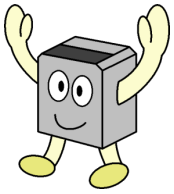
Tips for COIL users (7)



● Introduction

The seventh topic is about "**Open magnetic and shielded**". Fortunately (With your support), we have completed the half of schedule (total 12 times), and we will enter the second half.

● Coil and magnetic flux

When a current is supplied into a coil, a magnetic flux is generated. The problem here is when the magnetic flux passes through a metal (conductor), adversely an inductive current (eddy current) is generated in the metal (such as copper foil of printed board). As this current is not intentionally generated, it may adversely affect the operation of circuit. For detail, we'll describe in the next "magnetic shield".

● Shielded and open magnetic

A coil (inductor) involves a magnetic flux. The coil structure which is called shielded structure prevents such magnetic flux from leaking out of the coil. (There is the coil with the structure that avoids this magnetic flux to be leaked outside so much. This is called Shielded structure (or simply Shielded).) The structure of which the magnetic flux is still outside of coil is called open magnetic structure. (By contraries, there is the coil with what we call Open magnetic structure, which the magnetic flux is flowed outside freely.)

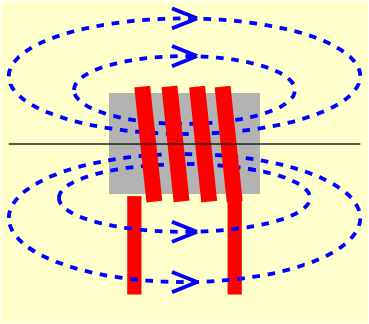


Figure-1 Open magnetic

The magnetic flux of coil circles around the coil and forms a loop like **Figure-1**. Therefore, in case of the open magnetic, the magnetic flux widely spreads around the coil. The way to make the shielded structure is to cover and hide the windings with the magnetic substance, and fill the flux path with magnetic substance. By doing so, the magnetic flux passes through the magnetic substance, and it is not leaked out of the coil.
For example, if the magnetic substance covers the sides of coil, the leakage of magnetic flux becomes less, as the magnetic flux passes through the magnetic substance like **Figure-2.**

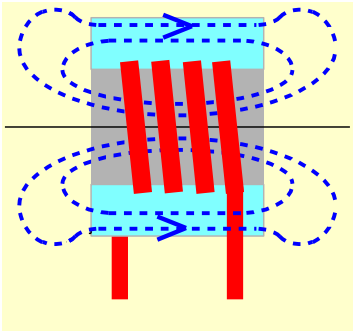


Figure-2 Shielded

If the magnetic substance covers the other side of coil as well, surely the leakage of magnetic flux can become less.
By the way, some coils have the shielded structure though the windings are exposed. Typical example is the toroidal coil (**Photo-1**).

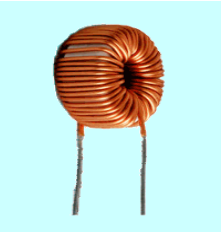
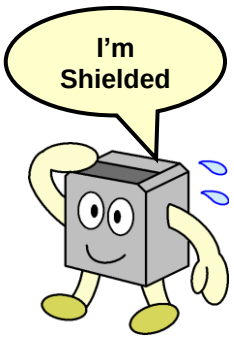


Photo-1
Toroidal coil

The magnetic flux which is generated from the coil doesn't spread outside, as it forms a loop by passing through the core within the coil. Recently downsizing of set is being progressed rapidly, so the shielded coil is preferred to avoid influence of each adjacent component.

● Definition of shielded

There is no clear rule (definition) where the range of shielded ends (to judge what is Shielded) in any specifications of components (component standard) and the industry.
Once a manufacturer declares a coil as "shielded", it will be regarded as a shielded coil.
In such situation, it seems that new words have been created to differentiate own products, such as "**full shielded**" and "**half shielded**".



● Differences of characteristics

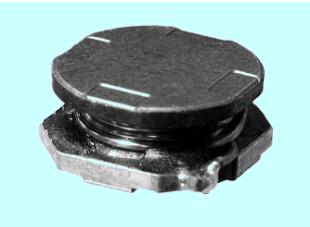


Photo-2 CWD1045C

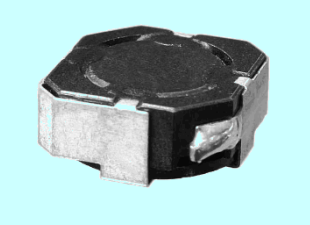
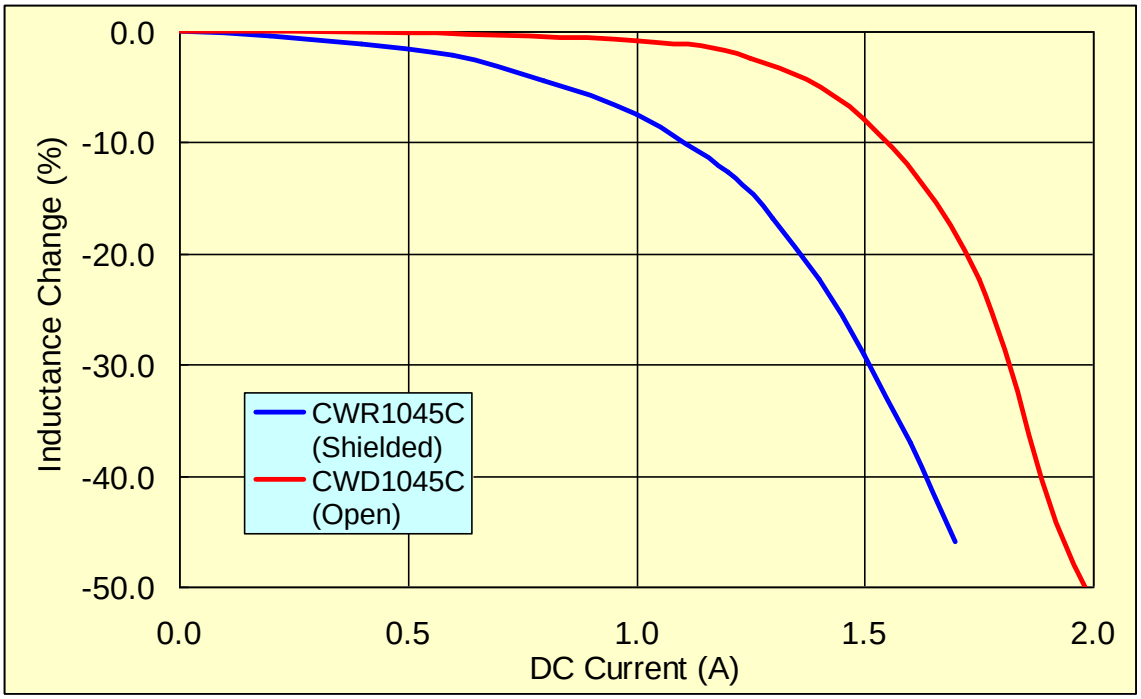


Photo-3 CWR1045C

For inductors, differences are found in the DC saturation curve between the shielded and the open magnetic inductors. These differences arise from the magnetic structure. The shielded tends to gradually decline according to increasing the DC saturation current.
On the other hand, for the open magnetic, the DC saturation curve tends to extend. Of course, tendency of curve varies depending on characteristics of magnetic materials which are used.

Graph-1 shows the characteristics comparison of our automotive power inductor **CWD1045C** (open magnetic inductor) with **CWR1045C** (shielded) based on the same inductance. As **CWD1045C** with the open magnetic has open magnetic structure and the magnetic saturation is hard to occur, the DC saturation allowable current extends.

※CWD1045C,CWR1045C This product is not currently in the lineup.



Graph -1 Inductance Saturation Characteristics

Generally, the shielded inductors have larger effective permeability (μe) than that of open magnetic inductors, as the structure of shielded can seal the flux in.
Then when both have the same inductance value, we can decrease winding turns of the shielded one.
However, as the area where we can wind the wire in a coil (for winding wire in a coil) is small because of coil's form (structure), if the winding turns are same as the open magnetic, you need to reduce the wire thickness of the shielded one.
As the result, for the DC resistance (also the temperature rising current), the differences of both tend to become smaller (for shielded, we can decrease the winding turns, while the wire diameter becomes thinner).

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