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24-Channel Ku-Band Low-Loss Slotted Waveguide Power Divider

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Abstract—A 24-channel Ku-band power divider for active phased antenna array has been proposed and developed. The divider is built using a tree network with 1×3×2×2×2 structure, while all its elements are implemented using a finline. As a result, additional insertion loss of the manufactured specimen amounted to 1.8 dB that corresponds to the efficiency of about 66%. The measured isolation of the divider outputs amounted to no less than 16 dB for any pair of channels with the irregularity of power division between channels of no more than 0.3 dB in the working frequency range of 9–14 GHz.

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The development of multichannel power dividers with small additional insertion losses in the shortwave part of the centimeter and millimeter wavelength bands is related to the development of multielement active phased antenna arrays in these frequency bands. In particular, in the case of multielement arrays, where each element of the array contains a transceiver, the power dividers must ensure the uniform power distribution of heterodynes of frequency converters and a high isolation of outputs. In this case, the intrinsic losses of power dividers must be reduced to minimum. It is also advisable that the divider design is planar, since it ensures the repeatability of characteristics, eliminates the tuning, and reduces the cost.

The power dividers implementing the above-listed requirements can be conventionally divided into two groups. The first group consists of power dividers representing a binary tree-like structure that are implemented on the basis of tandem-connected Wilkinson microstrip power dividers or their modifications [1]. A significant disadvantage of such construction is the rapid growth of additional losses with an increase of division stages that leads to the reduction of the device efficiency in accordance with ratio $1/L^K$, where $K = \log_2 N$ is the number of division stages, L are the losses per stage, and N is the number of outputs of the power divider.

In addition, the calculation of the efficiency expected value involves the need of taking into account the losses in intersection communication lines, the dimensions of which should be significant for eliminating the mutual interference of the sections [2].

If the microstrip line (MSL) made of polymer materials is used as a substrate, the value of L at Ku-band frequencies could not be reduced below the level of 1.2 dB. Thus, already a 16-channel power divider has additional losses of about 5 dB and the efficiency of ≈30%. These figures correspond to experimental data obtained by the authors, according to which a 16-channel microstrip divider built on material Rogers RT5880 (substrate thickness of 0.254 mm) had additional losses of 7 dB (the efficiency of ≈25%) in the frequency range 6–7 GHz.

Power dividers of the second group have much smaller losses. These dividers are of the parallel type, where the power division onto all N channels occurs at a single point or single area for all outputs. The losses of such divider do not depend on the number of outputs N and are equal to L.

In this group, the best characteristics are ensured by radial power dividers [3–6], where the excitation is performed from the center of circle, while the outputs are located axially symmetric over its perimeter. Microstrip dividers of this type [3, 4] have good isolation characteristics, where output microstrip ports are excited by the input coaxial line using an intermediate section of radial transmission line.

The structure of radial power divider was made spatial in a number of studies [5, 6] for reducing the MSL losses that inevitably grow with an increase of frequency. A completely planar design of divider was proposed in [7], where the phase equalization in its arms was achieved by a careful calculation of the

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