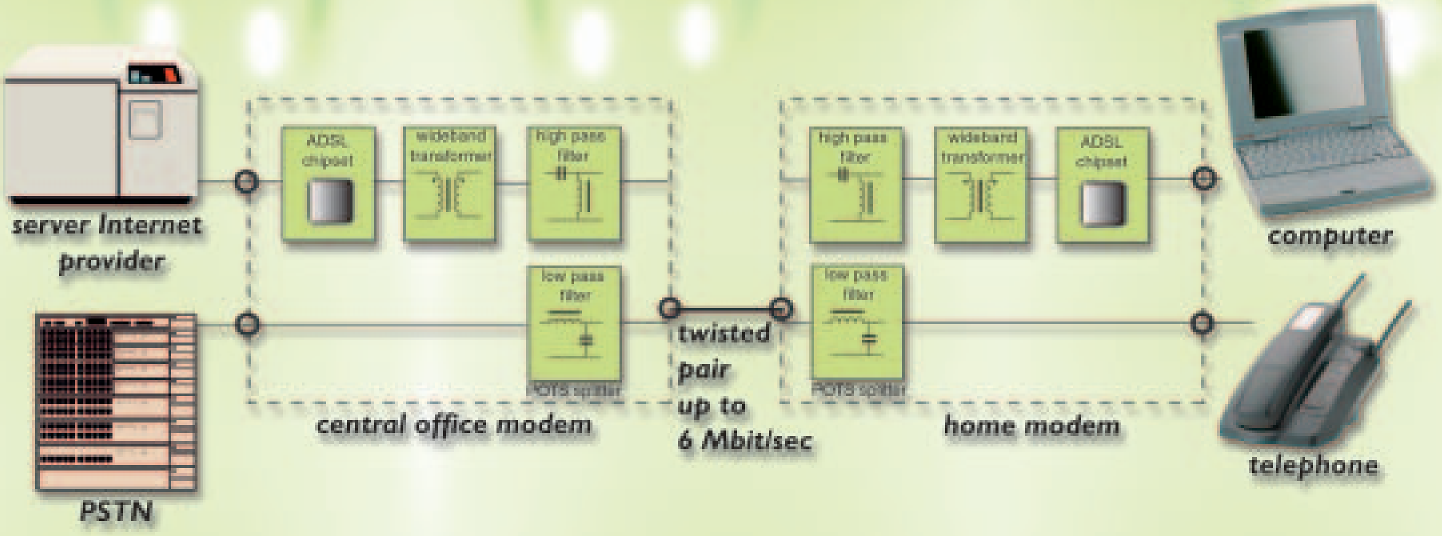
In modern Telecom applications like ISDN and DSL ferrite-cored pulse and wideband transformers play an important role. These transformers provide impedance matching and safety isolation in modems placed between networks and telephone sets or computers. Driven by miniaturization, equipment manufacturers design-in the smallest possible transformers while still fulfilling the requirements set by chip-set makers or standardization bodies like ITU-T.

For pulse transformers (ISDN) a high Lp is of prime importance to keep pulses within the prescribed mask, so cores with high AL values in high permeability materials like our 3E6 are often used. With these cores the number of turns, and thus parasitic capacitance, is kept low for improved high frequency behavior.
In DSL applications the key design parameter is THD (Total Harmonic Distortion). It must be kept low to avoid bit errors during the translation of analog signals to digital information.
The new low-THD material 3E55 is therefore ideal for use in DSL transformers and thus precision gapped products are offered.

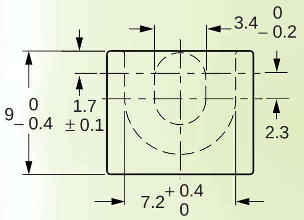
EP cores are very popular for these designs because of their flat top for easy handling and their closed shape for excellent magnetic shielding. Up to now the EP13 has been the racehorse to bet on for ADSL. A hurdle however is the relatively small minimum cross-section. The EPX shape features an increased centre pole area and achieves the same THD performance in a smaller core volume.

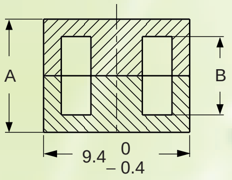
The new EPX designs, complete with SMD bobbin and clip, satisfy the need for slimmer pulse transformers. They are available in the high permeability material 3E6 for pulse transformers and in the low harmonic distortion material 3E55 for ADSL wideband applications. Power materials are introduced along with these. Even though the EPX's have a smaller volume than EP13 they are suitable to build pulse transformers which comply to CCITT (G.703).

ADSL transmission equipment (DSLAM) requires multi-channel interface boards. EPX7 and EPX9 are an alternative to EP13, to satisfy the demand for high-density mounting. They combine the height of EP13 with the footprint of EP7. As a result, about 30 % more lines per board can be accommodated.
The longer EPX9 has more winding space and can fulfil the same safety isolation requirements as EP13, while the core width is still the same as for EPX7.
EPX10 has the same outer dimensions as EP10, but due to the larger centre pole area the THD performance is improved.



EPX7 and EPX9 product range

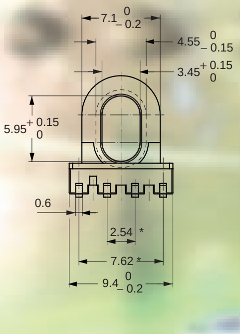


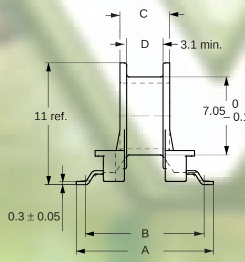


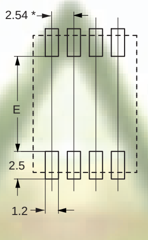
Core type		EPX7	EPX9
dim (mm)	A	7.5 – 0.2	9.5 – 0.2
	B	4.6 + 0.4	6.6 + 0.4

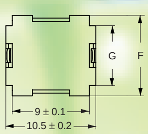
	Core type	EPX7	EPX9
effective core parameters	core factor Σ l/A(mm^{-1})	0.931	1.15
	eff. volume V_e (mm^3)	255	304
	eff. length l_e (mm)	15.4	18.7
	eff. area A_e (mm^2)	16.5	16.3
	min. area A_{min} (mm^2)	14.5	14.5
	mass of core set (g)	≈ 1.2	≈ 1.4

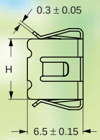
	Core type	EPX7		EPX9	
A_L (nH) & type number	3C94	1950 ± 25 %	EPX7-3C94	1700 ± 25 %	EPX7-3C94
	3C96	1750 ± 25 %	EPX7-3C96	1550 ± 25 %	EPX7-3C96
	3F35	1400 ± 25 %	EPX7-3F35	1200 ± 25 %	EPX7-3F35
	3E55	63 ± 3 %	EPX7-3E55-A63	63 ± 3 %	EPX7-3E55-A63
		100 ± 3 %	EPX7-3E55-A100	100 ± 3 %	EPX7-3E55-A100
		160 ± 3 %	EPX7-3E55-A160	160 ± 3 %	EPX7-3E55-A160
		250 ± 5 %	EPX7-3E55-A250	250 ± 5 %	EPX7-3E55-A250
		315 ± 5 %	EPX7-3E55-A315	315 ± 5 %	EPX7-3E55-A315
		400 ± 8 %	EPX7-3E55-A400	400 ± 8 %	EPX7-3E55-A400
		8400 + 40 / – 30 %	EPX7-3E55	7300 + 40 / – 30 %	EPX7-3E55
	3E6	9300 + 40 / – 30 %	EPX7-3E6	8200 + 40 / – 30 %	EPX7-3E6











Clip
material : CrNi steel
thickness : 0.3 mm

* also available with
2 mm pad distance

	Core type	EPX7	EPX9
bobbin & clip dimensions (mm)	A	12.4 ± 0.2	14.4 ± 0.2
	B	10.7 ± 0.2	12.7 ± 0.2
	C	4.5 – 0.1	6.5 – 0.1
	D	3.1 min.	5.1 min.
	E	8.6	10.6
	F	9.4 ± 0.2	11.4 ± 0.2
	G	7 ± 0.1	9 ± 0.1
	H	7 ± 0.2	9 ± 0.2

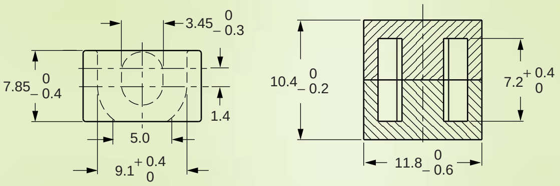
General data for 8-pads EPX7 or EPX9 coil former

PARAMETER	SPECIFICATION
Coil former material	Sumikon PM9630 (PF), glass-reinforced, flame retardant in accordance with *"UL 94V-0"*; UL file number E41429 (M)
Pin material	copper-tin alloy (CuSn), nickel flash, gold plated
Maximum operating temperature	180 ° C, *"IEC 60085"*, class H
Resistance to soldering heat	*"IEC 60068-2-20"*, Part 2, Test Tb, method 1B, 350 ° C, 3.5 s
Solderability	*"IEC 60068-2-20"*, Part 2, Test Ta, method 1, 235 ° C, 2 s

Winding data for 8-pads EPX7 or EPX9 coil former

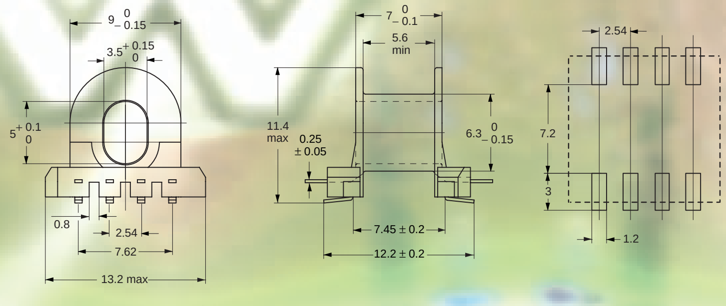
CORE TYPE	NUMBER OF SECTIONS	WINDING AREA (mm^2)	NOMINAL WINDING WIDTH (mm)	AVERAGE LENGTH OF TURN (mm)	TYPE NUMBER
EPX7	1	3.64	3.4	23.3	CSHS-EPX7-1S-8P
EPX9	1	5.99	5.4	23.3	CSHS-EPX9-1S-8P

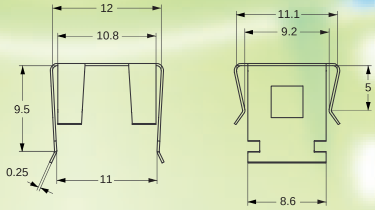
EPX10 product range



Core type		EPX10
effective core parameters	core factor $\Sigma l/A$ (mm^{-1})	1.45
	eff. volume V_e (mm^3)	325
	eff. length l_e (mm)	21.7
	eff. area A_e (mm^2)	15.0
	min. area A_{min} (mm^2)	12.5
	mass of core set (g)	≈ 1.5

Core type		EPX10	
A_L (nH) & type number	**3C94**	1400 ± 25 %	EPX10-3C94
	3C96	1250 ± 25 %	EPX10-3C96
	3F35	950 ± 25 %	EPX10-3F35
	3E55	63 ± 3 %	EPX10-3E55-A63
		100 ± 3 %	EPX10-3E55-A100
		160 ± 3 %	EPX10-3E55-A160
		250 ± 5 %	EPX10-3E55-A250
		315 ± 5 %	EPX10-3E55-A315
		400 ± 8 %	EPX10-3E55-A400
		6000 + 40 / – 30 %	EPX10-3E55
	3E6	6600 + 40 / – 30 %	EPX10-3E6





Clip
material : CrNi steel
thickness : 0.25 mm

General data for 8-pads EPX10 coil former

PARAMETER	SPECIFICATION
Coil former material	Sumikasuper E4008 (LCP), glass-reinforced, flame retardant in accordance with *"UL 94V-0"*; UL file number E54705
Pin material	copper-tin alloy (CuSn), nickel flash, tin-lead (SnPb) plated
Maximum operating temperature	155 °C, *"IEC 60085"*, class F
Resistance to soldering heat	*"IEC 60068-2-20"*, Part 2, Test Tb, method 1B, 350 °C, 3.5 s
Solderability	*"IEC 60068-2-20"*, Part 2, Test Ta, method 1, 235 °C, 2 s

Winding data for 8-pads EPX10 coil former

NUMBER OF SECTIONS	WINDING AREA (mm^2)	NOMINAL WINDING WIDTH (mm)	AVERAGE LENGTH OF TURN (mm)	TYPE NUMBER
1	11.6	5.9	24.6	CPHS-EPX10-1S-8P

New material 3E55 with improved THD properties

The THD of a ferrite component should be low under operating conditions. THD is a function of flux density (B), frequency (f) and temperature (T). To evaluate material quality with respect to THD, the fundamental V_1 and the third (and higher) harmonics V_3 have been measured with an audio analyzer on toroid samples together with their amplitude permeability μ_a.
In the curves of Fig.1 and 3 the behaviour of THD/μ_a as a function of B and T is shown for the current high permeability ferrite 3E6 (μ_i =10.000) and for the newly developed low THD material 3E55. Values are plotted in dB-units calculated with the formula :

$THD/\mu_a = 20.{}^{10}\log((V_3 / V_1) / \mu_a)$ [dB]

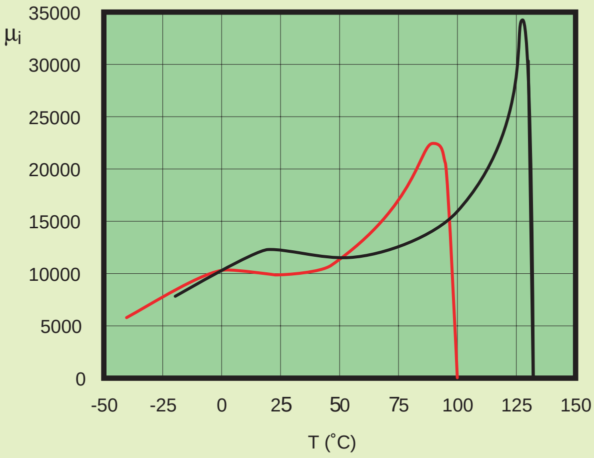
As expected, THD increases when the flux density level rises (Fig. 1). This can be explained by the fact that pores and impurities inside the material act as pinning points for the domain wall movement. At a certain magnetic field strength (H) the domain walls jump to the next pinning point. Such irreversible jumps result in a more than linear increase of the flux density B with field H, resulting in distortion. Ferrite materials having an improved, clean homogeneous microstructure will allow a "gentle" move of the domain walls with the driving field, resulting in a more linear behaviour. The newly developed material 3E55 is optimized by raw material choice, (low impurity level), addition of dopes and improved sintering conditions.

This results in an improvement for flux densities up to 20 mT.

Ferrite material properties

The curves clearly show the differences in material characteristics between "normal" high permeability ferrites and the new low distortion material 3E55. Notice the improved behaviour of THD at low flux densities and as a function of temperature.
However, at room temperature and higher flux densities (B > 30 mT), the differences between 3E55 and 3E6 are not significant.

Fig.2 μ_i-T curve



In the temperature behaviour of every ferrite a minimum for THD/μ_a is noticed. This minimum coincides with the point where the permeability versus temperature shows a (secondary) maximum denoted as T_{sm} (see Fig. 2). At this temperature the anisotropy and therefore hysteresis losses are minimal. To the left and right of this temperature the THD usually increases sharply. Changes in chemical composition of the material will shift the curie temperature T_c and the T_{sm} of the material. Materials optimized for THD show low values over a substantial temperature range and not for one or two specific temperatures. The optimum is found by placing the T_c slightly above 100 °C and the T_{sm} at about 5 °C.
Fig. 3 shows the improvement in THD performance over the temperature range for 3E55 compared to 3E6.

These results are based on measurements on toroids. For the THD in core sets not only the properties of the pure material but also the condition of the mating surfaces in the core set determine the overall distortion in the product. Bad planarity or grinding grooves will cause magnetic flux concentrations, which increases the distortion level, where the surfaces are directly in contact with each other. The parasitic gap as such has no influence on THD if the total gap is much larger.

Mating surface quality

For gapped cores, polishing can give a small improvement over grinding if it improves the flatness of the mating surfaces, which includes the outer wall. If the grinding quality is good (planarity, no grooves) then polishing will not contribute to THD. The difference disappears anyway when a spacer is put between the core halves instead of gapping the centre post, because in that case there are no mating faces (magnetically !) any more.

Fig.1 THD/μ_a - B measured at 10 kHz and 20˚C

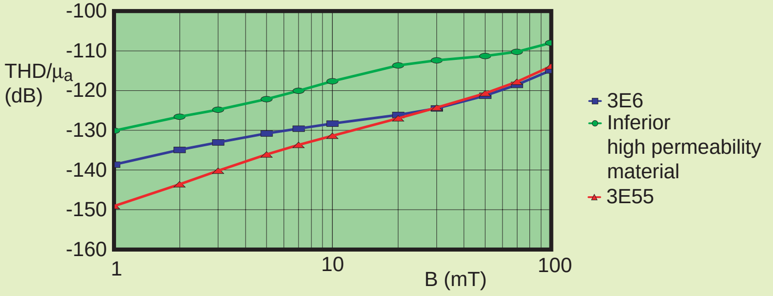


Fig.3 THD/μ_a - T at 10 kHz and 10 mT