

# TUNNEL-BASED ARTIFICIAL NEURAL NETWORK TECHNIQUE TO CALCULATE THE RESONANT FREQUENCY OF A THICK-SUBSTRATE MICROSTRIP ANTENNA

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**ABSTRACT:** *The mathematical formulation of empirically developed formulas for the calculation of the resonant frequency of a thick-substrate ( $h \geq 0.08151\lambda_0$ ) microstrip antenna has been analyzed. With the use of tunnel-based artificial neural networks (ANNs), the resonant frequency of antennas with  $h$  satisfying the thick-substrate condition are calculated and compared with the existing experimental results and also with the simulation results obtained with the use of an IE3D software package. The artificial neural network results are in very good agreement with the experimental results. © 2002 Wiley Periodicals, Inc. Microwave Opt Technol Lett 34: 460–462, 2002; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.10495*

**Key words:** *microstrip antenna; tunneling, electrically thick substrate; artificial neural networks; resonant frequency*

## 1. INTRODUCTION

Microstrip antennas, because of their low profile, low cost, light weight, conformal structure, and ease of fabrication, are popular in many applications. But one of the limitations of this antenna is inherently narrow bandwidth. Hence, the resonant frequency of the microstrip antenna must be accurately predicted. Recently, interest has developed in patch radiators etched on electrically thick substrates due to two facts [1]. One, these antennas are used for applications with increasingly higher operating frequencies. Second, with electrically thicker antennas, the bandwidth increases. The existing formulas can predict resonant frequency with reasonable accuracy when the antenna substrates are electrically thin. But when the thickness increases and the antenna becomes electrically

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