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60 GHz modified dipole for WiGig™ Reception

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ABSTRACT

Dipole antenna is usually required in the receiving end because any handheld receiver should receive the signals from all the directions. Wireless transmission is nowadays rapidly taking over the last mile connectivity and has become popular because the user gets high speed data transfer provided by the backbone technology and wireless user connectivity keeps the user mobile for a very good range. This paper presents a unique, high frequency and high efficiency antenna that is meant to act as a receiving antenna for high frequency applications such as WiGig™ (IEEE 802.11ad). WiGig™ is expected to work efficiently at a frequency of 60GHz. A 60GHz modified dipole for WiGig™ reception has been designed and simulated. This is expected to operate in the frequency band of 60 GHz. The simulated impedance bandwidth at the 60GHz is 12.43GHz (approximately). The simulated and measured results show that the antenna has very good efficiency.

Keywords:— *WiGig, self complementary antenna, resonance, polarization, VSWR, lumped feed, return loss.*

I. INTRODUCTION

Dipole antennas can never become obsolete because of its simplicity of design and omni-directional radiation pattern. However some of the problems with omni-directional antennas are less efficiency, narrow bandwidth and low gain. However, wideband dipole antennas are becoming popular because their bandwidth is high as compared to narrowband dipole antennas. This dipole antenna is usually required in the receiving end because any handheld receiver should receive the signals from all the directions. Wireless transmission is nowadays rapidly taking over the last mile connectivity and has become popular because the user gets high speed data transfer provided by the backbone technology and wireless user connectivity keeps the user mobile for a very good range. WiFi™ (IEEE 802.11) has become very popular and very handy standard that connects laptops, mobile, tablets etc. to any network. Highest data rate achieved by IEEE 802.11g is 54 Mbps. WiGig™ is a new standard established by WiFi™ Alliance in unison with Wireless Gigabit Alliance. It is expected to work at 60 GHz, provide the transfer rates up to 7 Gbit/s, about as fast as 8 times 802.11ac transmission, and nearly 50 times faster than the highest 802.11 rate [8].

II. PURPOSE

Presently the antenna used in laptops and mobile phones for WiFi™ reception works just fine. But as the WiFi™ is taking a leap towards WiGig™ technology the operating frequency will also change from 2.4 GHz to 60 GHz. Every new technology is made backward compatible but still through this proposed work an effort is made to better utilize the speed and bandwidth provided by 60 GHz WiGig™ technology.

Other antenna designs like Microstrip arrays or slot antenna are also modified to work on this frequency [1], [3] but the simplicity of dipole cannot be matched by any other antenna. However the challenges with dipole modifications are more because dipole is inherently a resonant antenna with poor efficiency. The solution is already present in terms of broadband dipoles. The proposed antenna uses the concept of broadband dipoles and achieves a working frequency of 60 GHz successfully while excelling in other parameters as well.

III. Antenna Design

In this wideband dipole antenna the length is 1.9756 mm, width 0.6168 mm and thickness 0.019 mm. The feed gap is 0.22 mm. The input impedance of the antenna is approximately 60 ohms. Antenna is designed for the frequency of 60 GHz. Table 1 shows a summary of the antenna design parameters.

Table 1: Design Parameters

Antenna length	1.975mm
Antenna width	0.6168mm
Antenna thickness	0.019mm
Feed Type	Lumped (diagonal)

The antenna design is inspired by frequency independent self complementary antennas. Two poles of the dipole are flattened to increase the current distribution and position of one of them is flipped along the vertical axis. This resulted in two strips in alternate positions on either side of the axis. To feed them a diagonal strip is placed and made a lumped port. Figure 1 shows a snapshot of the proposed antenna.

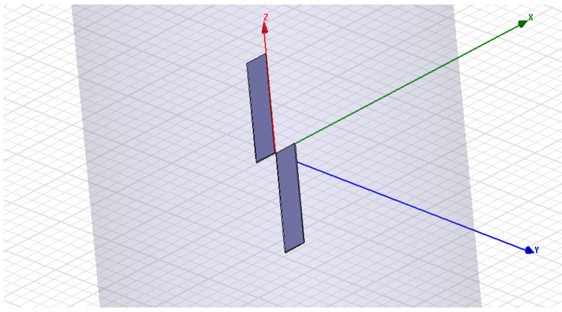

Figure 1: Proposed antenna design

IV. Simulation & Results

Simulation of the designed antenna is done with HFSS 11.1. Table 2 shows the results of the simulation.

***Polarization*:-** The polarization of an antenna is defined as the polarization of the wave radiated by that antenna. Polarization of a radiated wave is defined as that property electromagnetic wave describing the time varying direction and relative magnitude of the electric field vector [4]. The proposed antenna has low cross polarization. It deviates only by 20 degree from the desired polarization; moreover, this problem can be reduced using differential feeding mechanism [1].

***Return Loss & VSWR*:-** Efficiency of an antenna at a given frequency can be estimated by measuring the return loss (i.e. S11 parameter). Return loss of an antenna tells how much supplied power is not used by the antenna. The proposed wideband dipole antenna has the return loss of -25dB. VSWR (Voltage Standing Wave Ratio) is also an important parameter which gives an estimate of the amount of power reflected to the transmission line that is feeding the antenna. VSWR ideally should be 1 means no power is reflected from the antenna. VSWR of the proposed antenna is 1.125 at 60 GHz (Figure 2 and Figure 4).

Input Impedance of the antenna is the impedance at its terminals or the ratio of the voltage to current at a pair of or the ratio of appropriate components of the electric to magnetic fields at a point. The input impedance of an antenna should be such at it is easily fed and is real rather than complex [4]. Input impedance of the proposed antenna is 60 ohms.

***Gain*: -** The gain of an omnidirectional antenna is always less than a directional antenna. Inspite of antenna being a passive device it is expected to give some amount of gain. The proposed antenna has a gain of 2.04 dBi at 60 GHz. It is low if compared the antennas given in the reference papers [1], [2],[3] but the antenna proposed here has better omnidirectionality.

***Bandwidth*: -** The bandwidth of an antenna refers to the range of frequencies over which the antenna can operate correctly. Using tools like HFSS the bandwidth is calculated from S11 graph. -10 dB is taken as the reference and the first and the second intersection of the return loss curve with -10 dB line is taken as fl and fh respectively. The center frequency fc is 60 GHz and the bandwidth is given by fh-fl [7]. The bandwidth of the proposed antenna is 12.43 GHz which spans over the operating range of 54.66 GHz to 67.09 GHz (Figure 3).

Table 2: Simulation Result

Polarization	+/-20 degree
Return loss	-25 dB
Input impedance	60 ohms
VSWR	1.125
Gain	1.6 (2.04 dB)
Operating range	54.66 GHz to 67.09 GHz
Bandwidth (-10db reference)	12.43GHz
Operating frequency	60GHz

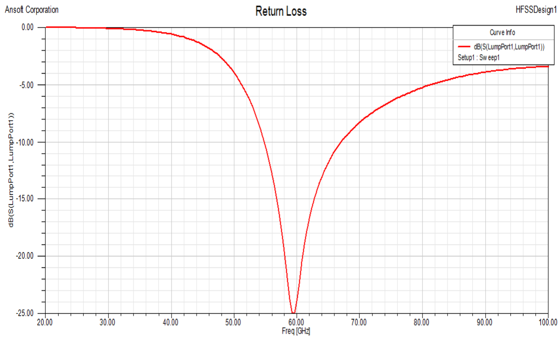

Figure 2: Return Loss (-25 dB)

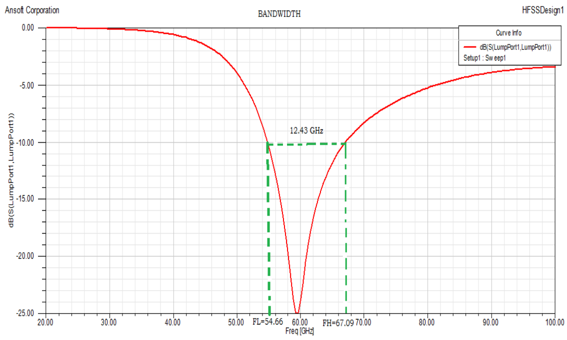

Figure 3: Bandwidth (-10 dB reference) (Frequency range: 54.66 GHz to 67.09 GHz)

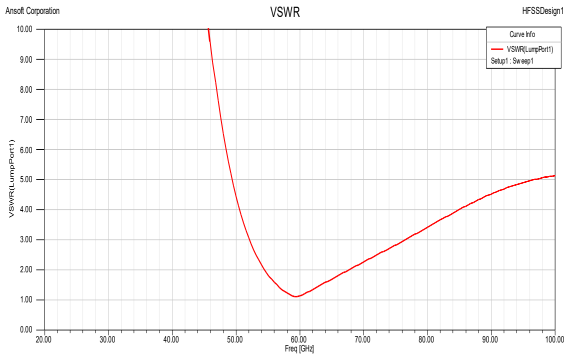

Figure 4: Voltage Standing Wave Ratio (1.125)

V. Conclusion

A 60GHz modified dipole for WiGig™ reception has been designed and simulated. This is expected to operate in the frequency band of 60 GHz. The simulated impedance bandwidth at the 60GHz is 12.43GHz (approximately). The simulated and measured results show that the antenna has very good efficiency. It is suitable for designing for WiGig™ reception applications.

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