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A Frequency-Polarization Microwave Discriminator

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Abstract—The paper describes a recently developed microwave device permitting, from signals with arbitrary polarization, applied to its input from different frequency ranges, to extract the signals of each frequency range at some outputs of the device and to define their type of polarization.

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The idea of frequency discrimination of signals arriving at one and the same input and, moreover, determination of the type of polarization of these signals, always presented a considerable difficulty, especially, in the microwave range of frequencies. This brief work suggests a functional diagram and description of an experimental prototype of such device with relevant specifications.

The developed frequency-polarization microwave discriminator (FPMD) is designed for reception of signals of the millimeter and centimeter range of any polarization, with subsequent separation of the signal in frequency and type of polarization at the outputs.

The block diagram of FPMD is presented in Fig. 1.

The main functional elements of the device are as follows: segments of round waveguides (RW); waveguide-coaxial junctions (WCJ); low-pass filters with their cutoff frequency 30 GHZ (LPF); phase shifters for changing phase by 180° (PhS); waveguide T-bridges (TB); and a contact bar (CB).

The principle of operation of FPMD is as follows. The signals in two frequency ranges are applied to input *1*. A signal with its frequency 20 GHz having, for example, the vertical polarization, drives in a round waveguide RW20 two probes located at opposite sides of this RW. The low-pass filter passes the frequency 20 GHz and plays the role of a short circuit for frequency 30 GHz. RW30 is an evanescent waveguide for frequency 20 GHz, i.e., operates as a short-circuiting element for this frequency.

The signals from two probes arrive at the T-bridge. In one of the bridge arms, the signal, passing through a PhS, acquires a phase shift of 180°, so that the signals at the T-bridge inputs are present in phase. Output *2* yields a signal with frequency 20 GHz and vertical polarization. Just in the same manner, at output *3* we have a signal with its frequency 20 GHz and horizontal polarization, since it comes from two other probes RW20, shifted by 90° with respect to the first two probes.

In the case when a signal of frequency 30 GHz comes to input *1*, it freely passes through RW20 and comes to RW30. Then the respective *4* probes arranged in this round waveguide at 90° intervals, will be excited depending on the polarization appeared. The role of contact bar (CB) is played by a metal plate. At outputs *4* and *5* we observe signals of frequency 30 GHz with vertical and horizontal polarization. The vertical or horizontal polarization is a particular case of the linear polarization. The arbitrary linear and circular polarizations can be extracted by means of an additional processing, which is beyond the scope of this paper.

The general view of FPMD hardware is shown in Fig. 2.

The FPMD input represents a flange of a round waveguide with its inner diameter 9.52 mm. The rectangular waveguides serve as outputs. For frequency 20 GHz we use an 11×5.5 mm waveguide while for frequency 30 GHz—an 7.2×3.4 mm waveguide. Connection elements for frequency 20 GHz are rigid coaxial cables, and for frequency 30 GHz—waveguides with their cross-section 7.2×3.4 mm. In their construction, two round waveguides (RW20 and RW30) represent a unitized metal cylinder. One part of the cylinder (from the input side) is a round waveguide RW20 whose inner diameter is 9.52 mm and length 11.4 mm. The second part of the cylinder is a round waveguide RW30, 6.4 mm in diameter, connected coaxially to a waveguide RW20 6.8 mm long. The end of the waveguide RW30 is terminated by the short-circuiting contact bar.