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# Dual Conical Electromagnetic Lens between a Marx Generator and a Helical Antenna

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***Abstract—*** This paper describes the design and performance of an electromagnetic lens to connect a high-power Marx generator to a helical antenna. The Marx generator is in a coaxial geometry and its outer conductor eventually becomes the ground plane of the helical antenna. The helix is fed by the inner conductor through a small hole in the ground plane. The dual conical EM lens described here transports nearly all of the energy from the Marx to the helical antenna in the pass band frequencies of the helix.

***Keywords- EM Lens, Helical Antenna, Transient pulse, Marx***

## I. INTRODUCTION

Baum et al [1] had considered the problem of launching the TEM mode on a coaxial circular cylindrical transmission line at high frequencies, by using a coaxial circular cone as a wave launcher. This can be seen in Figure 1.

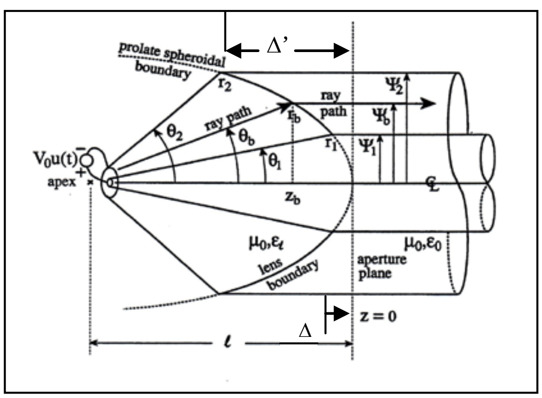


**Figure 1. Prolate spheroidal lens with a circular conical transmission line feeding circular coax**

The lens medium in Figure 1 can be a uniform isotropic dielectric, such as transformer oil or polyethylene for high-power applications. While the lens is not perfect in that there are small reflections at the lens surface, the high frequency performance has been demonstrated to be quite good for a large range of lens parameters. As has been described in [1], there are seven design parameters of this lens, $\psi_1, \psi_2, \ell, \theta_1, \theta_2, \Delta \; and \; \Delta'$. However, by setting $\psi_2 = 1$, we have six independent parameters and one can write six equations to solve for these parameters and complete the design and assess the lens performance In this paper, the above described lens design has been extended to the case of connecting a Marx generator [2,3] to a helical antenna. The last stage of the Marx with a peaking switch is in oil medium and the helical antenna is in a SF6 medium. The diameters of the Marx and the helical antenna are different and we have designed a dual conical lens for interconnecting the source to the antenna.

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## II DUAL CONCIAL LENS

The EM lens is shown in Figure 2.

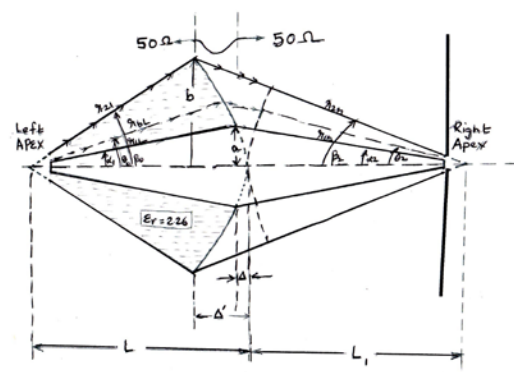


**Figure 2. Design parameters of a dual conical lens**

The design parameters are: input cone angles $(\alpha_1, \beta_1)$, output cone angles $(\alpha_2, \beta_2)$, and five geometrical parameters as seen in Figure 2. $(L, L_1, a, b, \Delta \; and \; \Delta_1)$. As before we can set b =1 and set up 8 equations for the 8 independent unknowns. The equations ensure proper impedances, equal transit times etc. It turns out there many sets of solutions and we have picked the one that minimizes the total length ($L + L_1$) of the dual conical lens. We have also verified that the solution of our lens reduces to the results in [1], when we make the length $L_1$ very large. Our lens tapers up and then down, adjusts for the needed dimensions at both ends and also provides for transitioning from oil medium in the input taper to SF6 in the output taper. We will be presenting detailed design and predicted performance which cannot be included here due to length limitation. This lens has been successfully fabricated and used.

## REFERENCES

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