DEVELOPMENT OF A 50 KW, 350 MHZ PULSED POWER COUPLER FOR RFQ CONDITIONING

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Abstract

The RFQ cavity of 400 keV deuteron accelerator will need RF conditioning before being used for CW operation. A coaxial loop type coupler with disc type alumina window has been designed for conditioning purpose. The coupler is made using standard 1 5/8" coaxial lines. The discontinuity by alumina disc is matched by under cuts on inner conductor. This paper reports the coupler's RF design and fabrication details.

INTRODUCTION

A 400 keV deuteron accelerator using Radio Frequency Quadrupole (RFQ) is presently under development at BARC [1]. The RFQ cavity and coupler development experience will be useful in the 20 MeV, 30 mA Low Energy High Intensity Proton accelerator (LEHIPA) [2] which is presently under development at BARC. Though, the 20 MeV, 30 mA proton accelerator will use waveguide type iris couplers [3], successful development of coaxial couplers will be helpful in cavity testing stages. The RFQ cavity of 400 keV deuteron accelerator will be coupled to two RF sources of 50 kW each by two no. of coaxial loop couplers [4] . As 50 kW 350 MHz CW coaxial power couplers are under fabrication, a low average power (1 kW) but full peak power (50 kW) loop coupler has been designed for pulsed power testing of the cavity. These couplers will be separately tested for pulsed and CW operation on a RF test cavity [5]. The pulsed power processing of RFQ cavity will be beneficial during high power CW conditioning.

RF DESIGN OF THECOUPLER

As the coupler acts as an impedance matching device between the cavity and incoming line, the loop area is optimized by using CST Microwave Studio. The coupler with 5 mm thick alumina disc type window inside 1 5/8" coaxial line is simulated separately. As expected, the capacitive discontinuity introduced by high purity alumina disc (with dielectric constant of 9.8) produces undesirable reflections. Hence, an unique matching scheme has been incorporated to match this capacitive discontinuity.

Matching by under-cuts on inner conductors

The capacitive discontinuity of alumina disc with ε_r = 9.8 is matched by decreasing the diameter of inner conductor on both sides of alumina disc. The length and depth of under cuts is optimized using transient solver of CST Microwave Studio. The CST Simulation model is shown in Fig. 1. Without matching, the return loss obtained at 350 MHz is only -15 dB as shown in Fig.2 It is important to mention here, that this technique is much simpler to choke type window matching from fabrication point of view.

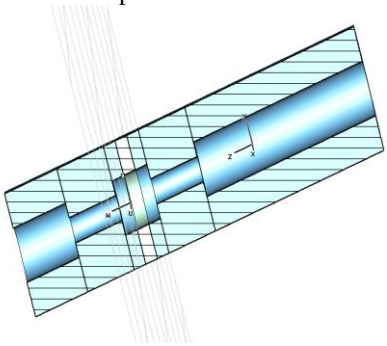

Fig.1 Simulation model of coaxial coupler with matched alumina disc with under cuts on alumina disc

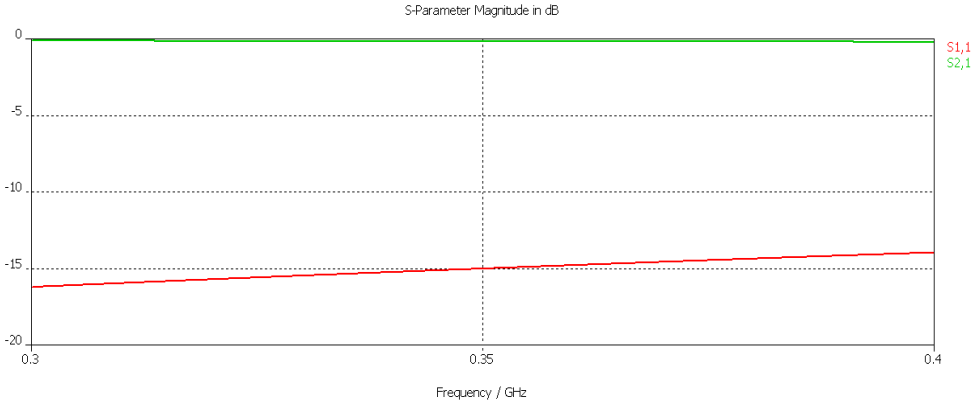

Fig. 2 Return loss and transmission characteristics of coupler with 5 mm alumina disc in 1 5/8" line

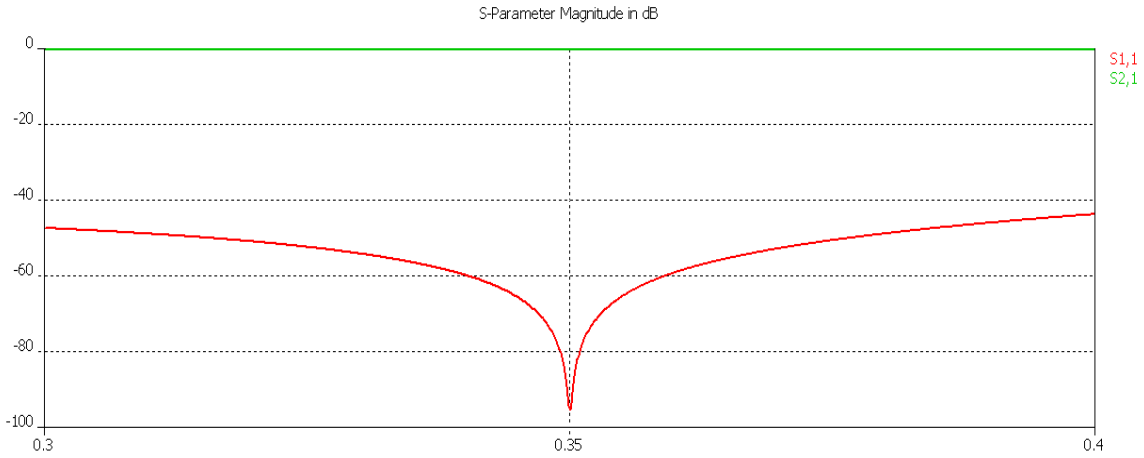

Fig. 3 Return loss and transmission characteristics of matched coupler with inner conductor under-cuts around 5 mm alumina disc in 1 5/8" line

The return loss and transmission characteristics for matched window are shown in Fig. 3. It can be seen that very good match is obtained at 350 MHz for a matched window.

FABRICATION ASPECTS OF COUPLER

The coaxial coupler's outer conductor was machined out of a thick ETP Cu rod. Whole assembly is divided into three parts for ease of fabrication. The brazing is carried out in hydrogen furnace at CEERI, Pilani as a part of MOU between BARC and CEERI for coupler development. The central conductor is machined in two parts and joined to high purity alumina discs in first brazing cycle. The alumina to ETP Cu inner and outer conductor's brazing joint has already been brazed at CEERI. The joint has been tested and vacuum leak rate of $1*10e^{-10}$ std. torr lit/sec has been obtained. The end flanges and loop will be joined in the next brazing cycle of furnace. The whole assembly should be delivered by CEERI after vacuum testing by mid of January 2011. The pre brazing assembly of coupler parts is shown in Fig. 4.

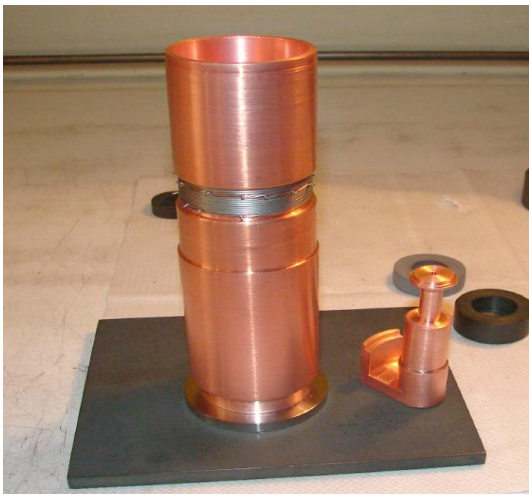

Fig. 4 Coupler parts before first cycle of brazing in hydrogen furnace

CONCLUSIONS

A simple matching scheme has been proposed for alumina window matching. The matching structure has been analyzed and optimized using CST Microwave studio. The scheme is simpler than choke type design. CEERI, Pilani has successfully joined the window part with acceptable vacuum leak rate. The successful testing of complete assembly with loop and end flanges will be crucial for high power coupler fabrication at CEERI under BARC-CEERI MOU.

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