Oversized interference microwave switches with distributed power of a switching wave

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Abstract. These are the results of research of the oversized (multimode) interference microwave switch at operating mode TE_{01}. The switch was produced from two H-plane T-junctions being connected to each other through straight arms (series connection). Two types of oversized tees were considered. One was based on an oversized waveguide with 25x58 mm^2 in cross-section and another was a package of regular H-tees operating at TE_{10} mode with a mutual switched arm. The operating frequency was 9.15 GHz. The conducted simulation showed the conditions of the "proper" TE_{01} mode at "open" and "close" states of the switch. Moreover, the relations between the arm' lengths and field intensity distribution were compared with the similar relations of a regular cascade microwave plasma switch. In additional, experiments were carried out at low power level.

1. Introduction

The microwave compressor is a passive amplifier of microwave pulses. It accumulates the input power into its own cavity and then rapidly radiates the power into the load. There are two types of compressors' switching, active and passive, differing by method of their switching.

Passive switches do not change resonance characteristics of cavities. On the contrary, an active switch changes the Q-factor of the compressor's cavity from high to low value. This feature provides higher amplification. The speed of commutation impacts on the gain and the envelope of output pulses. The switch should have the fast speed of switching and the high transmission attenuation in order to reach high amplification. One of implementation of such switches is a microwave interference switch.

The interference microwave switch is based on H-plane T-junction. One straight arm of the T-junction is coupled to the cavity and one of the others arms is shorted at a half wavelength. The last one is the output.

The shorted arm has the discharge gap at a quarter wavelength from the short. At Off state the waves from the cavity and the shorted arm radiate with the same amplitudes in anti-phase. At On state the waves' phases coincide.

The cross section of the shorted arm limits the electrical strength of the switch. The quartz tube, the blown contribute into the decrease of electrical strength.

One way for decreasing the switched power is distribution switched power among few switching units[1,2]. A construction of the cascade interference switch is studied in the paper[3].

Moreover, the oversized H-tee (figure 1) can provide greater electrical strength than in regular H-tee. Two implementations of the oversized H-tee were considered in [4,5,6]. The first implementation

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is an H-tee produced from an oversized waveguide and the second one is a package of the regular H-tees with the mutual switched side arm.

Geometrical similarity between the regular cascade switch and the oversized one gives a reason to suppose their similarity in operating.

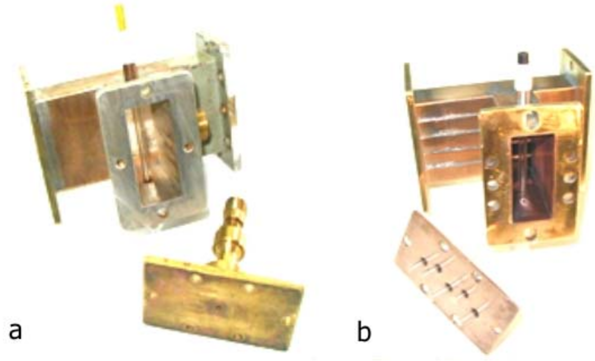

Figure 1. The interference microwave switches produced from an oversized waveguide (a) and a package of regular waveguides with the mutual side arm (b).

2. Condition of the "clear" operating mode

This paragraph concerns technical details appears in oversized waveguides.

The transmission attenuation depends on the correctness of the operating mode TE_{01} that is not primary mode for such waveguide. For exciting "clear" TE_{01} mode the waveguide taper turning TE_{10} mode of the regular waveguide was considered. The simulation demonstrated one of such tapers (figure2) that was performed for further experiments.

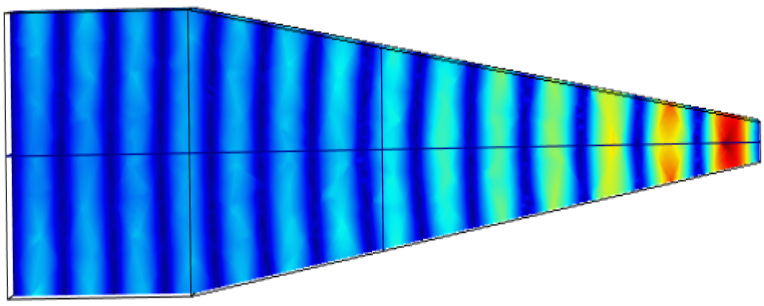

Figure 2. Figure shows the field structure of operating mode formed by a horn taper.

The problem of oversized units is their own geometrical distortions influence on field structure and transmission attenuation such as distortion of the short or the side arms. According to estimations the transmission attenuation is steadily at slope of distortions no greater than 0.01. The attenuation does not decrease less than -55 dB. The small geometrical distortions effect the field structure distortions insignificantly. Assess was carried out with simulation.

3. Experiment

Experiment was carried out with a model of the switch including two oversized H-tees with cross-section of 58x25 mm^2 at X-band. Each oversized H-tee was produced from five identical regular H-tees with cross-section of 25x10 mm^2. The switched arm was mutual for each regular H-tee (figure 3). The induction loops embedded in the short pick up signals from side arms in the view of control of switched power level. The detectors and loops were calibrated. The On state was imitated by copper wire injected along electric field lines at low power level. The operating frequency was 9150 MHz Excitation was through an input iris and the taper simulated in the previous section.

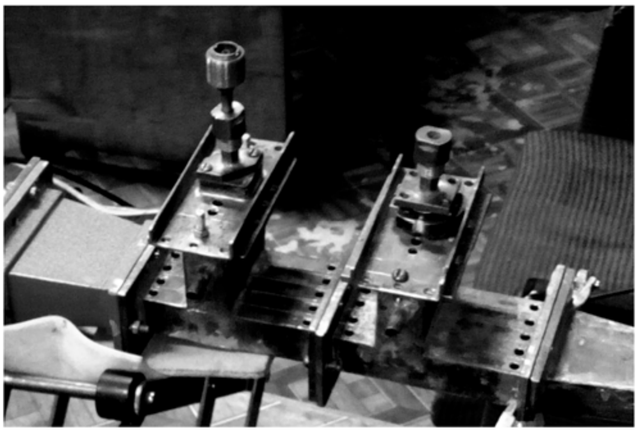

Figure 3. The oversized cascade interference switch based on two packages of regular H-tees with mutual switched arm.

A figure 4 demonstrates changes of wave amplitudes when one of the switches is commutated. As one can see a wave amplitude in the switch that is turned off increases significantly and electromagnetic field in the commutated switch almost disappears. This disappearance is caused by a node of a standing wave. Such behavior is identical to the regular cascade switch.

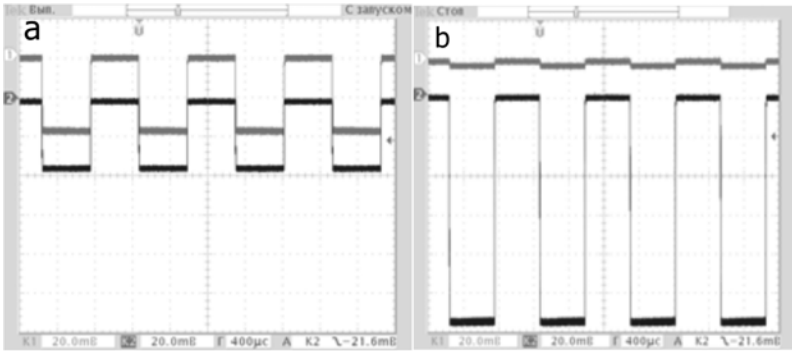

Figure 4. Oscillograms of wave amplitudes in the side arms of the switches. Amplitudes before commutation of any switch (a) and amplitudes after commutation of all switches (b).

4. Conclusion

The oversized cascade switch allows increasing efficiency of a compressor. Since, switched power is decreased. The relations of the cascade switch remain for oversized implementation.

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