ISSN 0735-2727, Radioelectronics and Communications Systems, 2008, Vol. 51, No. 10, pp. 544–545. © Allerton Press, Inc., 2008.
Original Russian Text © V.M. Pan, V.F. Tarasov, S.I. Futimsky, 2008, published in Izv. Vyssh. Uchebn. Zaved., Radioelektron., 2008, Vol. 51, No. 10, pp. 39–43.

An Ultra High Frequency Wideband Filter

V. M. Pan, V. F. Tarasov, and S. I. Futimsky
UNTC, Kyiv, Ukraine

Received in final form January 24, 2008

Abstract—An ultra high frequency wideband filter was developed and fabricated. High-temperature superconductive film, sputtered in a sapphire substrate, was used as a resonator material. Loss in the filter pass band is 0.7 dB, the filter pass band is 165 MHz, its central frequency is 1877 MHz. The filter topology and amplitude-frequency responses are given.

DOI: 10.3103/S0735272708100063

High-temperature superconductors, found in 1986, allow developing ultra frequency devices with higher technical parameters. As it is known, high electrodynamic parameters of ultra frequency devices (resonators, filters, couplers, etc) are determined by a structure geometric quotient and by a used materials surface resistance [1]. The surface resistance R is defined by operating frequency value ω and materials conductivity σ:

$$R = \sqrt{\frac{\omega\mu_0}{2\sigma}}, \qquad (1)$$

where $\mu_0 = 4\pi \times 10^{-7}$ H/m is permeability of vacuum.

Some ultra high frequency devices geometric structure does not allow obtaining high geometric factor, which defines reactive power accumulation in the structure. For example, in wide band systems (made from copper) quality factor greater than 150–300 could hardly be achieved. But it is essential to have high quality factors while micro ultra high frequency filters are developed with a frequency pass band about 0.5% from its fcentral frequency value. It is impossible to solve this problem using strip line of normal materials (copper, silver). So, the solution is to use superconductive materials for strip line design, as it is shown in formula (1). In this case we can obtain better electrodynamic characteristics of devices. So, for this purpose we can use superconductors. High-temperature superconductor has, for example, surface resistance 30 times less than copper one in frequency 2 GHz and temperature of liquid nitrogen (77 K) [2]. It provides development of ultra high frequency devices with high quality factor value. Analysis of data, given in the paper [2], shows possibility of this materials application for space communication systems in future. Today cooled receivers with filters of high-temperature superconductors are used in commercial base stations in USA and Asia countries. Development of radar station receiver of high-temperature superconductive films was reported in European conference EUCAS–2007.

We developed and fabricated band filter with high-temperature YBaCuO film to analyze technical characteristics of superconductive materials. These films were obtained by laser sputtering on a two layered monocrystal sapphire substrate with width of 0.5 mm and buffer sub layer made of CeO_2. High-temperature superconductive film width is 200 nm.

Topology of this filter is shown in Fig. 1. Its length is 40 mm, and its width is 15 mm. The filter consists of 10 resonators and autotransformer input and output. Filter input and output impedances are 50 Ohm. Each resonator has effective length for resonance frequency value equal to operating frequency value of 190 MHz. For calculation we suppose a value of effective inductivity is less than sapphire inductivity (which is equal to 9.6). This value of the inductivity was chosen taking into account edge effect of the strip line. Strip line width, which is equal to 0.5 mm, provides resonator wave resistance value of 50 Ω.

A resonator shape is “peg”. This topology is convenient, taking into account finite square values of realized films. We did not cut corners on resonator strip bends, as it is usually done in normal metal structures, because we suppose in superconductive state with low power filter corners loss is not substantial with regard to other strip loss (in borders of materials grains and in film imperfections).