Design and Test of a C-Band Water Load

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Abstract: *This paper describes the design and experiment test of a C-band water load developed for high power klystron test application. In order to reduce reflection microwave and expand the bandwidth, a structure with multi-level gradual change was adopted. In this load, a piece of alumina ceramic with a thickness of 3 mm was metalized and brazed on one cooper ring, two O-rings were used for sealing water. Finally, two water loads were fabricated and tested. Test result shows that the VSWR is 1.07 with a frequency of 1300 MHz, the VSWR is less than 1.2 with the frequency band of 5659MHz to 5746MHz. These two loads were mounted in the C-band klystron test system.*

Keywords: C-band, high; power klystron; water load; test.

Introduction

Microwave load is a high power terminal device intended to convert microwave energy into heat. In the process of radar transmitter debugging, feeder system testing and high power test of feeder components. High power microwave load is the best terminal. For high peak or average power microwave test, the waveguide is often in a vacuum environment, conventional microwave load cannot be used for testing. Under this condition, water load is an appropriate choice. In the water load, one side of the ceramic is atmosphere or vacuum, the other side is water. The water load uses the flowing water as the microwave absorber, because the water is a good absorbent, it can absorb microwave efficiently [1-3].

Model of the Water Load

Figure 1 shows the model of the C-band water load which consists of one rectangular waveguide, two cylindrical waveguides, one tapered waveguide, one ceramic and one complex structure water body. Microwave enters the water load through the rectangular waveguide, the cylindrical waveguide, and the ceramic, be converted into heat energy.

Resonance Mode Analysis

For this water load, the structure parameters of cylindrical waveguide, taper waveguide, ceramic, and water body can be adjusted for optimum absorption characteristics. Through extensive computational analysis, the structure parameters and ceramic parameter are determined. Figure 2 shows the simulated VSWR vs frequency, which meets our design requirements. Figure 3 shows the electric field pattern of the C-band water load, in the cylindrical waveguides and tapered waveguide, the electric field is TE11 mode, in the rectangular waveguide, the electric field is TE10 mode.

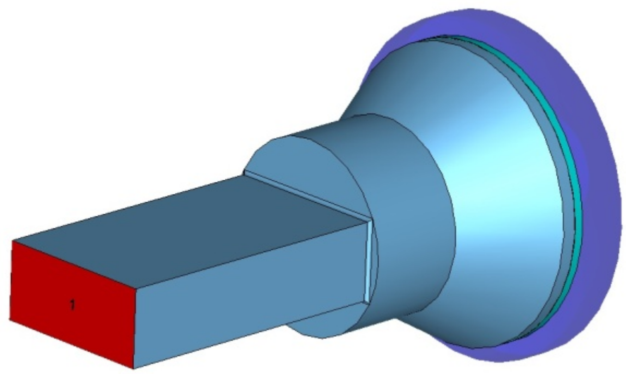

Figure 1. Model of the C-band water load.

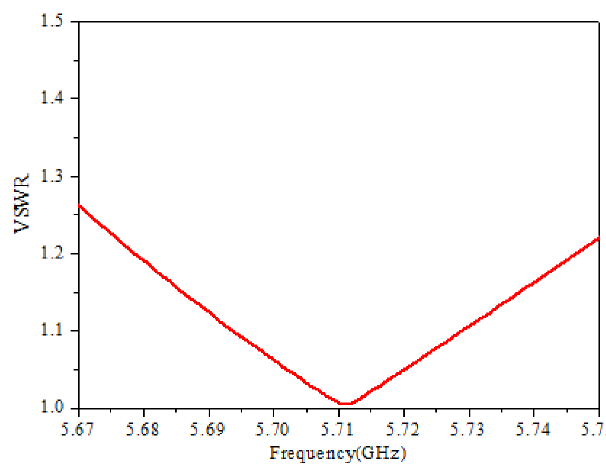

Figure 2. Simulated VSWR vs frequency.

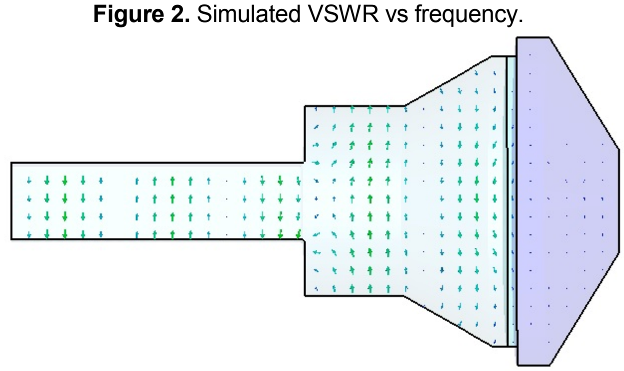

Figure 3. Electric field pattern of the C-band water load.

Fabrication and Test

In the high power microwave test system, the waveguide is in vacuum. The input flange adopts sealing structure with copper gaskets, the waveguides are made of oxygen-free copper or stainless steel plated with copper. The different metal parts are connected by welding. The flowing water is sealed with two O-rings. Figure 4 shows the section view of the C-band water load. With this water load, microwave power can be calculated by measuring the flow rate and temperature difference of the water.

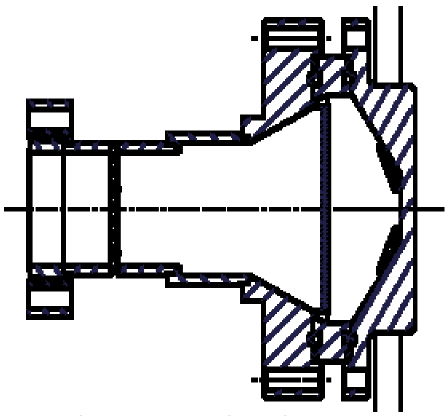

Figure 4. Section view of the C-band water load.

Firstly, a 99.5% alumina ceramic is welded to the oxygen-free copper rings, waveguides are welded together. Secondly, the copper ring is welded to the waveguide. Thirdly, waveguide, water jacket and flanges are mounted by screws. After the water load was assembled, we tested the water load with Vector Network Analyzed N5224A.

Because the power of the klystron to be tested has a power of 50 MW, we fabricated two water loads and used power divider to allocate microwave power to two loads. Test results of the two water load were identical. The VSWR of the water load was 1.07 with a frequency of 1300MHz. The frequency band with was 5659MHz to 5746MHz with a VSWR of less than 1.2.

As shown in Figure 5, in the C-band 50 MW klystron test circuit, a directional coupler, a vacuum-pumped waveguide, a power divider, and two water loads were sequentially connected. The VSWR of the whole test circuit is 1.13.

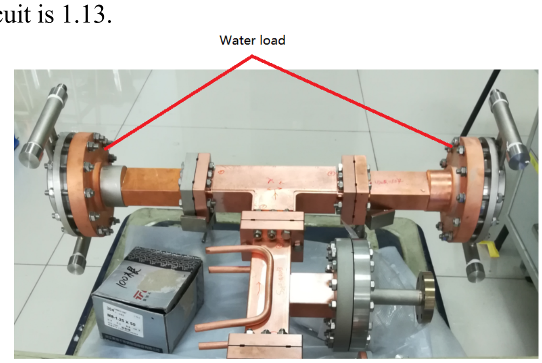

Figure 5. C band 50 MW klystron test circuit.

Conclusion

In the C-band 50 MW klystron test circuit, each water load needs to absorb 25 MW microwave peak power. The development of this water load provides technical support for testing high peak power klystron and lays a foundation for the development of other loads.

References

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