

Zeroth-Order Antenna with Wide Tuning Range

Miranda Mitrović*, Branka Jokanović

*Institute of Physics Belgrade, Belgrade, Serbia
miranda@ipb.ac.rs*

Metamaterials with relative dielectric permittivity close to zero - ENZ metamaterials can be realized with split-ring resonators [1] and also using dispersion characteristics of a rectangular waveguide near its cut-off frequency [2]. Various applications have been suggested for ENZ metamaterials, such as high directivity small antenna [3].

In this paper we consider ENZ channel constructed by reducing the height of a rectangular waveguide. Since the channel height is considerably smaller in respect to its width, transmission of TE₁₀ mode is an equivalent to TEM mode in a parallel-plate waveguide.

High-directivity small antenna is designed using vertical and horizontal slots located on the wider side of the channel. For this purpose the channel is placed on the middle of the waveguide height between two waveguide sections (Fig. 1).

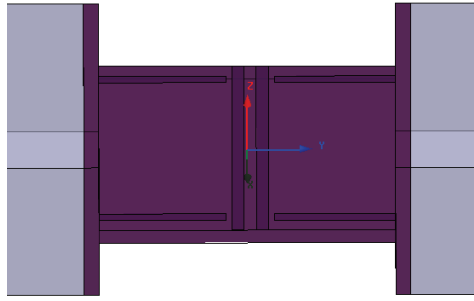


Figure 1. Antenna configuration with a channel placed in the middle between two waveguide sections; two radiating slots are perpendicular to direction of propagation while four tuning slots are in-line with direction of propagation (longitudinal slots)

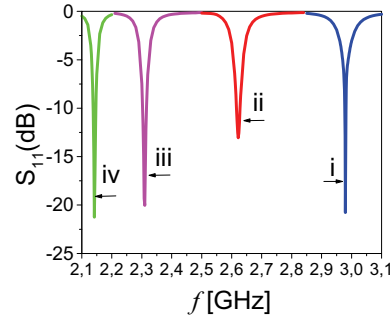


Figure 2. Tuning of antenna operating frequency using different lengths of horizontal slots L_s : **i)** without horizontal slots, **ii)** $L_s=15\text{mm}$, **iii)** $L_s=21\text{mm}$, **iv)** $L_s=22\text{mm}$. The tuning slots are placed 24mm off the centre of the channel.

Simulations show that horizontal slots oriented in-line with direction of propagation do not radiate, while perpendicular ones (vertical slots) are radiative slots. Small antenna with directivity of 5.44dBi is designed using two vertical slots placed in the middle of the channel. Dimensions of the slots are 1mm x 50mm, and their mutual distance is 3mm. Four horizontal slots oriented in-line with direction of propagation are added as a frequency tuning elements. Changing the lengths and offset of these slots in respect to the centre of the channel, antenna operating frequency can be changed in the range of 28% below 3GHz, which is the antenna operating frequency without horizontal slots (Fig. 2).

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