Miniaturized Cross Meander-Line Antenna Etched on Both Sides of Dielectric Substrate

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Abstract

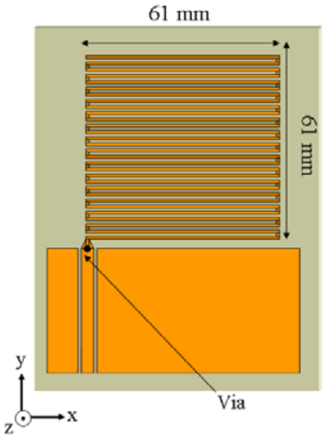
To improve the polarization characteristics of thin types of printed antennas, a cross meander-line antenna was developed for receiving terrestrial TV broadcasting at UHF band. This antenna consists of two meander-line etched on both surfaces of the dielectric substrate, where the line pattern on one surface was arranged by making a right-angled turn for that on the opposite surface to receive the horizontal and vertical polarizations. According to the analyzed results, the return loss of this antenna was more than 5 dB in the frequency ranges from 500 MHz to 700 MHz and the antenna gain was larger than -3 dBi in the frequency ranges from 550 MHz to 800 MHz. From evaluation of carrier noise ratio of the analogue terrestrial broadcasting channels at UHF band, it was confirmed that the proposed cross meander-line antenna has a capability to apply into mobile and indoor terrestrial broadcasting TV antenna. The size of this antenna was 80 mm x 100 mm x 1.6 mm and it was enough small to be used for such applications.

1. INTRODUCTION

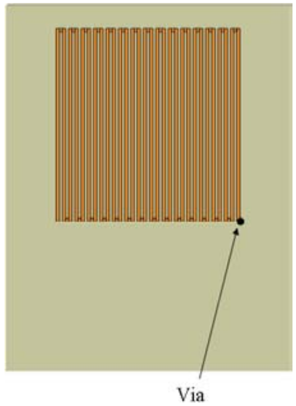
Several years has passed since terrestrial digital TV broadcasting services were started at UHF band in the limited areas in Japan, and the service areas are increasingly expanding to date. Miniaturization of antennas for receiving the digital broadcasting is an interesting issue. Actually, several antennas for the terrestrial digital broadcasting, such as the inversed-F antenna attached to the liquid crystal display [1] and the antenna structure using the chassis of the portable TV [2], have been reported. For the purpose of development of a small-sized, thin and dual-polarized antenna, a printed cross-meander line antenna was proposed. This antenna consists of two meander-lines etched on both surfaces of a dielectric substrate orthogonally for each other. To evaluate the antenna performance, the return loss, gain, radiation patterns and C/N ratios were analyzed and measured. Comparing the measured C/N ratios of the cross meander-line antenna with those of the single meander-line antenna and the Yagi-Uda antenna, the capability of the cross meander-line antenna was confirmed for receiving the terrestrial broad casting services

2. STRUCTURE OF CROSS MEANDER-LINE ANTENNA

Plane views of the cross meander-line antenna are shown in Fig. 1. A meander-line antenna for receiving the vertical polarization was patterned in an area of 61 mm x 61 mm and placed on the surface of the dielectric substrate as shown in this figure (a). The meander line with a width of 0.5 mm was spaced by a period of 0.5 mm. The antenna was fed by a 50 Ω coplanar waveguide with the infinite ground plane. A meander-line antenna for receiving the horizontal polarization was orthogonally placed with that of the surface on another side of the substrate and it was fed by a via-hole from the coplanar waveguide on front surface as shown in the figure (b). This antenna including the coplanar feed area was etched on a glass epoxy substrate with a thickness of 1.6 mm.



(a) Cross meander-line antenna on the front side



(b) Cross meander-line antenna on the opposite side
Fig. 1 Plane views of cross meander-line antenna

3. Characteristics of Cross Meander-Line Antenna

The characteristics of the single meander-line antenna and the cross meander-line antenna were calculated by an electromagnetic simulator (Ansoft Designer). The calculated return losses of these antennas are shown in Fig. 2. The solid and dashed curves correspond to the calculated return losses of the cross meander-line antenna and the single meander-line antenna. From this result, it was obvious that the return loss characteristics of the cross meander-line antenna is almost the same as that of the single meander-line antenna, and the return loss of the cross meander-line antenna was more than 5 dB in the frequency ranges from 500 MHz to 700 MHz. Figure 3 shows the calculated isotropic gains of the single meander-line antenna and cross meander-line antenna. The solid and dashed curves correspond to the calculated isotropic gains of the cross meander-line antenna and the single meander-line antenna. According to this result, the gain of cross meander-line antenna was larger than -3 dBi in the frequency ranges from 550 MHz to 800 MHz and it was improved by 5 dBi than that of the single meander-line antenna.

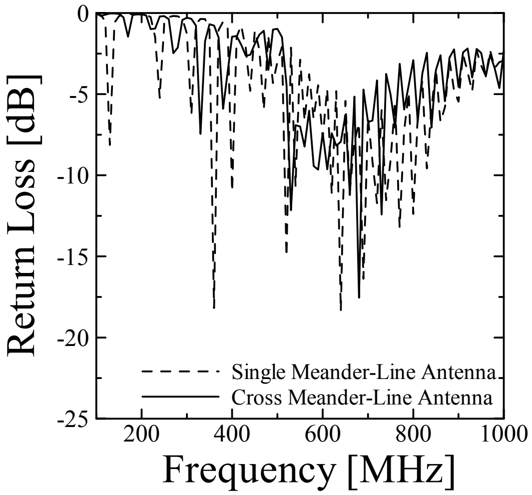


Fig. 2 Calculated return losses

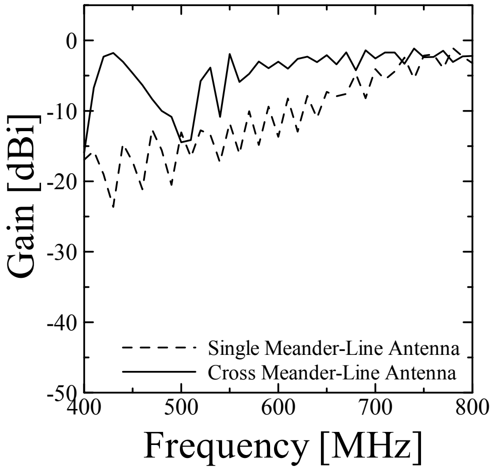
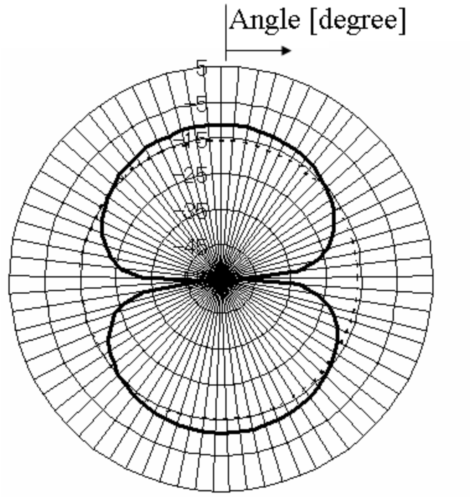
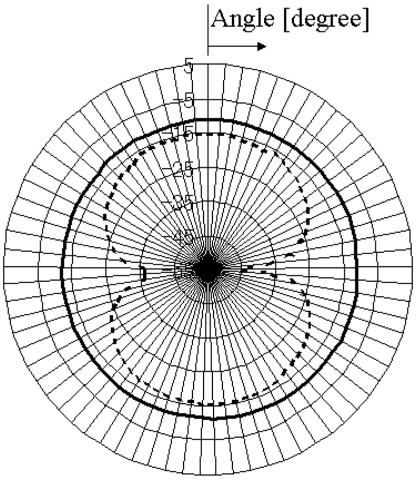


Fig. 3 Calculated isotropic gains

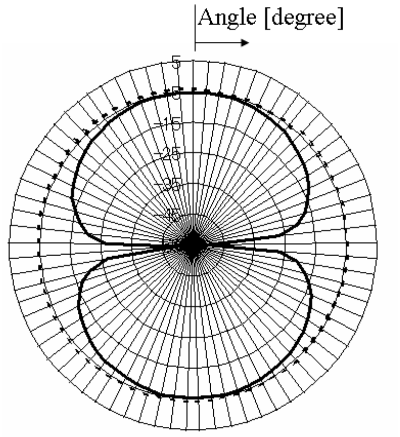
The calculated radiation patterns of the single meander-line antenna and the cross meander-line antenna in the azimuth and elevation planes at 600 MHz and 700 MHz are shown in Figs. 4 and 5. The solid and dashed curves correspond to the calculated radiation patterns of the horizontal (x-z plane) and vertical (y-z plane) polarizations. According to the calculated results, the radiation patterns of the cross and single meander-line antennas were similar to those of a cross dipole antenna placed along the x and y axes. Comparing the radiation patterns of the cross meander-line antenna with those of the single meander-line antenna, it was obvious that the gains of the vertical polarization of the cross meander-line antenna were almost the same with those of the horizontal polarization while the gains of the vertical polarization of the single meander-line antenna were smaller than those of the horizontal polarization.



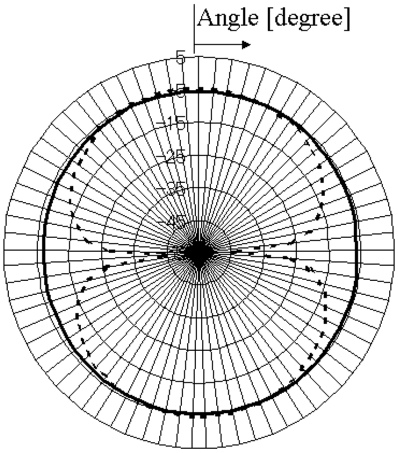
(a) Radiation pattern of single meander-line antenna on the azimuth plane (x-z plane)



(b) Radiation pattern of single meander-line antenna on the elevation plane (y-z plane)

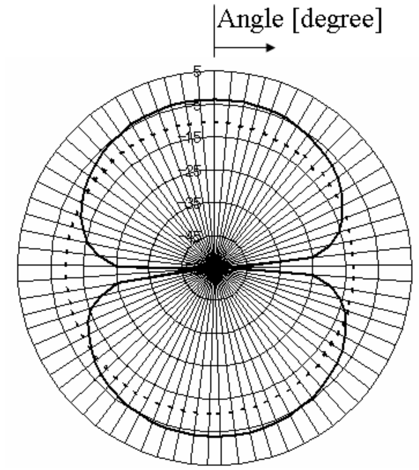


(c) Radiation pattern of cross meander-line antenna on the azimuth plane (x-z plane)

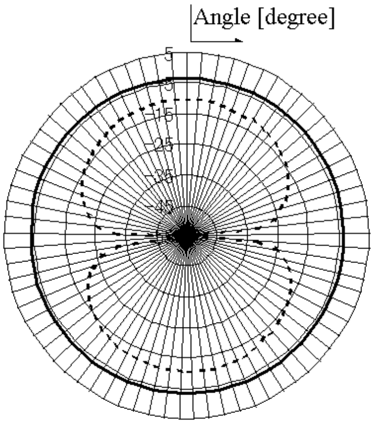


(d) Radiation pattern of cross meander-line antenna on the elevation plane (y-z plane)

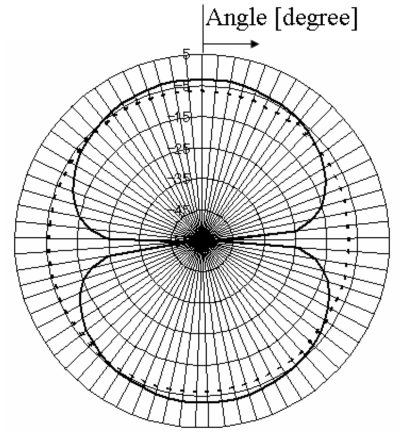
Fig. 4 Calculated radiation patterns at 600 MHz



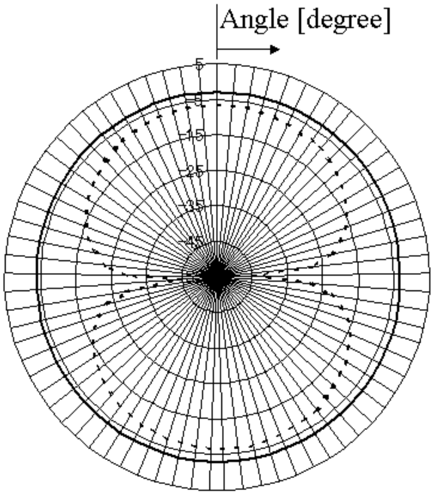
(a) Radiation pattern of single meander-line antenna on the azimuth plane (x-z plane)



(b) Radiation pattern of single meander-line antenna on the elevation plane (y-z plane)



(c) Radiation pattern of cross meander-line antenna on the azimuth plane (x-z plane)



(d) Radiation pattern of cross meander-line antenna on the elevation plane (y-z plane)

Fig. 5 Calculated radiation patterns at 600 MHz

4. MEASUREMENT ON C/N RATIO OF TERRESTRIAL ANALOGUE TV BROADCASTING AT UHF BAND

Six channels are allocated for the terrestrial digital broadcasting in specific areas in Japan, for example Tokyo and Osaka, so that we evaluated the capability of the cross meander-line antenna to apply for the broadcasting by measuring the C/N ratios of the terrestrial analogue broadcasting at 24 and 26 chs in Kure, Hiroshima region. At this measurement, the cross meander-line antenna was hanged on a wall as shown in Fig. 6. The measured C/N ratios are shown in Fig. 7. For comparison, the C/N ratios measured by a commercially available Yagi-Uda antenna and the single meander-line antenna are also plotted in the same figure. From these results, it was obvious that the measured C/N ratios of the cross meander-line antenna were larger than 70 dB and the differences of the measured C/N ratios between the cross and single meander-line antennas were about 7.1 and 4.8 dBs at 24 and 26 Chs. And the C/N ratios of the cross meander-line antenna were smaller than those of the Yagi-Uda antenna about 8 and 11 dBs at 24 and 26 chs. Specification of the C/N ratio to obtain a good image is more than 38 dB for terrestrial analogue TV broadcasting at UHF-band, and thus the cross meander-line antenna satisfied these criteria.

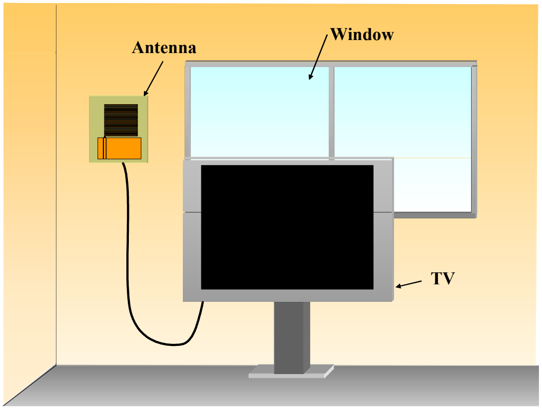
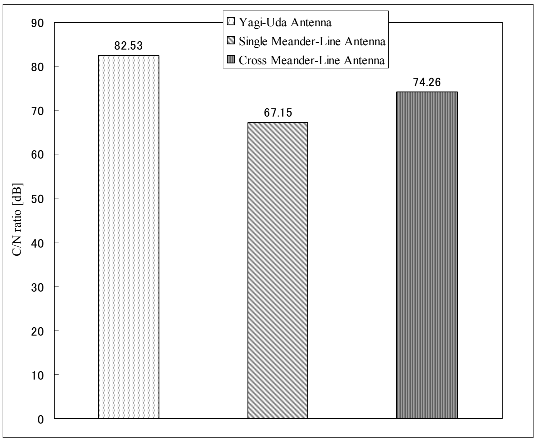
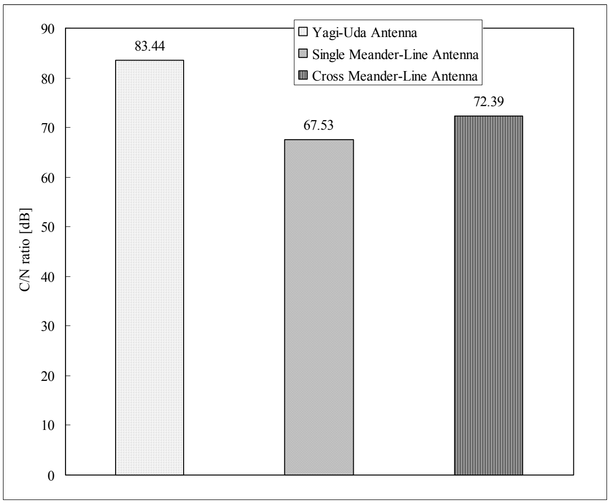


Fig. 6 Schematic view of the measurement on C/N ratio



(a) Measured C/N ratios at 24 ch



(b) Measured C/N ratios at 26 ch

Fig. 7 Measured C/N ratios by observing the terrestrial analog broadcasting

5. CONCLUSIONS

A cross meander-line antenna was considered. The return loss of the cross meander-line antenna was larger than 5 dB in the frequency band from 500 MHz to 700 MHz and the isotropic gain of this antenna was larger than -3 dBi in the frequency band from 550 MHz to 800 MHz. The differences between the measured C/N ratios of the cross meander-line antenna and the Yagi-Uda antenna were about 8 dB and 11 dB at 24 and 26 chs. From these results, it was confirmed that the cross meander-line antenna has a capability to apply for terrestrial digital broadcasting for vertical and horizontal polarizations. It has good characteristics at UHF band, and besides, the size of this cross meander-line antenna was reasonably small to be used for such applications because this antenna was made by 1.6mm-thickness dielectric substrate with an area of 80 mm x 100 mm.

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