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3 Meters Site-Attenuation Varied by VSWR

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1. Introduction

In current highly developed information-oriented society, we have lived our urban life in much dependence on a wide variety of electrical, electronic and informative apparatus. Recently, however, EMI (Electromagnetic Interference) caused by undesired electromagnetic wave radiated from these equipment has often occurred at every where. Especially misaction or efficiency down of various kinds of informative systems controlled by small-signal, typically such as digital computers, have fully puzzled us. And these mischievous influences on informative systems by EMI have been coming to one great environmental pollution.

To deal with such a environment, undesired signal strength radiated from electrical and electronic apparatus is put under control in some countries for themselves. Also a maximum limit and a measuring method of undesired signal strength from those apparatus and a standard test site where measurement is achieved are defined universally, for example, by CISPR, IEC or FCC. Moreover these committees recommend those memberships to adopt their standards. In these standards, the distance from EUT (Equipment Under Test) to antenna receiving undesired signal is provided for three degrees, 3, 10, or 30 meters, and the test site is also provided for each distance.

Now then, as an evaluation value judging whether a test site is adapted to a standard, the site-attenuation is defined. This site-attenuation is the value used for judging all test sites so that the theoretical value of site-attenuation have to be strict one. As calculating method of site-attenuation, some researches have ever been reported[1],[2].

To further discuss about EMI measurement system, it is necessary to analyzing measuring system for site-attenuation more minutely. In this paper we consider about the influences of mismatches on measuring system for site-attenuation. The chart of the power transmission ratio depending upon the VSWR on receiving antenna cable are shown.

2. Analyzing method

Figure 1 illustrates the model of measuring system for site-attenuation. Both transmitting antenna and receiving antenna are tuned dipole antennas which is resonant and has no reactance on measuring frequency.

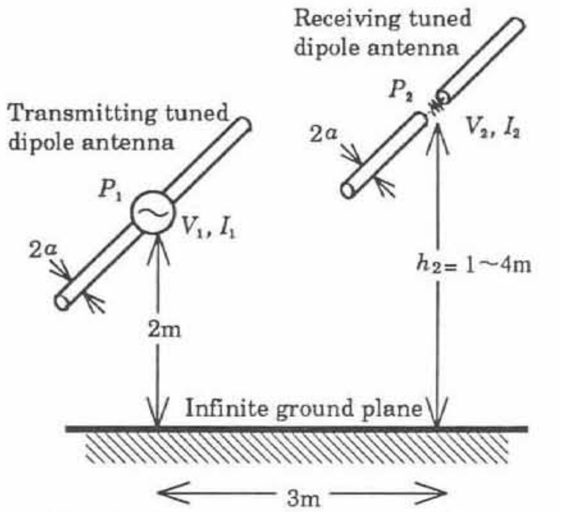


Fig. 1 The measuring system for site-attenuation.

Site-attenuation S is defined

$$S = 10\log_{10}\frac{|P_1|}{|P_2|} \quad (\mathrm{dB}), \qquad (1)$$

where

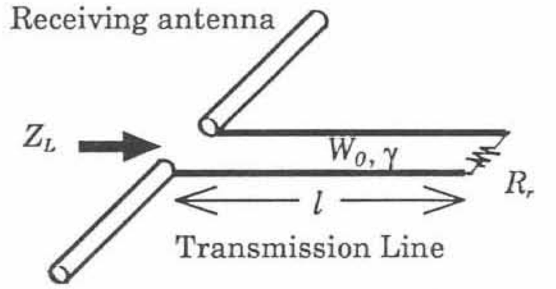
P_1: the input power of transmitting antenna,
P_2: the output power of receiving antenna.

Now we consider the case where the standing wave would occur on the only receiving transmission line so that the characteristic impedance W_0 of the line mismatches the input impedance R_r of receiver in Fig. 2(a), while no standing wave occurs on transmission line. The input impedance $Z_L = R_L + jX_L$ seeing from input port to receiver which has is

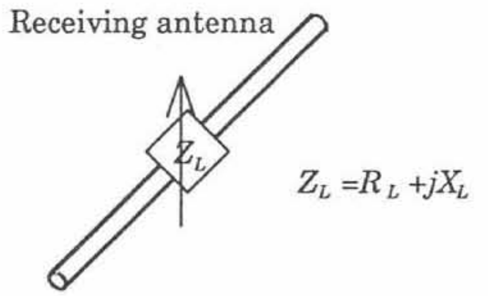
$$Z_L = W_0\frac{1-k^2}{1-2k\cos\phi+k^2} + jW_0\frac{2k\sin\phi}{1-2k\cos\phi+k^2}, \quad (2)$$

where

$k = |\Gamma|$,
$\phi = \arg(\Gamma)$,
Γ : the coefficient of reflection on transmission line.



(a) Feed system



(b) Equivalent loading impedances

Fig. 2 The receiving feed system.

Under the condition of settled input impedance of receiving antenna, k is constant and ϕ is varied from 0 to 2π with the cable length l from 0 to $\lambda/2$, where λ is wavelength. So we may vary the power transmission ratio $\eta\left(= 10\log_{10}\frac{\Re e(V_1 I_1^*)}{\Re e(V_2 I_2^*)}\right)$ depending upon ϕ in stead of l as shown in Fig. 2(b). It is noted that the site-attenuation is the power transmission ratio in the special case where $k = 1$ and $\phi = 0$, where VSWR=1, in eq.(2).

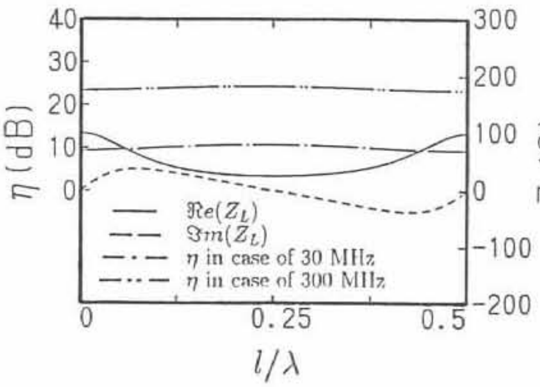
3. Results

The wire radius of antenna for which is analyzied are below

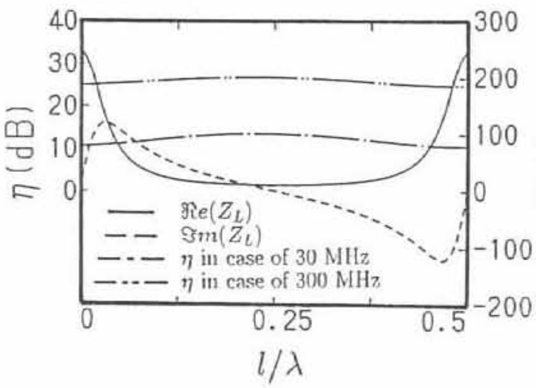
a =6.0mm (30 ∼ 300 MHz)

a =3.5mm (300 ∼ 1000 MHz)

Figure 3 shows the calculated results of Z_L and η of measuring system for the 3 meters site-attenuation for the case where VSWR $=$ 2 or 5, where the mutual impedances among four antennas including two image antennas are calculated by the moment method and the receiving antenna height h_2 is settled the value when the minimum attenuation is obtained at each frequency when VSWR=1.



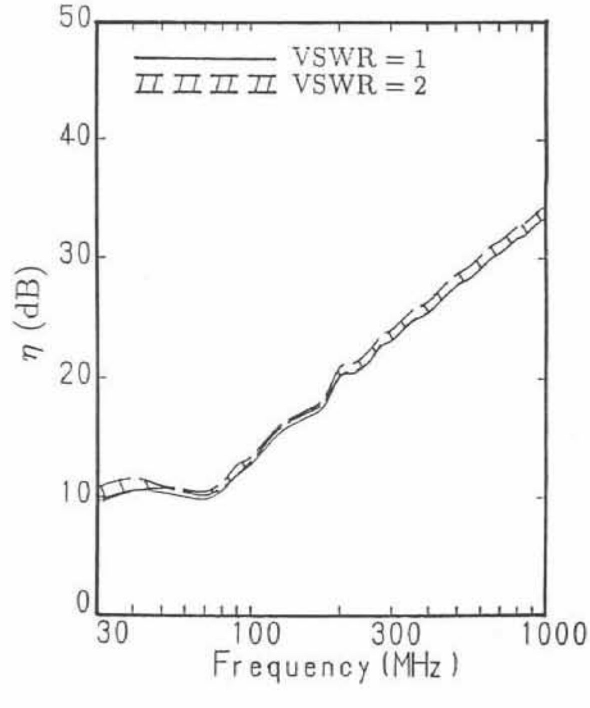
(a) VSWR=2



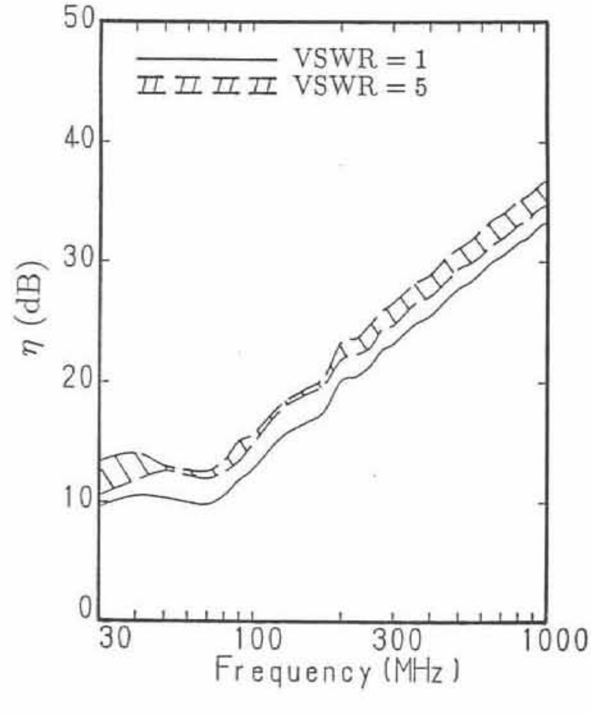
(b) VSWR=5

Fig. 3 Power transmission ratio η and equivalent loading impedance Z_L depending upon the transmission line length l.

And the width between maximum and minimum η values at each frequency is shown with two dashed lines in Fig. 4. The solid line in the case where VSWR $=$ 1 shows just the site-attenuation in Fig. 4.



(a) VSWR=2



(b) VSWR=5

Fig. 4 Frequency characteristics of power transmission ratio η.

Then Fig. 5 shows the width between S and maximum or minimum η all over 30~300 MHz depending upon VSWR. It is found that we could correct the error between η and S within 1 dB by adding appropriate coefficient, for example, the difference between the mean of two η values and S, at each frequency if VSWR is less than 2 from Fig. 5.

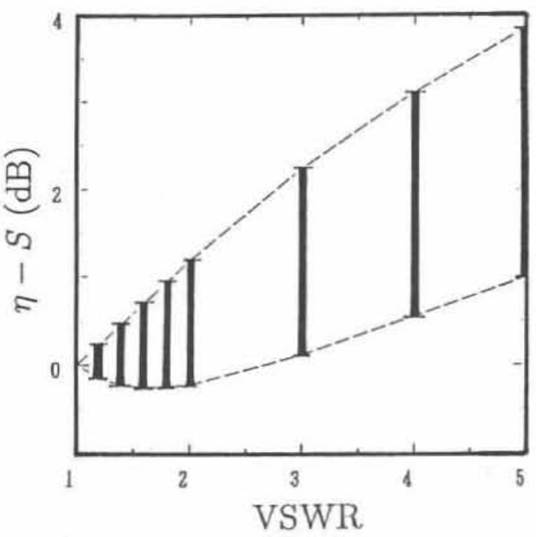


Fig. 5 Error width between η and S depending upon VSWR over 30~1000 MHz.

4. Conclusion

The site-attenuation varied by VSWR are shown. We get the map of error width for site-attenutaion. It is found that the upper limit of VSWR is about 2 in order to correct the measuring value by adding appropriate coefficient within 1 dB.

References

[1] K. Fukuzawa, M. Tada, T. Yoshikawa, K. Ouchi and R. Sato : "A New Method of Calculating 3-Meter Site Attenuation", IEEE Trans. on EMC, **EMC-24**, 4, pp.389-397 (Nov. 1982).

[2] T. Kawana, S. Horiguchi and Y. Yamanaka : "Evaluation of 3-Meter Site Attenuation by the Moment Method", IEEE Trans. on EMC, **EMC-28**, 3, pp.117-124 (Aug. 1986).

[3] R. Wakabayashi, K. Shimada, H. Kawakami and G. Sato : "Analyzing Method of Measuring System for Site-Attenuation Based on Four-Terminal Network Theory" , Trans. IEICE J74-**B-II**,2, pp.83-87 (Feb. 1991) (in Japanese).