

ABSTRACT

This Doctoral Thesis, entitled '*Contribution to the Analysis and Design of Transmitarray Lenses*' aims to be continuation of the research line in antennas and radiating devices, with special interest in the area of reconfigurable antennas, in the Radiation Group (Grupo de Radiación, GR) of the department of Signals, Systems and Radiocommunications (Señales, Sistemas y Radiocomunicaciones, SSR) of the Technical University of Madrid (Universidad Politécnica de Madrid, UPM). Considered the wide experience of the Group in the analysis, design and construction of all kind of antenna devices, specially in planar antennas, it is tried to deeply study planar type radiating structures known in technical literature as *transmitarrays* or *constrained lenses*. The research work contained in this Thesis is focused in the proper knowledge of design and prototyping techniques for radiative lens type structures, by means of antenna grouping (array of antennas) working as reception or transmission interface, and radiofrequency circuits inside the lens, for adequate signal processing of the received signal to be retransmitted. Initially, the study is centered in passive type structures, with fixed radiating features; afterwards active circuits are studied in order to integrate them into a lens device to provide reconfigurable functionality to it. The proper design of these active lens inner circuits are, in the same way, an essential portion of the entire work. In order to carry out the work contained in this Thesis, some guidelines have been followed and some hints have been achieved. All this is briefly outlined below, joined to some indications referred to contributions yielded in this work.

First, a previous thorough revision work of current *State of the Art* has been carried out, which allows to focus the main topic in this Thesis and to sight the possible actuation lines in the work contained in it.

Secondly, with the aim of analyzing deeply the devices under study along this Thesis, a broad electromagnetic study is presented and an analysis technique is implemented, turned into a basic tool when dealing all the rest of the work, regarding the design of the lens type devices and all their forming elements, including either transmission lines and circuits or radiating structures.

Thirdly, it is tried to explore the design possibilities in a passive lens, applying different architectures, realizing existing limitations and possible solutions. Thus, two different architecture models for transmitarray lens are proposed, and a complete prototype for each architecture is carried out, from initial design stages to its final prototyping and measurements.

In fourth place, it is studied diverse active circuits that allow the management of the ongoing processed signal (mainly, phase delay addition), in order to integrate them inside a lens type device, providing reconfigurability to it. For this reason two alternatives are studied, with completely different functioning principles.

In fifth place, as summit of all the developed work, one of the architectures employed for the passive lens design is chosen and, with certain modifications, it is combined with some of the electronically reconfigurable circuits developed *ad hoc* in this Thesis. According to this, an active lens is designed and prototyped, with electronic control of the main beam steering of the lens and its radiation pattern.

Therefore, the main objective of this Doctoral Thesis is to extend knowledge in the analysis, design and functioning of transmitarray devices, gradually introduced in this thesis in terms of complexity and lens functionality, to propose and provide new approaches and contributions in the study and design of this kind of devices, centre of this Thesis.