Design of Input Coaxial Coupler

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Abstract: *There is an emerging need of very high power microwave devices. These sources have wide applications in radars, telecommunication, remote sensing, and also for numerous industrial, scientific, and medical applications including material technology, bio-medical diagnosis, and chemical spectroscopy. High power microwave devices are vacuum electronic devices which are widely used as amplifiers and oscillators for military radars and satellite communication systems for industrial heating, drying and baking for medical diagnosis & treatment. Waveguide adapters are frequently used to provide transmission between microwave devices & a coaxial component such as a attenuator, switch or coupler. They are commonly used in satellite & terrestrial communication equipment. A proper emphasis has given to minimise the insertion loss and improve the return loss of the adapter. A model has been developed by using Computer Simulation Technology Microwave Studio(CST MWS) The paper presents the results of modelling & simulation of Waveguide adapter in CST MWS system.*

Keywords: Microwave, Waveguide, Attenuator

I. INTRODUCTION

A coaxial coupler has two conductors that is inner conductor and outer conductor. Inner conductor is made of solid copper depending on degree of flexibility. Coaxial couplers are widely used in helix TWT for efficient coupling of microwave power in and out of the tube because of its inherent broadband characteristics.

Coaxial coupler consists of

- Window assembly
- RF transformer
- Load impedance(SWS)

The window assembly consists of a metallic sleeve housing a ceramic disc with a central hole for the inner conductor. The window assembly is connected to a standard 50 ohm connector at the input while the transformer is terminated on the helix SWS. Coaxial window is designed for transmitting the output power more than 300 Watts with minimum absorption and reflection over wide frequency band.

The RF transformer assembly is a multi-section coaxial transmission line. RF transformer design is initiated by taking the length of the RF transformer close to quarter wavelength between window ceramic and barrel inner diameter at the mid frequency. Two steps in the diameter of the central conductor are introduced and their length adjusted to get the best possible VSWR at mid frequency. The performance is evaluated at end frequencies and the dimensions are adjusted for optimum VSWR over the desired frequency band. When the RF transformer is terminated with the actual helix SWS, return loss better than -20 dB over the operating frequency band of 10.9 to 11.7 GHz is achieved.

The helix SWS is supported inside the metallic barrel assembly using three proper sized and shaped dielectric rods at 120 degree. The characteristic impedance of the helix SWS acts as the load impedance for the input and output coupler.

1.1 Input Coaxial Coupler

The input coaxial coupler consists of RF window assembly and an impedance RF transformer assembly. The window assembly consists of a metallic sleeve housing a ceramic disc with a central hole for the inner conductor. The RF transformer assembly is a multi-section coaxial transmission line. The window assembly is connected to a SMA connector at the input while the transformer is terminated on the helix SWS through the laser welding the inner conductor of the coaxial line with the helix SWS.

When the initial parameters of the waveguide set, CST MWS has been used to optimise the design. The parameters of the developed model are shown in Table 1.

Table 1. Modeling parameters for the input coaxial coupler-

Sections	Outer radius (mm)	Inner radius (mm)	Length (mm)	Dielectric constant	Characteristic impedance(ohm)
1	2.55	0.255	1.55	9.3	45.3
2	2.55	0.255	0.15	1	138.2
3	1.17	0.45	4.35	1	57.3
4	1.17	0.30	6.8	1	81.7

Designing model from the CST MWS is as shown in fig1.1.Simulated insertion loss of the frequency ranges from 10.9-11.7GHZ as shown in fig.1.1
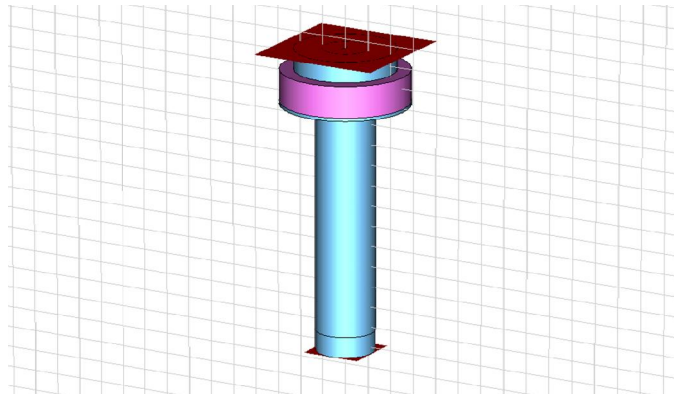
Fig.1.1 Design of Input coaxial coupler using CST

II. SOFTWARE IMPLEMENTATION

CST MW Studio – Computer Simulation Technology Microwave Studio

CST MICROWAVE STUDIO (CST MWS) is a specialist tool for the 3D EM simulation of high frequency components. It is fully featured software for electromagnetic analysis and design in the high frequency range. It simplifies the process of inputting the structure by providing a powerful solid modelling front end.

CST MWS is the first commercial high frequency EM simulation code to offer the advantages of both Cartesian and tetrahedral meshing in one 3D EM simulator. Customers are able to choose the method and the mesh best suited to a particular structure. The simulator itself features the new Perfect Boundary Approximation (PBA method), which increase the accuracy of the simulation by an order of magnitude in comparison to conventional simulators. Since no method works equally well in all applications domains, the software contains four different simulation techniques (transient solver, frequency domain solver, Eigen mode solver, modal analysis solver), which best fit, their particular applications.

A) Simulation Implementation *Set Units*

Select set units option from the top and set the units as required. Smaller the units lesser will be the time taken to calculate its result. Because for greater units there will be more mesh nodes and more will be the time taken**.**

Set Background Material

Select set background material option and select the material as background or atmosphere. Two types of materials are there.

1) PEC (Perfect Electric Conductor) 2) Normal

Normal as background material, we fill its properties like its relative permittivity and relative permeability. We can fill dimensions for background material. Then it creates a box itself of given dimensions otherwise by default it creates box of dimension same as the design.

Set Frequency Range: set the option of frequency range from the top and write the frequency range required. The frequency has the same units selected in the very first option**.**

Set Boundary Conditions: set boundary conditions of the design.

Waveguide Ports: apply ports for excitation. Surface dimensions for the ports can also be given. Other facilities are also there like multipin port, polarization angle, distance to reference plane and number of modes.

Discrete Ports: there is also an option for discrete ports. These types of ports can be applied to a line also. Fill the coordinates of line then we get a discrete port.

Field Monitors: field monitors are used to show results for the given particular frequency and in particular field (electric or Magnetic, power, current etc). Now the model is ready for calculating results. After applying these excitation modes we select the solver in which we to calculate our simulated results- transient domain solver, frequency domain solver, Eigen mode solver.
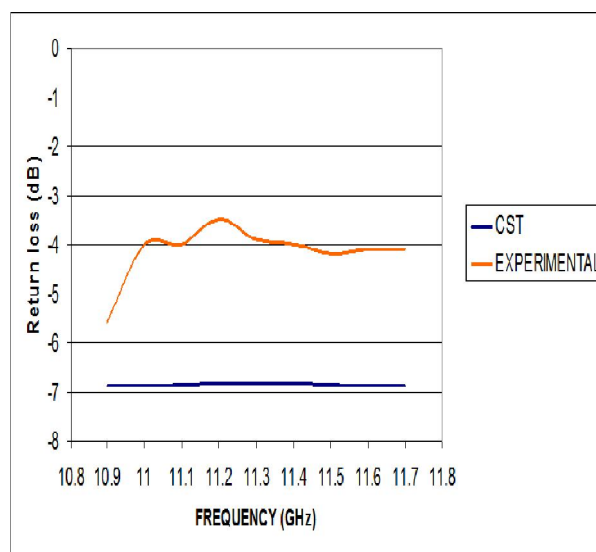
III. SIMULATION RESULT

Fig.3.1 Simulation Result of the model By varying the inner radius of different sections the return loss graph is improved up to 12 dB.

IV. CONCLUSION

From the above graph it represents that the return loss is between -5.5 to -4 dB. Also by varying the outer and inner radius the return loss graph is improved.Additionally,from the designing model of adapter in CST MWS the above simulation result of return loss has been obtained at the frequency ranges between 10.9-11.7 GHz. The future advancement of this device to get maximum saturated output power and efficiency.

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