INTRODUCTION

Recent years have witnessed tremendous advances in electronics. In the field of computers related equipment, legal restrictions regarding safety and noise generation have grown more strict with each passing year. In most cases, electronic devices exported must now conform to the noise regulations of the target country in order for them to be given market approval.

The following is an introductory description of the ways in which noise is generated and the various noise regulations currently enforced throughout the world.

NOISE GENERATION AND TRANSMISSION

The noise generated by electronic devices consists of two kinds. **Radiated noise** is transmitted directly into the air from an electronic device, taking the form of an electric wave that interferes with other electronic devices. In contrast **Conductive noise** interferes with other components and devices by being transmitted along power lines and the wiring of electronic circuits. These two kinds of noise can be briefly explained in the context of an electronic device by means of the following diagram (Figure 1).

A) Electronic device

1. Conductive noise from electric power line.
2. Conductive noise along the signal lines connecting electronic devices.
3. Radiated noise transmitted from an electronic device which interferes with another device.
4. Radiated noise picked up and generated by the power line which acts as an antenna.
5. Radiated noise picked up and generated by the signal lines which act as an antenna.
6. Noise produced from a source within the electronic device.
7. Noise entering from the ground line..

As shown in Figure 2, conductive noise can also be divided into two types, normal mode noise involving symmetrical noise components oscillating between lines (L1-L2) and common mode noise involving asymmetrical noise components transmitted between a line and ground (L1-E, L2- E).

OPERATING PRINCIPLES OF NOISE FILTERS

A key counter measure taken against noise is the use of noise filters. The operating principles of these devices are described in the following:

Viewed from the perspective of the circuit network, the noise filter is a kind of low range or low pass filter. It is designed to pass only frequencies lower than the cut off frequency of the filter, while attenuating or blocking all ranges higher than the cut off frequency.

As shown in Figure 3, the filter operates according to a principle whereby inductance connected directly in series with the line has virtually no affect on the noise current at low frequencies, but at high frequencies it demonstrates a high interruptive effect with respect to the noise current.

Also, a capacitor connected in parallel with the line is used as a side path to return high frequency back to the power line. The result is that normal mode noise passes through the capacitor and is shunted back to the other line. In the case of common mode noise, the result is that the noise passes through the midpoint of the two capacitors to ground.

The use of special materials such as amorphous alloys and toroidal cores gives the Okaya noise filters excellent insertion loss characteristics and high voltage pulse attenuation capability.

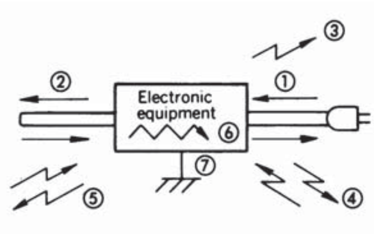


Figure 1

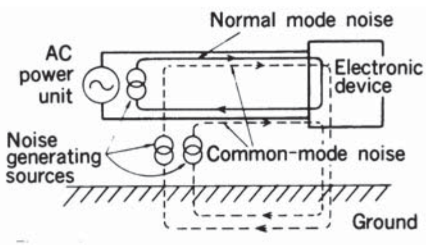


Figure 2

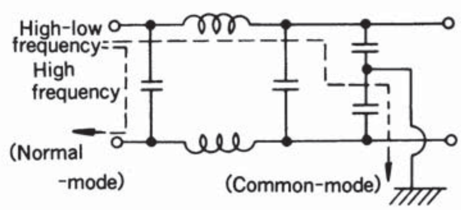


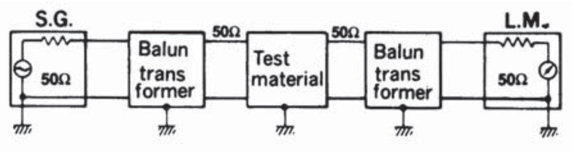
Figure 3

EVALUATION METHODS OF NOISE FILTER CHARACTERISTICS

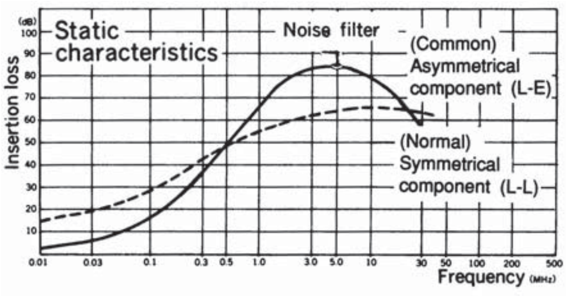
1. Static Characteristics

With a measuring impedance of 50 ohms, the amount of attenuation (insertion loss) is determined by using a level meter to measure the voltage before and after insertion of a noise filter into the test circuit. Using this method, both normal mode and common mode attenuation can be measured.

Measuring Circuit

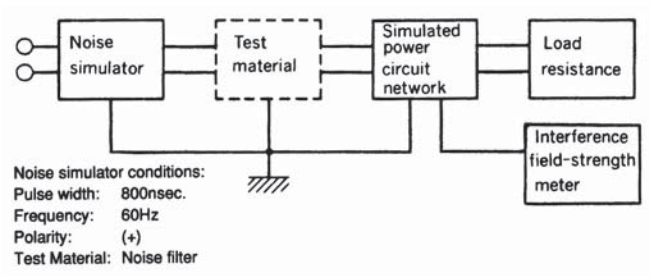


Attenuation = 20 log $_{10}$ (V_2 / V_1) [dB]
V1 Level when test material is inserted
V2 Level when test material is not inserted
Test material: Noise filter.



2. Dynamic Characteristics

In order to achieve measurement results as near as possible to actual application conditions, the following method is used: With a noise simulator as the noise generating source, a rated current is allowed to flow through the test device and a simulated power circuit network. The amount or normal mode and common mode attenuation is measured.

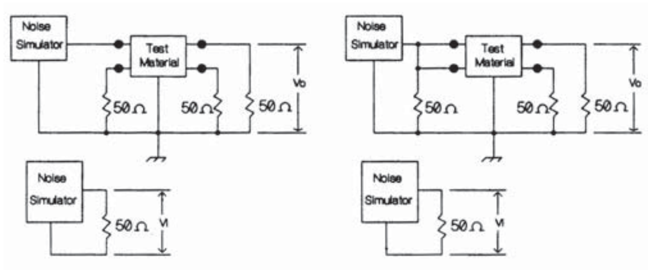


3. Pulse Attenuation Characteristics

The following method is used to measure the noise margin for the external noise in an electronic device: a noise simulator is connected and the input/output voltages are measured. The formula noted below is then used to calculate the amount of attenuation in the form of the pulse absorption effect produced. In general, the noise condition used to test malfunctions is a high voltage pulse of 50nsec. to 1μsec at 1,000V to 2,000V in amplitude.

Attenuation = 20 log $_{10}$ (V_o / V_i) [dB]

Normal Mode   Common Mode



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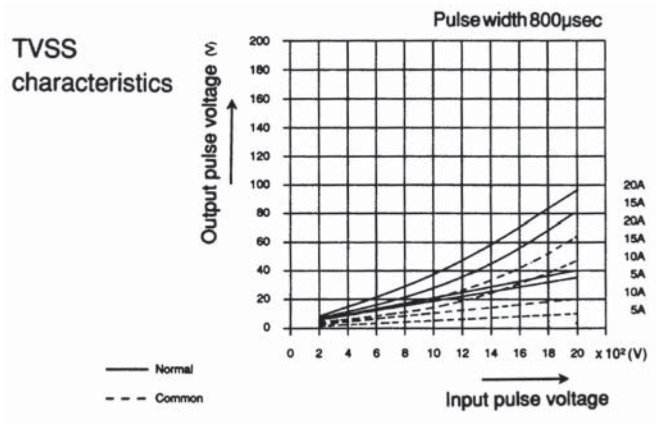
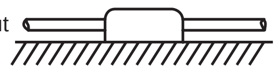


APPLICATION PRECAUTIONS

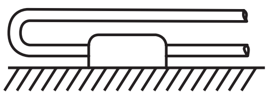
The following points should be kept in mind with regard to the installation of noise filters.

1. When mounting on the noise producing side, they should be mounted as close as possible to the source of the noise with noise electrical or mechanical contact between the input and output side of the filter.
   (Example) When the input/output lines are bundled together or arranged parallel with each other, high frequency noise components induced on the input side, results in the production of noise current on the output side.

   Separation of input/output lines (good example)

   Bundling or parallel arrangement of input/output lines (poor example)

2. When the device is directly installed on the equipment exposed to interference, it is important to mount the noise filter as close as possible to the machines power unit or input wiring. If a power line is allowed to enter the case of the equipment without passing through the noise filter, noise current can be radiated throughout the inside of the equipment enclosure, affecting the internal electronics.

3. Precautions should be taken to insure that the ground line for the noise filter has a lower impedance than that of the noise current. If this is not done, the noise prevention effect will be lost. Also, ground lines should be as short as possible. The use of long ground lines will result in substantial reduction of the noise prevention effects (particularly in the high frequency ranges above several MHz.).

4. Whenever possible, the outer case of the noise filter should be mounted directly to the outer case of the electronic equipment. When this is not possible, a short grounding line should be used to link the outer case of the filter and the equipment.