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Development of Dual Band Feed

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Abstract: ***In this paper, Development of dual band feed operating in C and Ku bands to obtain high illumination and spill over efficiencies and high cross polarization discrimination, maximum gain and low side lobes for shaped Cassegrain Antenna of larger diameter is presented. The Design envisages a common aperture C and Ku band corrugated horn. Corrugated horn of suitable dimensions for the propagation of hybrid modes in both C and Ku bands having equal beam widths in principal planes (E&H) and pattern of rotationally symmetric radiation will be illuminating the shaped sub reflector in modified Cassegrain geometry. The corrugated horn is designed to operate over a frequency range of C (3.4-4.8 GHz) and Ku (10.7-12.75 GHz) bands. CHAMP is used to simulate and analyze the designed model.***

Keywords: Corrugated horn, reflector antennas and cross polarization discrimination.

I. INTRODUCTION

The horn antennas are one of the most popular and commonly used as primary radiators in microwave reflector antennas. Horn feeds can be classified as sectoral horns, pyramidal horns and conical horns having rectangular, square and circular apertures. They suffer from pattern asymmetry and unequal beam widths leading to reduced gain of reflector antennas, when they are employed as primary radiators. On the other hand corrugated horns generate rotationally symmetric radiation pattern, improved cross polarization discrimination, almost in variant phase center across the frequency band, compared to smooth-walled horns. Corrugations are added to the smooth walled horn to enhance the radiation features. In addition to the circular waveguide's dominant TE_{11} mode, the TM_{11} mode is generated internally to change the TE_{11} mode field distribution in the E-plane to almost the same in the H-plane.

In the 1960s, Kay first regarded the concept of corrugated horns, Simons and Kay and Thomas and Minnett [1], [2]& [4]. This was due to the particular interest in achieving symmetrical radiation patterns in order to produce low-side lobes and high-efficiency reflector antennas. Since then corrugated horns have become the preferred feed antenna option for use in satellite earth station antennas. This is due to their improved efficiency in radiation and especially their increased symmetry of copolar patterns and low cross polarization.

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The horn antenna is a vital element because it must match the minimum losses and highest effectiveness of the microwave signal from the source to the reflector surface. Corrugated horns that support hybrid modes are well established as feeds for illuminating the reflector antennas, and direct radiators. Due to the ability of some hybrid modes to produce radiation patterns with extremely good beam symmetry with low cross-polarization levels, high beam efficiency with very low side lobes and the potential for wide bandwidth performance, popularity of corrugated horn is enhanced. For corrugated horns will also be helpful to describe the field within the wave guide by the HE and EH family of hybrid modes. In reality, in terms of TE and TM modes, we can define the field within the corrugated horn antennas. The wavelength of the corrugation is smoothly tapered from λ/2 to λ/4.The presence of corrugated horn antennas is due to three primary factors. First, it shows symmetry of the radiation pattern, which provides the ability to produce high-gain and low-spill over in reflector antennas. Secondly, radiating with very low cross-polarization, which is crucial in dual polarization schemes, and lastly, provide wide-band operation. Whereas the designing of single band corrugated horn is relatively simple, design of Dual band corrugated horns separated widely in frequency is a challenge itself. Towards achieving the goal of meeting high efficiency, study has been carried out for optimum performance of corrugated horn for the dual band operation.

II. PRINCIPLE OF OPERATION

The operating principle of corrugated horn can be described physically by considering how the corrugated wall impacts the field distribution within a corrugated waveguide.

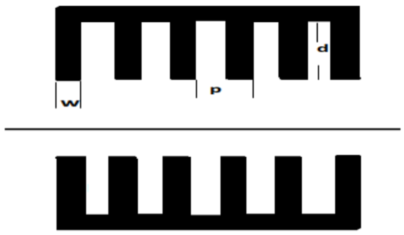

Fig. 1. Corrugated wave guide

As shown, corrugations alter the areas that travel through the corrugated horn waveguide to create desirable radiating characteristics of symmetry of axial beams, low side lobes and low cross polarization and good return loss [3]. Figure 1. represents the inside of the wave guide where W is the width of the slot and p is the slot pitch, d is the depth.

A linear electrical field for low crosspolar level is desirable, but it cannot be obtained with smooth waveguides supporting pure transverse electrical (TE) or pure transverse magnetic (TM) modes only. These methods have curved the aperture lines of the electrical field as shown in figure 2.

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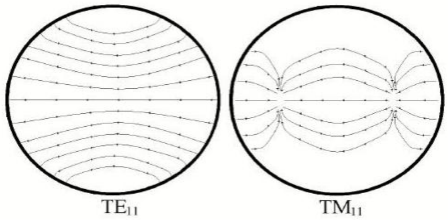

Fig. 2. TE$_{11}$ and TM$_{11}$ aperture electric fields

III. DESIGN OF CORRUGATED HORN (C AND KU BAND)

The design of corrugated horn has a parallel slots, input waveguide, corrugated profile, common aperture, mode converter, slot pitch, slot width, slot width to pitch ratio, width of the slot teeth, depth of the slot as shown in figure 3. Where the inside wall is produced in succession of slots and teeth.The aim of the corrugated layer is to provide the means of supporting the propagation within the horn of hybrid mo des.

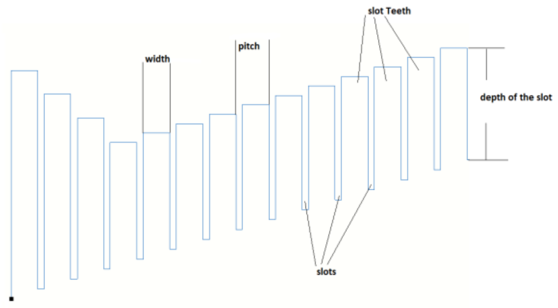

Fig. 3. Details Of The Corrugated Horn Inside Perspective

To generate symmetrical E-plane and H-plane patterns with very small cross-polarization, the horn should generate linear electrical fields of aperture. The hybrid mode can generate only the necessary electric fields. In principle, hybrid modes are a mixture of TE and TM mod es. The aim of the corrugated layer is to provide the means to promote the spread of hybrid types in the horn. Such hybrid mode can be produced by a horn with a corrugated inner surface. In fact, corrugations on the horn's walls alter the electrical and magnetic fields so that the horn produces symmetrical co-polar patterns with less cross-polar radiation. The horn or waveguide must have anisotropic surface-reactance characteristics in order to propagate as a single entity with a prevalent propagating speed: characteristics that are satisfied by the corrugated surface. Table 1 shows the parameters and dimensions of the corrugated horn.

Table- I: Parameters And Dimensions For Corrugated Horn

Serial No:	Parameter	Dimensions(mm)
1.	Profile type	Linear profile
2.	Input radius	40.0mm
3.	Output radius	200.0mm
4.	length	550.0mm
5.	Width to pitch ratio	0.8mm
6.	Number of slots	100
7.	No of slot in the mode converter	3
8.	Mode convert type	Variable depth slots

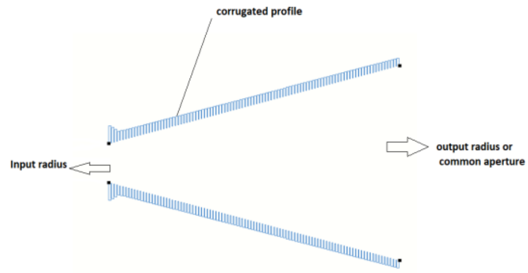

Fig. 4. Design Of Corrugated Horn

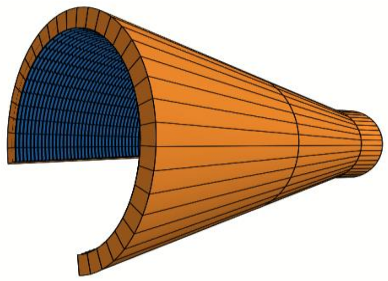

Fig. 5. 3D View Of Corrugated Horn

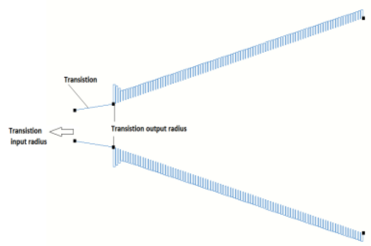

Fig. 6. Design Of Corrugated Horn With Transition

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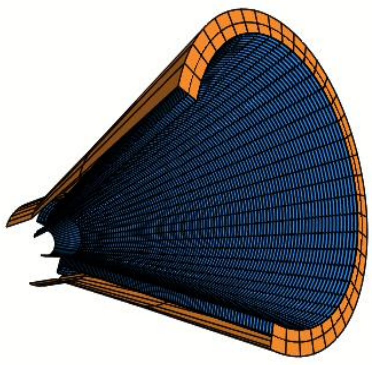


Fig. 7. 3D View Of Corrugated Horn With Transition

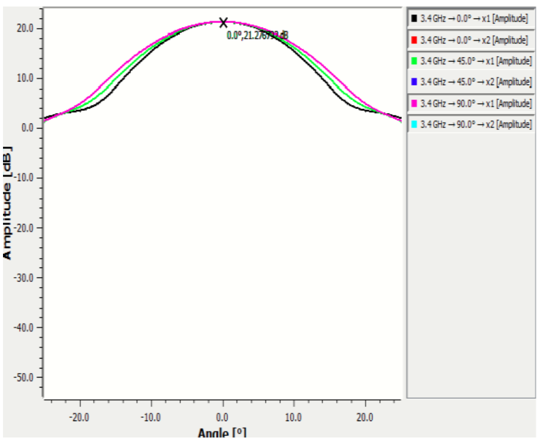
Table- II: Parameters And Dimensions For The Corrugated Horn With Transition.

Serial No:	Parameter	Dimensions(mm)
1.	Profile type	Linear profile
2.	Input radius	28.75mm
3.	Output radius	40.0mm
4.	length	84.35mm

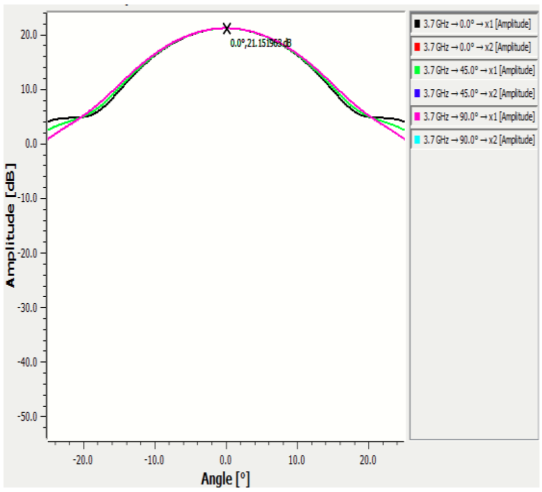
Connecting the corrugated horn to a circular, smooth-walled input waveguide is usual in figure 6. The basic mode of this guide is the TE_{ll} mode, and the transition between the smooth-walled input waveguide and the corrugated horn body requires a so-called "mode converter." This converter mode is intended to ensure a smooth transition from the TE_{ll} to the HE_{11}, which is supported by the corrugated horn. Figure 7 demonstrates a 3D perspective of the corrugated horn with Transistion. In order to obtain maximum gain, high cross polarization and low side lobes for shaped Cassegrain antenna.This layout is simulated using CHAMP.

IV. SIMULATED RESULTS AND DISCUSSIONS

The figure below shows the corrugated horn with Transition simulated radiation patterns of C band over a frequency range of (3.4- 4.8 GHz). The gain of corrugated horn with transition is demonstrated in figure 8. The gain of dual band feed is better than 20 dB over the entire frequency band.



(a)



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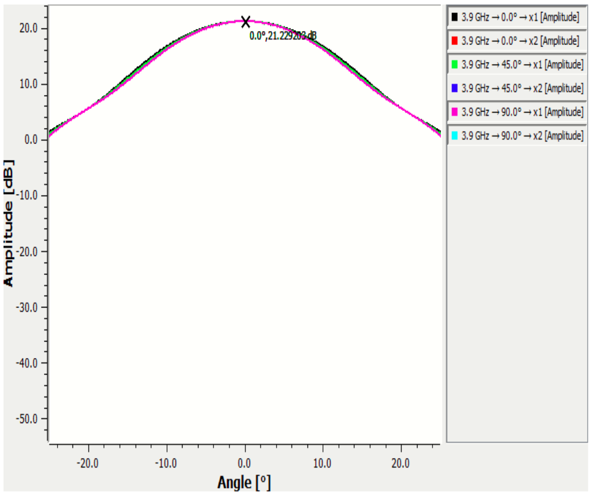

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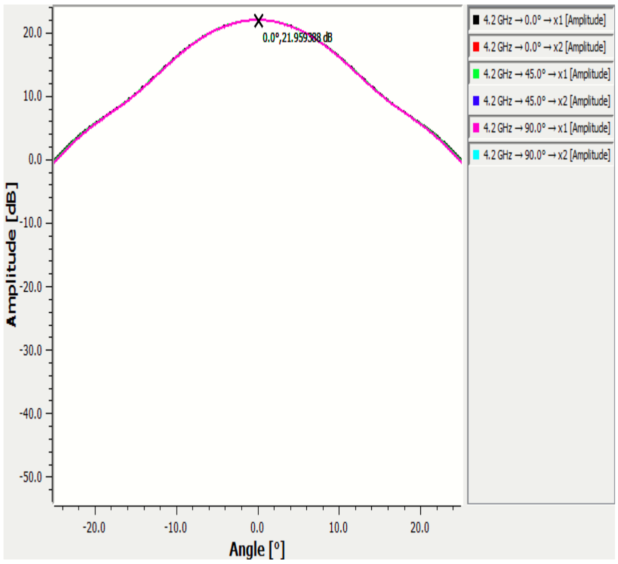

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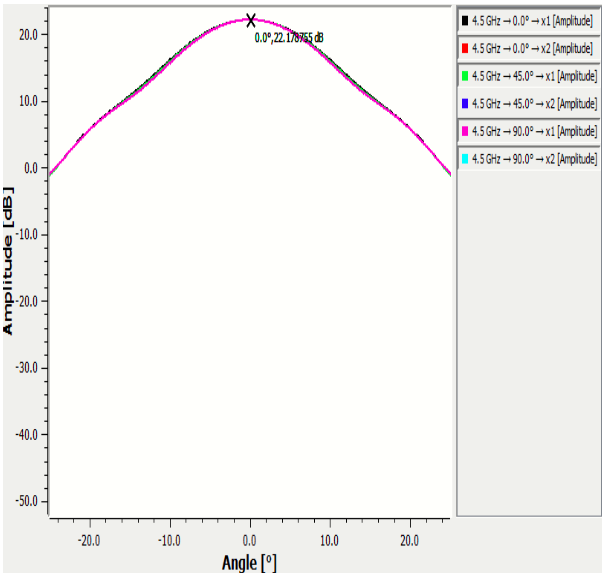

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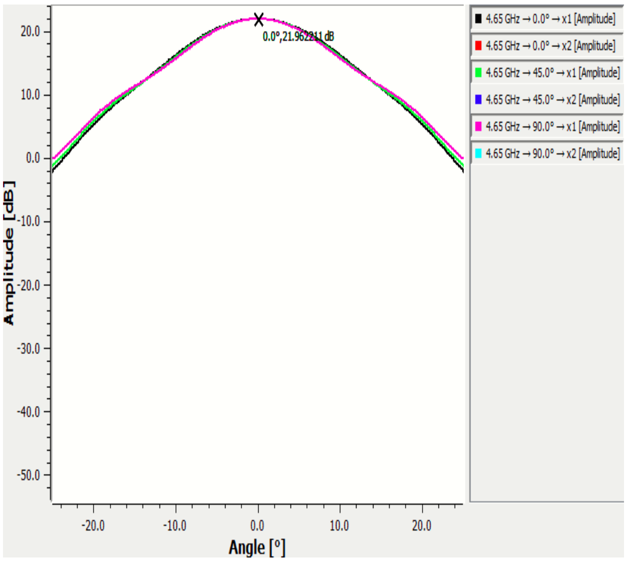

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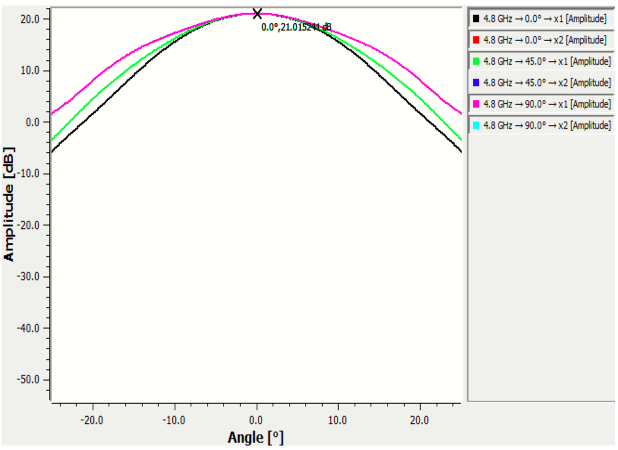
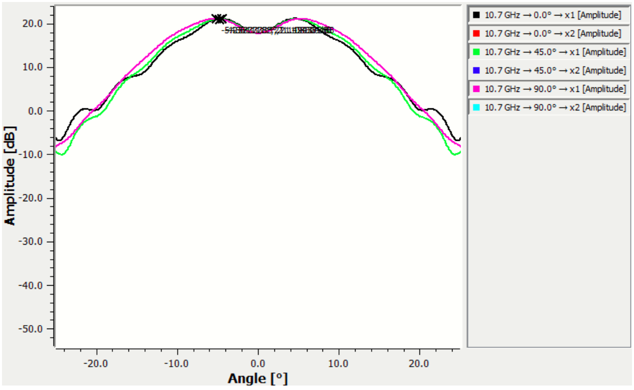


(g)

Fig. 8.(a)-(g) Presents The Gain Of Corrugated Horn Of C Band (3.4-4.8 Ghz)

The Figure below shows the radiation pattern for corrugated for Ku band over a frequency range of (10.7-12.75 GHz).

Figure 9. demonstrates the gain of dual band feed is more than 20 dB over a frequency range of Ku band.



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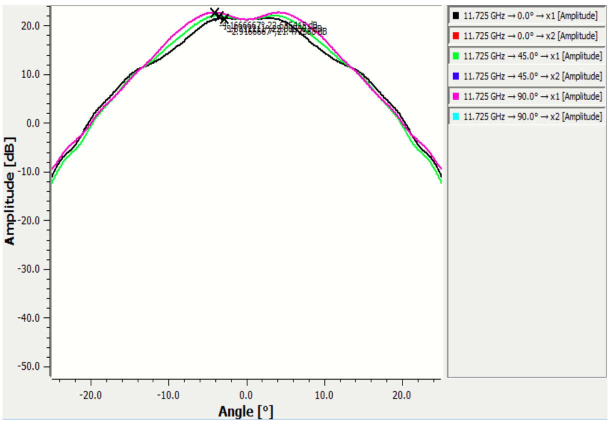
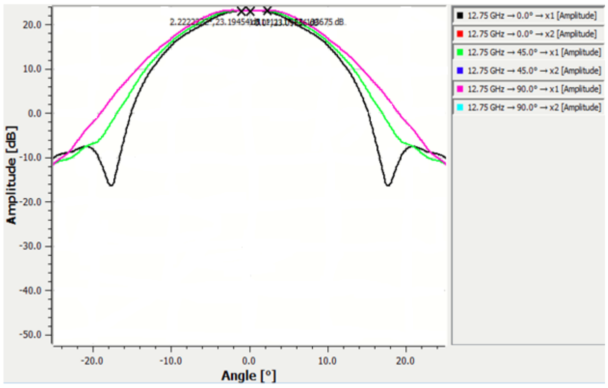


(i)



(j)

Fig. 9. (h)-(j) Presents Gain Of Corrugated Horn For Ku Band (10.7-12.75 Ghz).

Cross polarization discrimination has the ability to preserve the polarization purity radiated or obtained between horizontally and vertically polarized signals. Figure 10. (k)-(q) depicts the cross polarization and discrimination for C band (3.4-4.8 GHz).

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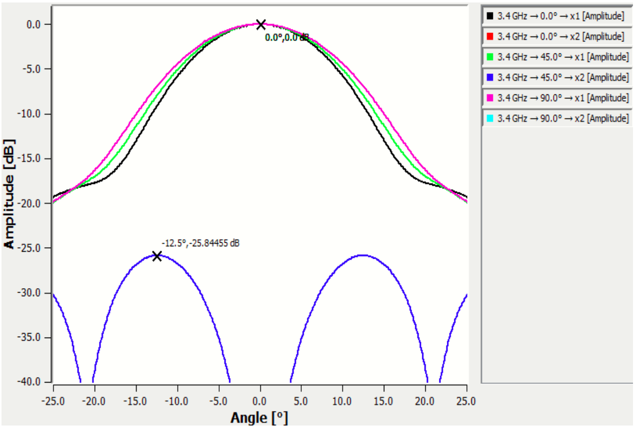
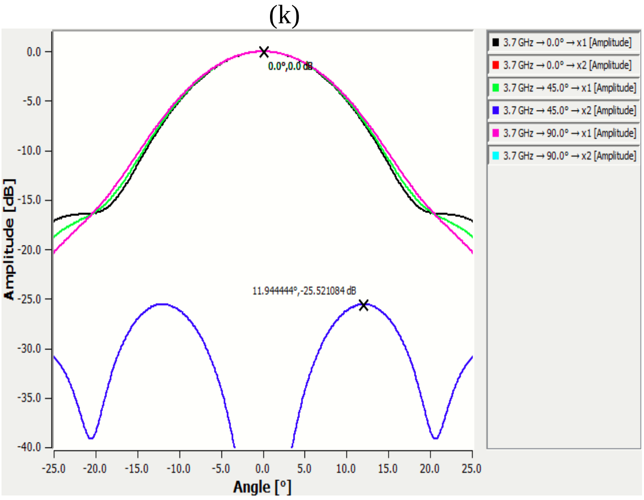


(k)



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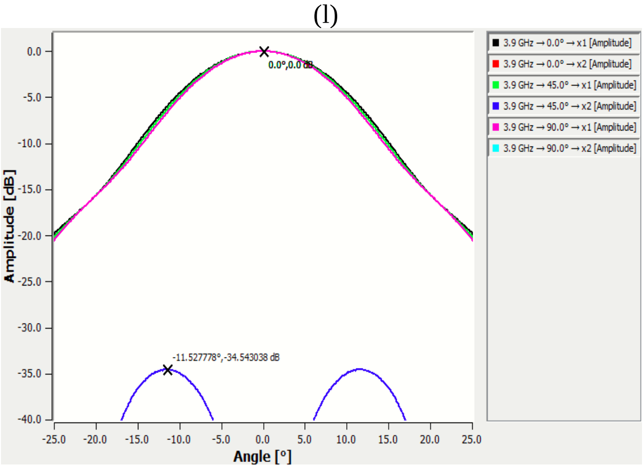
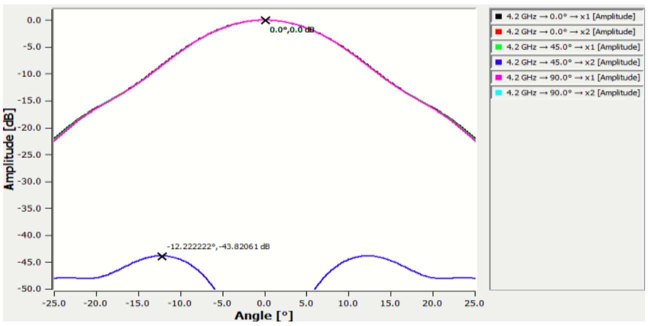


(m)



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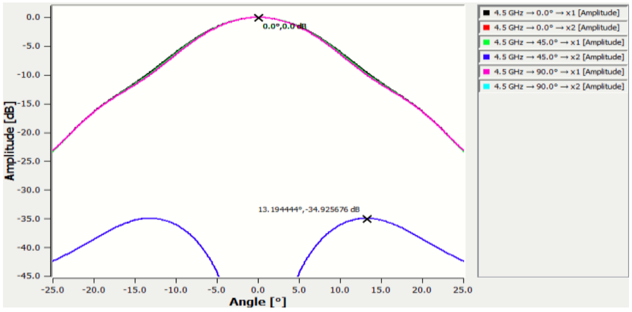

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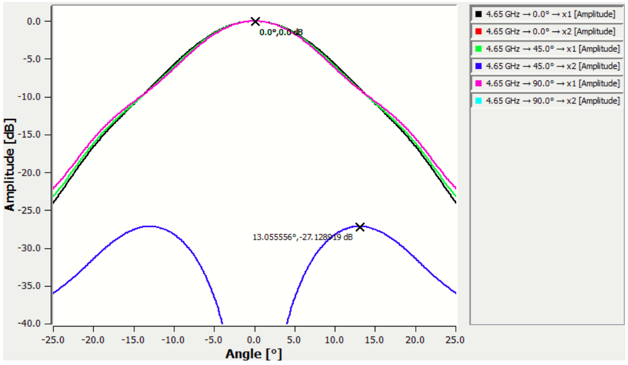
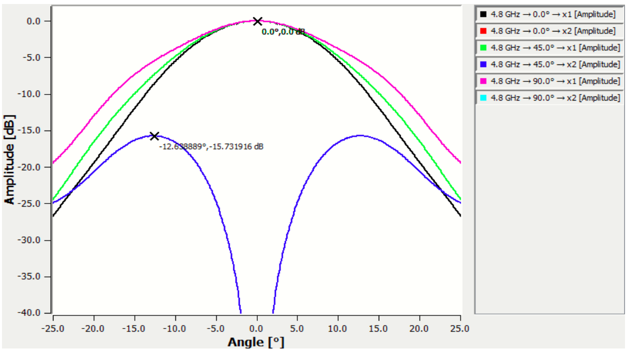
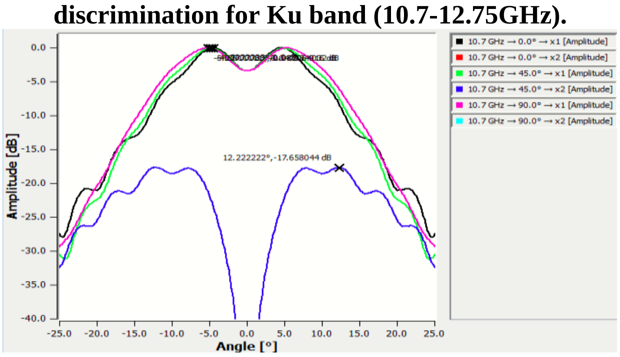


(p)



(q)

Figure 11. represents the cross polarization discrimination for Ku band (10.7-12.75GHz).



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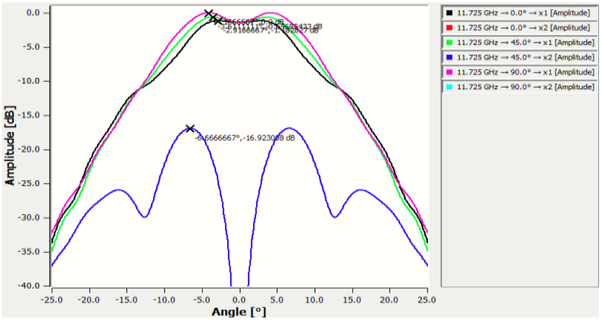

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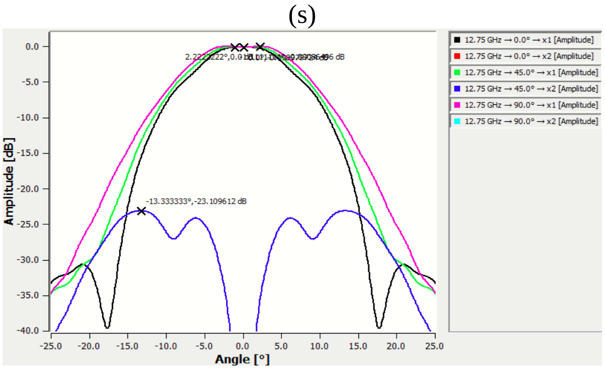

(t)

Fig.11.(r)-(t) Presents The Cross Polarization Discrimination For Ku Band (10.7-12.75 Ghz).

V. CONCLUSION

In this work, CHAMP is used to simulate the design of corrugated horn for dual band feed (C-(3.4-4.8GHz) and Ku (10.7-12.75 GHz) bands) in order to obtain, symmetrical radiation pattern in both E- plane and H- plane, maximum gain, low side lobes, high illumination and spill over efficiency, high cross polarization discrimination. In this design dual band corrugated horn with transition used as a feed for shaped cassegrain reflector antennas.

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REFERENCES

1. A. F. Kay, "A horn with a wide angle of flare. A novel feed for low noise broadband and high aperture efficiency an-tennas, "Laborato-ries US Airforce Cambridge Research, Rep. 62-757, October 1962
2. A.J. Simons and A. F. Kay, "The scalar feed – a high performance feed for large paraboloidal reflectors," in IEE Conference, pp. 213-217, 1966
3. A.D. Olver, P.J.B. Clarricoats, A.A. Kishk and L. Shafai, "Microwave Horns and Feeds", IEE Electromagnetic waves series 39, The Institution of Electrical Engineers, 1994.
4. P.D. Potter, "A new horn antenna with suppressed sidelobes and equal beamwidths", Microwave Journal, 6, pp. 71-78, 1963.

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