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Students]
[-BY S.SRINATH]



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Design of 3rd Order Coupled Line Bandpass Filter for Wireless Application using Agilent ADS

S.Srinath

B.Tech Alumnus, School of Electronics Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu, India.

ABSTRACT: Design of a parallel-coupled microstrip bandpass filter is presented in this paper. The aim of this paper is to present the design technique, parameter analysis, real prototype fabrication and measurement results at a simulation frequency of 5.85 GHz. Half wavelength long resonators and admittance inverters are used to design the filter. The filter is simulated using **Agilent ADS (Advanced Design System) 2011**.

KEYWORDS: Bandpass filter; Microstrip; 5.85 GHz; Parallel Coupled Line; Microwave Engineering; Agilent ADS simulator.

I. INTRODUCTION

Filters are an essential part of telecommunications and radar systems. Of its low-cost fabrication, easy integration and simple designing procedure, the parallel coupled-line/edge-coupled filters are widely used in microwave microstrip circuits with a required bandwidth up to 20 % of central frequency.

The parallel coupled transmission lines can be used to construct many types of filters. Fabrication of multi-section bandpass or bandstop coupled line filters is particularly easy in microstrip or stripline form for bandwidths less than about 20%. Wider bandwidth filters generally require very tightly coupled lines, which are difficult to fabricate. A two-port network can be formed from a coupled line section by terminating two of the four ports with either open or short circuits, or by connecting two ends.

A bandpass filter only passes the frequencies within a certain desired band and attenuates other signals whose frequencies are either below a lower cutoff frequency or above an upper cut-off frequency. The range of frequencies that a bandpass filter lets to pass through is referred to as passband. A typical bandpass filter can be obtained by combining a low-pass filter and a high-pass filter or applying conventional low-pass to bandpass transformation. The architecture demonstrated here is a coupled line type filter, since this is among the most practical and common filter types which can meet the stated specifications.

The filter response will be based on the Chebyshev transfer function. Chebyshev type filters are popular for their high selectivity, i.e., they have a relatively fast signal cut off between pass and stop band.

II. RELATED WORK

This paper presents the design of a parallel-coupled microstrip bandpass. The design is based on the use of half wavelength resonators and admittance inverters. The center frequency of 5.85 GHz is selected, the bandwidth (BW) is about 200 MHz, the minimum attenuation amounts to -20 dB and the pass-band ripple is obtained equal to 0.5 dB. The design technique, parameter analysis, real prototype fabrication and measurement results of a 3rd order coupled line bandpass filter at a simulation frequency of 5.85 GHz is presented in this paper.

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III. THEORY

A general layout of a parallel coupled microstrip bandpass is shown in figure 1. The filter structure consists of open-circuited coupled microstrip lines. These coupled lines are quarter wavelength, ($\lambda/4$) long and are equivalent to shunt resonant circuits. The coupling gaps correspond to the admittance inverters in the low-pass prototype circuit. Even- and odd- mode characteristic impedances of parallel-coupled half-wave resonators are computed using admittance inverters. These even- and odd- mode impedances are then used to compute physical dimensions of the filter. Now consider a bandpass filter composed of a cascade of $N + 1$ coupled line sections, as shown in Figure 1. The sections are numbered from left to right, with the load on the right, but the filter can be reversed without affecting the response. Since each coupled line section has an equivalent circuit of the form, the equivalent circuit of the cascade is as shown in figure 2.

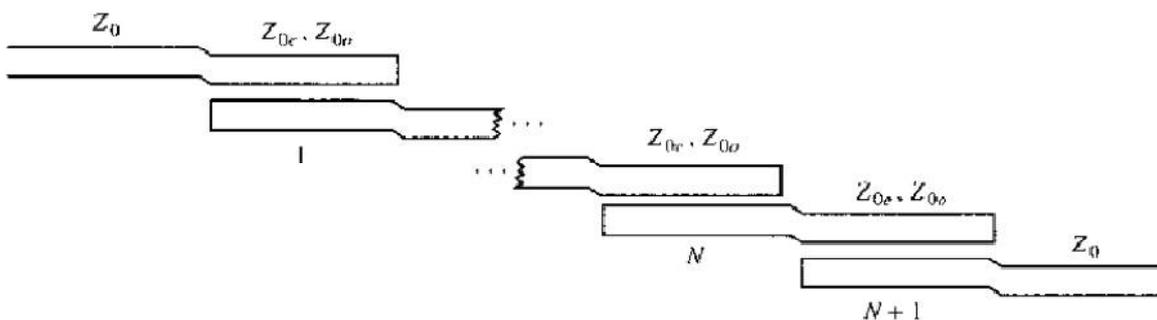


Figure 1. : Layout of an (N + 1)-section coupled line bandpass filter.

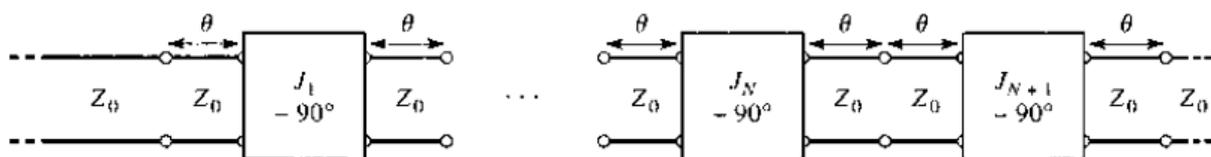


Figure 2. : Using the equivalent circuit of Figure 1. for each coupled line section.

IV. IMMITTANCE INVERTER

Immittance inverters play a very important role in filter design. They are used to transform a filter circuit into an equivalent form that can be easily implemented using various microwave structures. Immittance inverters are either impedance or admittance inverters. Making use of the properties of immittance inverters, bandpass filters may be realized by series (L-C) resonant circuits separated by impedance inverters (K) or shunt (L-C) parallel resonant circuits separated by admittance inverters (J). To design a bandpass filter, first of all a low-pass prototype circuit is modified to include immittance inverters. These low pass structures are then converted to bandpass circuits by applying conventional low-pass to bandpass transformation.

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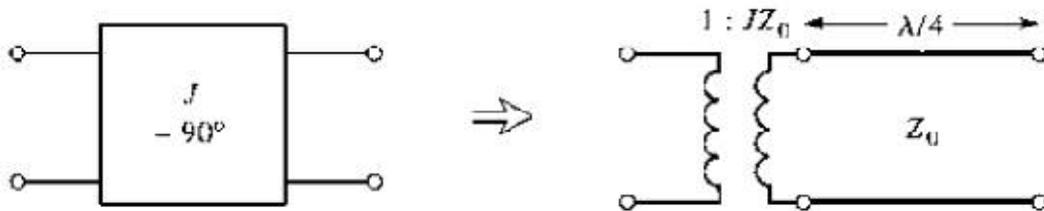


Figure 3. : Equivalent circuit of the admittance inverters.

V. SIMULATION MODELLING AND DISCUSSION

The order of the filter was calculated assuming an equi-ripple (Chebyshev type1) response with an attenuation of 20dB at the center frequency of 5.85 Ghz and the pass band ripple amplitude (G) of 0.5dB. Hence the upper and lower cutoff frequencies of the passband are 6.5 GHz and 5.3 GHz respectively. Based on the filter application in system design, the fractional bandwidth (FBW) is calculated using equation below:

$$FBW = \{(\omega_2 - \omega_1) / \omega_0\}$$

where, ω_1 and ω_2 denote the edges of the passband frequency.

$$FBW = (6.5\text{Ghz} - 5.3\text{Ghz}) / 5.85\text{Ghz} = 205\text{MHz}$$

Using the standard Chebyshev model:

$$n = \cosh^{-1} \frac{\sqrt{\left(10^{\frac{L}{10}} - 1\right) \left(10^{\frac{G}{10}} - 1\right)}}{\cosh^{-1} \left(\frac{f}{f_c}\right)}$$

This gives us $n=3$. Now, we get the low pass prototype values from the standard Chebyshev table:

$g_0 = 1$
$g_2 = 1.5963$
$g_2 = 1.0967$
$g_3 = 1.5963$
$g_4 = 1$

Now, we use the following design equations to get the inverter constants for a coupled line filter with $N+ 1$ sections:

$$Z_0 J_1 = \frac{\sqrt{(\pi \Delta)}}{\sqrt{(2g_1)}}$$

$$Z_0 J_n = \frac{\pi \Delta}{2\sqrt{(g_{n-1} g_n)}} \quad ; n = 2, 3, 4, \dots, N$$

$$Z_0 J_{n+1} = \sqrt{\left(\frac{\pi \Delta}{2g_n g_{n+1}}\right)}$$

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Now, the even and odd mode impedances can be calculated as follows:

$$Z_{oe} = Z_0[1 + JZ_0 + (JZ_0)^2]$$

$$Z_{oo} = Z_0[1 + JZ_0 + (JZ_0)^2]$$

The results of these calculations are tabulated below:

N	Admittance inverters	Even mode impedance $Z_{oe}(\Omega)$	Even mode impedance $Z_{oo}(\Omega)$
1	0.1805	60.655	42.605
2	0.0394	52.045	48.105
3	0.0394	52.045	48.105
4	0.1805	60.055	42.605

Using an Agilent ADS coupled line calculator, the width, length and line spacing for each coupled line was calculated. The width of the coupled lines 1 & 4 was calculated to be 1.0858mm, the length was calculated to be 7.702mm and the gap was calculated to be 0.3083mm.

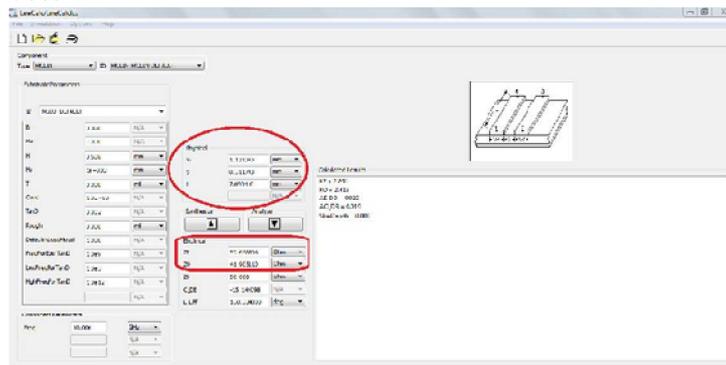


Figure 4. : Agilent Line Calc for coupled lines 1 & 4

Similarly, we use Agilent ADS coupled line calculator to calculate the width, length and line spacing for coupled lines 2 & 3. The width of the coupled lines 2 & 3 was calculated to be 1.1758mm, the length was calculated to be 7.6372mm and the gap was calculated to be 1.4395mm.

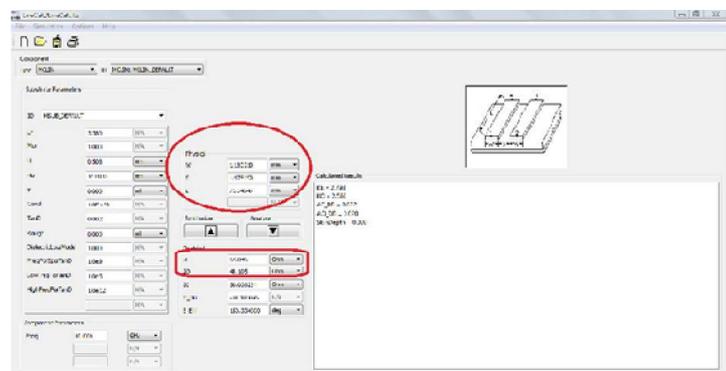


Figure 5. : Agilent Line Calc for coupled lines 2 & 3

The summarized results calculated from Agilent Line Calc are tabulated below. This includes 50Ω Line, coupled lines 1, 2, 3 & 4.

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Here, the parameter S_{11} (dB) represents the insertion loss at port 1 and the parameter S_{21} (dB) represents the insertion loss from port 1 to port 2.

VII. CONCLUSION

On a substrate with a dielectric constant of 3.38, the centerfrequency of 5.85 GHz was selected, the bandwidth is 200MHz, the minimum attenuation amounts to -20 dB and the pass-band ripple is obtained equal to 0.5 dB. Thus the design technique, parameter analysis, real prototype fabrication and measurement results at a simulation frequency of 5.85 GHz of a 3rd order coupled line bandpass filter was presented in this paper.

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BIOGRAPHY



S.Srinath passed 10th C.B.S.E. Board with a mark of 475/500(95%) in 2009 and 12th C.B.S.E. Board from D.A.V. Boys Senior Secondary School, Gopalpuram, Chennai, India with a mark of 458/500(91.6%) in 2011 .He graduated with B.Tech, ECE, from School of Electronics Engineering in Vellore Institute of Technology, Vellore, India with a C.G.P.A. of 8.39/10 in May 2015.

Design and Real Prototype Fabrication Of a Free Space Optical Transmitter and Receiver

S.Srinath

UG Student, ECE, Vellore Institute of Technology, Vellore, India

Abstract: We are communicating with each others for every purpose. Different modes of communication are used. Free space optics is one of the mode of communication. Free space optics is widely used by satellites for transmitting with each other. Design and real prototype fabrication of a low cost portable free space optical transmitter and receiver is presented in this paper. Using this prototype wireless communication is possible. Light from a laser torch is used as the carrier in the circuit. The laser torch can transmit light up to a distance of about 500 meters. The transmitter circuit comprises of condenser microphone transistor amplifier BC548. The gain of the op-amp can be controlled with the help of 1-mega-ohm potmeter. The transmitter uses 9V power supply. The receiver circuit uses an npn phototransistor as the light sensor that is followed by a two-stage transistor preamplifier and LM386-based audio Power amplifier. This paper deals with the designing of a very low cost free space optical system which is perfect for information transmission of general conversation, using an ordinary available Laser torch of cost. The circuit is designed using National Instrumentations Multisim11.0 (**N.I. Multisim 11.0**) and National Instrumentations UltiBoard11.0 (**N.I. UltiBoard 11.0**).

Keywords: Battery driven design, Free space optics, Laser torch, Low cost design, N.I. Multisim and N.I. UltiBoard Simulator, Voice or data transmission.

I. INTRODUCTION

This paper is based on the concept of Laser (Light Amplification by Stimulated Emission of Radiation) for transmitting analog as well as digital signals. As laser is stimulated radiation, problem of interference occurs in electromagnetic wave is eliminated, it can be a good substitution of present day communication systems and high deal of secrecy is available. Use of laser in communication systems is the future because of the advantages of the full channel speeds, no communication licenses required at present, compatibility with copper or fiber interfaces and no bridge or router requirements. Also it cannot be detected with use of spectrum analyzers and RF meters and hence can be used for diverse applications including financial, medical and military. Lasers can also transmit through glass. Laser transmitter and receiver units ensure easy, straightforward systems alignment and long-term stable, service free operation, especially in inaccessible environments. Optical wireless systems offer ideal, economical alternative to expensive leased lines for buildings. The laser can be commissioned in satellites for communication, as laser radar requires small aperture as compared to microwave radar. For voice transmission amplitude modulation of laser pulse was used to transmit the voice signal. Condenser microphone converts the voice into electric pulse which was then amplified and transmitted through laser. Photo detector at receiver detects the laser light and voice was output through loud speaker.

II. RELATED WORK

This paper presents the design and real prototype fabrication of a free space optical system. The circuits are simulated in N.I. Multisim 11.0 and checked for validity and routing for the P.C.B. design is done with N.I. UltiBoard 11.0. The given design is thus checked and

routed as per 'INDUSTRY STANDARDS' and the real prototype can thus be etched out and a P.C.B. can be made on which components can be easily soldered. This paper mainly focuses on checking the validity of my design and performing a routing for my design for making a P.C.B.

III. OBJECTIVES OF THE DESIGN

This paper aims to provide simple and cheap wireless communication design and real prototype fabrication for larger data rate with less distortion and to reduce the complexity for communication in the places where optical fiber or any wired communication is very difficult and expensive. The design is so easy, inexpensive and makeable with the available equipments that the technical as well as non technical person can construct it by themselves for their personal use.

A. Block Diagram and Algorithm used for the Design

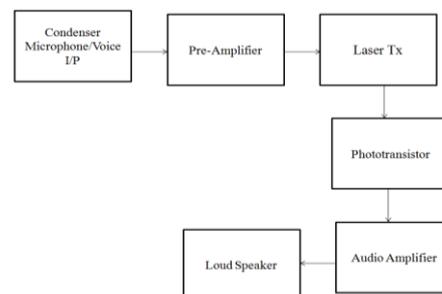
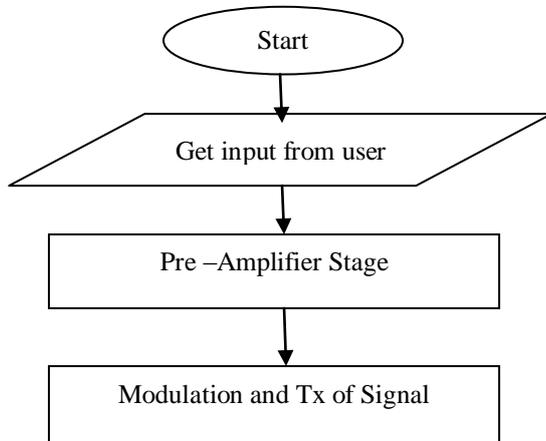


Fig. 1 Block Diagram for Voice and Data Transmission

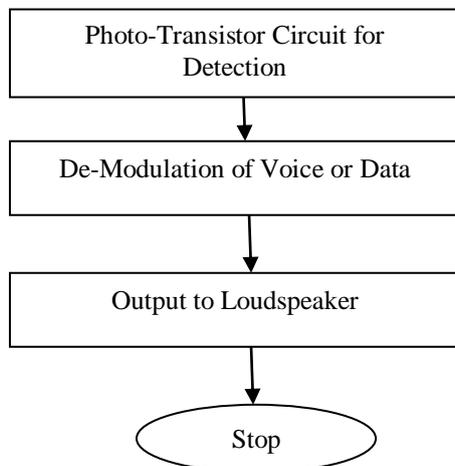
The algorithm is as follows. The input voice is taken through condenser microphone or a plug-in is taken as the input. The voice signal is amplified through the

preamplifier phase. Then, the signal is transmitted through laser light. The phototransistor at receiving side converts the signal into electrical signal. The electrical signal is passed through two transistor amplifier phases. Then LM386 audio amplifier amplifies the signal and drive speaker to generate voice output.

Flow Chart for Transmitter Circuit :



Flow Chart for Receiver Circuit :



IV. EQUIPMENTS REQUIRED

TABLE I
EQUIPMENTS REQUIRED

Resistors All of (1/4)W, 5% unless otherwise stated	Capacitors	Others
10R (brown, black, black) 1 Num	100 uF electrolytic 1Num	LM 358 IC 2Nos
100R (brown, black, brown) 2 Num.	10 uF electrolytic 3Nos.	LM 386 IC 1Num.
1K (brown, black, red) 1Num	100 nF monoblock (104) 4 Nos.	78L05 regulator 1Num

10K (brown, black, orange) 1Num	10 nF mylar (103) 2 Nos.	BC547 transistor 1 Num.
22K (red, red, orange) 2 Nos.	47nF box poly 1 Num	IF-D93 detector (red dot on black case) 1Num
100K (brown, black, yellow) 4Nos	-	IF-E96 emitter (pink dot on blue case) 1Num
220K (red, red, yellow) 1 Num.	-	Electret Microphone 1Num
680K (blue, grey, yellow) 1Num.	-	Speaker 8 ohm, 1W 1Num
1M (brown, black, green) 1Num.	-	8 pin DIL IC socket 3 Nos.
100K Koa trimpot (104) 1Num.	-	2 pole terminal block 3Nos.
-	-	9V battery snap 2Nos.

V. WORKING OF CIRCUIT DIAGRAM OF TRANSMITTER

The electret microphone converts sound waves to an electrical signal in the Tx circuit. R1 provides DC bias for the microphone and should be removed if you wish to connect any other input instead. This signal is coupled via C2 and amplified by two LM358 op amps, and converted to an optical signal by the LED emitter, driven from transistor Q1. R3 and R6 set the gain of IC1A to 1+R3/R6, or 221. Since IC1A is direct coupled, R4/R2 determine the DC input and thus the DC output level. IC1B is also direct coupled and provides both the DC base current for Q1 and the AC modulation current. R7 determines the DC bias current for Q1. The modulated collector current drives the LED emitter.

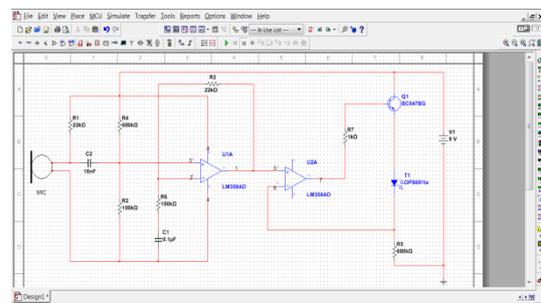


Fig. 2 Transmitter schematic in N.I. Multisim 11.0

VI. REAL PROTOTYPE FABRICATION OF TRANSMITTER

After checking the validity of the circuit in N.I. Multisim11.0, now convert the circuit to UltiBoard 11.0. To do this check if all the components are blue in colour(i.e. they have a foot-print) and select 'Transfer To UltiBoard 11.0' button.

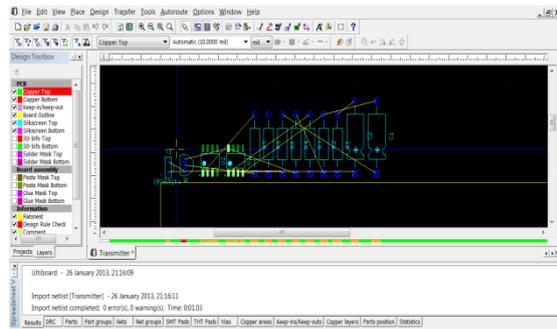


Fig. 3 Basic View of the Converted Schematic in N.I. UltiBoard 11.0

Now, align the components on the workspace and perform 'Routing'.

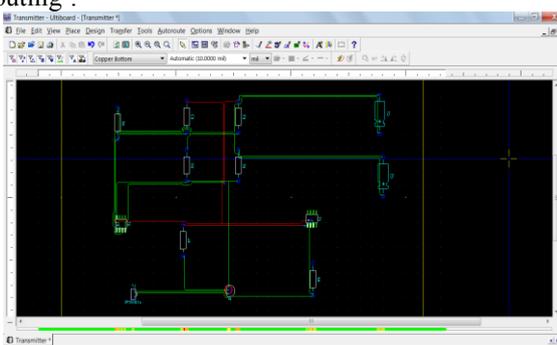


Fig. 4 View after Performing Routing of the Schematic in N.I. UltiBoard 11.0 for Transmitter Design

The 3D View of the real prototype fabrication of my design is shown below.



Fig. 5 3D View of my Design Showing PCB Connections for Transmitter Design



Fig. 6 3D View Showing Connections Appearing at the back-side of the PCB for Transmitter Design

VII. WORKING OF CIRCUIT DIAGRAM OF RECEIVER

At the other end of the cable, the optical signal is directed at a photo-darlington detector in the receiver that converts it into an electrical signal again. The signal is amplified by op amp IC2 and power amp IC3 before being fed into a speaker where it becomes a sound wave. A voltage regulator has been used in the receiver gain stage to reduce DC supply ripple caused by the higher currents drawn in the power amplifier section. C1 and C2 are filter caps, C3 couples the detector voltage imposed across R1, into IC2.

R2 and R4 set the op amp input to half the supply voltage, since only one supply is used rather than positive and negative supplies, as is usually the case. The gain of IC2 is adjustable by the pot in the feedback circuit. The range is therefore 1+1M/110k to 1+1M/10k, or 10 to 101. This is used as a volume control. IC2 output is coupled via C6 into an LM386 power amp IC with gain set to 20. R6 and C8 act as a low pass filter on the input. R7 and C9 form a network that provides a high frequency load to ensure stability.

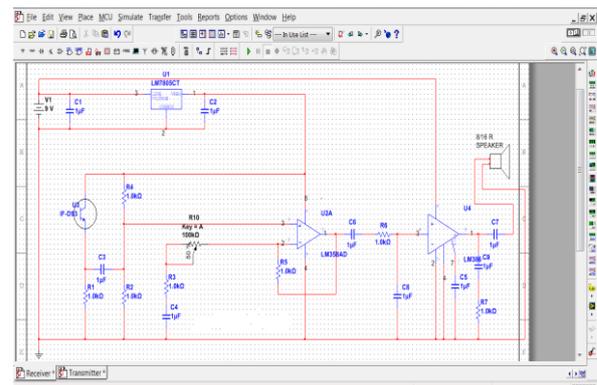


Fig. 7 Receiver schematic in N.I. Multisim 11.0

VIII. REAL PROTOTYPE FABRICATION OF RECEIVER

After checking the validity of the circuit in N.I. Multisim11.0, now convert the circuit to UltiBoard 11.0. To do this check if all the components are blue in colour(i.e. they have a foot-print) and select 'Transfer To UltiBoard 11.0' button.

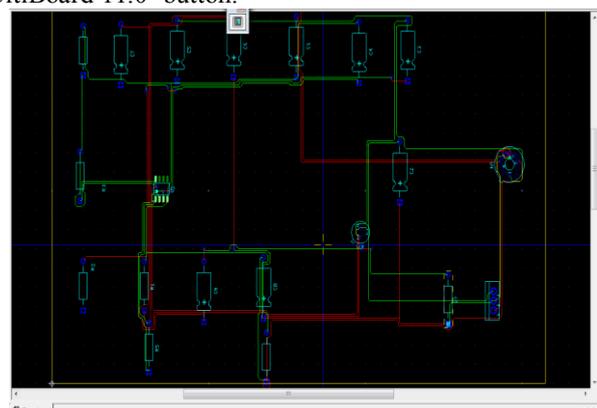


Fig. 8 View after Performing Routing of the Schematic in N.I. UltiBoard 11.0 for Receiver Design

The 3D View of the real prototype fabrication of my design is shown below.

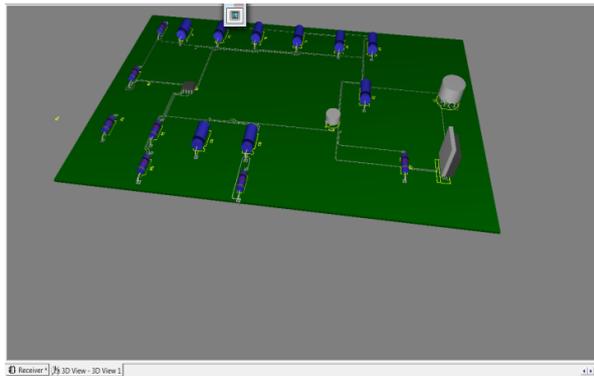


Fig. 9 3D View of my Design Showing PCB Connections for Receiver Design

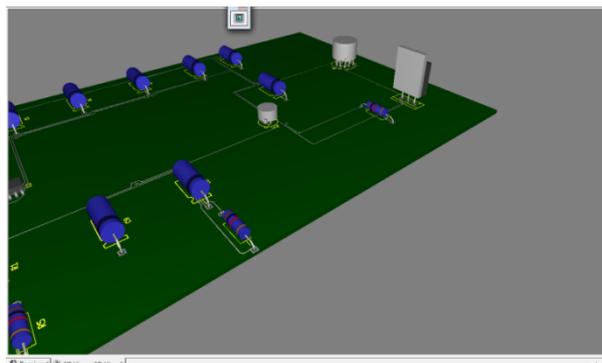


Fig. 10 3D Side View of my Design Showing PCB Connections for Receiver Design



Fig. 11 3D View Showing Connections Appearing at the back-side of the PCB for Receiver Design

IX. ADVANTAGES

Light from a laser torch is used as the carrier in the circuit instead of RF and FM signals. The laser transmission is very secure because it has a narrow beam[6]. The main advantage of this system is high reliability as it is impossible to track the data on the way of transmission. This design of Laser voice transmission system can be made at anywhere with low cost and can be used for frequent conversation at free of cost instead of using cell phone.

X. CONCLUSION

This paper is completely based on wireless communication system. Presently there are various techniques which are being successfully used for transmission of data. The data transmission techniques employ RF, FM signals for transmission of data. Laser Torch Based Transmission

and Reception are cheaper and simpler in construction than RF transmitter and receiver. Although, wireless communication predominantly means the use of radio frequency for communication, the use of light based carriers for transfer of information is explored in this paper. This design can be made and used successfully at political assembly, lecture halls and for general conversation between two houses. The main problem with lasers is the beam dispersion can occurs due to external factors. In order to overcome these problems most advanced powerful lasers are to be employed. Although the optical data communication technology is prevailing from last decade as optical fiber communication devices available in the market, this design was presented to get all ideas that are behind such wireless system.

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BIOGRAPHY



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Design and Electromagnetic Modeling of E-Plane Sectoral Horn Antenna For Ultra Wide Band Applications On WR-137 & WR-62 Waveguides

S.Srinath

(Final Year Student,ECE, Vellore Institute of Technology, Vellore, India)

ABSTRACT : The Design and EM modeling of a E-Plane Sectoral Horn Antenna for Ultra Wide Band Application on WR-137 and WR-62 standard waveguides are presented in this paper. In E-plane sectoral antenna, the E-Plane is much narrower as the flaring and dimensions of the horn are much greater in that direction. The horn flare angle, horn size, wall thickness, etc of the E-plane sectoral horn antenna are examined. The return loss, input impedance, total gain and field pattern of the E-plane sectoral horn antenna are observed. The antenna is simulated using ANSOFT HFSS 14.0.

KEYWORDS : Ansoft HFSS Simulator, Beam width, Directivity, E-Plane Horn Antenna, Electromagnetic modeling, Radiation Pattern, Return Loss

I. INTRODUCTION

An antenna is an electrical device which converts electric currents into radio waves, and vice versa. To transmit the signal a transmitter applies an oscillating radio frequency electric signal to the antenna's terminals, and the antenna radiates the energy in the form of electromagnetic waves. Horn antennas are used as antennas at UHF and microwave frequencies, above 300 MHz. They are used as feeders for larger antenna structures such as parabolic antennas. Over the hundred years, horn antennas have given the best directive and high power operation for Microwave Frequencies. Design Simplicity and large gain with best matching properties are added advantage of Horn antenna. Applications include Radar, Satellite tracking, Radio astronomy and Communication dish antennas. Other applications are Reflector feeds, Gain standards for antenna measurements, EMC/EMI tests, Communication systems, Direction finding (DF), mm-wave systems.



Fig 1 : A Practical Horn Antenna

A E-plane sectoral horn is one in which the opening is flared in the direction of the E-field.

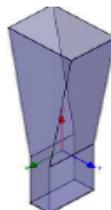


Fig 2 : E-Sectoral Horn Antenna

The E-Plane sectoral horn antennas are chosen because of their directional radiation pattern, ability to achieve high gain and directivity, and their ease of fabrication. The horn antenna which is designed was subject to the following constraints:

- Operating frequency around 8 GHz (C Band) for first case and 16 GHz (Ku Band) for second case.
- Maintain a gain of 10 dB over the entire operating frequency range

II. ANTENNA DESIGN

The C and Ku frequency bands were selected as the operating frequency. These bands are selected as they pertain to the communication frequency bands. The design was performed to accomplish an ultra-wide bandwidth. (i) For the first case of 8GHz (C Band) the operating frequency was chosen to be 8GHz. The waveguide dimensions are $a = 34.85\text{mm}$, $b = 15.8\text{mm}$, waveguide length = 31.75mm. These indicate the standard WR-137 waveguide. Horn size dimensions are $b=44.45\text{mm}$, horn flare length = 95.25mm, wall thickness = 1.626mm. (ii) For the second case of 16GHz (Ku Band) the operating frequency was chosen to be 16GHz. The waveguide dimensions are $a = 15.8\text{mm}$, $b = 7.9\text{mm}$, waveguide length = 15.88mm. These indicate the standard WR-62 waveguide. Horn size dimensions are $b=22.23\text{mm}$, horn flare length = 47.63mm, wall thickness = 1.016mm. For both the cases the outer boundary condition is Radiation Boundary Condition. The Radiation Boundary Condition are as follows :

- Absorption achieved via 2nd order radiation boundary
- Place at least $\lambda/4$ from strongly radiating structure
- Place at least $\lambda/10$ from weakly radiating structure
- The radiation boundary will reflect varying amounts of energy depending on the incidence angle. The best performance is achieved at normal incidence. Avoid angles greater than ~ 30 degrees. In addition, the radiation boundary must remain convex relative to the wave

In HFSS to properly model the far field behavior of an antenna, an appropriate volume of air must be included in the simulation. Truncation of the solution space is performed by including a radiation boundary condition on the faces of this air volume that mimics free space. The appropriate distance between strongly radiating structures and the nearest face of the air volume depends upon whether a radiation boundary condition is used. HFSS also uses Finite Element Method (FEM) as analysis & solution to Electromagnetic problems by developing technologies such as tangential vector finite elements, adaptive meshing, and Adaptive Lanczos-Pade Sweep (ALPS).

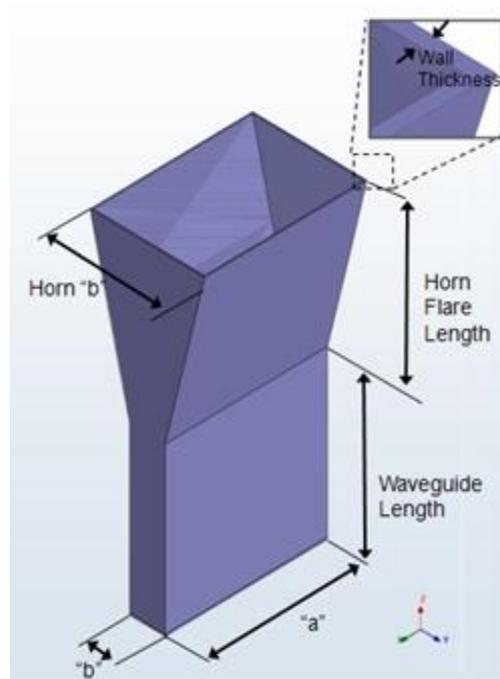


Fig 3 : Structure of the proposed E-Plane Horn Antenna

III. PROPOSED MODEL IN ANSOFT HFSS 14.0 FOR CASE 1

The 3D view of the designed E-Plane Horn Antenna in HFSS for a solution frequency of 8GHz (C-Band) is shown below. The boundaries for the air-box are set as an ideal propagation space and the ground plane as perfect electric conductor.

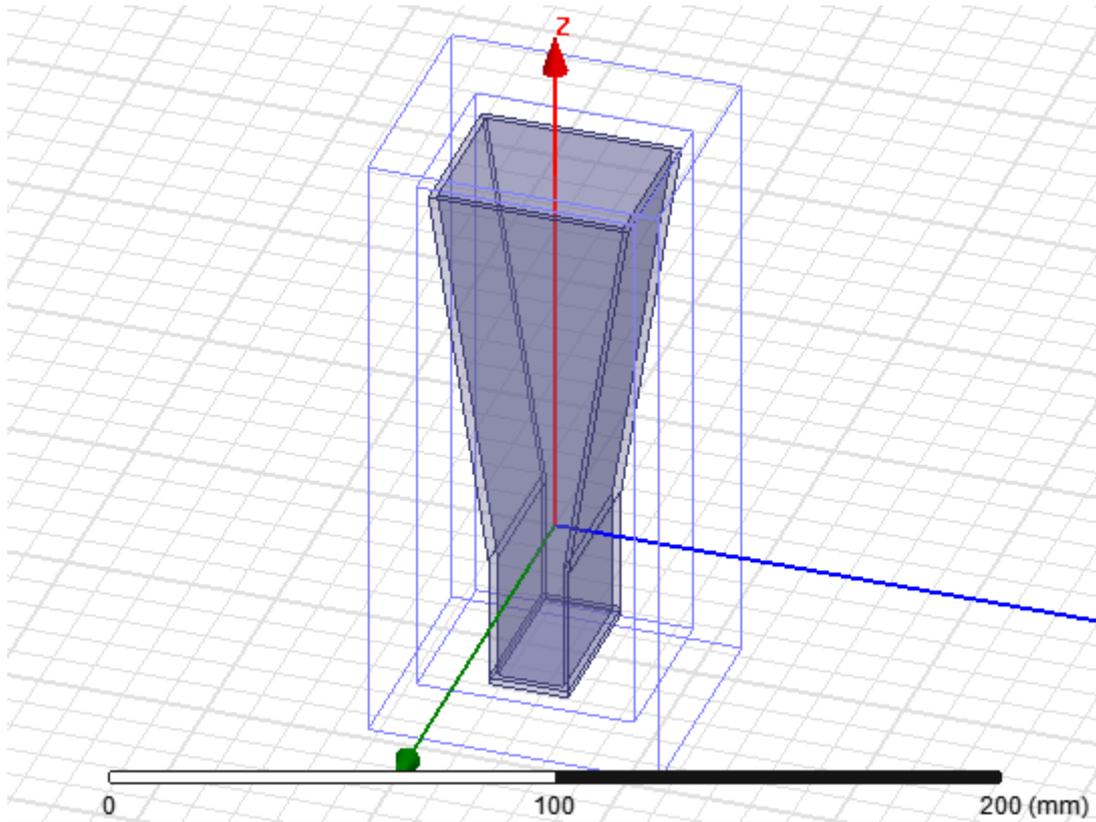


Fig 4 : 3D View of the E-Plane Horn antenna in HFSS for a solution frequency of 8Ghz

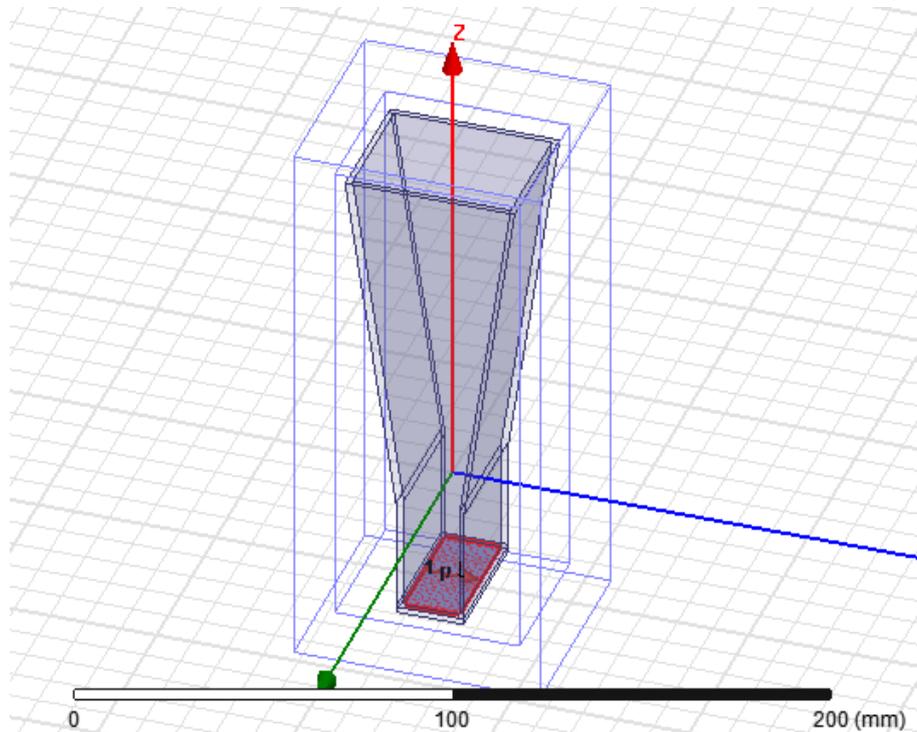


Fig 5 : Figure showing the direction of excitation for a solution frequency of 8Ghz

IV. RESULTS AND DISCUSSION FOR CASE 1

The parameters which verify the success of antenna design are beam width, impedance matching , etc. These are analysed here. The gain of the antenna versus frequency with return loss is -44dB at 8Ghz is shown below.

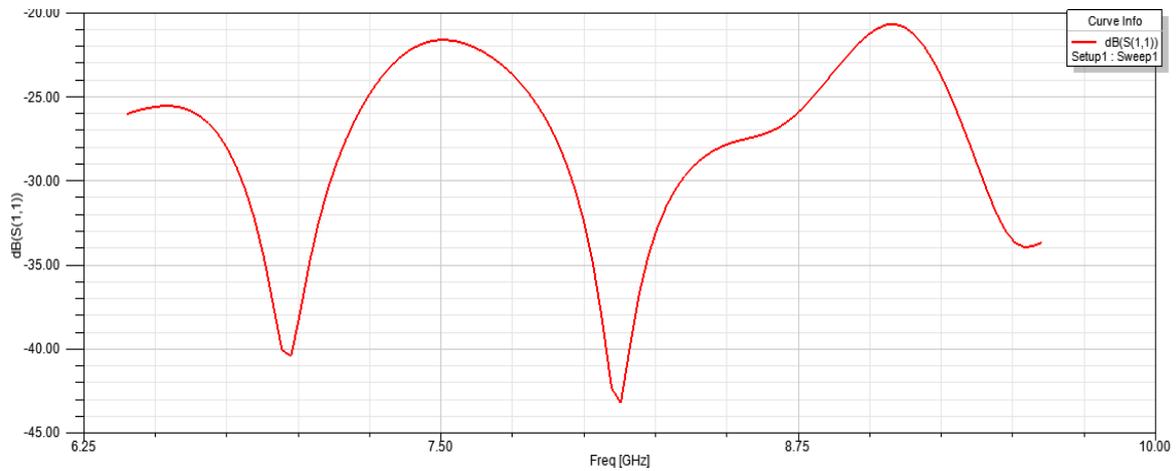


Fig 6 : Return loss in db over frequency range for a solution frequency of 8Ghz

The Radiation pattern for the antenna design in 3D is shown in below.

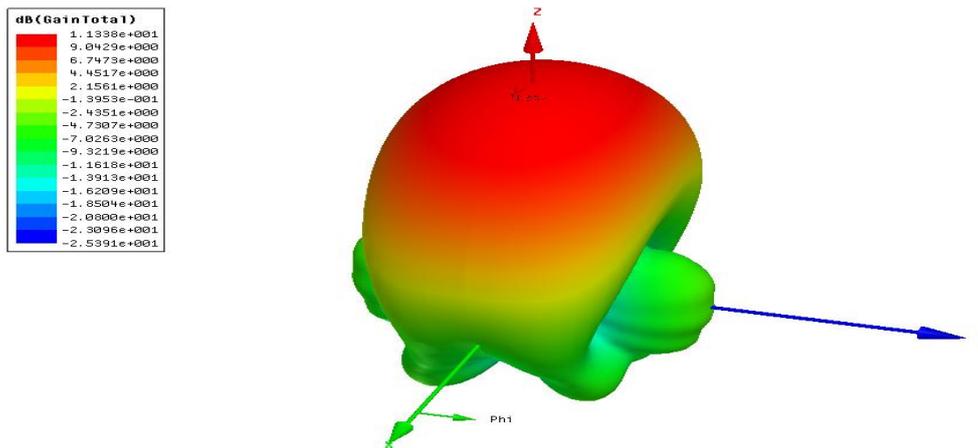


Fig 7 : 3D Radiation pattern of the antenna in HFSS for a solution frequency of 8Ghz

The 2D plot is total gain for phi = '0 deg' and phi = '90 deg' is shown below.

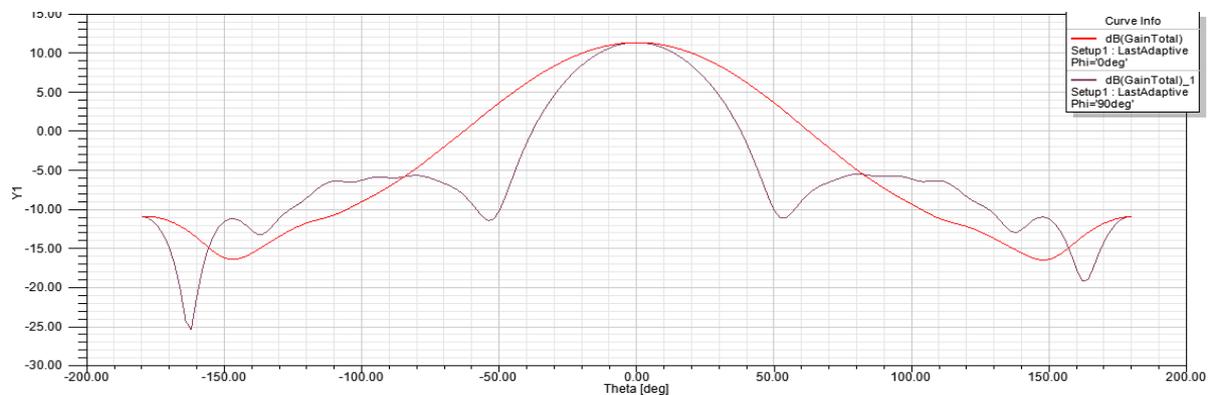


Fig 8 : 2D Plot for total gain versus theta (deg) with phi for a solution frequency of 8Ghz

V. PROPOSED MODEL IN ANSOFT HFSS 14.0 FOR CASE 2

The 3D view of the designed E-Plane Horn Antenna in HFSS for a solution frequency of 16Ghz (Ku-Band) is shown below.

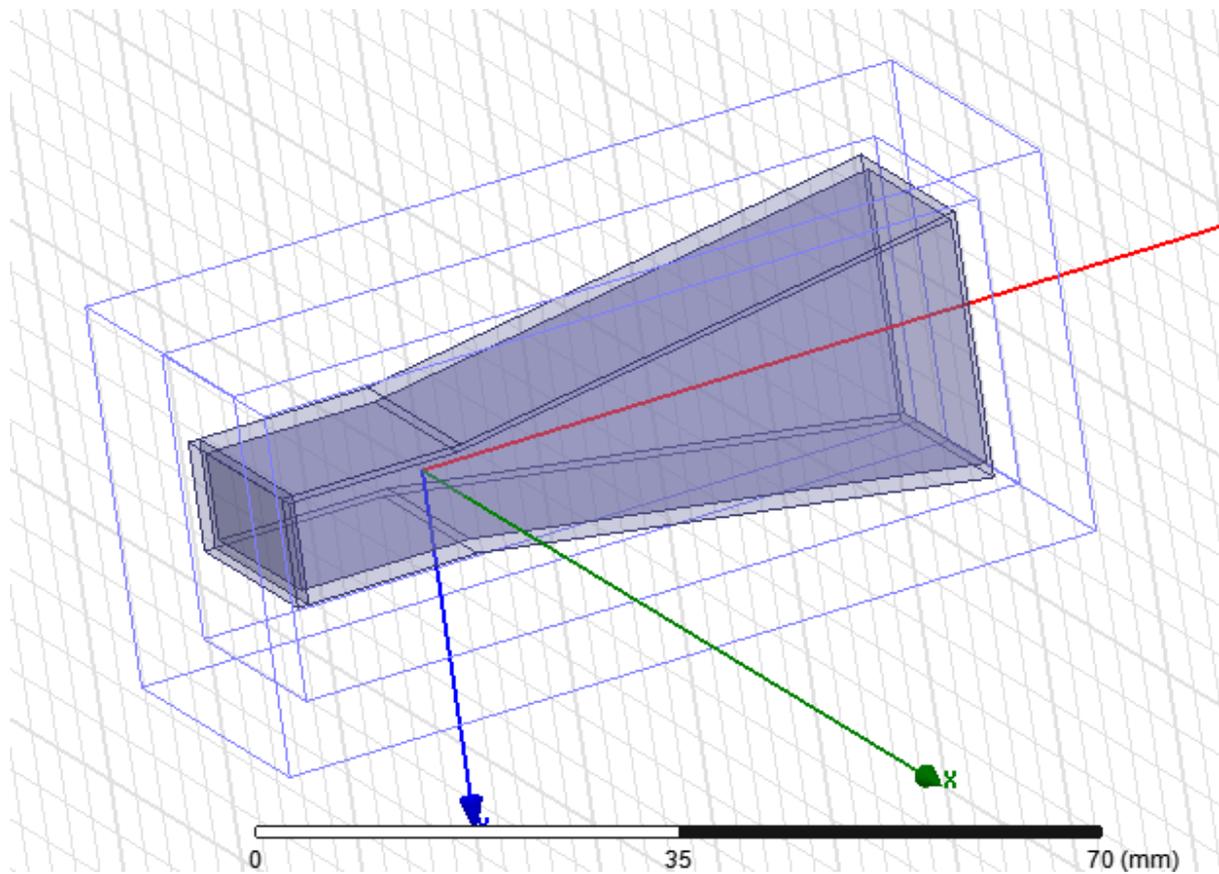


Fig 9 : 3D View of the E-Plane Horn antenna in HFSS for a solution frequency of 16Ghz

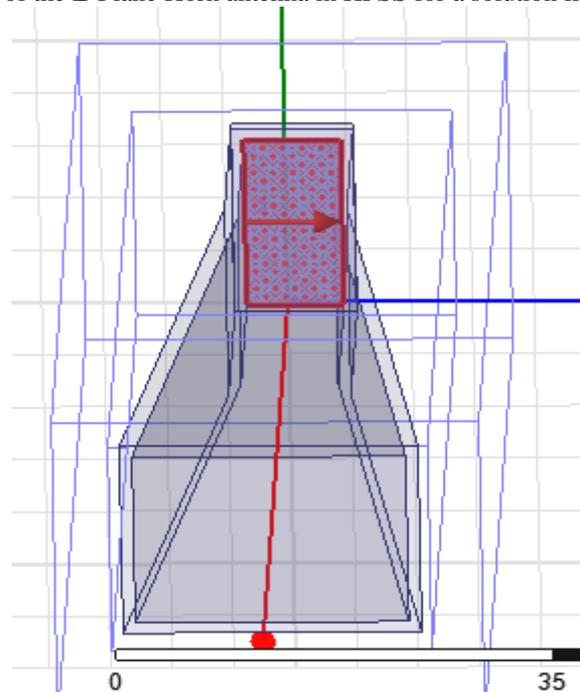


Fig 10 : Figure showing the direction of excitation for a solution frequency of 16Ghz

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