

## Tips for COIL users (12)



### ●Introduction

The last twelfth topic is about "Tips when you use a coil".

### ●For better understanding of coil performance

Although a coil and a capacitor are same electronic component, there may be more difficulty to understand coil, comparing with capacitor. It may be because the capacitor is a **voltage element** while the coil is a **current element**.

It is generally known that "It can be used if the electronic device has the same operation voltage". Therefore, even ordinary people know that "a product with AC 100V cannot be used at AC 200V".

So, which phrase do you think is easier to understand, (1) or (2)?

(1) When applying voltage to a resistor, a current flows in the resistor.

Voltage → Current

(2) When a current passes through a resistor, a voltage occurs at both ends of resistor. Current → Voltage

Probably, most of people think it is easier to understand (1). The coil and the capacitor are in an electrically-opposing relationship. So, when you think an performance of coil (**current**), it may help you when it is compared with capacitor(**voltage**). Let us see the contents which are paired in **Table-1**.

Table-1

Capacitor	Inductor
Voltage	Current
Voltage source	Current source
Parallel	Series
Series	Parallel
Open	Short
Short	Open
$E = 0$	$I = 0$
$I = \infty$	$E = \infty$

When we explain with figures, **SW is turned on** in the connection diagram on the left of **Figure-1**, and a voltage is applied between terminals of capacitor. Then SW is turned off so that it is **charged**.

After that terminals are contacted (SW is closed), a **big current (i)** flows for a moment as shown in Figure-2 (The spark tells you that the electrical energy was generated).

In the same way, **SW is turned off** in the connection diagram on the right of **Figure-1**, and a current is supplied to the coil. Then SW is closed like a loop with **keeping the current flowing**. After that the power is separated.

Then, when **the circuit is opened (SW is opened)**, a **big voltage (e)** is generated for a moment as shown in a **Figure-2**. Actual discharge event shows that the electrical energy is generated.

I hope that in this way, it could be understood that the coil and the capacitor are same if we think from a different aspect,...yet you may still think it is easier to understand the voltage!

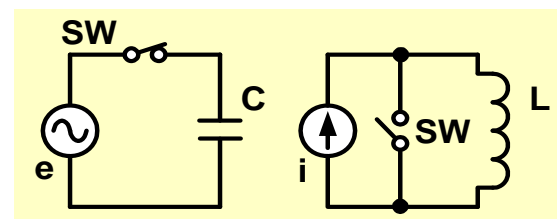


Figure-1 Charge to capacitor/coil

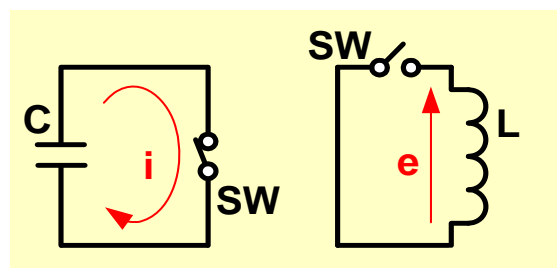


Figure-2 Discharge of the energy



● **The generation of back electromotive force**

As explained above, if a current is interrupted for a moment by a switch or a transistor during supplying current through a coil, very high voltage is generated on the both ends of coil to try to keep supplying the current through the coil.

There is a way to generate a high voltage by using this phenomenon. However, in the case of the circuit which current through coil is ON-OFF, other studies will be necessary such as a protection circuit for high voltage.

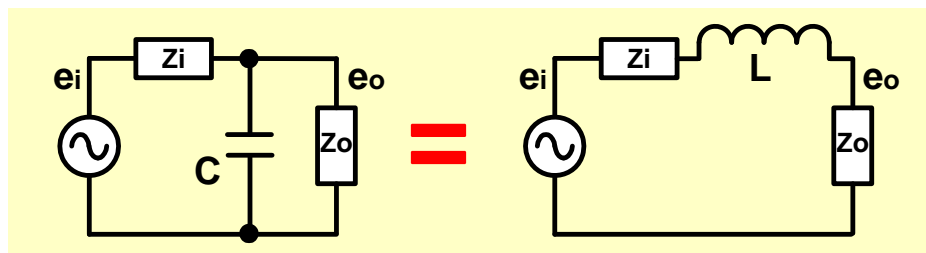
Attention must be paid in the case like putting a choke coil in a power supply for noise control during prototype study as the similar situation may happen.

● **Frequency characteristics**

For both coil and capacitor, their impedance and electrical characteristics change depending on frequency. If we think the frequency characteristic of coil in a circuit in a contrast with capacitor, based on **Table-1** following circuits show similar frequency characteristics (refer to Figure-3):

**"Capacitor put on a circuit in series (parallel)" = "Coil put on a circuit in parallel(serial)"**

However, it must be considered that the fundamental operation is different.

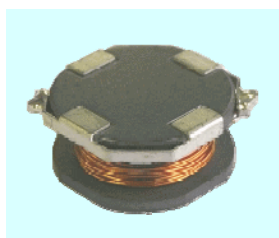


**Fig-3 Parallel C and Series L**

● **Failure mode of coil**

For wire wound coil, there are various causes of failures, and the most major failure mode is "disconnection (open circuit)".

Besides, when a coil is used under bad condition, short circuit may occur between wires due to insulation degradation of wire coating.



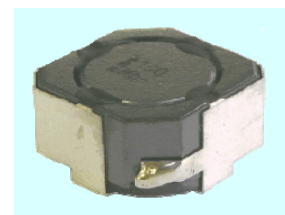
**Photo-2 CWD1242C**

In the case of the disconnection, a coil becomes open, and a current is interrupted.

The damage is smaller than the one becoming short circuit in the most cases, however the disconnection may have a great impact to other components. In mechanical failure, there is a cause "removed solder section between a coil terminal and circuit board", which occurs in the case like vibration is applied continuously.

If a device which our coil is put requires high reliability and safety against failure, attention must be paid to such failure modes as well as selecting the coil which reliability was fully studied.

**Photo-1 & -2** (Photo-2 shows bottom side of product) show our **CWD·CWR series** developed for automotive application. These have 4 terminals structure to ensure high resistance to impact and vibration.



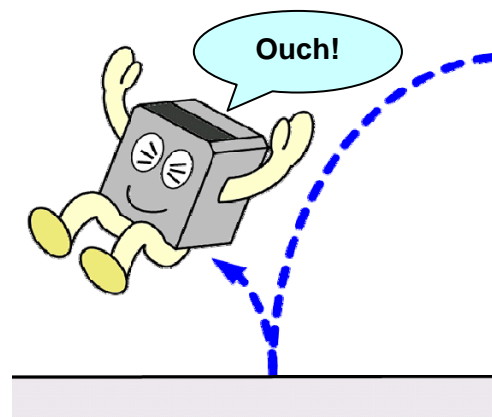
**Photo-1 CWR1277C**

● **If impact is made to coil**

It often happens that a component is dropped to a floor accidentally, and the impact is made to it. If a floor is hard like a concrete, the impact reaches **1,000G** although it is short time (several **mill seconds**).

Ferrite core is used for many of coil as magnetic materials. If big impact is made, it may be damaged same as ceramics (china).

We think that nobody uses the coil which dropped and damaged on the appearance. Even if there is no damage in an appearance, the inside of a ferrite core may have cracked with the impact. We strongly recommended not using the dropped coil.



**Any impact damages coil!**

● **In closing**



We could complete **total 12 topics of the first series**. We appreciate that a lot of people have read them than expected. Thank you very much. We hope it will be useful for your work as much as possible.

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**Notes**

While we pay sufficient attention to this description in preparing this, if you have any questions or doubts in this description, please contact following address.

e-mail: [engineer@sagami-elec.co.jp](mailto:engineer@sagami-elec.co.jp)  
Y.Hoshino  
Engineering control Dept.  
SAGAMI ELEC CO.,LTD.

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