3. Noise Suppression by Low-pass Filters

3.3. Low-pass Filters

Low-pass Filters

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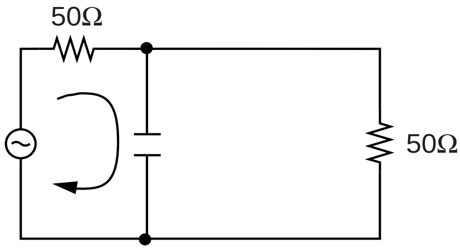
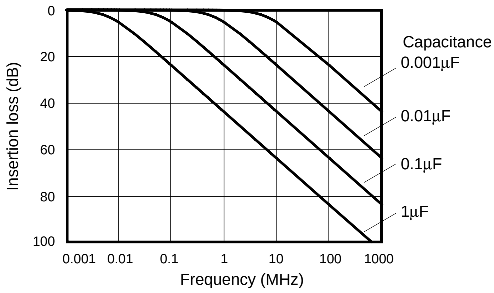
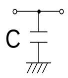
1. Capacitor



Insertion loss



Capacitor

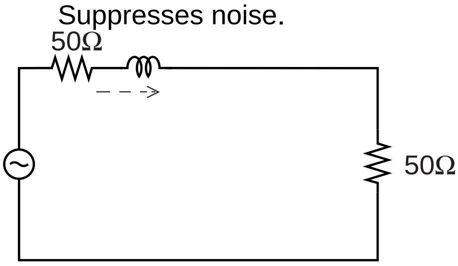


$| Z | = \frac{1}{2\ fC}$

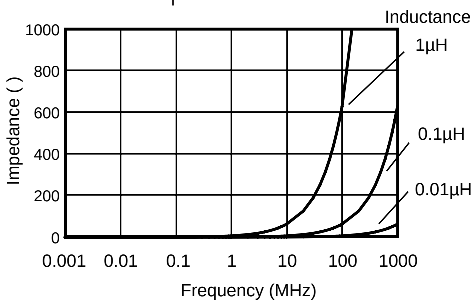
| Z | : Impedance ( )
f : Frequency (Hz)
C : Capacitance (F)

2. Inductor

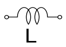
Suppresses noise.



Impedance



Coil



$| Z | = 2\ fL$

| Z | : Impedance ( )
f : Frequency (Hz)
L : Inductance (H)

The most basic low-pass filter includes the following two components.

1. A capacitor installed between the signal line and GND line. (As the frequency becomes higher, the impedance of the capacitor becomes lower. Thus noise is forced to go through bypass capacitors to GND.)
2. An inductor (coil) installed in series with the signal line. As the frequency increases, the impedance of the inductor increases which prevents noise from flowing into the signal line.

[Notes]

3. Noise Suppression by Low-pass Filters

3.3. Low-pass Filters

Filter Construction - Constant and Insertion Loss

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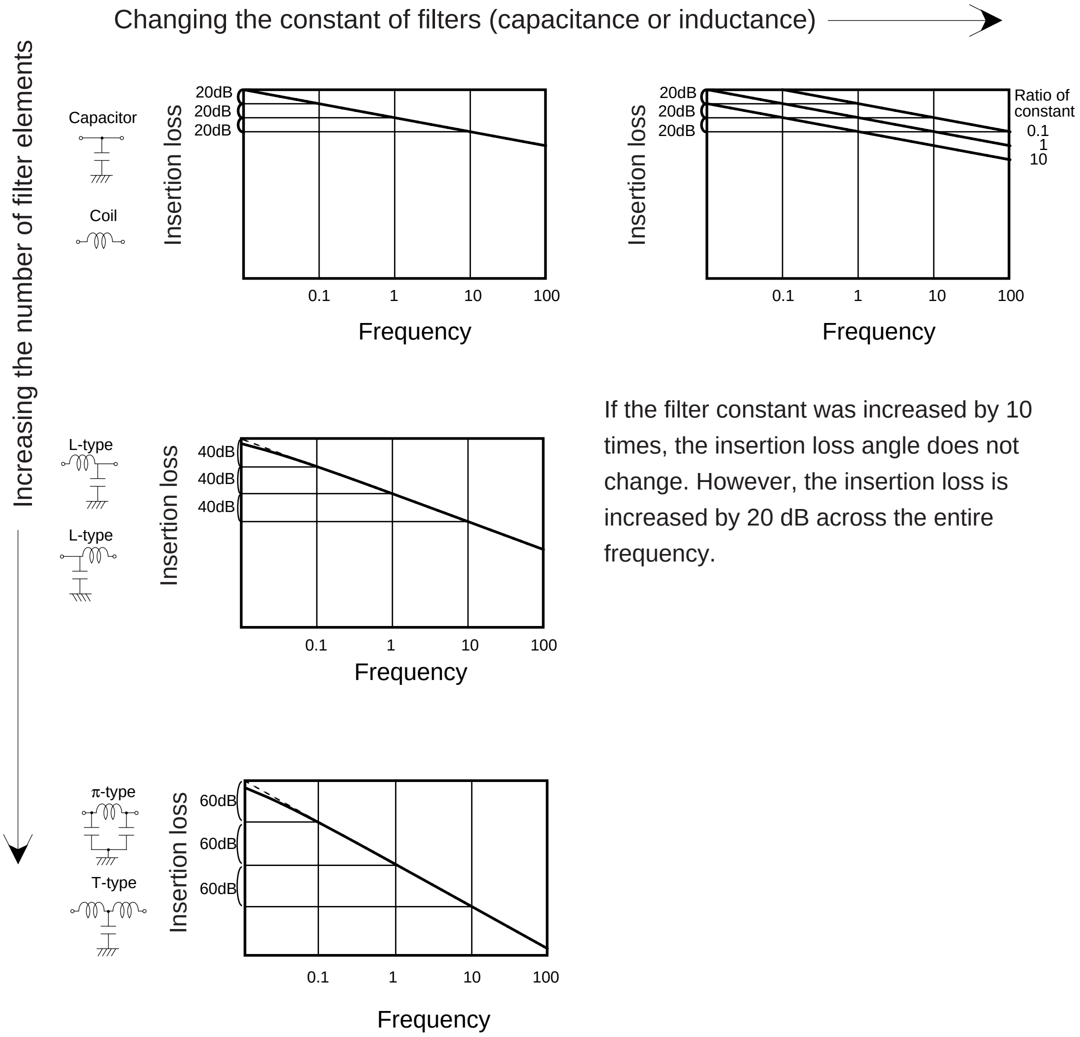

If the filter constant was increased by 10 times, the insertion loss angle does not change. However, the insertion loss is increased by 20 dB across the entire frequency.

The angle of insertion loss increases by 20 dB/decade every time one filter element is added.

In the frequency band where EMI noise problems occur, the insertion loss of filters increases by 20 dB every time the frequency is multiplied by ten.

When the constant of filters (capacitor's capacitance or inductor's inductance) is increased, the insertion loss of filters increases by 20 dB every time the constant is multiplied by ten.

To increase the angle of the insertion loss, filters are used in combination.

[Notes]

3. Noise Suppression by Low-pass Filters
3.4. Suitable Filter for Input/Output Impedance

Suitable Filter for Input/Output Impedance

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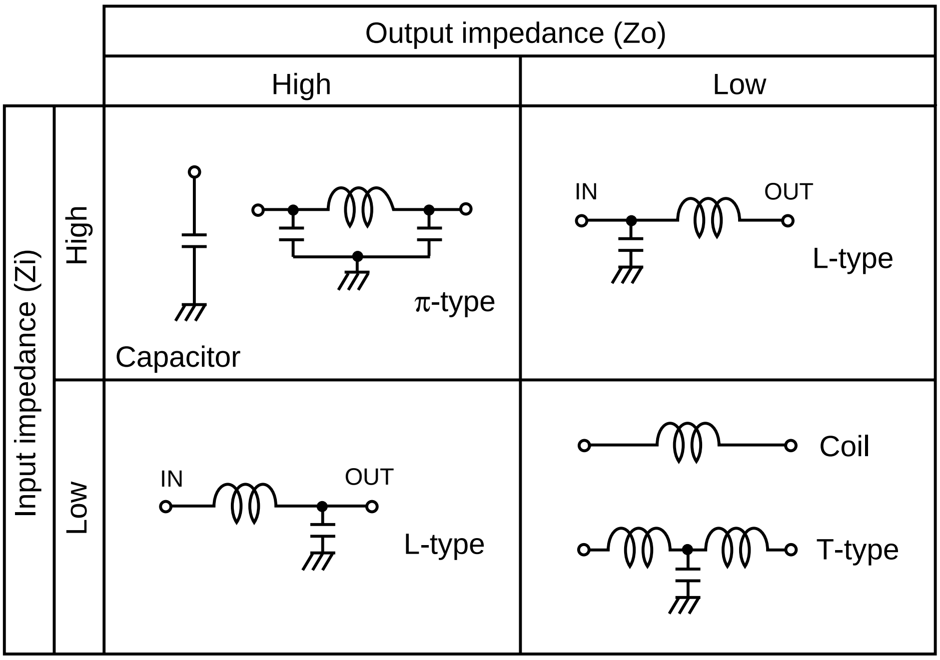

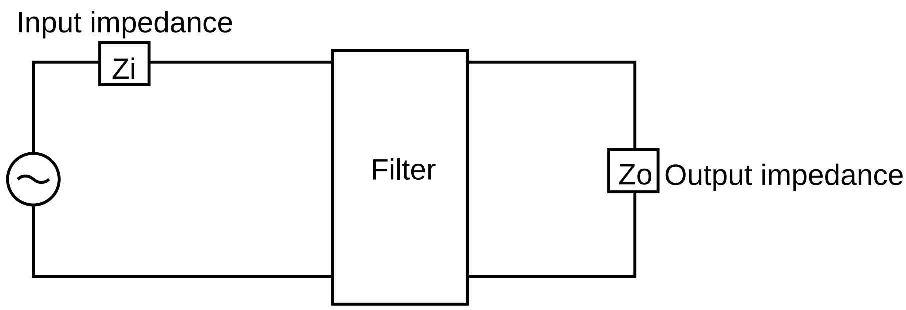

Filter effect varies depending on the input/output impedances.

As mentioned earlier, the insertion loss is measured with input and output impedances of 50 Ω . However, actual circuit impedances are not 50 Ω. Actual filter effects vary depending on the impedances of the circuit where the filter is installed.

Generally, a capacitor is more effective in suppressing noise in high impedance circuits, while an inductor is more effective in low impedance circuits.

[Notes]