Technical Report

Multilayer Choke Coils for Decoupling MLZ-W Series

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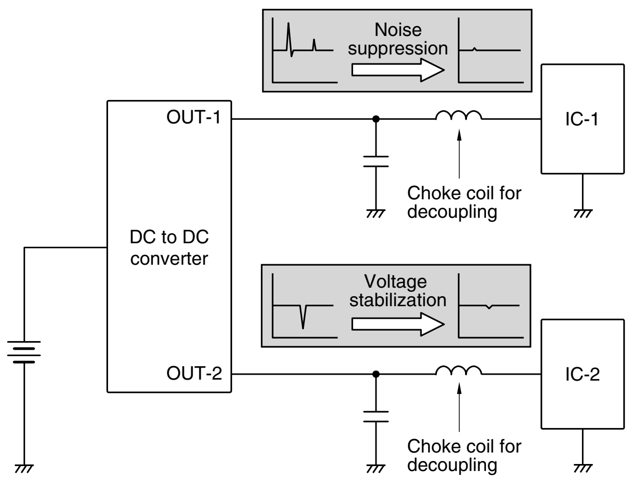
Dempa Shimbun High-Technology June 4, 2009 Edition

1. Introduction

Electronics continue to get small, thinner, and have more functionality. Most electrical devices use ICs such as CPUs, memory, and LSIs. These ICs require a driving power source, and recently, power is supplied through DC to DC converters. Noise that is emitted from the DC to DC converter can easily flow to the power source line, so it is necessary to implement noise suppression measures for the power source. Usually, choke coils for decoupling are used for noise suppression of power source lines.

Choke coils for decoupling have two major functions. One function is to suppress noise by separating the current and noise on the power source line. Using the coil itself, noise can be removed, but the coil is normally used with a capacitor as a low-pass filter to improve efficiency. The second function is stabilizing the power source for the IC. Coils are able to store electric energy as magnetic energy in order to reduce sudden changes in the magnetic field. Coils can control momentary changes related to voltage increases and voltage drops so that the current is stable (Figure 1).

Figure 1 Operation of choke coils for decoupling



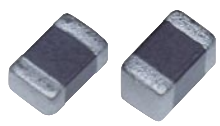
Using coils makes it possible to supply stable power to ICs, which prevents operation errors due to noise and voltage variance.

The following will explain multilayer choke coils for decoupling.

2. Ferrite with improved DC superimposition characteristics

Now, there is greater interest in the environment. Power efficiency is considered important for electrical devices, and the current that flows to ICs has become smaller. Conventional choke coils for decoupling are mainly wound type coils. Multilayer coils have become more commonly used for more purposes due to their lower power consumption. Five years ago, TDK developed the "MLZ Series" of multilayer choke coils for decoupling using our multilayering technology and specially developed materials. However, multilayer configurations have a downside; they have a small rated current. As a result, multilayer choke coils could not be used to replace wound coils, and therefore have only been used for small power circuits. Therefore, we began developing a ferrite material that is resistant to magnetic saturation even when the current is distributed. We were able to develop a ferrite material with improved DC superimposition characteristics. This ferrite material is used in the "MLZ-W Series" (Photo 1).

Photo 1 MLZ-W series



The rated current for the MLZ-W series has been increased by 2.5 times that of conventional products due to the characteristics of the ferrite material, and as a result, it became possible for multilayer type coils to step into markets dominated by wound coils (Figure 2).

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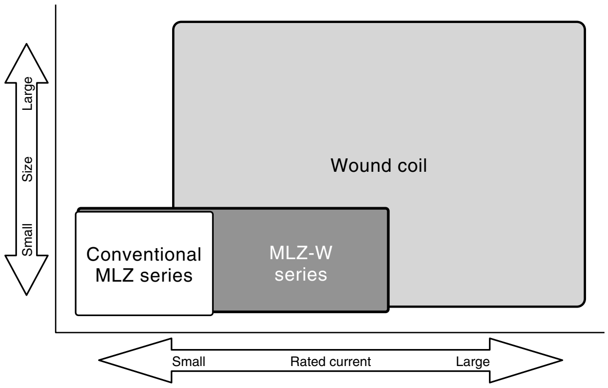
Figure 2 Position of the MLZ-W series



Ferrite characteristics are often expressed by the B-H curve (relationship between the magnetic flux density and magnetic field). The ΔB/ΔH(gradient in a small area) at the faint current of the measured signal becomes the permeability for determining the inductance. The B-H curve can be replaced by the DC-Bias characteristics graph. Without a magnetic field, the permeability is the same as the original ferrite value, and when the magnetic field (Bias current) is applied gradually, the gradient of the ΔB/ΔH becomes softer as it gets closer to the saturation flux density. As a result, the inductance is also lower. When the saturation flux density is achieved, the ferrite loses its function and becomes an air core coil. Once the saturation flux density is reached, the residual flux remains in the ferrite, and the initial status cannot be restored even when the magnetic field becomes zero. This relationship is expressed by the B-H curve (Figure 3).

The sintered status of the body is controlled for the ferrite material that was developed this time so that the saturation flux density can be improved while maintaining the same basic composition as conventional materials.

This improvement allows for the power distribution current to be larger until the ferrite reaches magnetic saturation. As a result, using this material makes it possible to improve the rated current.

3. Important characteristics (MLZ-W Series)

As mentioned in the above, choke coils for decoupling are mainly used to suppress noise on power source lines and to stabilize the current. Their important characteristics include inductance, DC resistance, and rated current.

1. Inductance

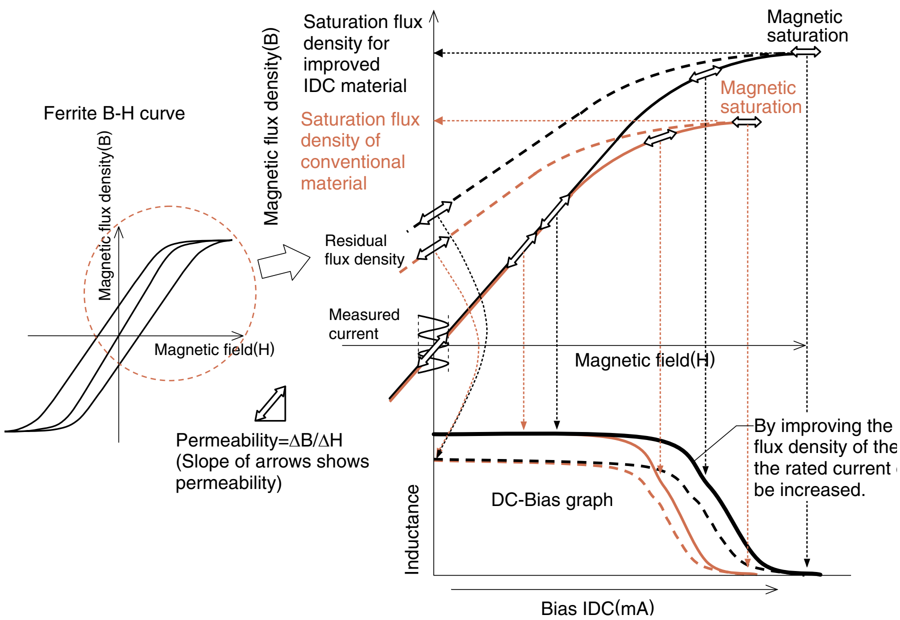
Generally, choke coils for decoupling do not require narrow tolerance for inductance. Therefore, high inductance products are used for low emission frequency DC to DC converters, and low inductance products are used with high emission frequencies.

The MLZ-W series includes the E3 series of products from 1.0μH to 10μH, and we are developing higher inductance products to expand the lineup up to 47μH to cover a wide range of usages.

2. DC resistance

Choke coils for decoupling are mainly used for power source lines, so high DC resistance directly affects current loss. Therefore, coils with lower DC resistance are better. Low resistance electrode materials are used for internal electrodes of MLZ-W series products, and resistance is at least 30% lower than existing multilayer ferrite coils for signals. This contributes to lower power consumption of electronic devices.

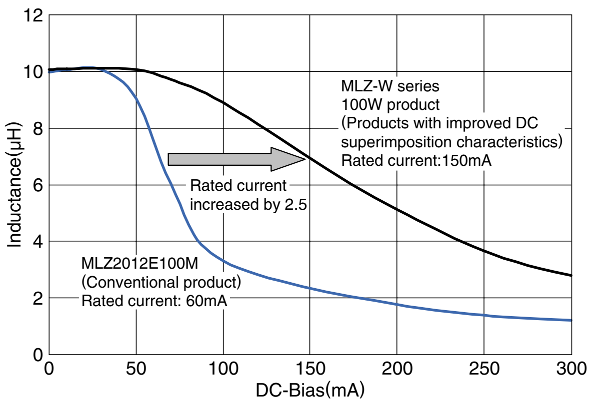
Figure 3   Ferrite with improved dc superimposition characteristics



3. Rated current

Higher rated current is desirable, and the strong point of the MLZ-W series is the expanded rated current. This series has the highest rated current of any multilayer choke coil for decoupling, and the rated current is improved by up to 2.5 times that of the existing MLZ series. The MLZ-W series can be used to replace over-engineered wound coils (Figure 4).

Figure 4 Comparison with MLZ-10μH product DC-Bias characteristics



4. Market requests and future developments

The MLZ2012-W series products, which use a newly developed ferrite material with improved DC superimposition characteristics, were placed on the market last year. We have already received the following additional requests from users.

1. Smaller

The first product in the MLZ-W series was 2012 size (2.0×1.25mm), and immediately after it was released, we received requests for smaller sized products.

We now offer 1608 size (1.6×0.8mm) products ranging from 1.0μH to 10μH. Some users have requested thinner products, so we also handle customized products.

2. Expanded product lineup

As with our currently developed high-inductance products, we have received requests for products with higher inductance immediately after the MLZ2012-W series entered the market. The same requests were made for our current E3 series and E6 series products.

3. Lower resistance

TDK has been improving the rated current of choke coils for decoupling. We recognized that for some users, DC characteristics are most important. Therefore, we are developing a low resistance MLZ series that focuses on DC resistance.

4. Higher power

The rated current of the MLZ-W series is higher than that of existing products, but it still has not reached the same level as wound coils. Therefore, we are continuing to develop ferrite materials with improved DC superimposition characteristics in order to expand the market of multilayer choke coils for decoupling and fill the gap between the rated currents for these products and wound coils.

5. Conclusion

Coils along with capacitors and resistors make up the three major passive components. However, inductor functions for signal systems have come to be included in ICs due to digitization. It is believed that the demand for inductors will not diminish because they are used for power sources or power source lines. It is expected that the market for these will expand in harmony with the increased functionality of electronic devices. Multilayer choke coils for decoupling have only just begun to be used to replace wound choke coils, and the trend is toward lower power consumption, which bodes well for multilayer type choke coils.

TDK will continue to develop inductors that meet users' requests, and to develop components that meet future demands in order to expand our market share.

• Please note that the articles from the June 4, 2009 Edition of the Dempa Shimbun contained in this chapter have been edited by our company.