Trilogy of Magnetics

Components

Design Guide
for EMI Filter Design,
SMPS & RF Circuits

EMC ferrite

2 EMC Components

2.1 Various forms of ferrites

Ferrite used primarily for EMC comes in the form of beads, cores, rods, sleeves or toroids (see Figure 2.1).

Fig. 2.1: Various forms of ferrite

All other forms have the same technical functionality; they only differ in their application. Ferrite cores or rods are more sensitive to external interference fields and themselves have a larger magnetic stray field.

Coils with toroidal cores however, have a lower stray field and are also less sensitive to interference (Figure 2.2). Pot cores have the most effective shielding and also the lowest stray field. As a result of defined internal routing of the magnetic flux, these coils are largely free from external stray fields. The coil with a ferrite core is more sensitive to magnetic field interference than the air coil. It is often necessary to shield coils to spatially restrict stray fields.

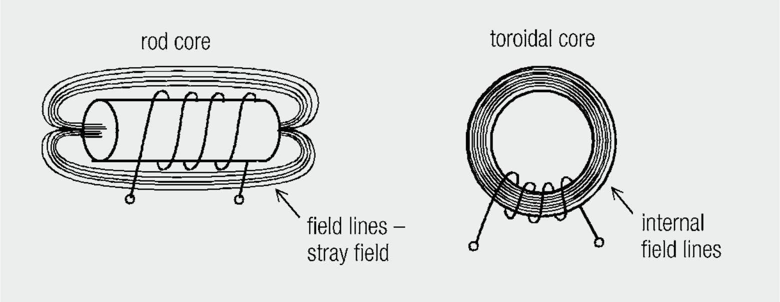

Fig. 2.2: Field line orientation for a rod and toroidal coil

2.2 WE-CBF SMD Ferrites

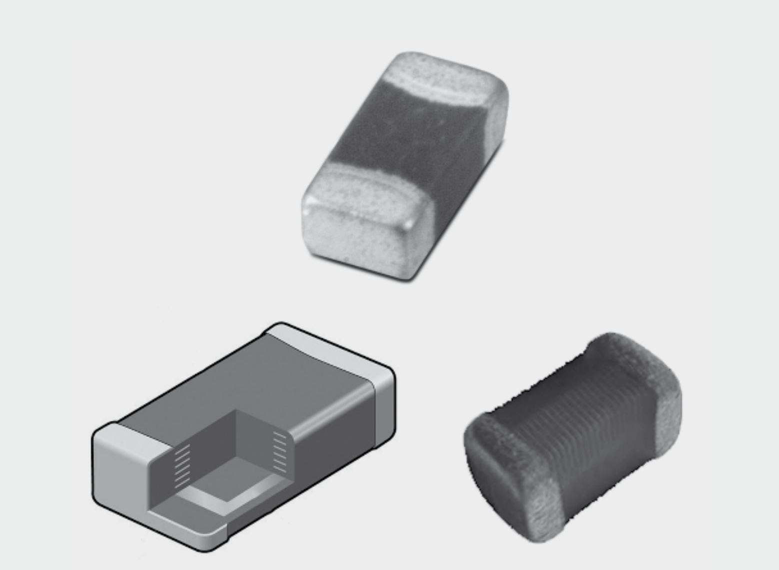

Fig. 2.3: SMD ferrite WE-CBF

SMD ferrites

SMD ferrites for EMC applications are constructed in multilayer technology and use a nickel-zinc as ferrite material.

The special feature of this material composition is that the real (loss) component essentially determines the impedance above 50 MHz. This means it is a filter component, which absorbs, i.e. converts to heat, a broad interference spectrum without being ground referenced.

Würth Elektronik distinguishes their ferrites in High Speed and Wide Band ferrites. The permeability of the Wide Band types is $\mu_i = 200$. High Speed SMD Ferrites have smaller permeabilities. Due to this fact High Speed types do not influence high frequent signals up to 1 MHz.

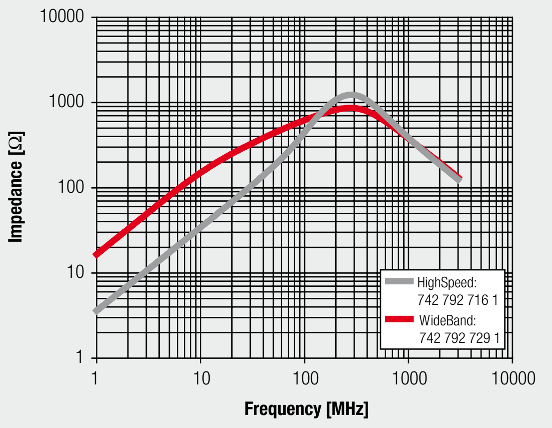

Fig. 2.4: HighSpeed vs. Wideband

SMD ferrites are available in a wide spectrum of sizes from 0402–1812 with current carrying capability up to 6 A as well as impedances up to 2000 Ω at 100 MHz.

Chip bead

SMD ferrites are also often known as chip beads or chip bead inductors or impeders. It is really an inductor with high losses for frequencies above 10 MHz.

To prevent confusion, the term SMD ferrite has shown itself to be favorable.

Datasheet specifications:

The impedance of the SMD ferrite is clearly described with the following parameters (Figure 2.5):

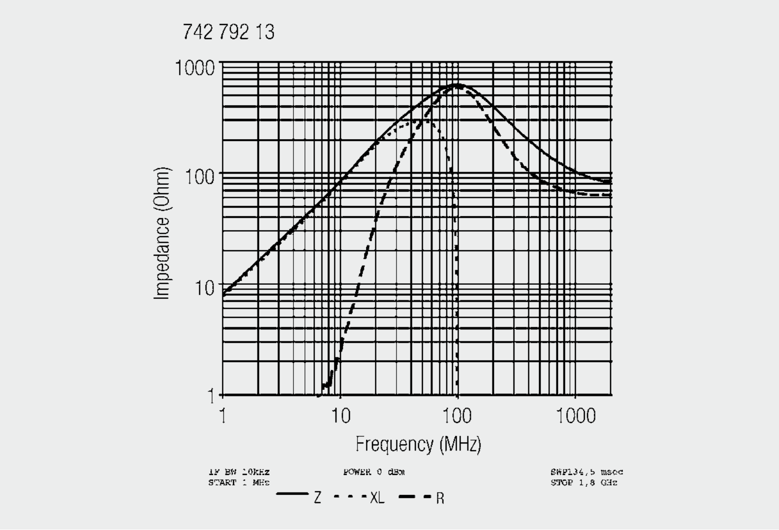

Fig. 2.5: Impedance curve for the SMD ferrite 742 792 13

Resonant frequency

Below the ferromagnetic resonant frequency, the impedance of the component is essentially determined by the inductive component. In the range between 50 MHz–100 MHz, the situation is reversed (see Figure 2.5 SMD ferrite 742 792 13); the "R" loss component dominates with increasing frequency and the inductive component tends towards zero. In this example, the inductive component is around 1.5 µH (f = 10 MHz) and the impedance Z attains a value of 600 Ω at f = 100 MHz.

DC resistance

DC resistance (DCR):

The DC resistance results from the internal length and layer thickness of the multilayer meander in the SMD ferrite. This is measured at room temperature. The maximum expected DC resistance is determined from a production lot and this worse case scenario is published as in the data sheet specifications.

Values in a range between a few milliohms up to even 1 Ω (depending on the type) are obtained. Because of their very low DC resistance, SMD ferrites are significantly superior to inductors of the same construction and size and largely avoid problems of voltage drop or potential differences.