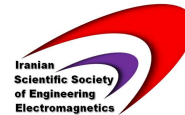


1928

K. N. Toosi University of Technology  
Faculty of Electrical Engineering  
Center of Excellence in Computation  
and Characterization of Devices and  
Subsystems

# The Second Iranian Conference on Engineering Electromagnetics (ICEEM 2014), Jan. 8-9, 2014



## Miniaturized broadside 3-dB quadrature coupler using slow-wave effect

A. Ghafouri<sup>1</sup>, A. Molaei<sup>2\*</sup>, and M. Tayarani<sup>3</sup>

<sup>1</sup> School of Electrical & Computer Engineering, Islamic Azad University, Tehran, Iran

<sup>2</sup> School of Electrical & Computer Engineering, University of Tehran, Tehran, Iran

<sup>3</sup> School of Electrical & Computer Engineering, Iran University of Science and Technology, Tehran, Iran

\*Corresponding author: [a.molaei@ut.ac.ir](mailto:a.molaei@ut.ac.ir)

**ABSTRACT**— A novel slow-wave broadside quadrature 3-dB coupler is presented. The proposed coupler miniaturises the effective occupied area to 73.54 % of the conventional coupler of its type. Operational bandwidth is 470-862 MHz for DVB-T applications. A good agreement between simulation and measurement results is shown.

**KEYWORDS:** Hybrid Coupler, Slow wave, DVB-T.

### I. INTRODUCTION

A quadrature 3-dB coupler is a four port passive structure which is broadly used in microwave systems for dividing the incoming signal into two signals, equal in amplitude but having 90° relative phase difference. It could be used for combining signals as well. Different designs for improving the performance of quadrature couplers have been reported [1-4]. Basically all of the designs occupy a large area, because they normally use a  $\lambda/4$  transmission line and therefore a lot of effort to miniaturize them recently.

In this letter, to miniaturize the effective area of the coupler an idea of using a slow-wave artificial transmission line (ATL) is proposed. In contrast to the conventional quadrature

couplers presented in [1-4], the proposed coupler has a significantly shorter effective electrical length, while keeping the performance very good. Compared to other miniaturized designs using metamaterial, meander, and folded transmission lines [5, 6], which have some fabrication complexities, our design has a very simple topology and adds no complexity to the fabrication procedure.

In the following we present the design concept, the simulation and measurement results, and finally we conclude them.

### II. CONCEPTUAL DESIGN

The structure of the proposed quadrature 3-dB coupler is shown in Fig. 1. It is fabricated on a two-layer printed circuit board. AD PIM 250 substrate with relative dielectric permittivity of 2.55, thickness of 1.575 mm, and the loss tangent of 0.0018 is used.

It comprises of a broadside coupled line with electrical length of much less than  $\lambda/4$  due to slow-wave technique applied to structure, and four ports connected to the four ends of the broadside coupled lines. The longitudinal slot located at the centre of the broadside coupled