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IMPROVED WINDOWS OF A STRIP ELEMENT FOR A TRIPLATE-TYPE CIRCULARLY POLARIZED PRINTED ARRAY

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1. INTRODUCTION

Two different satellite broadcasting systems have been adopting in Japan since last year. One is a BS (broadcasting satellite) system of circularly polarized waves, the other is a CS (communication satellite) system of linearly polarized waves. CP-PASS (Circularly Polarized Printed Array composed of Strip dipoles and Slots)[1] has a good potential for an application to polarization controllable antennas because of its operating principle[1]. The basic element of the array consists of a strip dipole in a window and a slot which are fed in series by a feeder line. The window increases effectively the gain and bandwidth of the strip dipole. We reported a microstrip-type CP-PASS for receiving BS program[2]. A strip element (a strip dipole and a window) was improved for an electrically thick substrate[3]. All of the elements were placed in the ground plane. Then a triplate-type CP-PASS was proposed[4] to suppress unwanted radiation.

In this paper, a geometry of the window is discussed in order to improve a triplate-type CP-PASS, and some experimental results in the 12GHz band are shown. A CP-PASS using the previous window is tested. Then, a CP-PASS using the improved windows is fabricated and measured.

2. CP-PASS USING THE PREVIOUS WINDOWS

The window, a kind of a wide and long slot, is excited slightly by the magnetic field along the line and radiates unwanted waves. An H-shaped feed network[5] excites a pair of windows out of phase and strip dipoles in phase, so the unwanted radiation is effectively suppressed. However, the H-shaped feed network can not realize equal element spacing in the yz-plane, when the difference between offsets of the strip dipoles and the slots are considerable. On the contrary, a T-shaped feed network[2], as shown in Fig. 1, is more suitable for high efficiency planar arrays because the elements can be arrayed with equal spacing in the yz-plane.

A 18 × 2 element sets CP-PASS using the T-shaped feed network and the previous windows was constructed on a triplate substrate. A minimum axial ratio of 0.8 dB was obtained at 11.9 GHz. At this frequency the radiation pattern of |Ey| component was measured in the yz-plane. The windows might cause the asymmetry of the sidelobe levels as shown in Fig. 2. In the xz-plane, the radiation pattern of |Ey| component was also measured as shown in Fig. 3. In this figure, the 1st sidelobe level was -6 dB and unwanted radiation was high in level around θ = 45 degrees. These results have indicated that an optimization of the dimensions of the window is necessary for the triplate-type CP-PASS.

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Unwanted radiation from a part of the window edges at the voltage maxima along the line can be negligible because of week excitation. The unwanted radiation can be improved by narrower windows, however the bandwidth was decreased.

The voltage distribution of the strip dipole at resonance, in general, has a maximum at its edges. In order to increase the bandwidth, it is conceivable that the width of the window is modified according to the voltage distribution along the strip dipole.

3. CP-PASS USING IMPROVED WINDOWS

Fig. 4 shows a geometry of a strip element using the improved window. Around the center of the strip dipole, width of the window is narrowed and almost equal to the width of the strip dipole. The narrowest part of the window is called as a "mode suppressor". By adding a mode suppressor to the window, radiation intensity of the window at the fundamental resonance is reduced.

To verify the effect of the mode suppressor, a 18 × 2 element sets CP-PASS using the improved windows was constructed on a triplate substrate. This antenna used a simple T-shaped feed network and have an outer size of 0.05 × 0.38 m^2. Fig. 5 and Fig. 6 show the measured radiation patterns at 12.0 GHz of |Ey| component in the yz-plane and in the xz-plane, respectively. Comparing these results with the patterns of Fig. 2 and Fig. 3, it is easily found out that unwanted radiation from the windows was reduced by using the improved windows.

Fig. 7 shows an actual gain and an axial ratio against frequency. A maximum actual gain of 20.3 dBi was obtained at 11.9 GHz and a minimum axial ratio of 0.8 dB was obtained at 12.0 GHz. A bandwidth of axial ratio less than 3 dB was obtained over 600 MHz. Fig. 8 shows the measured return loss of the array. Good impedance matching was obtained at 12.0 GHz.

4. CONCLUSION

A geometry of the window used as a part of a strip element of CP-PASS has been discussed and tested on a triplate-type substrate in the 12 GHz band. A mode suppressor reduced unwanted radiation from the strip element even with a simple T-shaped feed network. The dimensions of the window with the mode suppressor will be optimized in the future research, and a higher gain planar array will be reported.

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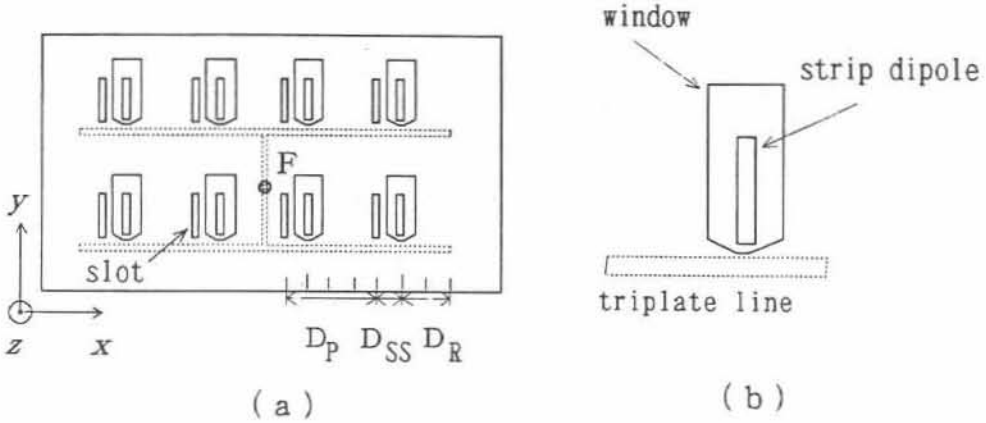

Fig. 1 Antenna configuration.
(a) 4 × 2 array with T-shaped feed network
(b) Strip element with the previous window

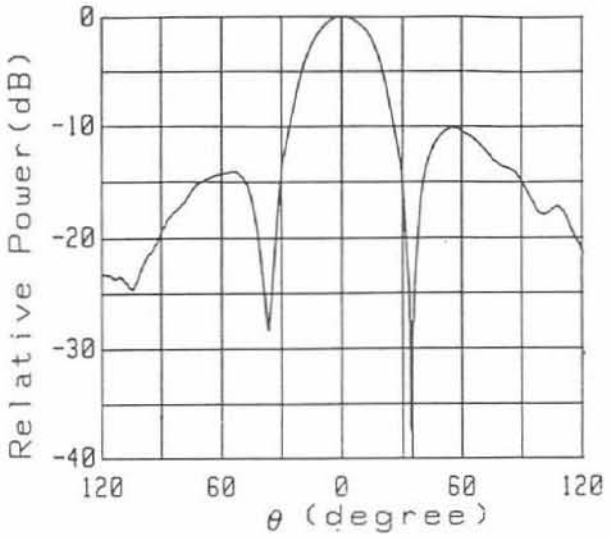

Fig. 2 Measured radiation pattern of |Ey| component in yz-plane at 11.9 GHz (the previous window).

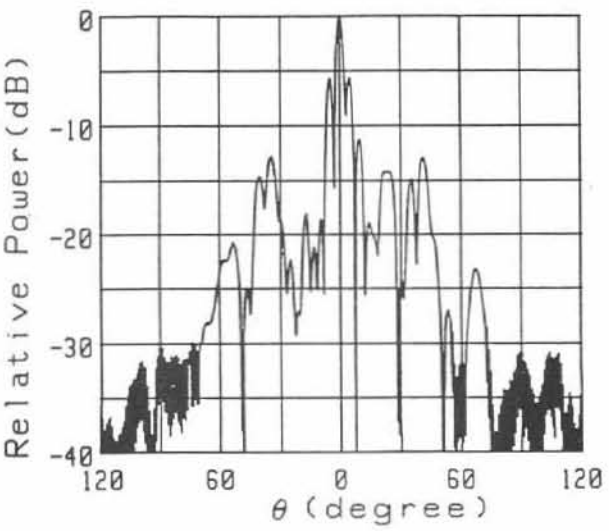

Fig. 3 Measured radiation pattern of |Ey| component in xz-plane at 11.9 GHz (the previous window).

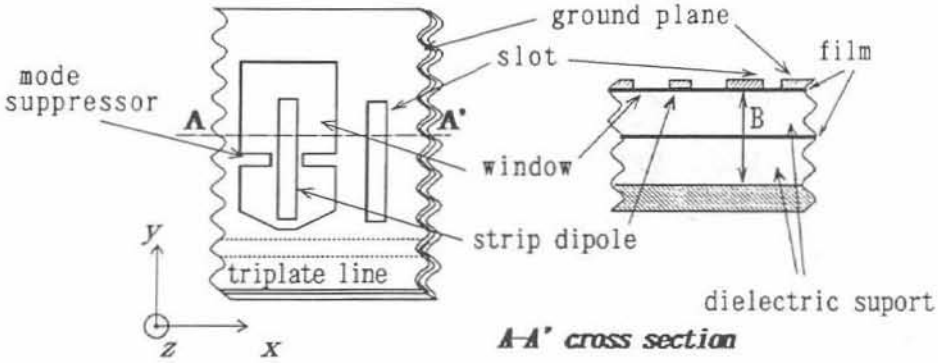

Fig. 4 Geometry of a strip element with improved window.

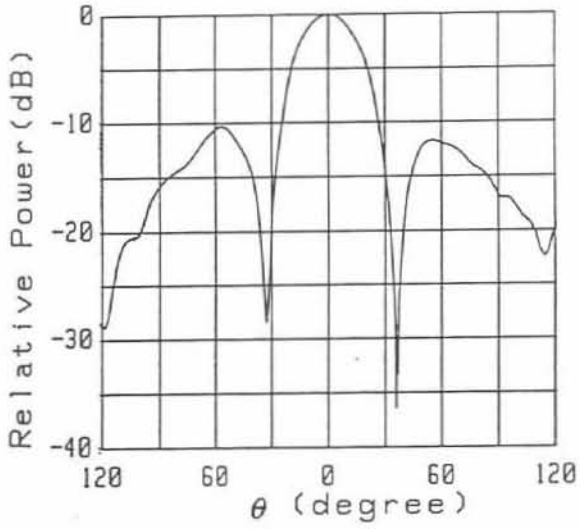

Fig. 5 Measured radiation pattern of |Ey| component in yz-plane at 12.0 GHz (improved window).

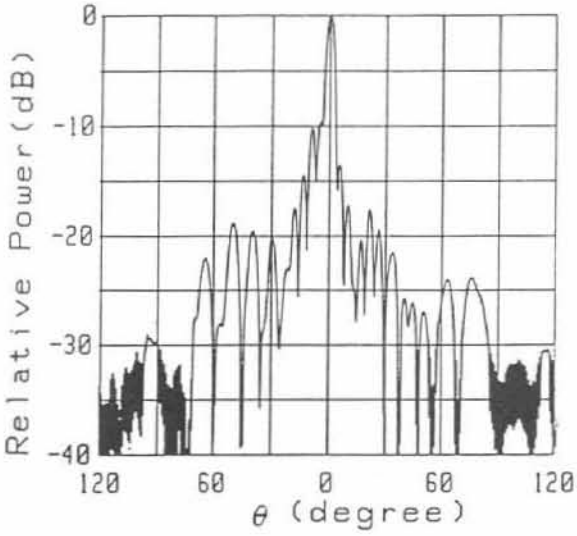

Fig. 6 Measured radiation pattern of |Ey| component in xz-plane at 12.0 GHz (improved window).

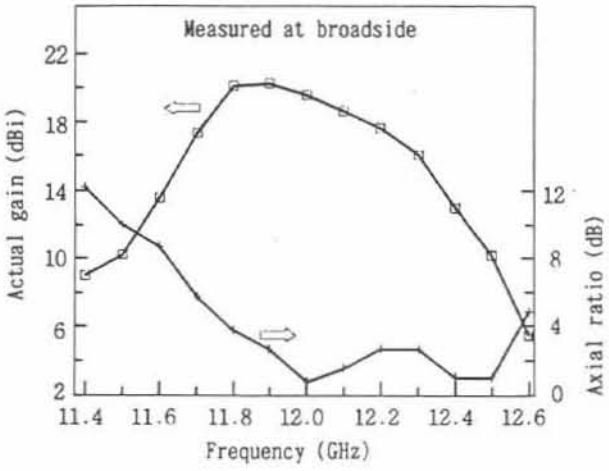

Fig. 7 Actual gain and axial ratio against frequency.

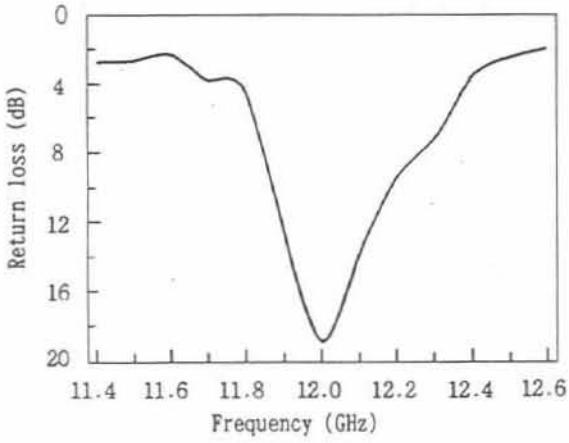

Fig. 8 Measured return loss against frequency.