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Radiation Power Measurement using Compact Shield Box

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1 Introduction

For the interference radiation measurement of hand-held terminals, a reverberating chamber has been used to reduce measurement time under an open field test facility[1][2]. The reverberating chamber includes a test device radiating microwave, a wide band receiving antenna, and two flat rotating vanes installed on the adjacent walls to obtain stable received signals. The chamber size of 2 or 3 m cube is too large for the laboratory measurement, then, the compact chamber for the radiation power measurement is required.

On the other hand, a field simulator was proposed for the random field measurement (RFM)[3] under the indoor facility, which uses a compact shield box[4][5]. The field simulator will be used to test the device under multiple reflected waves for any fading conditions, however, the measured median of received power can be utilized for the relative radiation power measurement.

This paper proposes the radiation power measurement method by the RFM and a compact shield box. First we present the measurement procedure using the RFM and show the calculated field distributions inside the box which will be verified by experiments. To simulate the radiated power measurement, $\lambda/4$ and $3\lambda/4$ monopole antennas are used for the test device, and we will verify very small power deviation by this measurement procedure.

2 Radiation Power Measurement inside Compact Shield Box

The size of the shield box in this paper is 50 cm (width) $\times$ 50 cm (height) $\times$ 100 cm (length), which will be used in the frequency range above 900 [MHz]. A reception antenna such as $\lambda/2$ dipole is installed on the side wall inside the box. To obtain the random field from the test unit, it is mounted on the edge of a small turn table shown in Fig.1. We also placed three kinds of partition metal board (A, B, C) shown in Fig.2 at the center of the shield box. The partition is used to eliminate a direct path from the test unit to the reception antenna. In the measurement, the test unit rotates a few times and received signals are recorded as the output of the dipole antenna.

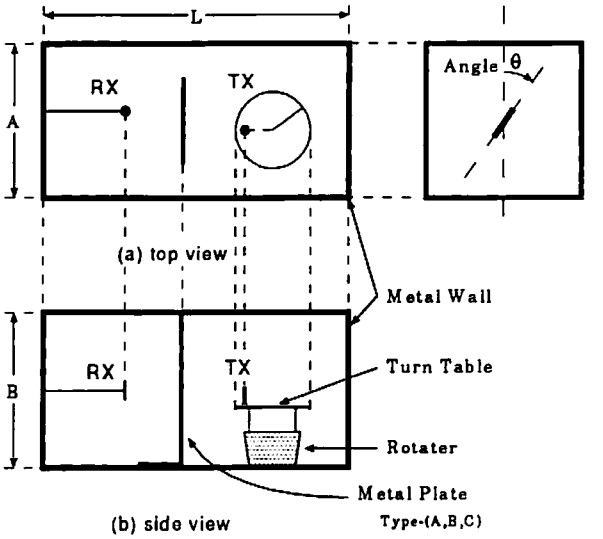

Figure 1: Measured Compact Shield Box

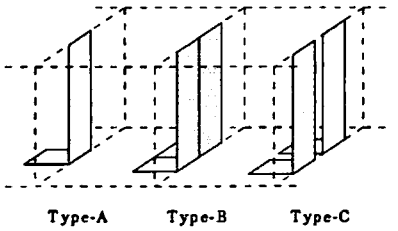

Figure 2: Arrange of Metal Plate

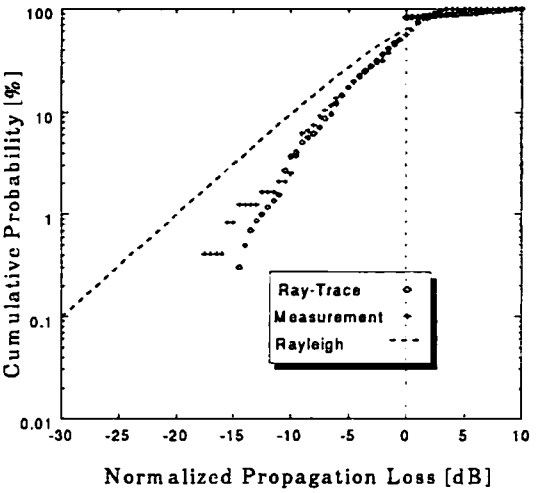

Figure 3: Cumulative Probability
(calculations and measurements at 1.9 [GHz])

The reflections from the walls cause serious fading in this measurement procedure. We obtain the median of the standard power radiator in the same measurement in advance, then, we obtain the radiated power of the test unit by their relative power. The key feature of the system is to verify the power deviation for different radiation pattern of the test unit, because $\lambda/4$ monopole on the hand-held terminals is resonated as $3\lambda/4$ monopole at the third harmonic in the measurement.

RX Angle of θ	Metal Plate	$1/4\lambda$ Mono-pole	$3/4\lambda$ Mono-pole
0 °	No-Metal	-38.477 [dB]	-39.546 [dB]
0 °	Type-A	-43.282 [dB]	-42.676 [dB]
0 °	Type-B	-42.997 [dB]	-42.690 [dB]
0 °	Type-C	-43.336 [dB]	-45.390 [dB]
45 °	No-Metal	-41.260 [dB]	-41.528 [dB]
45 °	Type-A	-43.096 [dB]	-43.024 [dB]
45 °	Type-B	-45.032 [dB]	-41.392 [dB]
45 °	Type-C	-44.907 [dB]	-42.253 [dB]
90 °	No-Metal	-43.656 [dB]	-41.077 [dB]
90 °	Type-A	-41.368 [dB]	-40.381 [dB]
90 °	Type-B	-41.425 [dB]	-45.300 [dB]
90 °	Type-C	-45.272 [dB]	-47.349 [dB]

Table 1: The Interval Median

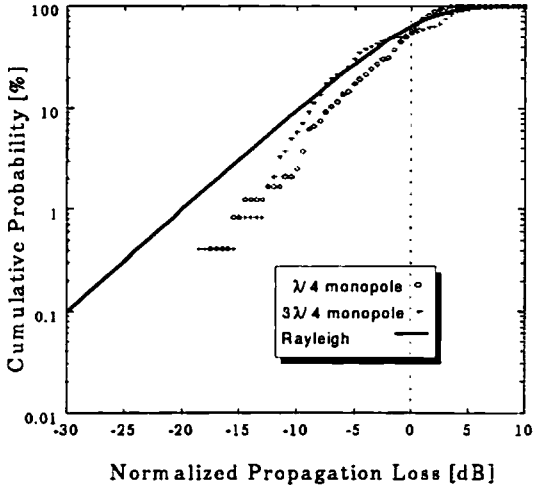

Figure 4: Cumulative Probability
(Reception antenna is vertical polarization.)

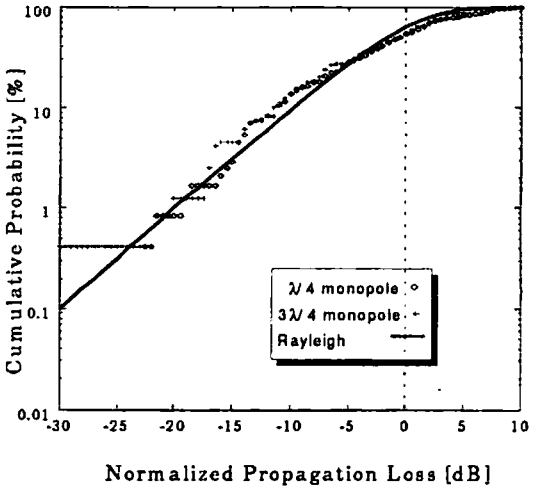

Figure 5: Cumulative Probability
(Reception antenna is the 45 ° polarization.)

At first, we calculate the cumulative probability inside the shield box without partition boards shown in Fig.3. The calculations are verifies by the measurement in which $\lambda/4$ monopole in installed on the turn table at 1.9 [GHz]. The calculations is well agree with the measurement, however, the fading structure is not Rayleigh but Rican distribution.

To obtain the random field inside the shield box. we insert a partition board in the measurement. We also change the the polarization of the reception antenna such as vertical , horizontal, and 45 ° polarization. Two monopole antennas such as $\lambda/4$ and $3\lambda/4$ are used for the test unit to simulate the different radiation pattern due to the hand-held terminals.

Table.1 summaries the measured results. To obtain the median value, we collected 1300 data in each measurement. The different of the median value between $\lambda/4$ and $3\lambda/4$ monopole

becomes the minimum when the 45 ° polarization is used for reception antenna. Fig.4 shows cumulative probability, when the reception antenna is vertical polarization for no partition board. The Nakagami-Rice distribution obtained for two monopole antennas, which shows that the propagation environment in this compact shield box is dominated by a direct path. Fig.5 shows the cumulative probability of the reception antenna is the 45 ° polarization for no partition board. The Rayleigh distribution obtained for two monopole antennas, which shows that the propagation environment in this compact shield box is obtained by multiple reflected waves.

In this measurement, the cumulative probability close to Rayleigh distribution, indicates that the random fields are obtained.

3 Conclusion

In this paper, we proposed radiation power measurement method using compact shield box. We calculated the cumulative probability using Ray-trace method and compared calculations with measurements. We measured the median value and cumulative probability in the compact shield box using $\lambda/4$ and $3\lambda/4$ monopole antenna for the test device, and we obtained Rayleigh distribution for two monopole antennas, when the reception antenna is the 45 ° polarization. Therefore, we obtained random fields in the compact shield box.

References

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