THE HIGH ACCURACY OUTDOOR ANTENNA GAIN MEASURING SYSTEM BY THE FOUR STACKED LOOP ARRAY ANTENNA IN UHF TV BAND

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SUMMARY

The high accuracy outdoor antenna gain measuring system (Improved system, I.S) is proposed and considered with the effects of elimination for complicated ground or surroundings reflected waves.

In particularly, field fluctuations of this system are less than about 0.5 dB and improved by 0.2 ~ 2.0 dB compared to the other conventional outdoor measuring system (Improved Dipole System, I.D.S)[1]

The measured error between available gain and directional gain is less than about 0.3 dB.

DISCUSSION AND RESULTS

In the case of the antenna gain measurment by the replacement method, the gain G to the standard antenna is expressed by the following equation :

$$G=20\cdot\log\left|\frac{E+RE}{E_0+R_0E_0}\right|$$

$$=20\cdot\log\left|\frac{E}{E_0}\right|+20\cdot\log\left|\frac{1+R}{1+R_0}\right| \quad \cdots\cdots(1)$$

where E is receiving voltage by the direct wave of measuring antenna, E_0 is receiving voltage by the direct wave of standard antenna, RE is receiving voltage by the reflected wave of measuring antenna and R_0E_0 is receiving voltage by the reflected wave of standard antenna.

The first terms is true value and the second terms is error. If reflected and scattered waves can be recieved as small as posible, the second terms is neglected and therby it can be measured true value only.

Consider the measured field fluctuation which corresponds to height and distance as shown in Fig.1 .

A measuring system used dipole antenna (Dipole system, D.S) has a field fluctuation about 6 ~ 12 dB with height and 2 ~ 8 dB with distance. A testing ground on top of a 9-storied building is obviously generating the remarkable reflected and scattered waves from ground or surrounding structures. it is quite hard to obtain reproductive results. because the effects of these reflected waves vary with the weather or season and frequency, so that the measuring accuracy decreases.

Therfore, in order to negrect the second terms in equation (1),

I.S is composed as follows:

A directional 3 elements Yagi-Uda array antenna, as the standard for the replacement method, and a countermeasure antenna shown in Fig.2 are applied to transmission and receiving antenna , respectively.

The receiving antenna is constracted with the Four Stacked circular Loop Yagi-Uda array[2] as E-plane polarization antenna and 8 elements Four Stacked Yagi-Uda dipole array as H-plane polarization antenna.

The reflectors of E-plane porarization antenna are composed of a rear reflector and a ground reflector which attached at a 10° angle for the front of radiation.

As a result, lobe for reflected wave in E-plane is controled under -20 dB and the half-power angle of main lobe in H-plane is only 15° at 470 ~ 770MHZ as shown in Fig.3.

I.S set up the transmission antenna so that the UHF TV broadcasting wave which is radiated from 70° angle for the direction of main lobe can be avoided and thereby side lobe for broadcasting wave becomes under -20 dB.

The field fluctuations of height and distance patterns are under 0.5 dB and 0.3 dB as shown in Fig.4 and suppresed about -11.5dB and -12dB in comparison with D.S, respectively. Fig.5 shows the field fluctuation of height patterns in H-plane.

The directional gain G_d equals the available gain G_a according to rise the radiation efficiency.

Fig. 6 shows comparison with G_a and G_d. Here, G_a is measured by the replacement method which replaced a testing 8 elements UHF TV Yagi-Uda array antenna with a standard antenna. G_d is calculated by the arithmetical means value $F(\theta)$ with E-plane pattern $E(\theta)$ and H-plane pattern $H(\theta)$.

The curve of G_d calculated from $F(\theta)$ is plotted smoothely. all plotted points are almost agree with G_a and the error between G_a and G_d is attained under 0.3 dB.

CONCLUSION

A high accuracy outdoor antenna gain measurment system by I.S was proposed at first. The effects of elimination for testing ground surface or surroundings reflected waves were discussed. In spite of generating of the field fluctuation nearly 12dB, the field fluctuations of height and distance patterns were suppresed under 0.5 dB and 0.3 dB , respectibely. The gain measurment error was less than under 0.3 dB.

REFERENCE

[1] A.Oyama,H.Ohyama and Y.Kawai "Measurment of antenna Gain in for VHF ~ UHF Band" J.Inst. TV Engrs. of Japan, Vol.25, No1, p28, 1971.

[2] T.Korekado,K.Okuno " Characteristics of the Four-Stacked Circular-Loop Array Antenna for UHF TV Band Antenna Gain Meeasurement and the Elimination Effect of Ground or Surrounding Reflected Waves" J.Inst. TV Engrs. of Japan, Vol.42, No.12, pp1345 ~ 1350, 1988.

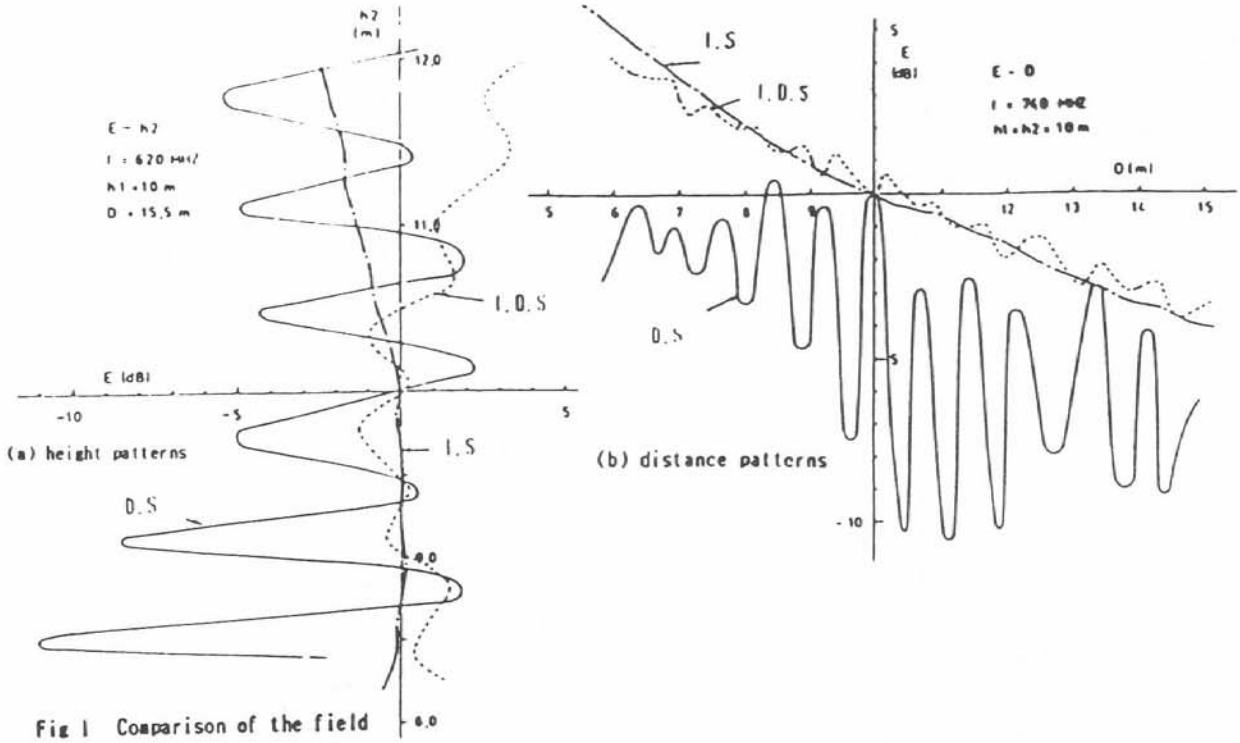


Fig 1 Comparison of the field interference patterns of D.S, I.D.S and I.S

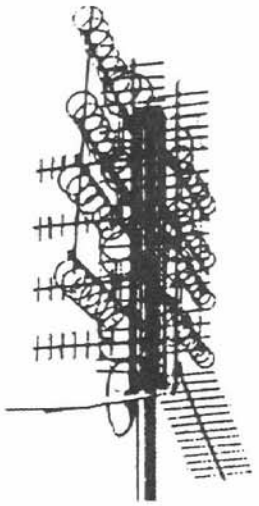
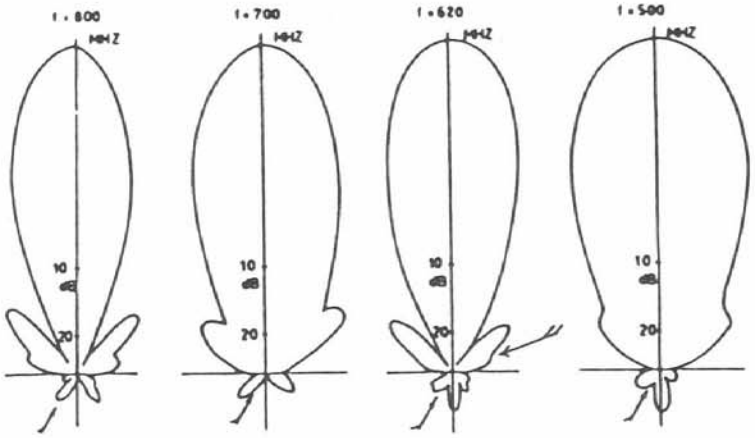
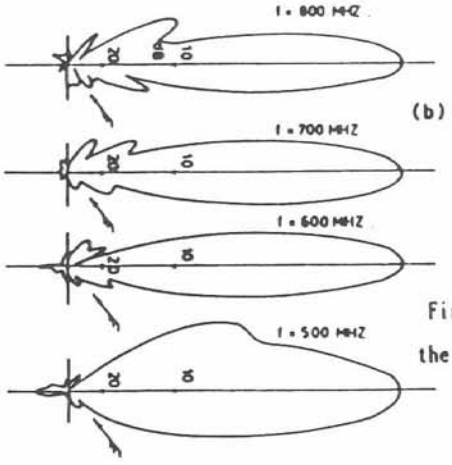


Fig 2 Constitution of the countermeasure antenna for reflected waves.

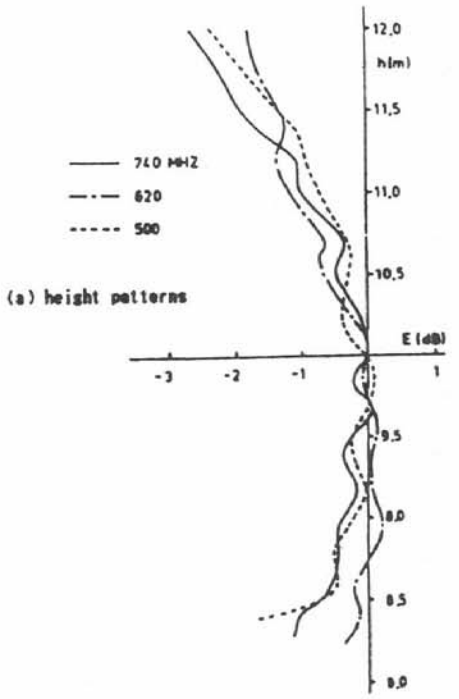


(a) E-plane



(b) H-plane

Fig 3 Field patterns of the countermeasure antenna



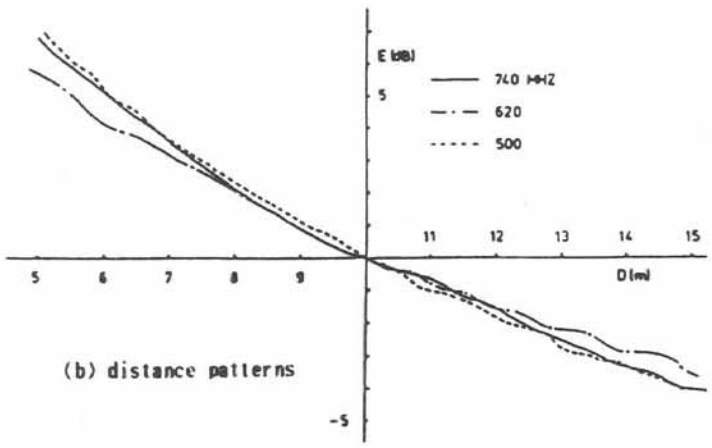


Fig 4 Frequency characteristics of the field interference pattern of I.S in E-plane polarization

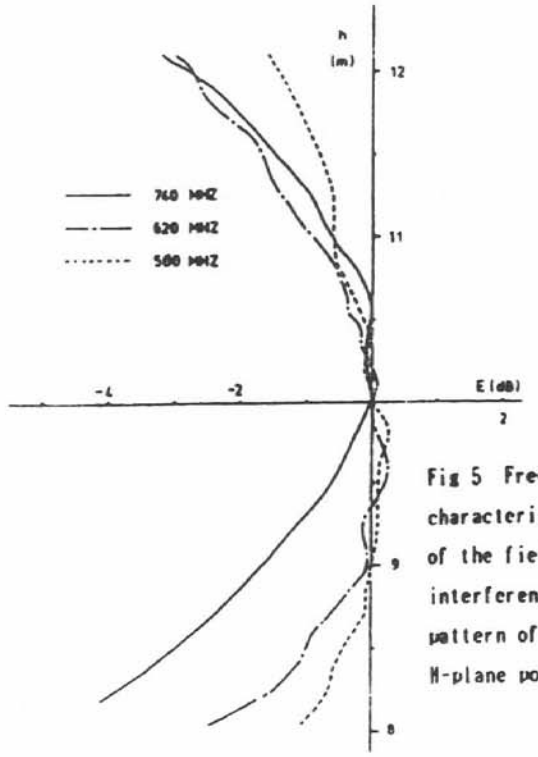


Fig 5 Frequency characteristics of the field interference pattern of I.S in H-plane polarization

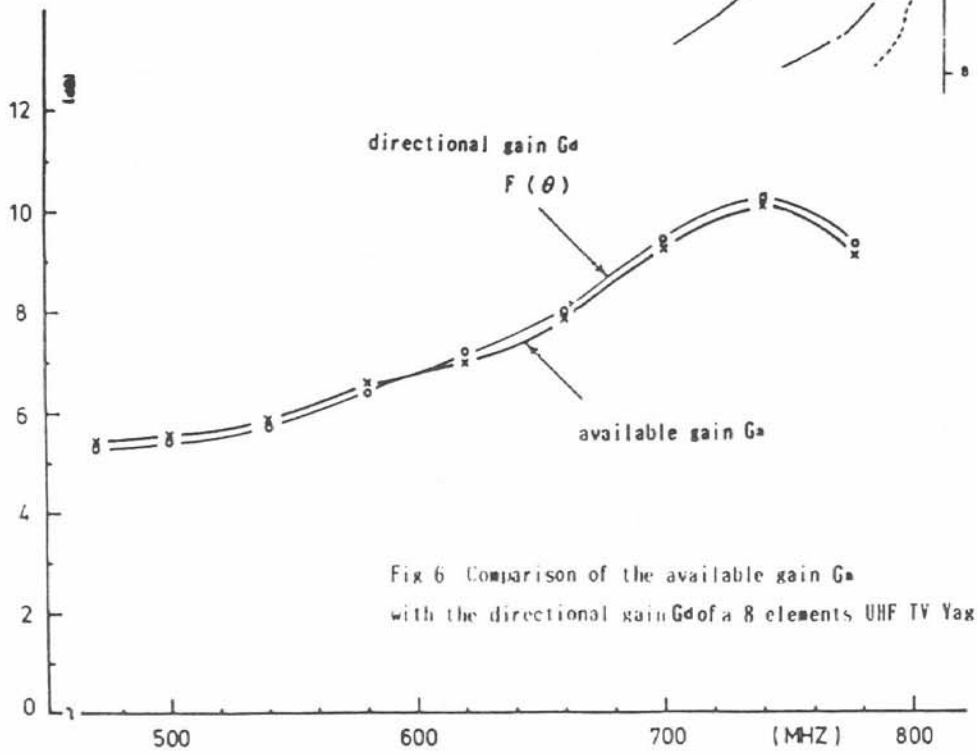


Fig 6 Comparison of the available gain Ga with the directional gain Gd of a 8 elements UHF TV Yagi Uda array antenna