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STUDY ON WAVEGUIDE SLOTS USING HFSS

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ABSTRACT
In this paper we present the design of WR975 waveguide using HFSS simulation software. The slot present in the wave guide will cause the waveguide to radiate and act as an antenna. Another slot is also kept to check the results with a single slot and compared.

INTRODUCTION
Waveguide is a structure that guides waves, such as electromagnetic waves or sound waves. They enable a signal to propagate with minimal loss of energy by restricting expansion to one dimension or two. This is a similar effect to waves of water constrained within a canal, or why guns have barrels that restrict hot gas expansion to maximize energy transfer to their bullets. Without the physical constraint of a waveguide, signals will typically be radiated and decreased according to the inverse square law as they expand into three dimensional space.

The matrix elements S11,S12,S21,S22 are referred to as the scattering parameters or the S-parameters. The parameters S11, S22 have the meaning of reflection coefficients, and S21, S12, the meaning of transmission coefficients. In our paper , we have considered S11 for understanding radiation characteristics[1].

Reflection coefficient: Reflection coefficient is a parameter that describes how much of an electromagnetic wave is reflected by an impedance discontinuity in the transmission medium. It is equal to the ratio of the amplitude of the reflected wave to the incident wave, with each expressed as phasors.

The tool that we have used for showing our results is HFSS. HFSS stands for High Frequency Structure Simulator. It offers multiple state of the art high frequency electromagnetic solvers.

DESIGN CONSIDERATIONS
We have considered a standard WR-975 waveguide, of length, $L = 3\lambda_g$, where $\lambda_g = 43.74273$ cm is the waveguide wavelength at 915 MHz, width, W = 24.765 cm, and height, H=W/2=12.3825 cm.

A rounded-end slot with an initial length of $\lambda/2$ is considered first. The slot length will be optimized to achieve resonance, and the width of the slot is fixed at $\lambda/20$. . The slot present in the wave guide will cause the waveguide to radiate and act as an antenna [2].

Design steps:
1. Create a wave guide with dimensions $L = 3\lambda_g$, H=12.3825cm, W=24.675cm
2. Set the offset value from 10 to 15 cm.
3. Create a slot having length=16.39cm using cylinder and detach the faces which are not necessary.
4. Assign boundaries for the slot/s PerfectH.
5. Assign the boundaries of the waveguide as PerfectE
6. Assign right face and left face of the waveguide as waveport . i.e excitation is given to those faces.

7. Add the solution setup and sweep as required for our case it is from 900MHz to 1050 MHz.
8. Create a radiation box with flexible dimension to fit the waveguide.
9. Go for validation check and then simulate it
10. Repeat the steps for wave guide with two slots.
11. Obtain the plots like rectangular plots
12. Compare the plots of single slot with two slots on wave guide.

Figure:

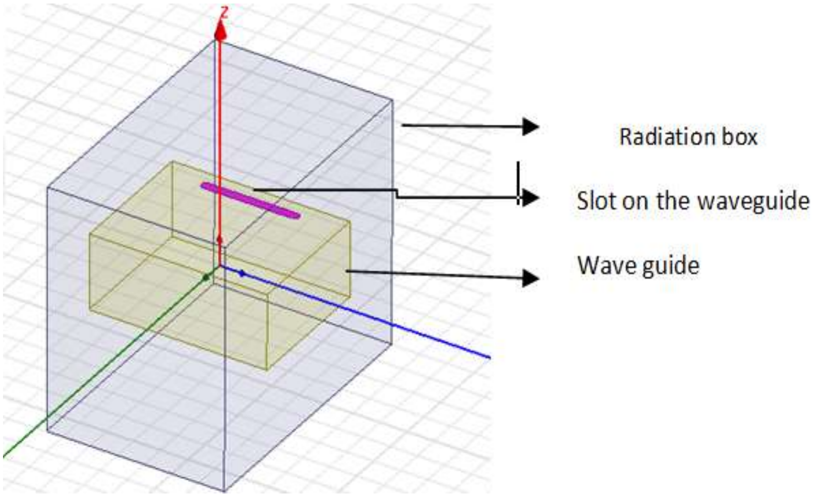

Fig 1.0 Diagram showing different parts of the design.

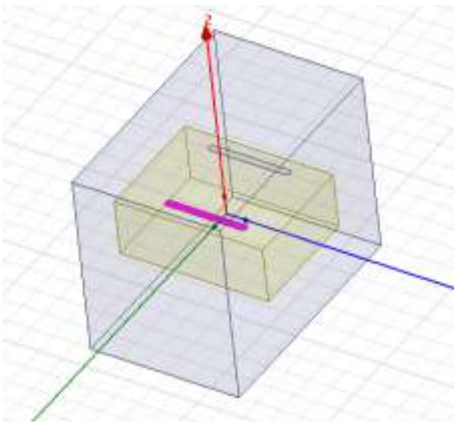

Fig 1.1 a)

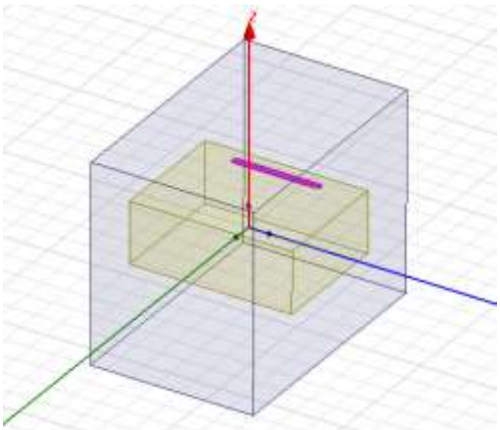

fig 1.1 b)

Models developed using HFSS a) wave guide with one slot b) wave guide with two slots

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RESULTS AND DISCUSSION

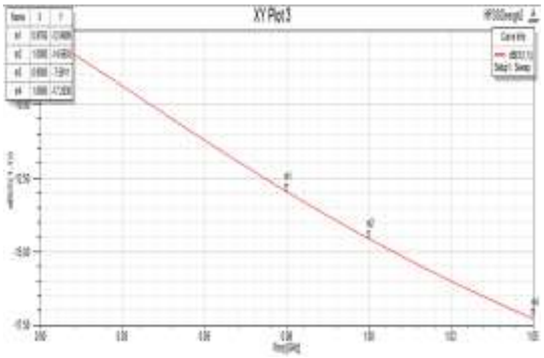
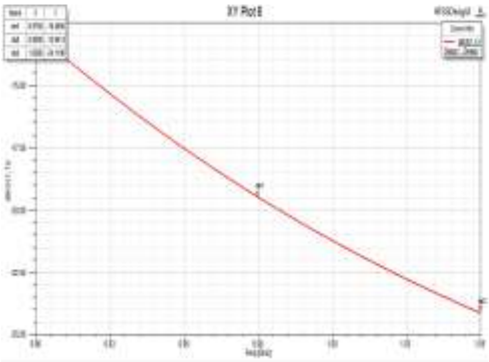

Fig 1.2a) *Fig 1.2 b)*

Plot of S11 versus frequency Fig 1.2a) for Two slots Fig 1.3a) for One slot

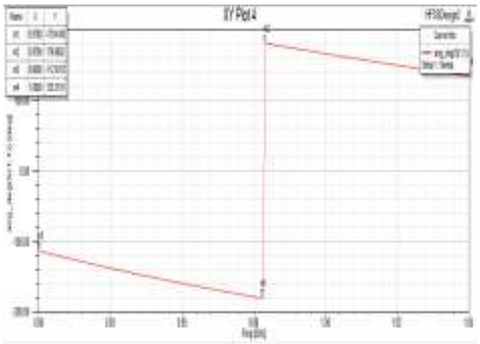
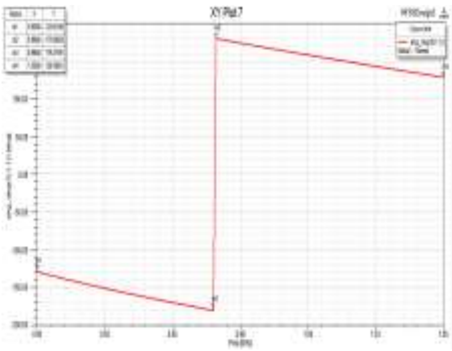

Fig 1.3a) *Fig 1.3b)*

Plot of S11 in degree versus frequency Fig 1.3 a) for Two slots b) for One slot

If we observe plots 1.2a) and 1.3a) we notice that resonance occurs at 965.5MHz. This is for two slots which were kept longitudinally on the waveguide as shown in fig 1.1a). If we observe plots 1.2b) and 1.3b) we notice that resonance occurs at 978.5 MHz. This is for one slots which is kept longitudinally on the waveguide as shown in fig 1.1b). We observe a shift of 13MHz shift due to the presence of additional slot.
Whereas the reflection coefficient S11 is -12.5dB for two slots whereas for one slot it is -19.0db.

Table 9. Comparison table for two models

	Two slot	One slots
Resonance frequency	965.5 MHz	978.5 Mhz
S11	-12.5dB	-19.0dB

CONCLUSION

In this paper, we have presented a standard wave guide WR-975. We have described its operation by using HFSS.

We have showed that the waveguide will radiate with a minimum reflected power. Reflection coefficient graph will prove this. Comparison between the two slots and a single slot is clearly shown.

REFERENCES

1. Edward C Jordan and Keith G Balmain, Electromagnetic waves and Radiating Systems, 2nd Edition , PHI 2003
2. Constantine A Balanis, Antenna Theory: Analysis and Design, Harper and Row Publishers , 2002