ELECTROMAGNETIC CONSTRAINTS ON THE MECHANICAL DESIGN OF E.P.I.R.B.S.

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Introduction

In this paper it is presented the study made of the variations of the radiation pattern of a buoy placed over the sea surface when it is varied the length "l" (distance between the centre of phase of the antenna and the waterline) and the inclination "β" with respect to the vertical line. The aims are to determine the optimum "l" (in order to minimize the fading due to the ripple of the pattern over the sea) and to minimize the outage time which may appear as a consequence of an important decrease of the gain when the antenna is inclined.

The application chosen is an E.P.I.R.B. in L band (1.645 GHz). The antenna is a $3\lambda/4$ quadrifilar helix with dielectric nucleus of quasi-hemispherical radiation pattern, whose cut $\phi = 0^\circ$ can be seen in figure 1.

Numerical Modelling

In order to do this study it has been used an algorithm that allows to study the reflection in the sea surface. In this algorithm the centre of reflection is determined as if the sea surface was flat and horizontal; however, the reflected electric field is obtained from the incident one multiplied by a matrix, which is not of the type $\left(\!\!\begin{pmatrix}1 & 0\\ 0 & -1\end{pmatrix}\!\!\right)$ as in the specular reflection, but their elements are functions of the colatitude θ, [1], [2]. In this simplified model, only the specular component of the multipath (which is of the order of the 25%) is considered, because any other treatment (statistical) does not take into account the phase. The consequence of this model in the final radiation pattern is the representation of the characteristic fading due to the multipath in a rough surface by a strong ripple of the pattern for low elevations. This model has satisfactorily applied to maritime communication antennas via satellite in this frequency and the ripple foreseen of the pattern coincides with the really observed amplitudes of the fading, [3].

For this study it has been taken a pattern of revolution for the antenna whose generatrix is the cut shown in figure 1.

Numerical results

The study has been done considering lengths of the buoy from $l=1\lambda$ to 6λ and inclinations from $\beta=0^\circ$ to 30°. In figure 2 it is shown the ripple (difference between a contiguous maximum and minimum near $\theta=85^\circ$) versus the inclination angle β for different lengths. The curve corresponding to $l=1\lambda$ does not appear because the ripple is negligible for it. It can be observed that small lengths are advisable in order to achieve small variations. Besides, for these lengths the difference of behaviour as a function of β is smaller.

Figure 3(a) shows the elevation $\alpha=90-\theta$ from which the gain is above 0 dBi (arbitrary level, the buoy can work at -2dBi) versus the length of the buoy for the different inclinations. On the other side, figure 3(b) shows the linear regression of the set of curves of figure 3(a) when l and β are interchanged. It can be observed that the slope is almost 1 and the correlation factor 0.953 (cf=1 perfect correlation). It is deduced that the best situation is that of low β what implies that the buoy must be as stable as possible in order to avoid perturbations due to the sea movements. This fact leads to decide that the most of the buoy must be submerged in the way that the speed of recovery towards the vertical line be as high as possible.

Conclusions

To minimize the effects due to the sea multipath leads to a mechanical design which includes the two following characteristics:

- Centre of phase of the antenna placed very near the waterline ($l \leqslant 2\lambda$).
- Most of the volume of the buoy must be submerged and the careening design will be in the way that the recuperation couple towards the vertical line be maximum.

Figure 4 shows the radiation patterns for $l=\lambda$ and $\beta=0^{\circ}$ (normal position) and $\beta=30^{\circ}$ (maximum inclination). It can be observed that the pendular movement of the buoy is not very important because the gain variation due to this fact is only appreciable for elevations $\alpha<\beta$

Acknowledgements

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References

[1] M.W. Long, "Radar Reflectivity of Land and Sea". Artech Inc. 2nd Ed. 1983.

[2] M. Hernanz and M.J. Fernández, "Tratamiento GTD de la estructura de un barco carguero". IV Reunión Anual del Comité Español de la URSI, Sevilla 1984.

[3] C. Martín et al., "Hemispherical Coverage Antennas for Satellite Mobile Communications", ISAP, Kyoto,August 1985.

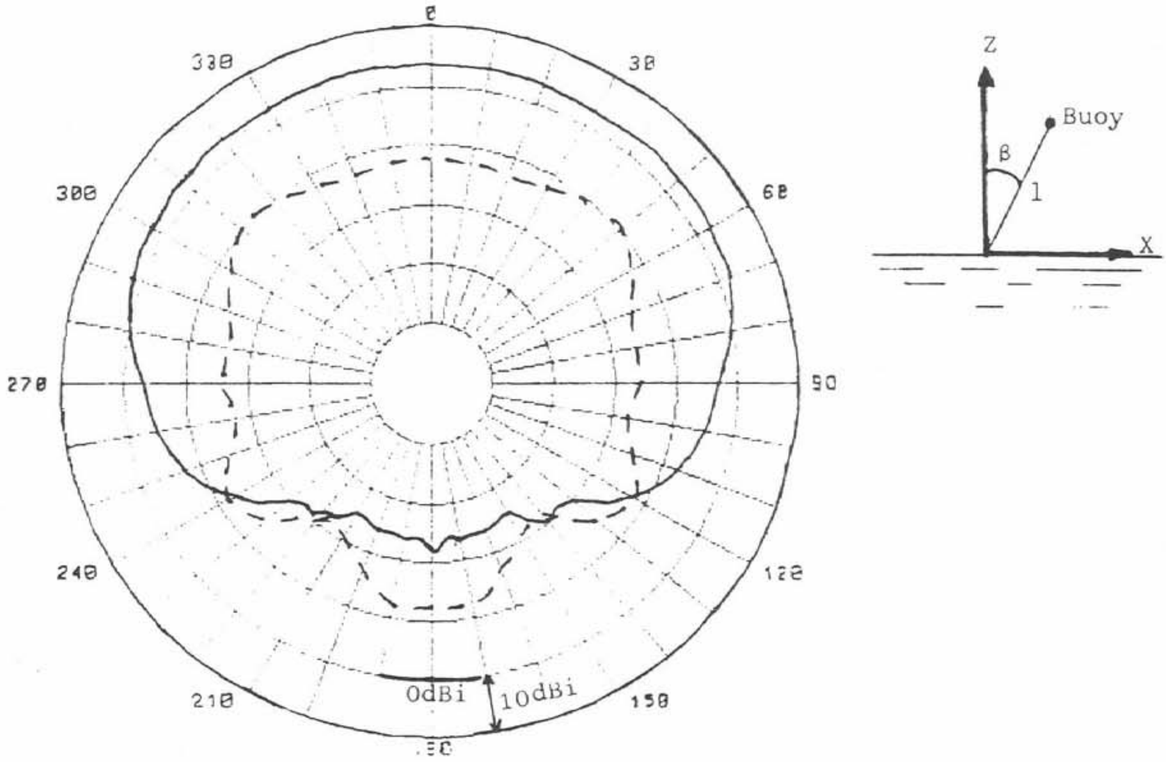
0
30
60
90
120
150
180
210
240
270
300
330
0dBi
10dBi
Z
Buoy
β
l
X

Fig. 1

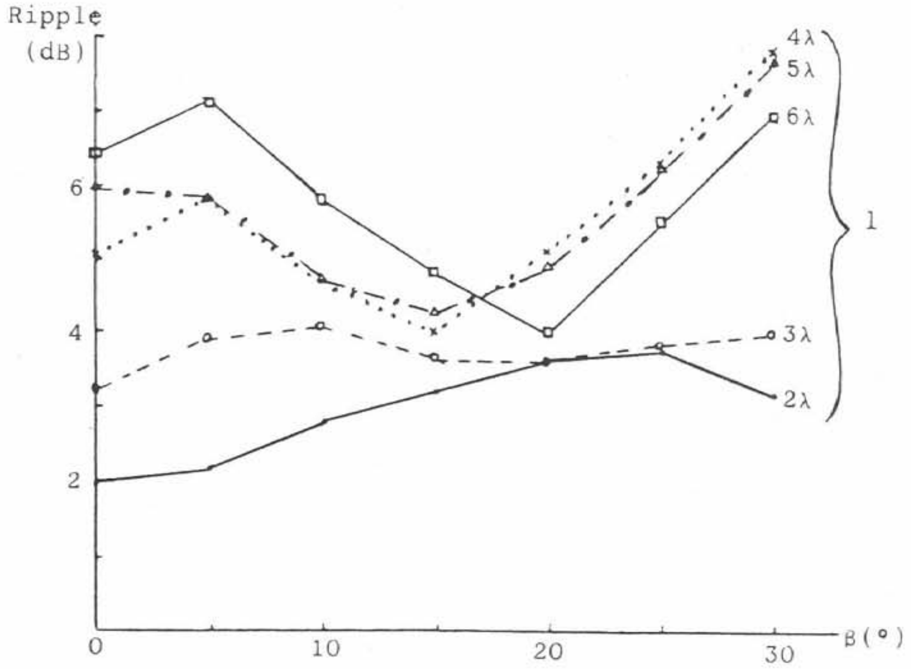
Ripple
(dB)
6
4
2
0
10
20
30
β(°)
4λ
5λ
6λ
3λ
2λ
l

Fig. 2

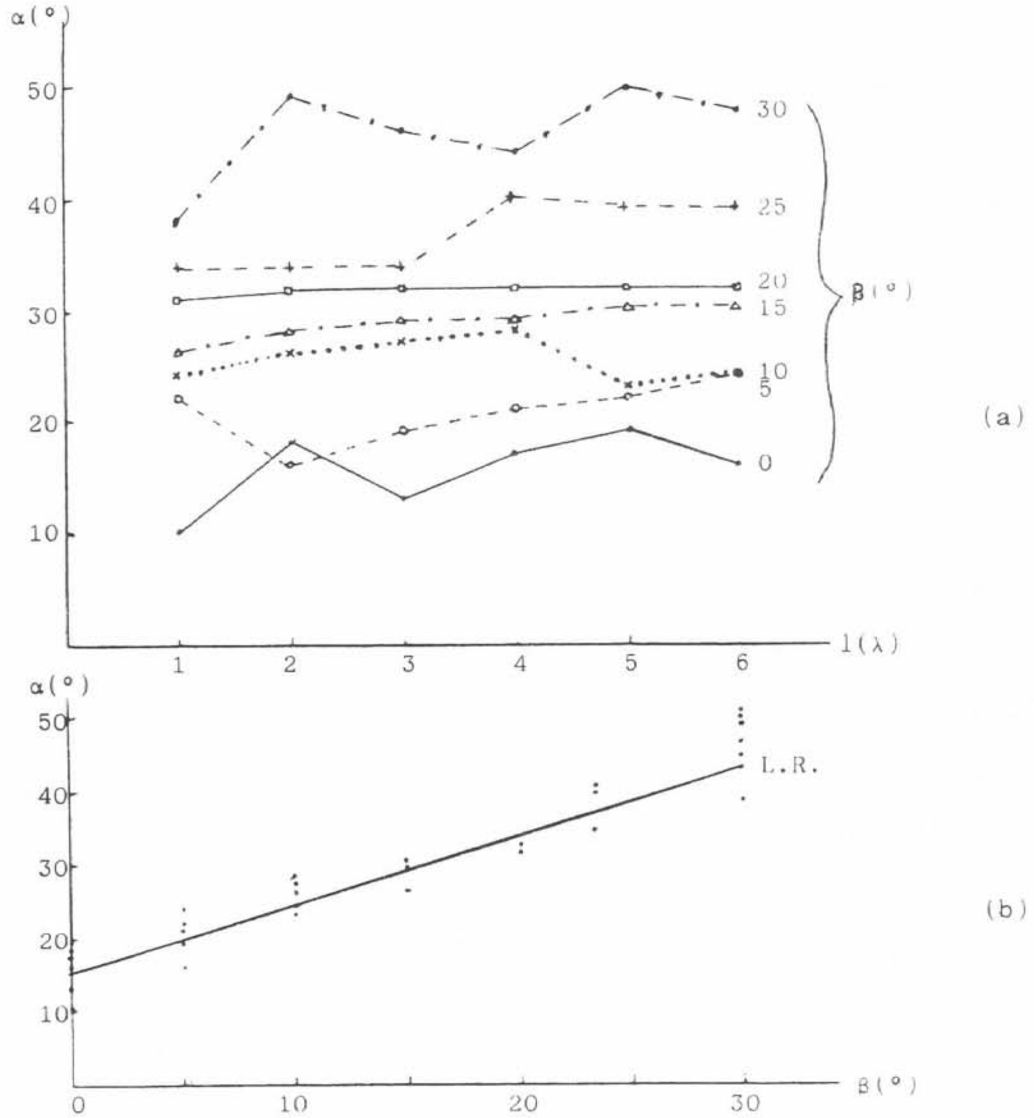
α(°)
50
40
30
20
10
30
25
20
15
10
5
0
β(°)
(a)
1
2
3
4
5
6
l(λ)
α(°)
50
40
30
20
10
L.R.
(b)
0
10
20
30
β(°)

Fig. 3

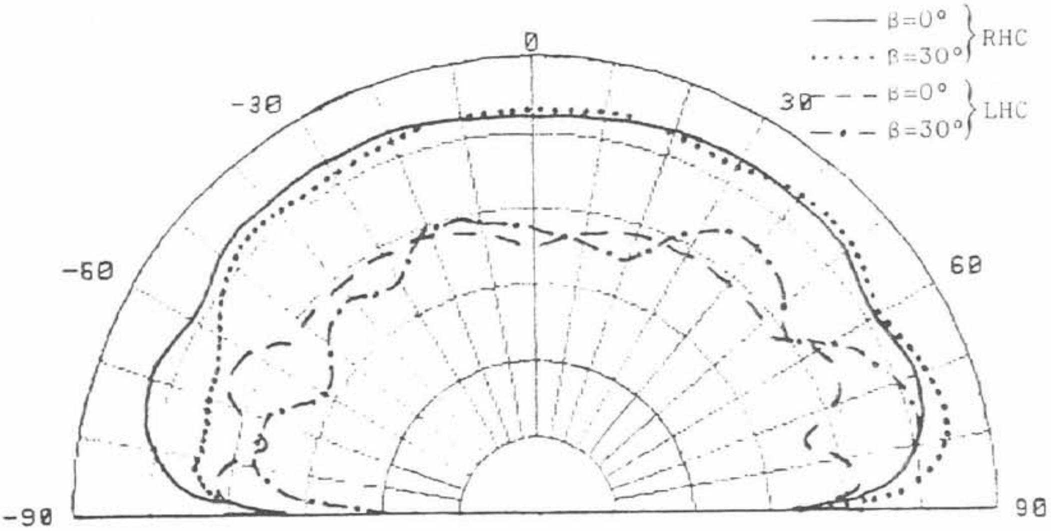
β=0°
β=30°
RHC
β=0°
β=30°
LHC
0
-30
30
-60
60
-90
90

Fig. 4