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ScienceDirect

Procedia Manufacturing 22 (2018) 514–518

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

11th International Conference Interdisciplinarity in Engineering, INTER-ENG 2017, 5-6 October 2017, Tirgu-Mures, Romania

Design of substrate integrated waveguide fifth order band pass filter

Imane Badaoui[a,]*, Naima Amar Touhami[a], Mohammed Boussouiss[a], Mohammed Lamsalli[a], Mahmoud Moubadir[a]

[a]*Information systems and telecommunication laboratory, Faculty of Science Tetouan, Morocco*

Abstract

This paper presents the design and the comparison between an X-band waveguide band-pass filter with irises (WG) and it equivalent in substrate integrated waveguide technology (SIW). The filters are designed for the pass band from 10 GHz to 11.4 GHz and realized by using symmetrical inductive irises. Good agreement between the simulation results of S-parameters for the proposed SIW filters. The bandwidth of the SIW filter is about 13% the return loss is about 40dB at 11.2 GHz which characterized by good selective performances.

Peer-review under responsibility of the scientific committee of the 11th International Conference Interdisciplinarity in Engineering.

Keywords: substrate integrated waveguide; microstrip; conventional waveguide; vias.

1. Introduction

Substrate Integrated Waveguides (SIW) is a technology used for the transmission of electromagnetic waves; this technology has been proposed as promising solution to meet the great demand of high performance of miniature and compact devices which are operating at very high frequencies [1]. Reduction of the sizes, low costs of fabrication and reduction of losses in the SIW devices are major factors of making this technology a strong alternative of the conventional wave guides that are characterized by a very strong performance but stay bulky because of their solid nature and their large size. This technology consists of two rows of metallic vias which guarantee a guided

* Corresponding author. Tel.: +212-067-398-0824.
E-mail address: badaoui1987@gmail.com

2351-9789 © 2018 The Authors. Published by Elsevier B.V.
Peer-review under responsibility of the scientific committee of the 11th International Conference Interdisciplinarity in Engineering.
10.1016/j.promfg.2018.03.063

transmission of the electromagnetic waves because those rows of vias play a role of metallic walls [2]. The wave guide embedded in the substrate is widely used as an interconnection in high-speed circuits, filters, directional couplers and antennas. Filtering is an electronic function which gives us the control of the frequency band by eliminating and passing the chosen frequencies. In order to have a performing function of filtering we must use the suitable component such as waveguide technology which is based on the use of rectangular or circular waveguides, dielectric resonators or metal cavities [3].

There are many kinds of waveguide filters that are cited and described in literatures among them [4],[5]: filter evanescent modes ,E-plan filters and Filter resonator-coupled which present our case of study this kind of filters are made of a series resonators separated by inductive or capacitive iris operating as an impedance inverter.

In this paper we present the design of a fifth order band pass filter operating in the X-band frequency [8-12] GHz. Our work has expanded on a parametric description of a tapered transition and also designing a waveguide filter with iris which gave us very good results that we based on to find the dimensions of the equivalent SIW fifth order band pass filter. We got good results that have been optimized to find the final optimal filter design the planar filter based on SIW technology. This filter design was made by using the electromagnetic Simulator CST – MWS.

2. Design of Waveguide Iris Bandpass Filter:

One of the most used design forms of filters is the symmetrical structures which facilitate the optimization process by reducing the number of parameters that we use. In the design process of the band-pass filters based on rectangular waveguides we used the formulas described bellow which consist to determine the parameters G, of inverter impedance corresponding to discontinuities in waveguides from the elements of the prototype Chebyshev [4].in order to obtain an optimal design structure of filter with irises, we had use to work with the Chebychev prototype to determine the (li) and (di) which present respectively the distances between the irises and the width of the windows irises presented in the fig(1)

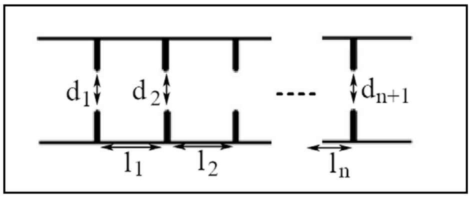

Fig 1. Equivalent circuit of a rectangular waveguide filter.

In this part the whole equations that allow calculate the physical parameters of the filter is presented we toke in our consideration by using those formulas that the width of the Irises is converge to 0.

$$f_0 = \sqrt{f_1 f_2} \approx \frac{f_1+f_2}{2} \tag{1}$$

$$\lambda_{g_i} = \frac{2a}{\sqrt{\frac{(2af_i)^2-1}{c}}} \quad i=0,\ 1,\ 2 \tag{2}$$

a : The broadside dimension of the rectangular waveguide
f_i : Frequencies that corresponding of each wavelength λ_{g_i}

The element values for Equal-Ripple Low-pass filter prototypes 0.1 dB Ripple which are presented in the chart below [3]