1. Reasons for Noise Suppression

1.1. Conditions for Electromagnetic Interference and Future Trends

Conditions for Electromagnetic Interference and Future Trends

1

There are three conditions or elements required for EMI

A: EMI generator - a source that emits noise.

B: EMI receiver - a device that is susceptible to noise.

C: EMI path - a path for which the EMI generated can reach the EMI receiver.

Future trend of noise problems

There is a continual increase in the density of electronic equipment used in applications where they are affected by each other.

(Solution)

A: Electronic equipment that emits less noise
B: Electronic equipment that is more immune to noise
"A" and "B" shown above are required.

[Notes]

The wide array of electronic equipment available makes our life more comfortable, and such equipment is now essential in our society. The operation of these electronic devices may be disturbed by noise interference which, in many cases, may jeopardize human life. For this reason, it is no exaggeration to say that the prevention of noise interference is an obligation to society.

However, with the increasing amount of electronic equipment being used together in areas where they can affect each other, the probability of electoromagenetic interference becomes higher.

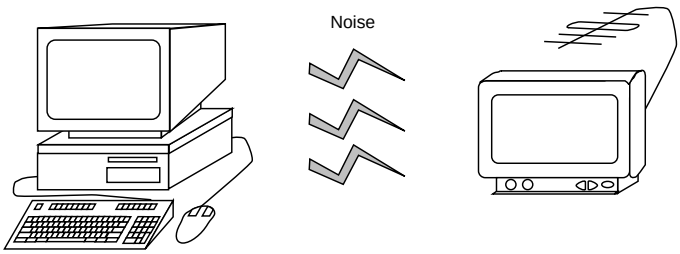
Therefore, electronic equipment that emits less noise and will be in greater demand.

1. Reasons for Noise Suppression

1.2. Noise Emission and Immunity

Noise Emission and Immunity

2



Equipment that emits noise

⇩

Preventing equipment from emitting noise

⇩

Noise emission suppression

Equipment that is exposed to noise

⇩

Preventing equipment from being affected by noise

⇩

Immunization against noise

Emission:

The phenomenon by which electromagnetic energy emanates from a source.

Immunity:

The ability of equipment to perform without degradation or being damaged by electromagnetic interference.

EMC (Electromagnetic Compatibility):

The ability of equipment or system to function satisfactorily in an electromagnetic environment without introducing intolerable electromagnetic disturbance to anything in that environment.

EMI (Electromagnetic Interference):

Degradation of the performance of equipment, transmission channel or system, caused by an electromagnetic disturbance.

"Preventing equipment from emitting noise" is called "suppression of emission". "Emission" means "to emit noise from equipment". "Preventing equipment from being affected by noise" is called "immunization against noise". "Immunity" means "the extent to which equipment is resistant to noise without malfunctioning (degradation of performance) or being damaged". Though "EMS" (electromagnetic susceptibility), which refers to the susceptibility of equipment to noise, is also used, "immunity" is generally used as an antonym of "emission".

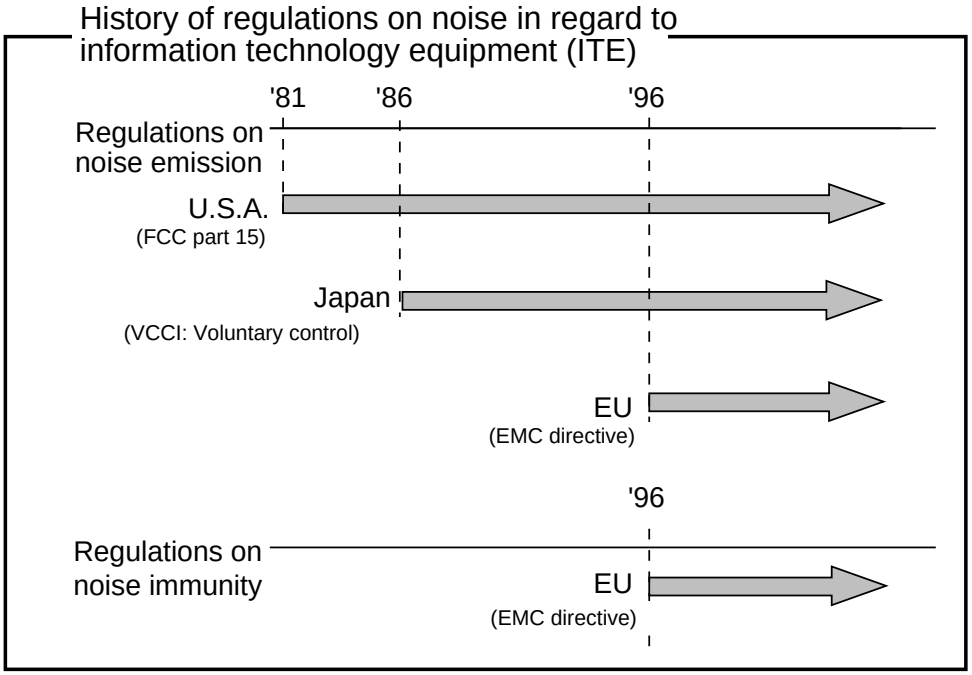
"EMC" (electromagnetic compatibility) means "equipment's or system's capability to prevent the equipment or system from emitting unacceptable noise externally and from malfunctioning due to noise". "EMI" (electromagnetic interference) means "decline in the performance of equipment, transmission channels, or systems due to noise (electromagnetic disturbance) when the EMC is unsatisfactory".

1. Reasons for Noise Suppression

1.3. Noise Regulations

Noise Regulations

3

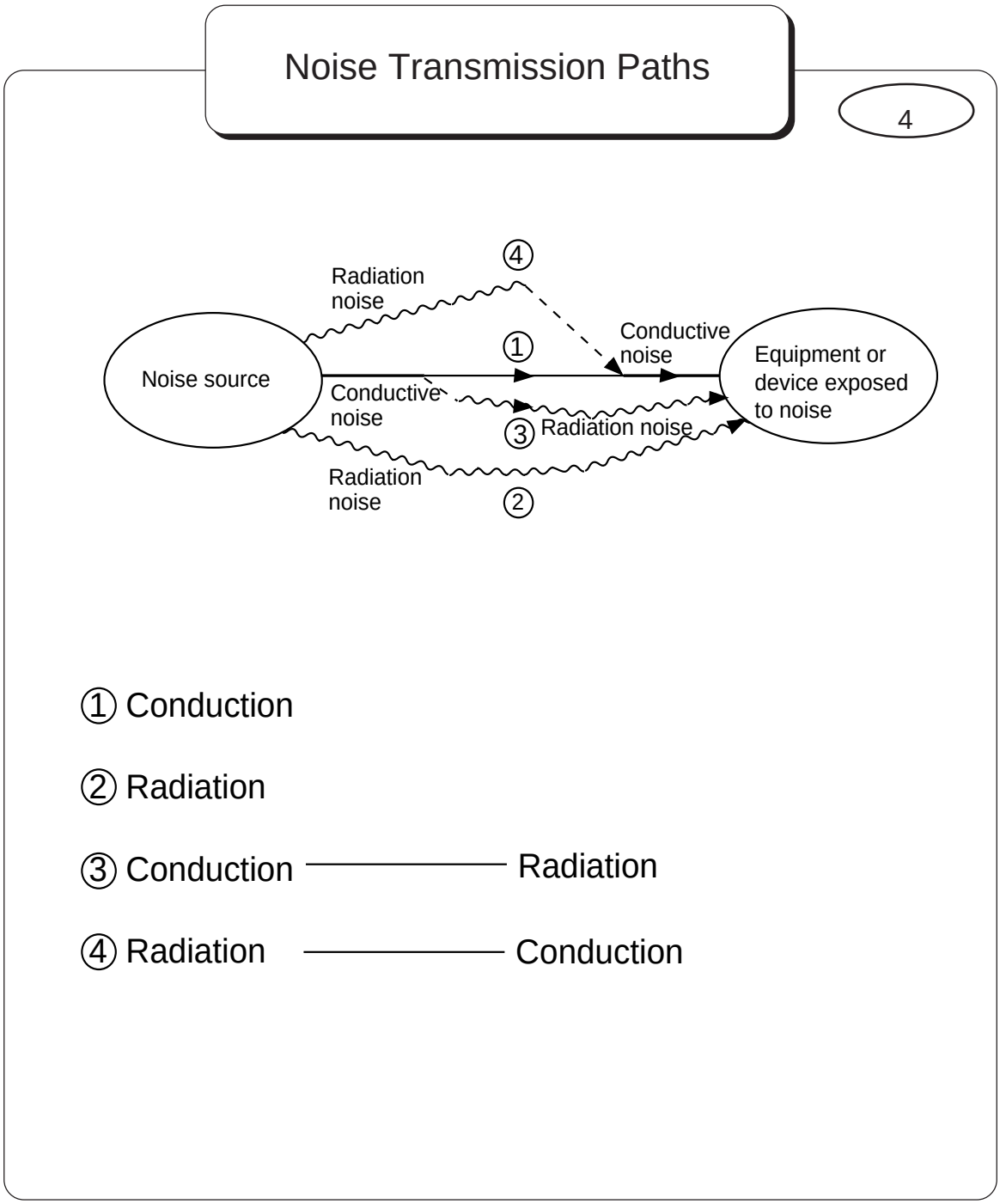


Noise regulations are enforced in many countries. Since most of these regulations have become laws, equipment that does not comply with the regulations cannot be sold in the country. Though most of the previous regulations were intended to prevent noise emission, there is an increasing number of regulations dealing with noise immunity.These regulations state that the equipment should not degrade perfirmance due to noise.

[Notes]

2. Noise Transmission Paths and Basic Concepts for Noise Suppression

2.1. Principle of Noise Suppression



Noise emitted from a source is transmitted through many complicated paths, sometimes through a conductor and sometimes as radiation. When it reaches a device or equipment, that equipment is exposed to noise.

[Notes]

2. Noise Transmission Paths and Basic Concepts for Noise Suppression

2.1. Principle of Noise Suppression

Principle of Noise Suppression

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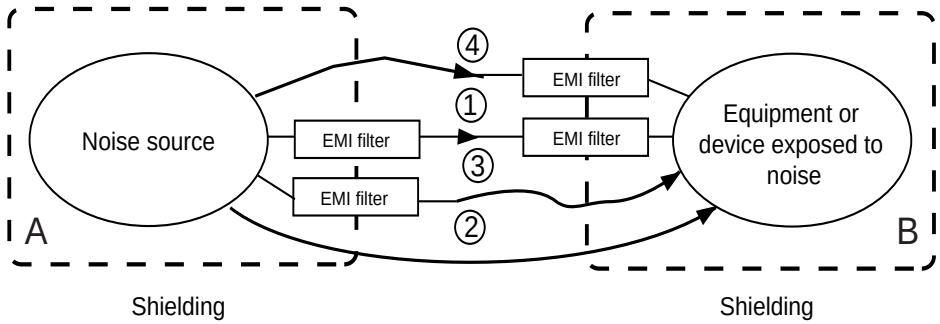


How to suppress noise

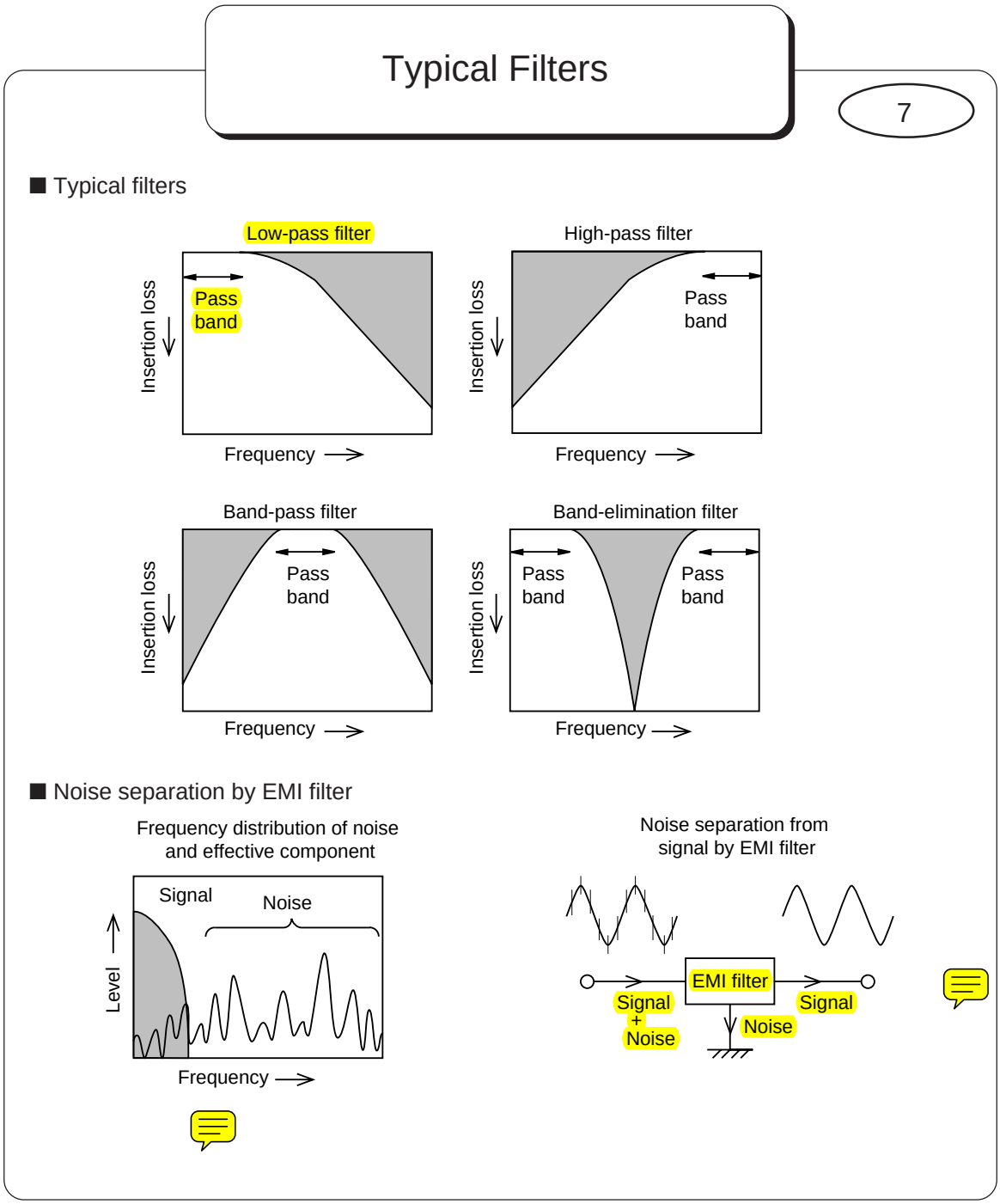
	(Side A)	(Side B)
① Conduction.....	EMI filter	EMI filter
② Radiation.....	Shielding	Shielding
③ Conduction → Radiation.....	EMI filter	Shielding
④ Radiation → Conduction.....	Shielding	EMI filter

In order to properly suppress noise, we must know the noise source and how it is transmitted. If the initial check is inaccurate, we cannot judge whether the noise suppression technique has failed or the technique was applied to an incorrect source.
The principle of noise suppression is to use an EMI filter for conducted noise and shielding for radiated noise.

[Notes]

3. Noise Suppression by Low-pass Filters

3.1. Typical Filters



Filters used to pick out the desired signals are classified into the following four types.

Low-pass filter (LPF):

A filter which passes signals at frequencies lower than a specified frequency but attenuates signals at frequencies higher than the specified frequency.

High-pass filter (HPF):

A filter which passes signals at frequencies higher than a specified frequency but attenuates signals with frequencies lower than the specified frequency.

Band-pass filter (BPF):

A filter which only passes signals within a specified range of frequencies.

Band-elimination filter (BEF):

Filter which does not pass signals within a specified range of frequencies.

Most noise emitted from electronic equipment is at frequencies higher than circuit signals. Therefore, low-pass filters, which only pass signals with frequencies lower than a specified frequency and attenuates signals with frequencies higher than this frequency, are generally used as EMI filters.

3. Noise Suppression by Low-pass Filters

3.3. Low-pass Filters

Low-pass Filters

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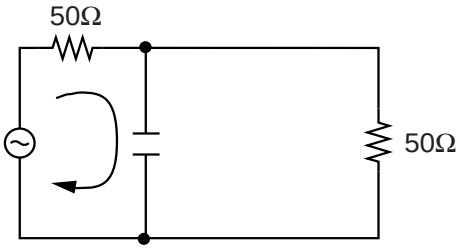
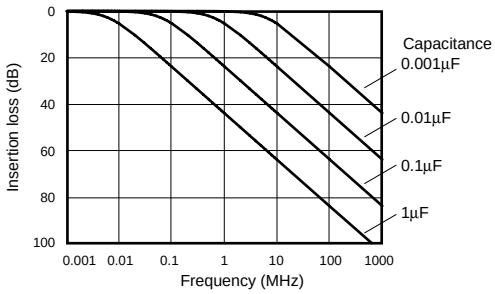
1. Capacitor



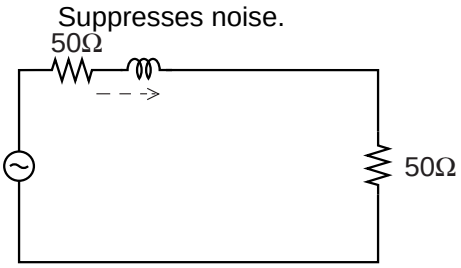


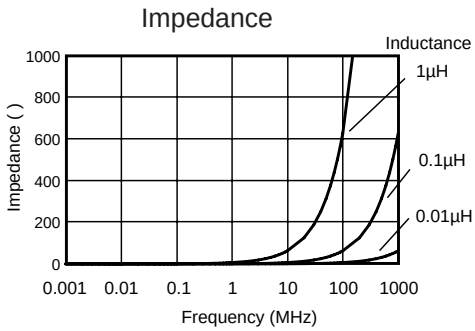
Capacitor

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

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

2. Inductor





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]