Compact and Efficient Mode Converter for HPEM Applications in L Band

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Abstract— Many high-power microwave (HPM) sources, such as relativistic backward wave oscillators, magnetically insulated transmission-line oscillators, and magnetrons, use circular waveguides output. When the antenna to be used has a rectangular waveguide input a is required in order to make an efficient transition. Such converter must be compact, present high-efficiency conversion, and have low return loss. This paper presents a design adapting a custom size circular-TE_{11} pulsed-magnetron output waveguide, insulated in ceramic, to a standard WR650 TE10 waveguide, insulated in air. The device was designed based on the principle of LC matching on a rectangular waveguide and was manufactured using CNC technology. The measurements show that the device has a return loss (S_{11}) lower than -20 dB over a bandwidth of 400 MHz, centered around a central frequency of 1.3 GHz, at 1.3 MW peak power.

Keywords-mode converter; high-power microwave; HPEM.

I. DESIGN AND PROTOTYPE

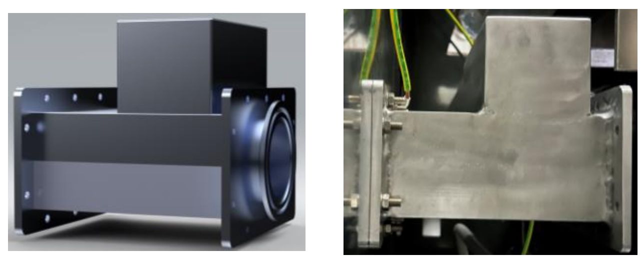
The aim of this paper is to present the design and measurements of a TE_{10} to TE_{11} mode converter for high-power applications [1].

The power source is a 1-MW RK6517 magnetron oscillator operating in the L band. The magnetron output is a circular waveguide with a diameter of 75.4 mm, ceramic of unknown dielectric constant.

A classical stub-turner transmission line approach [2] was proposed as the solution to the problem. However, this required overcoming one of the most challenging tasks of the project: determining the impedance of the circular waveguide filled with a ceramic material of unknown permittivity. Two measurement methods were implemented: open-ended coaxial probe and cut-off frequency of circular waveguide. Both methods predicted an ε_r=6.5.

The designed mode converter (MC) consists of a rectangular waveguide WR650 (main transmission line) with one end connected directly to the circular waveguide through a custom-made flange on the transversal excitation plane. The remaining end was terminated on a standard rectangular flange, allowing the connection of the antenna. A stub waveguide was connected in parallel to the main transmission line. It consists of a WR650 segment, terminated in a short-circuit. The length and positioning of the stub were calculated to reduce the reflections back to the magnetron. The mode converter was designed with a return loss of less than -25 dB at 1.3 GHz.

The primary waveguide was manufactured in aluminium on a CNC with a total length of 202 mm. The 84.7-mm long stub was placed on one of the broad walls at 92 mm from the rectangular end.



(a) (b)

Figure 1. Mode converter. (a) model. (b) installed prototype.

III. RESULTS

The measurements of the manufactured MC, return loss and insertion loss, are shown in Fig. 2. As it can be seen, the mode conversion efficiency is higher than 97% over the frequency range from 1.28 to 1.32 GHz, with a return loss of less than -20 dB over the bandwidth. The conversion efficiency is about 99.3% at the central frequency, with a return loss of approximately −37 dB at 1.30 GHz.

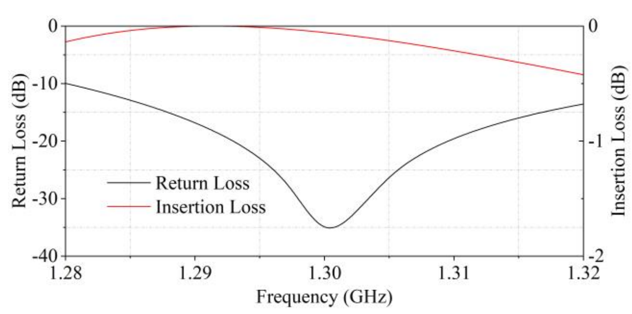


Figure 2. Mode converter's return loss and insertion loss.

REFERENCES

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