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A New Quassi Yagi Uda Antenna for Millimeter Wave Applications at 60 GHz

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ABSTRACT: A new and improved version of a Quassi Yagi Uda Antenna has been designed in this paper. This design has been made in manner in order to utilize the frequency range of 56.3 GHz to 65.2 GHz. The design is optimized so as to keep the return loss less than 10dB in the desired frequency range. This design is proposed for 5th generation short distance wireless communication. The antenna is gives a peak gain of nearly 8 dB and front to Back ratio which was achieved was 12.1.Peak value of s11 was -56dB.We have considered the 60 GHz for working as the band is an unlicensed band as per the FCC protocols and thus this band alone would be enough to provide multiple Gbps data rate which is an amazing data rate as if now for wireless communication standards.

KEYWORDS: Quassi Yagi Uda Antenna; Antenna for millimeter wave applications, Printed Yagi Uda antenna for 60 GHz frequency range. Yagi Uda antenna for planar circuits

I. INTRODUCTION

In today's scenario of high speed wireless communication the planar antennas which are integer able with RF end circuits and characterized by low cost and small size have attracted the researchers a lot and mainly in the 60GHz frequency band for the reason that there is a huge amount of unlicensed bandwidth available in this region. This unprecedented amount of bandwidth holds the potential for much higher data rates than other channels that are bandwidth-limited. Wireless data rates in the range of 1gbps become reasonable. [24] [25]

There are some disadvantages to the 60GHz band. Probably the most important aspect of the 60GHz band for low-power wireless communications is the path loss. Path loss will be discussed in more depth below, but it suffices to say that an Omni directional antenna at 60GHz suffers from severe path loss. This factor allows us the use of the antennas in this band for shorter distance communication only.

II. DESIGN PART OF ANTENNA

The following figure shows the schematics of the antennas design. The design consists of the driven dipole, three directors following the fed dipole and the truncated ground plane acts as a director of the Quassi Yagi Antennas. The elimination of the reflector and using the ground plane as the director helps in keeping the design simple and small. Feeding of the design is made by micro strip line where as the dipole needs to fed using a double end structure hence a BALUN (Balanced to Unbalanced Transformer) is used for the matching purpose.

The substrate which has been used for the designing is RT Duroid-6202 which has the characteristics of Loss Tangent = 0.0028 and ε_r = 3.04.

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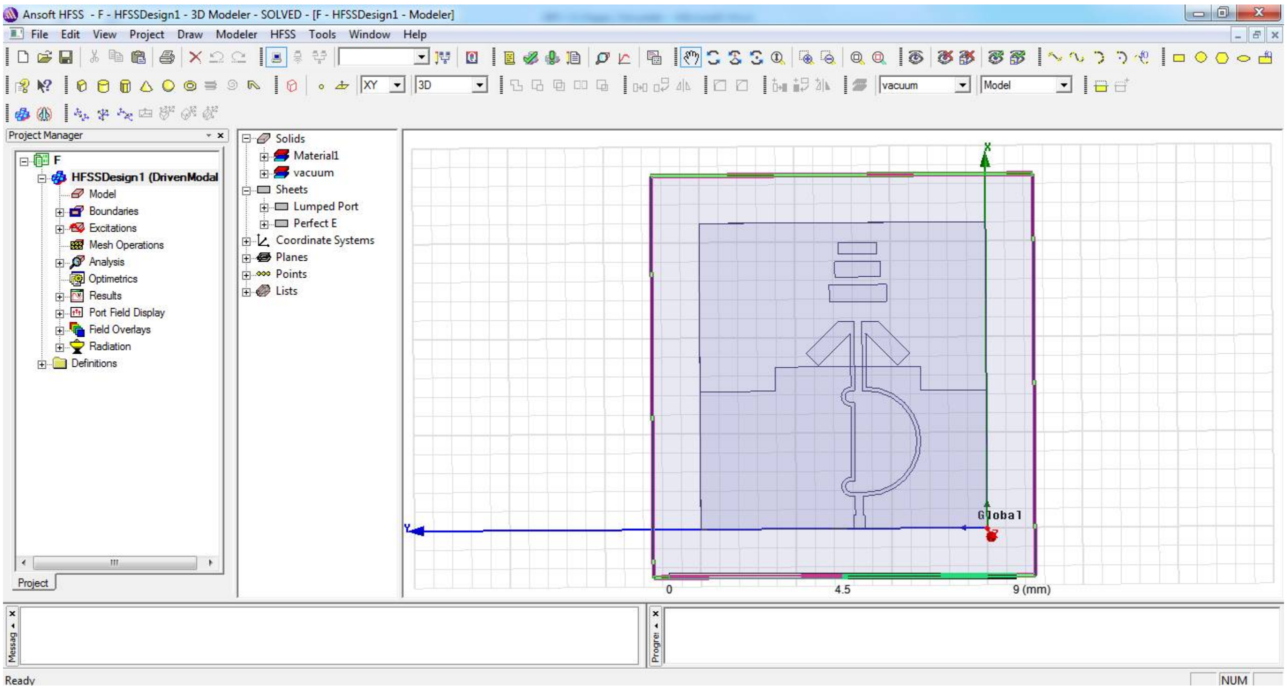

It was observed that the length of the driven dipole was increasing the gain of the antennas but simultaneously the back lobes were also increasing with the increment in the length of the dipole hence the bent structure was opted in was [4] the optimised gain and return loss.

The Balun not only provide the means of converting the single ended RF input into a differential one but it also provide as the measure of the impedance matcher to the design due to which the losses decreases and the overall reflection coefficient also decreases.

III. SUPPORTING THEORY

Various method of designing the baluns in the literature open are available for the micro strip to the CPS transition. However the conventional square shape is not preferred and the deign shown above is used owing to the fact that at such a high frequency the wavelength is too small because of which the effect of parasitic coupling is high also due sharp edges in the square shape of dipoles the reflection loss to the RF wave are significant.[26]

This structure of dipole is made using the symmetric T Junction and circular loops. It can be easily shown here that the waves at the output of of the balun shall be 180 degree out of phase which is a prerequisite for the proper odd mode excitation at the driven dipole of the structure.

The Electric field pattern of the excited patch appears like as the of the screen shot below in the ANSYS HFSS tool .

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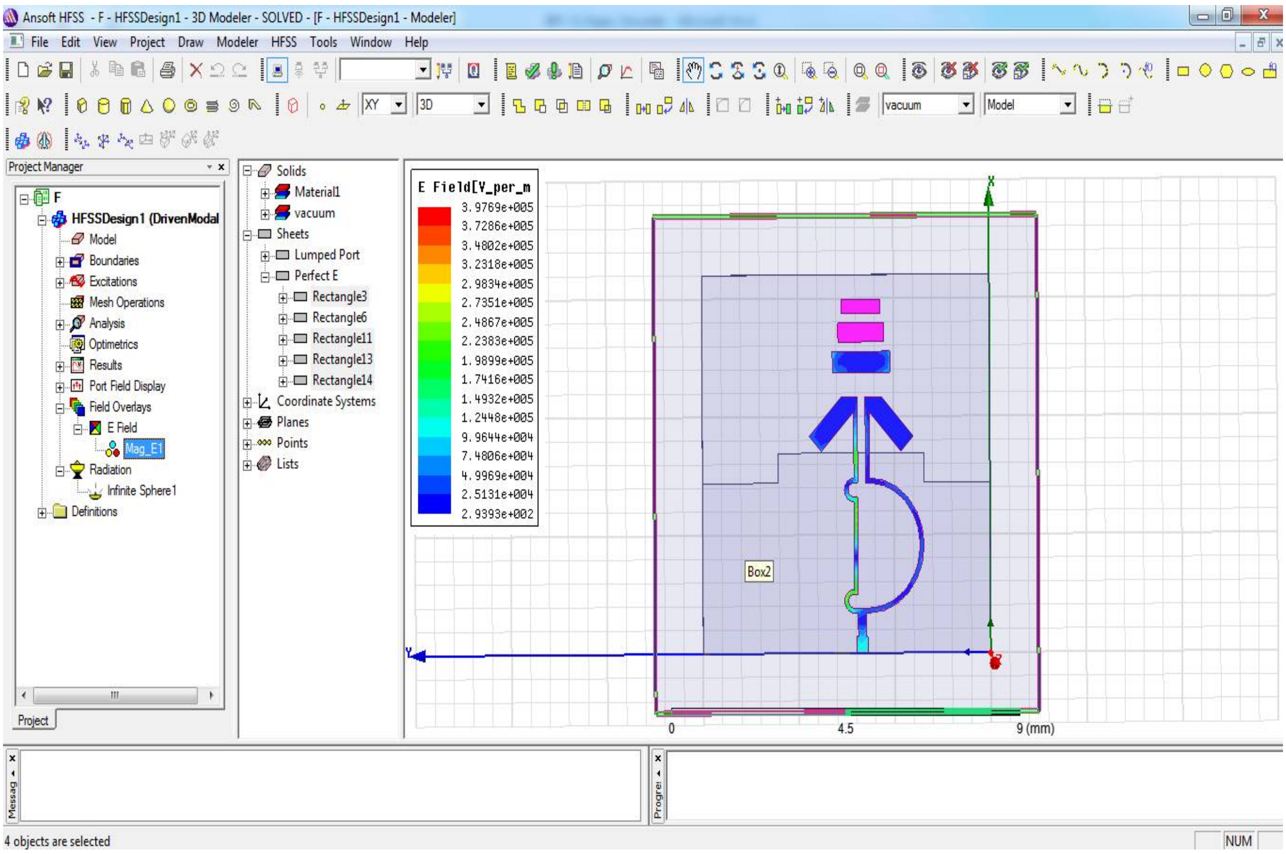

Design of the Antenna

IV. SIMULATED RESULTS

The design has been simulated on ANSYS HFSS and the various results are as under

Return Loss & Bandwidth:

The design is successfully simulated for the value of S11 as low as -55dB at nearly 59 GHz. The design gives the return loss of less than 10 dB in the frequency range of 54.5 to 65.5 GHz hence the bandwidth of nearly 9 GHz is achievable from the said design.

The return loss in improved due to increased coupling efficiency and better feeding efficiency due to the presence of the Balun due to which the antenna radiation efficiency increases. The circular design of the Balun provides the design to be more reluctant from the losses that occur due to cross coupling which are prominent in the square shape of design of the Balun. [23]

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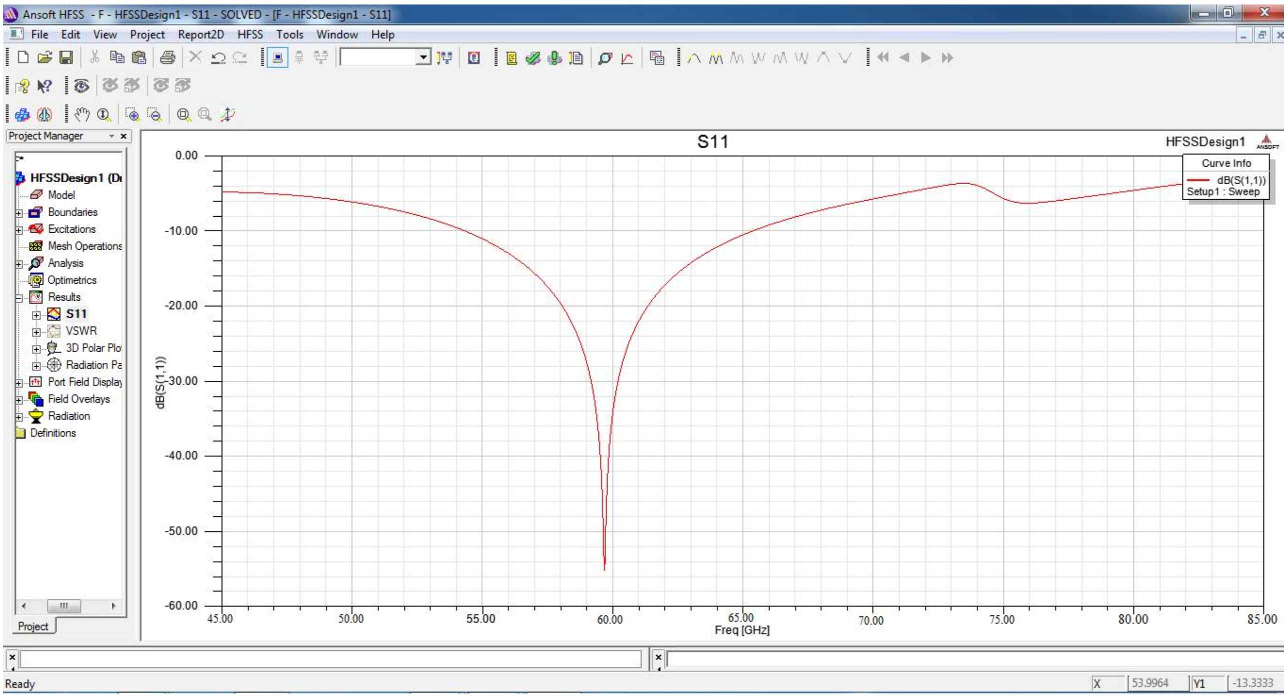
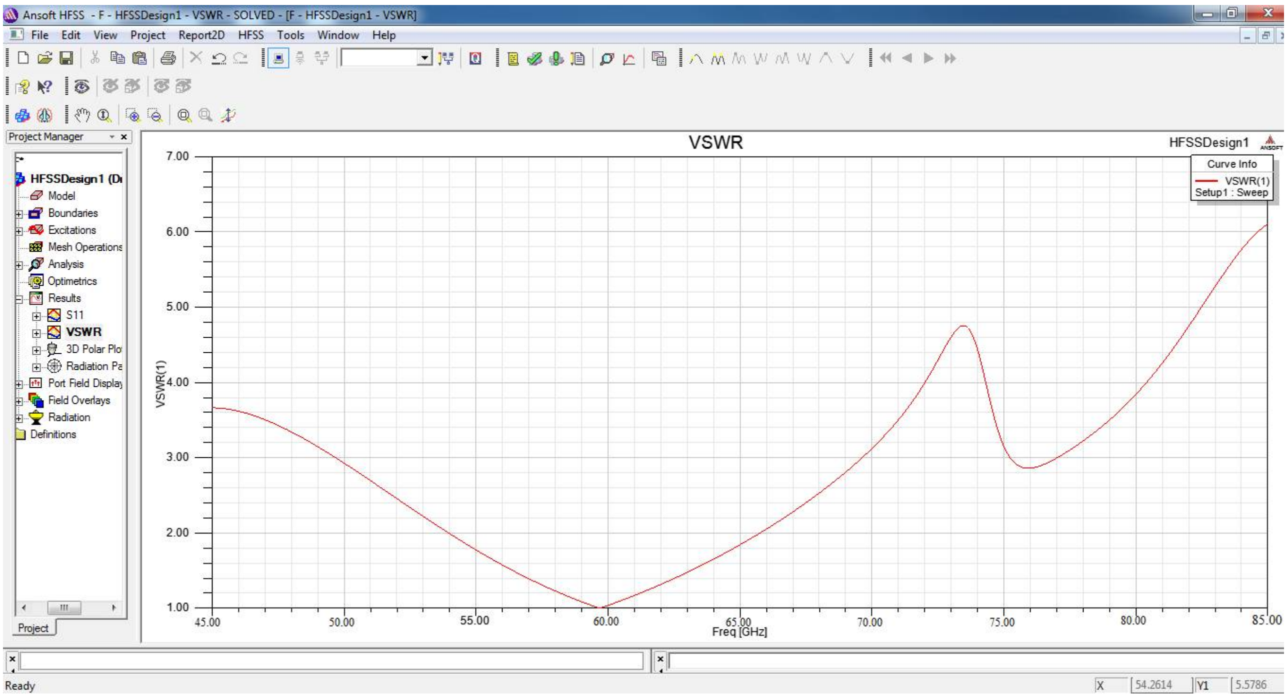


VSWR: The Corresponding VSWR Plot of the design is also plotted which gives a lowest value as as low as 1.01 at 59 GHZ and the value of VSWR stays less than 2 in the frequency range of 54.5 to 65.5 GHz.



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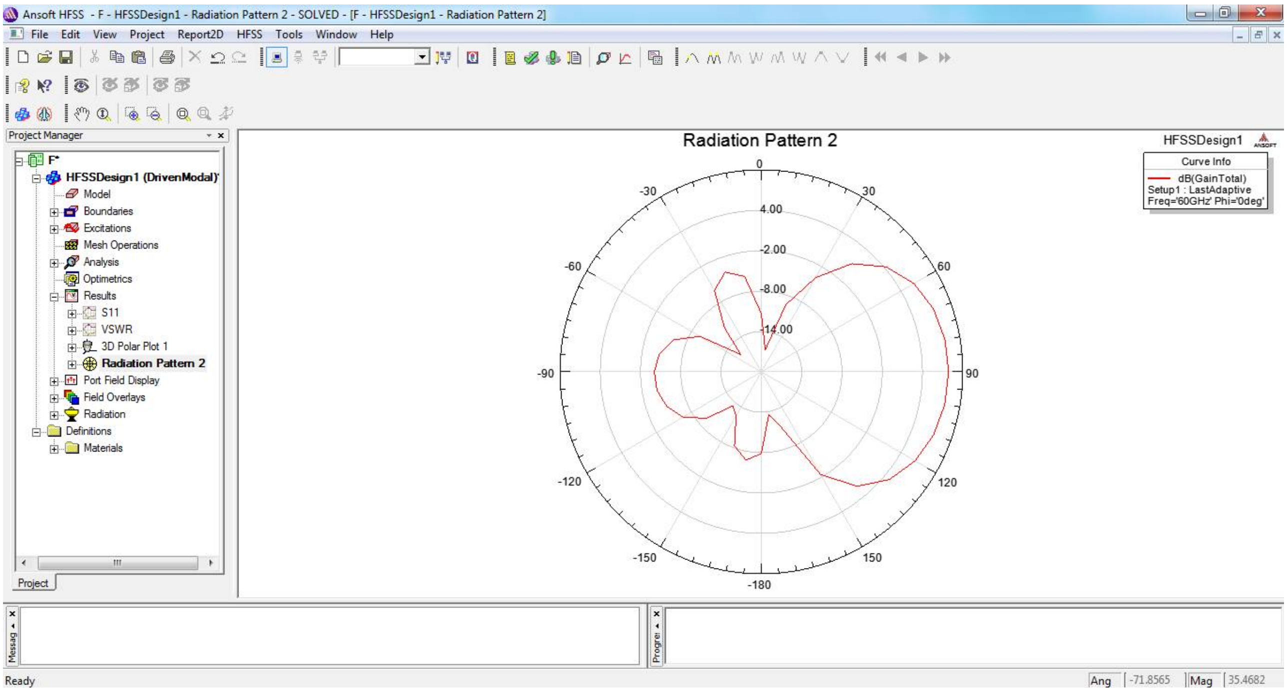
Radiation Pattern.

The radiation pattern also describes that most of the power lies in the major lobe side and negligible amount of RF energy is in the back lobe direction which is imperative to make sure the better directivity of the antenna.



Radiation Pattern of the Design

The peak gain of the design is nearly 9dB where as the Front to Back ratio obtained is 12 dB.

3D Polar Plot:

In this plot the antenna is considered to be at the origin of the simulator and the system plots the 3D radiation pattern of the antenna in the spherical coordinate system. It can be seen from the adjoining figure that the antennas shows better directivity.

3 D Polar Plot can be considered as the the replica of the radiation pattern which is plotted in 2 d where as this pattern is plotted in the space.

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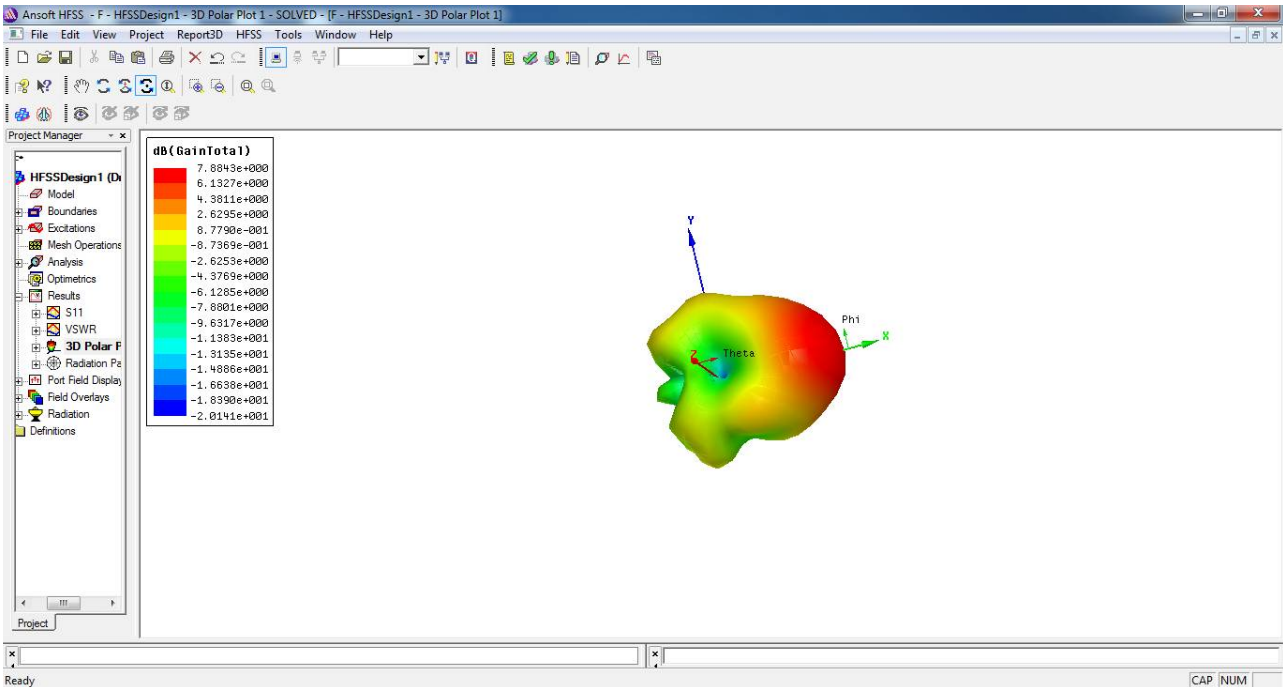

3D Polar Plot of the Design

V. CONCLUSION AND FUTURE WORK

In recent years the demand for the antennas in the millimeter wave band for high speed wireless communication has significantly increased. As we know that there is sever attenuation by the atmosphere to the RF wave in this band the antennas design becomes an important parameter to ensure the high speed as the directivity, low return loss and high gain of the design would be extremely important for the purpose of flawless wireless communication.

It has been proposed that, The IEEE 802.11ad standard is aimed at providing data throughput speeds of up to 7 Gbps. To achieve these speeds the technology uses the 60 GHz ISM band to achieve the levels of bandwidth needed and ensure reduced interference levels.

[8]Using frequencies in the millimeter range IEEE 802.11ad microwave Wi-Fi has a range that is measured of a few metres. The aim is that it will be used for very short range (across a room) high volume data transfers such as HD video transfers. When longer ranges are needed standards such as 802.11ac can be used.

As part of the marketing, the scheme will be known by the name wigig after the Wireless Gigabit Alliance that endorses the system.

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