THE CROSSED TWIN-DELTA-LOOP-ANTENNAS WITH DIFFERENT PERIPHERAL LENGTHS

TAKEHIKO TSUKIJI and YASUNORI KUMON

DEPERTMENT OF ELECTRONICS ENGINEERING, FUKUOKA UNIVERSITY
FUKUOKA,814-01,JAPAN

1. INTRODUCTION

For years,we have introduced the excellent features of the Twin Delta Loop Antenna(TDLA) which consists of a couple of co-planer triangular loop antennas. It has a certain possibility to be applied for practical communication antenna in VHF and UHF region due to the broad band property in both impedance and gain characteristics.

In this paper, a new crossed antennas consists of two TDLAs with different peripheral length is proposed for the circular polarization antenna with relatively broad band and high gain.

2. THEORY

Fig.1 shows the conceptional design configuration for the crossed TDLAs. The peripheral length of each triangular loop element of TDLAs is one wavelength at designated frequency. It should be noted that one of TDLAs,C-D is fed through the parallel transmission line with a quarter wavelength long to obtain current in phase quadrature.

This is a fundamental concept to achieve the circular polarization for the crossed TDLAs. But in order to realize good axial ratio for this configuration, one should account for the difference in array factor of each TDLA. Because the mean distance between two delta loops of C and D is longer by about a half wavelength than that of the other TDLA and this will cause some difference in the radiated field intensity.

On the other hand, from our investigation for the TDLA itself , it is said that its gain change is fractional for the frequency band width of more than 80%. So it is expected to have good results by replacing the TDLA with a quarter wave transmission line by a TDLA with same shape but rather longer peripheral length without the transmission line.

From above reasons,the proposed crossed TDLAs with different peripheral length for the circular polarization is shown in Fig.2. In this figure,the peripheral length of the delta loop element of c′ or D′ is longer than that of A or B by 40%. For each TDLA, distance measured from reflector plane to the center of each conductor is defined as d1 and d2. a is the radius of the antenna wire.

For rigorous analysis to obtain the optimum design parameters of this antenna, so called Richmond type moment method where the piece wise sinusoidal function is used as expansion function for the antenna current is used together with Galerkin's technique.

Fig.3 shows the calculated current distribution of the crossed TDLAs when the axial ratio is 0.1dB at 1380MHz where C1 is 30cm and C2 is 42cm. The heavy line indicates the current of the small TDLA and dotted line is that of large TDLA.

The Phase relation of the current is shown in the lower part of the figure, there exhibits apperent phase difference of about 90 degrees between the current at the center part of each delta loop conductor.

The calculated axial ratio relative to frequency is shown in Fig.4 for several antenna to reflector distances. This figure shows that the presented crossed TDLA antenna produce circular polarized wave with fairly good axial ratio as is expected by rough theory. These results are confirmed by experiment. The measured data are plotted in the same figure as white circles.

The minimum of axial ratio goes to below 0.1dB and its band width less than 2dB extends to about 13% from 1270MHz to 1420 MHz, when d1=6.55cm and d2=6.45cm.

The impedance characteristics is shown in Fig.5 and the directive gain property is shown in Fig.6.

3. CONCLUSION

It is shown that the presented crossed TDLA antenna with different peripheral length produces the circular polarized wave even though driven by one signal source. The band width of low axial ratio is relatively broad and the directive gain reaches to about 12.5dBi. Application of this antenna to satellite communication seems feasible.

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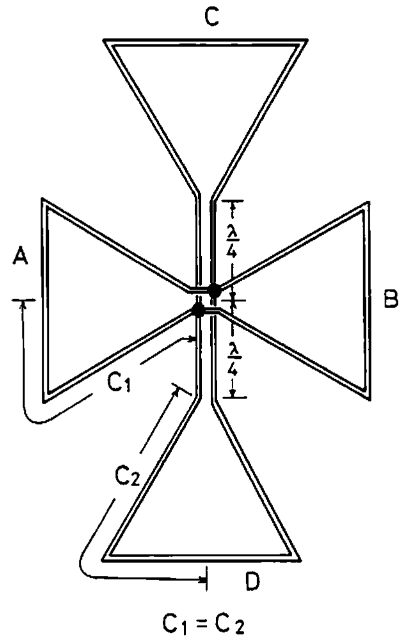

Fig. 1
Conceptional arrengement crossed Twin Delta Loop Antennas(TDLAs)

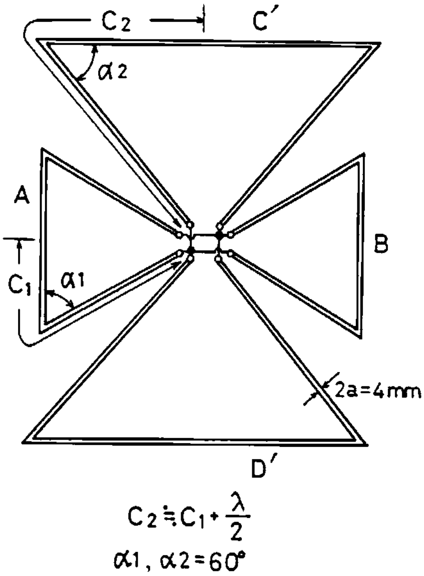

Fig.2
Crossed TDLAs with different peripheral length

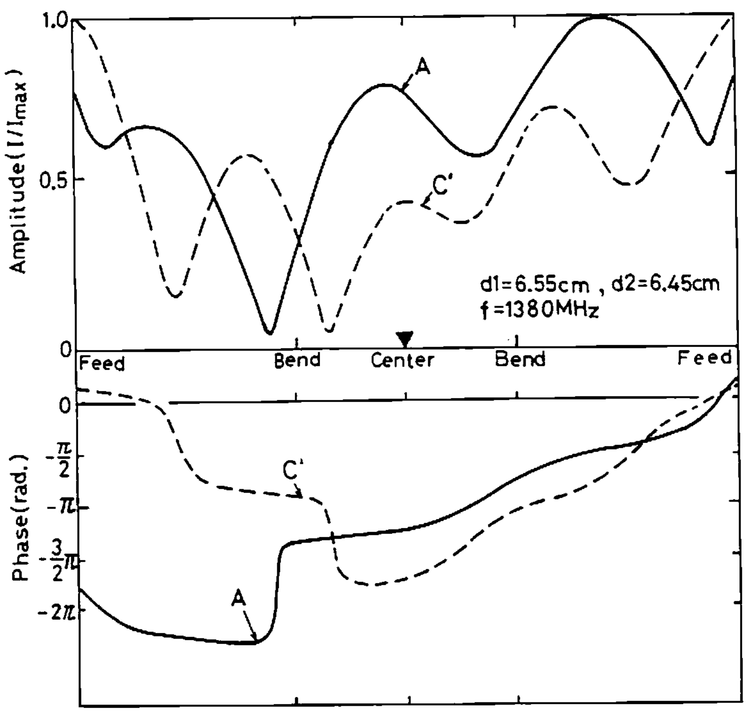

Fig.3
Current distribution of the crossed TDLAs (c1/c2=1.4)

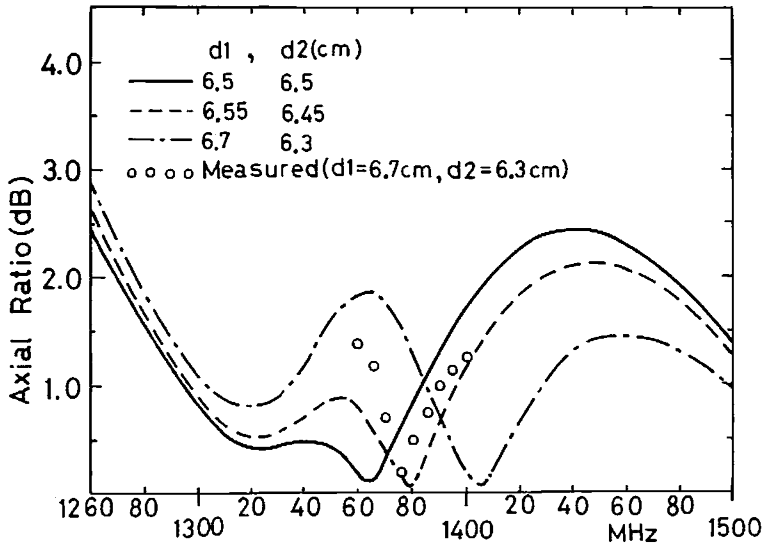

Fig.5
Axial ratio of the crossed TDLAs
(c1/c2=1.4)

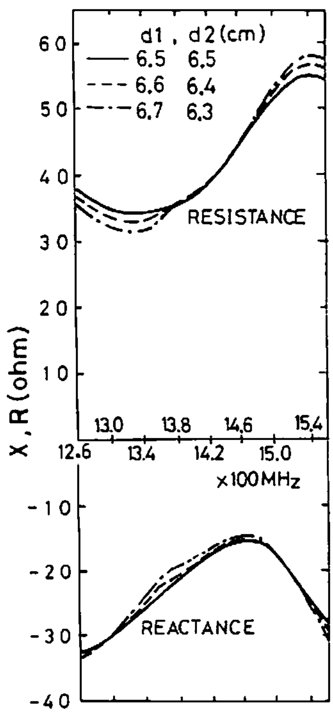

Fig.4
Impedance characteristics
(c1/c2=1.4, a=2mm)

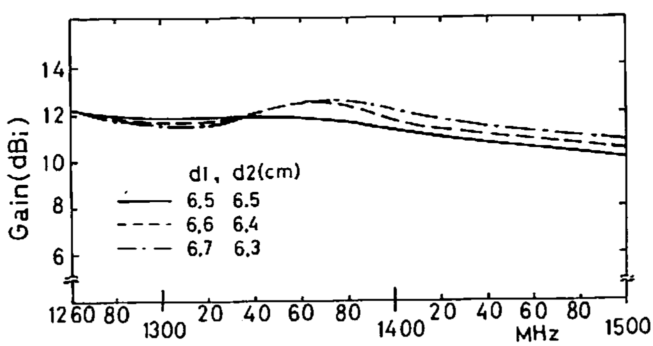

Fig.6
Gain of the crossed TDLAs(c1/c2=1.4)