# Proposal of a new shield measurement method and the theoretical calculations

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We report on the development of a new electromagnetic shielding measurement method. Conventionally, it was believed that permalloy foil had a shielding effect at low frequencies and Cu foil at high frequencies, but for the first time in the world, permalloy foil has demonstrated a high shielding effect compared to Cu foil in all frequency ranges. In the case of soft magnetic metal materials such as permalloy foil, it was found that the shielding effect cannot be calculated even if the magnetic permeability and electrical conductivity are known, so it is of great significance to internationally standardize this measurement method for shielding effect and evaluate various materials using this measurement method.

*Keywords:* Shield measurement method; Permeability; Permalloy; Aluminum; Copper

## 1. Introduction

In recent years, the spread of AI and the big data trend EMC problems are increasing due to the high frequency of carriers in beyond 5G/6G mobile phones. Various EMC materials (Al, Cu, soft magnetic foil, etc.) are used. On the other hand, there are several methods for measuring the shielding effect of these materials, but since there are no international standards, electronic product designers implicitly use Cu foil and soft magnetic foil. Therefore, we have developed a shielding measurement method [1] shown in Figure 1 to propose the optimal material, and we report on it here.

## 2. Results and discussion

(1) Overview

In the shield measurement method we developed, we used a multi-turn coil or a shield coil for the antenna depending on the frequency, and the magnetic field direction was arranged parallel or perpendicular to the sample.

The sample was made 30 cm square to reduce its size, which caused the problem of magnetic field leakage from the edge of the sample. To solve this problem, a 1 m square aluminum plate with a 30 cm square hole was installed for the sample to suppress magnetic field leakage due to miniaturization.

For Cu foil, as shown in Figure 2, the theoretical calculation values and experimental values showed good agreement, demonstrating the effectiveness of this measurement method. However, for soft magnetic metal foil, there was no agreement. The theoretical calculation was performed using electrical conductivity and magnetic permeability as material constants, but it was estimated that there was no agreement because the magnetic permeability of soft magnetic metal foil changes depending on the frequency and magnetic field strength.

This shows that in the case of soft magnetic metal materials, the shielding effect cannot be calculated even if the magnetic permeability and electrical conductivity are known.

(2) Shielding effectiveness of Cu foil and permalloy foil

Conventionally, permalloy foil was thought to have a shielding effect at low frequencies and Cu foil at high frequencies, but in Figure 3, permalloy foil showed a high shielding effect over the entire frequency range for the first time in the world.

## 3. Proposal

Therefore, it is very meaningful to internationalize the measurement method for shielding effectiveness and evaluate various materials using the same measurement method.

## 4. Acknowledgements

I was invited by Carlo Ragusa to give this presentation.

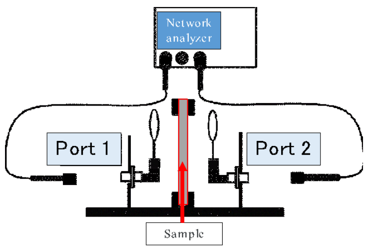
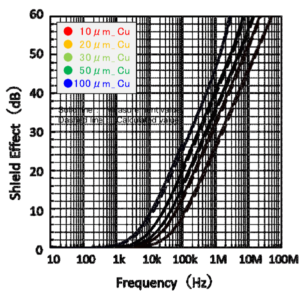



Figure 1: Schematic diagram of shield measurement.



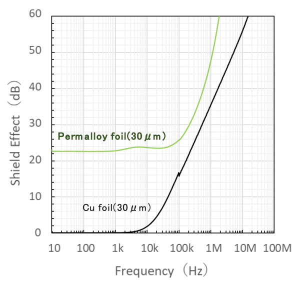




Figure2: Measured and calculated values for Cu foil (left)

Figure3: Permalloy foil and Cu foil (right)

## References

[1] K. Yuasa *et al.*, DENKI SEIKO., 95(2024), 19-25.