# 346:Design of Coaxial Transformer for Ku-Band Short Length TWT

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**Abstract:** *To extract rf power from a traveling wave tube (TWT), proper impedance transformation of the helix slow-wave structure (SWS) has to be done through coaxial couplers to a standard 50 ohm connector. Mismatch of impedance gives poor return loss (RL) behavior and leads to reflection of rf power causing oscillation and destruction of the TWT. In this paper authors have presented design of a co-axial coupler for high power space TWT using CST Microwave Studio and ANSOFT HFSS.*

**Keywords:** Helix TWT; Center conductor; Lossy ceramic

## Introduction

Helix traveling wave tube is a vacuum microwave device that is used as high power microwave amplifier in communication satellites [1].The TWT is based on the beam wave interaction between the electromagnetic wave and the electron beam. The transformer provides the path for the RF coming from the outer environment to the interaction structure. The RF transformer is mainly used to Propagation of generated RF power from the helical structure to outer wave guide. In the Ku-band short TWT The amount of RF power (140 Watt) is high enough to degrade the transformer quality and even can damage the transformer. Therefore molybdenum is used as center conductor. Lossy ceramics are used at the end of transformer to prevent the vacuum of tube. The center conductor is placed between RF window and helix structure. The transformer can be decreased by replacing the quarter wave section by two sections with different wave impedances. The propagation of the amplified RF power and its absorption in the output wave guide depends on the transformer geometry and dielectric properties of the window material as well as the thickness of window disc.

## Initial Design

Initially, the design of the transformer was carried out for matching the SWS at its characteristic impedance obtained from the equivalent circuit analysis. A certain value of the helix slow wave structure is required for the efficient interaction. Various slow wave structure parameters of Ku-band short length TWT are shown in Table: 1. Proper impedance match of the input / output transformers to the slow-wave structure (SWS) of a helix travelling- wave tube (TWT) has always been a challenge in the TWT design. For this the tip loss profile at sever ends for the input and the output section of the helix slow wave

**Table: 1** required parameter of slow wave structure.

| | |
|---|---|
| Barrel inner radius | 1.70 mm |
| Helix Tape thickness | 0.15 mm |
| Helix Tape width | 0.30 mm |
| Helix inner radius | 0.55 mm |
| Helix Pitch | 0.6 mm |
| APBN Rod thickness | 0.60 mm |

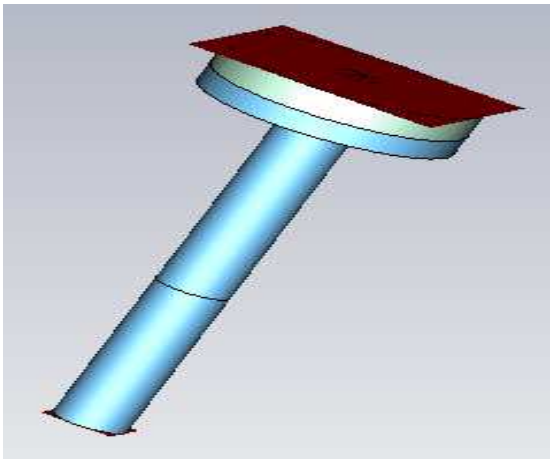

**Figure1**. CST model of transformer without SWS.

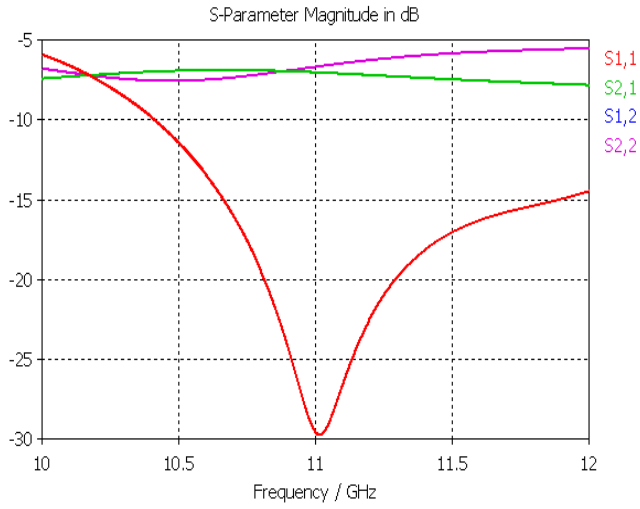


**Figure2.** S parameters of the transformer without SWS.

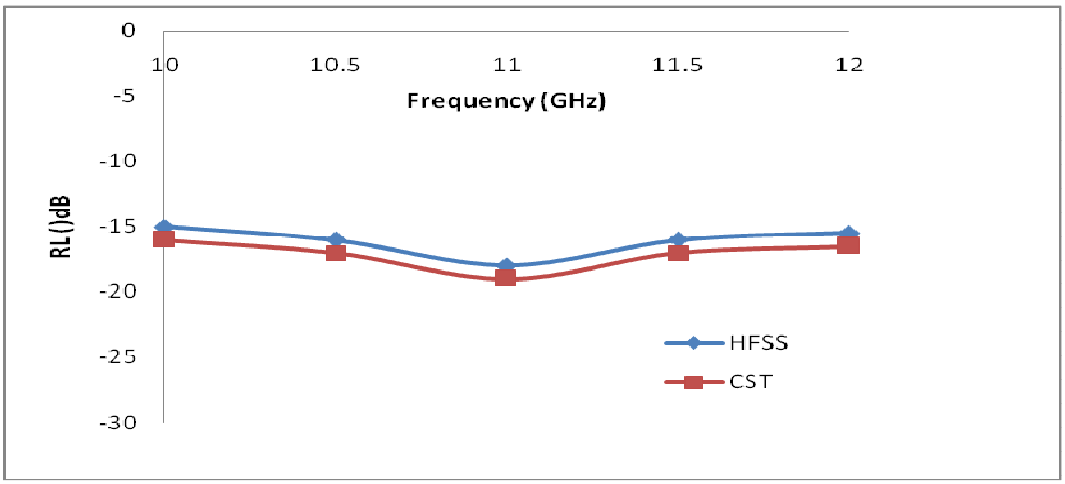


**Figure4.** S parameters of the transformer with SWS

structure has been designed. Helix TWT may oscillate in the presence of reflections from the terminations of the input and output section. In the design of the transformer for Ku-band 140 Watt helix traveling wave tube, 12 turns of helix taken for time saving. The transformer has placed at top of first and last turn on the axial scale. Simulated dimensions of transformer are given in table: 2. Severs are essential parts of modern multisection traveling-wave tubes (TWTs) and serve the purpose of stabilizing the device against oscillations.

## Simulation and Discussion

The commercially available 3-D simulation codes CST-Microwave Studio (CST-MS) and Ansoft HFSS have been used for the analysis of RF reflection and transmission by the designed transformer [2, 3]. The thickness of the lossy ceramic disc has been optimized on the basis of minimum absorption.

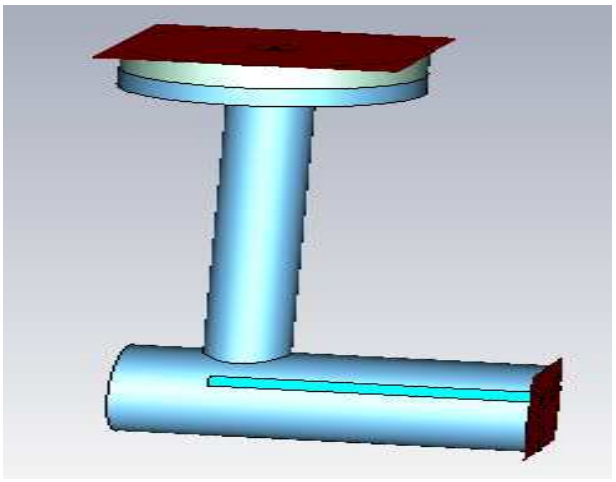

**Figure3.** CST Model of transformer with SWS

**Table: 2** simulated parameters of coaxial transformer

| Section | Inner diameter (mm) | Outer diameter (mm) | Length (mm) | Dielectric constant ($\varepsilon_r$) |
|---|---|---|---|---|
| 1st | 1.02 | 6.2 | 0.9 | 9.4 |
| 2nd | 1.02 | 6.2 | 0.7 | 1.0 |
| 3rd | 1.02 | 1.8 | 5.6 | 1.0 |
| 4th | 0.62 | 1.8 | 5.0 | 1.0 |

## Conclusion

The design of the coaxial transformer for the Ku band (10.9– 11.7 GHz), 140Watt short length TWT has been presented. A lossy ceramic material of the high relative permittivity and the high loss tangent has been analyzed for the maximum transmission of the RF power. For the initial design of the transformer, CST-MS and HFSS code has been used. On the basis of slow wave structure simulation, length, radius of the centre conductor has been decided. In the designed structure of coaxial transformer for the Ku band (10.9– 11.7 GHz), 140Watt short length TWT, the return loss is sufficiently low.


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## References


1. A. S. Gilmour Jr., *Principles of Traveling Wave Tube. Artech House,* Boston, London, 1994.
2. Ansoft HFSS, 3-DElectromagnetic Simulation Software. Ansoft corp., Pittsburgh, PA.
3. CST-Microwave Studio, User manual:2006 version,Darmstadt,Germany