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Designing a Dipole Antenna Operating At A Frequency of 28GHz

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ABSTRACT: The Indigence for inexpensive wireless sensor devices operating under strict energy constraints, data transmission range, and size limits poses new challenges in the design methodology for the antenna in wireless sensor communication

A wide-band millimeter-wave (mm-Wave) printed dipole antenna is proposed to be used for fifth-generation (5G) communications. In this research, a 28 GHz Dipole Antenna is designed and simulated. It operates the frequency space from 2.2 GHz to 4.8 GHz. The antenna is developed with FR4 material with a dielectric consistency of 4.4, a loss tangent of 0.02, and a density of 1.6 mm. An inset feed transmission line technique is used for matching the radiating patch and the 50 Ω microstripfeed line. The antenna's geometry was calculated, and simulated results were displayed and analyzed using HFSS.

KEYWORDS: - Fifth generation, Dipole Antenna, inset feed, VSWR, radiation pattern, HFSS.

I. INTRODUCTION

- The antenna is an electromagnetic device that can transmit and receive radio waves. The antenna consists of an electrical conductor designed for working on radiofrequency.
- Dipole antenna is a radio frequency antenna that can be made very simply by just using a wire. It belongs to a wire antenna. It is made of one transmitter element which is divided into two parts.

Power of radiofrequency is applied in the middle of the antenna, between the two conductors. This antenna has an omnidirectional pattern which means the antenna radiates energy in a particular field, equally in all directions.

- Dipole antenna is one type of antenna that is commonly used because its fabrications are easier and cheaper than other types of antennae. An appropriate design is required to get optimal results from manufacturing a dipole antenna.
- This research focuses on the design of a dipole antenna using two different materials, namely aluminum (annealed) and iron for TV application. The real frequency range of TV channels in Jakarta is 450MHz-900MHz.
- In radio and telecommunications, a dipole antenna or doublet[1] is the simplest and most widely used class of antenna.[2][3] The dipole is any one of a class of antennas producing a radiation pattern approximating that of an elementary electric dipole with a radiating structure supporting a line current so energized that the current has only one node at each end.[4] A dipole antenna commonly consists of two identical conductive elements[5] such as metal wires or rods.[3][6][7] The driving current from the transmitter is applied, or for receiving antennasthe output signal to the receiver is taken, between the two halves of the antenna. Each side of the feed line to the transmitter or receiver is connected to one of the conductors. This contrasts with a monopole antenna, which consists of a single rod or

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conductor with one side of the feed line connected to it, and the other side connected to some type of ground.[8] A common example of a dipole is the "rabbit ears" television antenna found on broadcast television sets.

- The dipole is the simplest type of antenna from a theoretical point of view.[1] Most commonly it consists of two conductors of equal length oriented end-to-end with the feed line connected between them.[9][10] Dipoles are frequently used as resonant antennas. If the feed point of such an antenna is shorted, then it will be able to resonate at a particular frequency, just like a guitar string that is plucked. Using the antenna at around that frequency is advantageous in terms of feed point impedance (and thus standing wave ratio), so its length is determined by the intended wavelength (or frequency) of operation.[3] The most commonly used is the centre-fed **half-wave dipole** which is just under a half-wavelength long. The radiation pattern of the half-wave dipole is maximum perpendicular to the conductor, falling to zero in the axial direction, thus implementing an omnidirectional antenna if installed vertically, or (more commonly) a weakly directional antenna if horizontal.[11]
- Although they may be used as standalone low-gain antennas, dipoles are also employed as driven elements in more complex antenna designs [3][5] such as the Yagi antenna and driven arrays. Dipole antennas (or such designs derived from them, including the monopole) are used to feed more elaborate directional antennas such as a horn antenna, parabolic reflector, or corner reflector. Engineers analyze vertical (or another monopole) antennas based on dipole antennas of which they are one-half.
- receive radio waves. The antenna can consist electrical conductor designed for working on radiofrequency. The dipole antenna is a radio frequency antenna that can be made very simply by just using a wire belongs long a to wire antenna. It is made of one transmitter element which is divided into two parts. Power of radiofrequency is applied in the middle of the antenna, between the two conductors. This antenna has an omnidirectional pattern which means the antenna radiates energy in a particular field, equally in all direct .The dipole Dipole antenna is one type of antenna that is commonly used by fabrication variations are easier and cheaper than other types of antenna. An appropriate design is required to get optimal results from manufacturing a dipole antenna. This research focuses on the design of a dipole antenna using two different materials, namely aluminum (annealed) and iron for TV application. The real frequency range of the T channel sold in Jakarta is 450MHz-900MHz [1]. Nowadays antennas become the component that is most needed in modern industry. Another type of antenna is a microstrip antenna. Microstrip antennas have been found to d to apply to high-performance performance aircraft and satellites satellite. and missiles; where size, weight, cost, performance, ease, installation, and aerodynamic profiles are important [2]. The microstrip consists antenna consisting of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side. The patch can assume any shape like rectangular, circuit lar, triangular, or elliptical but regular shapes are generally used to simplify analysis and performance prediction. For good, antenna performance ta hick substrates with low dielectric centenaries are used to enhance the fringing fields accountants for the radiation and larger bandwidth but it results in larger antenna size [3]. In this research, aluminum (annealed) and iron dipole antenna, and rectangular microstrip antenna are designed to observe the performance result before t design is applied in the real implementation.

II. DIPOLE ANTENNAS OF VARIOUS LENGTHS

The fundamental resonance of a thin linear conductor occurs at a frequency whose free-space wavelength is *twice* the wire's length, i.e., where the conductor is 1/2 wavelength long. Dipole antennas are frequently used around that The antenna is an electromagnetic device that can transmit and

Gain of dipole antennas[12]

Length, L, in wavelengths	Directive gain (dBi)	Notes
≪0.5	1.76	Poor efficiency
0.5	2.15	Most common
1.0	4.0	Only with fat dipoles
1.25	5.2	Best gain
1.5	3.5	Third harmonic
2.0	4.3	Not used

Other reasonable lengths of dipole do not offer advantages and are seldom used. However, the overtone resonances of a half-wave dipole antenna at odd multiples of its fundamental frequency are sometimes exploited. For instance, amateur radio antennas designed as half-wave dipoles at 7 MHz can also be used as 3/2-wave dipoles at 21 MHz; likewise, VHF television antennas resonant at the low VHF television band (centered around 65 MHz) are also resonant at the high VHF television band (around 195 MHz).

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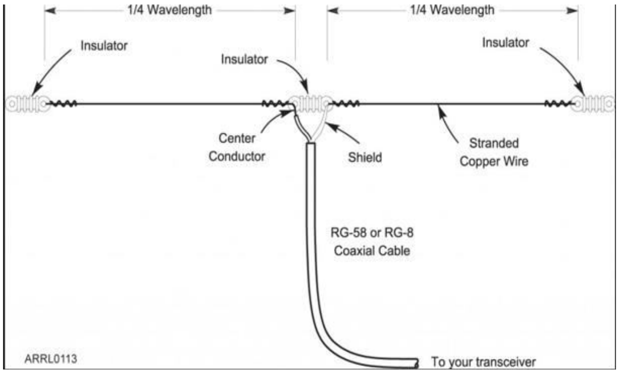
III.DIPOLE ANTENNA



The dipole antenna has current distributions for the length of = λ/10, λ/2, λ, and 1.5λ. A dipole antenna that is commonly used is a single dipole antenna or a half-wave dipole antenna. The length of a single dipole antenna is ½λ, the corresponding input impedance is 73Ω, and has a figure-eight-shaped radiation pattern toward the front of the wire [4]. Fig.1 shows the structure of the λ/2 dipole antenna. The wavelength of the dipole antenna can be determined by using Eq. (1) [4].

λ = c/ λ……… (1)

- Where: is wavelength in meter c is the velocity of electromagnetic wave (3x108 m/s)
- F is the center frequency in Hz To determine the total length of the dipole antenna wire we use Eq. (2), Eq. (3), and Eq. (4) [6] [7].

- Length of a half-wave dipole antenna,
- L=143/f…. …... (2)
- Feeding gap of the antenna,

g = 200 /L …… (3)

- Radius of the wire,

R=1000/ λ …… (4)

- Equations above are used for the starting point to measure the dimension of a dipole antenna. In this research, optimization was done to meet the specifications.

III. LITERATURE SURVEY

P. Revathy1, T.Ananth Kumar2 & R.S. Rajesh3

The Dipole Antenna is the most efficient RF-based Antenna which can be developed from a part of a more complicated antenna array. This paper mainly aimed in making an effective dipole antenna. The dipole antenna is one of the highest gains producing antennae and is highly used in the n radio and telecommunication field. The efficiency level of this antenna is very high. The dipole antenna is designed using the HFSS v15 software and impedance, directivity, gain are examined. It shows that the proposed model is more efficient than the previous antenna. Keywords: Dipole antenna, Radiation pattern, Efficiency, Directivity, HFSS

The dipole antenna is the most efficient class of antenna in the radio and telecommunication field. The dipole antenna whose radiation pattern produced is approximately equal to a radiating structure which is having an elementary structure [1]. In a dipole antenna, the feed line is connected between the two conductors of equal length providing the end-to-end connection. Dipole antennas are highly preferred to act as resonant antennas. Feed point plays a vital role in this kind of antenna. When the feed point is shorted, then the antenna can resonate at a particular frequency. E.g. Guitar. It is very useful for operating the antenna at a particular frequency in terms of feed point impedance. Hence, the length of the feed point decides the frequency of operation. Out of these all, the use of center-fed-half-wave dipole is high [2]. The dipole antenna act as omnidirectional installed vertically and acts as a weekly directional antenna when it is installed horizontally. Nowadays, most of the antennas used are to be seen as based on the dipole. Many directional

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antennas like horn, parabolic, and reflector are fed by dipole antennas. It is already analyzed that the vertical antenna on the base of the dipole antenna design is half of the vertical antenna.

Kaushal Mukherjee

Design of wideband planar antenna withinverted I-shaped tuning stubs for application in 5G, satellite communication, and Internet of Things

In this article, a wideband planar antenna is proposed for 5G mobile communications, satellite communication, and Internet of Things (IoT)-enabled applications. The proposed antenna consists of a rectangular radiating patch and two I-shaped tuning stubs, excited by two I-shape microstrip lines. The antenna of size (17 × 20 × 1) mm^3 is designed using FR4 material having a dielectric constant (εr) of 4.4. Simulated results illustrate that the antenna operates with a radiation efficiency of 90% and a peak gain of 9.33 dBi. The achieved bandwidth of 161.54 GHz ranging from 31.6 to 193.14 GHz covers the licensed and planned bands of 5G communication (n257, n258, n259, n260, and n261). This antenna will support lower bands within 30 GHz (X, K, Ka, middle-frequency bands), within 110 GHz (Q, U, V, W, F bands), and upper-frequency bands up to 170 GHz (D-band) used for satellite communication. The IoT framework is required to be updated, with ultra-high-speed antennas, which will improve the user experience in the fields like agriculture, communication, education, and transportation. A comparative study between the proposed antenna and other existing antennas with supporting results such as VSWR, impedance bandwidth, radiation efficiency, and gain is also presented in this work.

Ashok Kumar

Broadband circularly polarized monopole antenna for millimeter-wave short-range 5G wireless communication

This article describes the design and measurement of broadband circularly polarized (CP) monopole antenna for millimeter-waveshort-range 5G Wireless communication applications. This antenna is comprised of a T-shaped monopole antenna with an inverted-L grounded stub and an asymmetric coplanar waveguide feed. To attain the broadband CP, an inverted-L grounded stub is embedded in the coplanar ground and introducesan asymmetry in the horizontal T-shaped patch-connected feed line monopole antenna. A compact size of $1.877\lambda_L \times 1.706\lambda_L \times 0.130\lambda_L$ is accomplished when measured at a lower edge frequency ($f_{L,|S11|}$). For the proposed antenna structure conforming to $f_{L,|S11|}$, a measured 3-dB axial ratio bandwidth of 13.67% (4 GHz, 27.26-31.26 GHz), impedance bandwidth of 27.9% (8.3 GHz, 25.6-33.9 GHz), the peak gain of 7.15dBi, and a bidirectional pattern with a dual sense polarization are attained.

Sanyog Rawat

Efficiency enhancement techniques of microwave and millimeter-wave antennas for 5G communication: A survey
Efficiency is a critical antenna parameter that describes how well an antenna emits and accepts electromagnetic signals.

When an antenna has poor efficiency, the input power is only partially radiated and is primarily wasted due to internal losses such as conduction, dielectric, mismatching, and several other losses within the antenna. To enhance signal quality, a communication system requires an antenna with high efficiency and gain.

The fifth-generation wireless system will use millimeter wave spectrum along with sub 1 GHz and sub 6 GHz bands to fulfill the wide bandwidth, ultra-high-speed, and low latency requirements of 5G communication. Compact low-profile antenna with high radiation efficiency, high gain, and wideband characteristics are required to support bandwidth requirements of 5G and mitigate the signal degradation due to high link losses caused by environmental absorptions at the millimeter-wave (mm-wave) spectrum.

Compact planar antennas have become an important part of modern wireless communication equipment, but these antennas are associated with many issues like low efficiency, poor gain, small radiation resistance, and high cross-polarization, which is due to the increased conductor and dielectric losses, surface wave losses and so forth. Various techniques need to be employed for the improvement of the efficiency of the antenna, which results in high gain low loss antenna characteristics.

This article presents the survey of various efficiency enhancement techniques for 5G antennas and a review of structures that provides good radiation efficiency for 5G communications.

Naser Ojaroudiparchin; Ming Shen; Gert Frolund Pedersen

A 28 GHz FR-4 compatible phased array antenna for 5G mobile phone applications

The design of a 28 GHz phased array antenna for future fifth-generation (5G) mobile-phone applications has been presented in this paper.

The proposed antenna can be implemented using low-cost FR-4 substrates while maintaining good performance in terms of gain and efficiency. This is achieved by employing a new air-filled slot-loop structure as the radiator.

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A prototype array consisting of ten radiator elements has been designed for concept validation.
Both the radiation and total efficiencies of the antenna array are higher than ™0.5 dB (90%) for the scanning range between 0° to 50°, while the gains are higher than 13 dB. In addition, the simulated and experimental results show that the antenna has an S11 response of less than ™10 dB in the frequency range of 27 to 29 GHz

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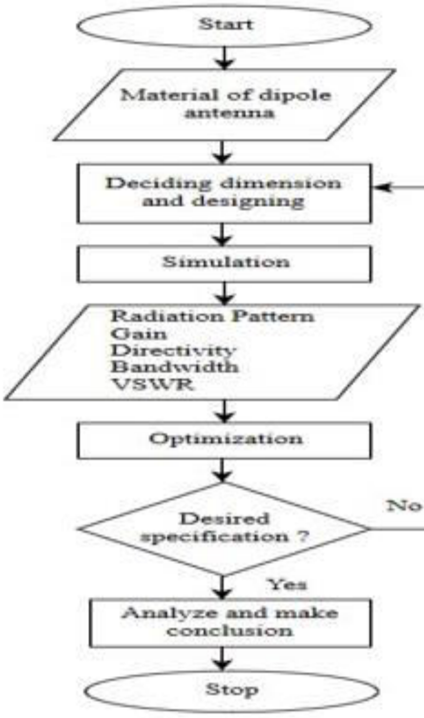

IV. RESULT AND DISCUSSIONS

Taking the substrate and material radiation area

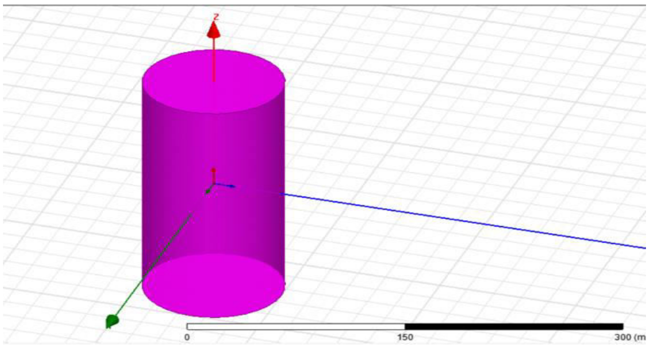

Fig 1: The pure electric conductor is cut into two monopole or different conductors with a gap of vacuum

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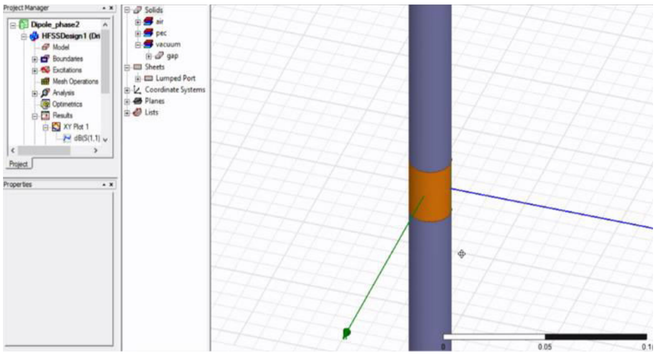

Fig 2: An air gap or divided portions of the material andSheet is inserted between the two conductors for applying an input to the PEC material

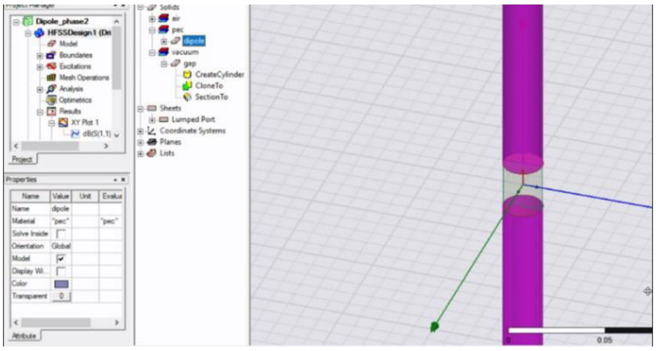

Fig3: Applying radiation boundaries for the area around the dipole antenna

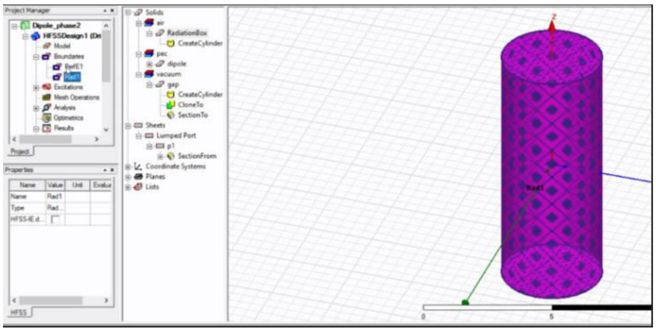

Fig4:Applying boundaries for the dipole PEC material to test the resonating frequency

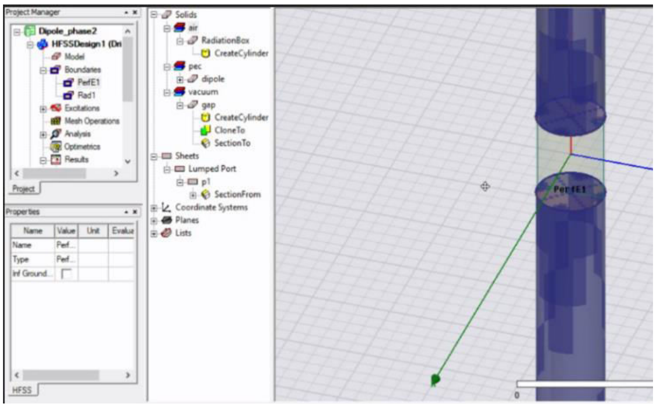

Fig5

Fig5:Excitation is applied in between the conducting material through the lumped port

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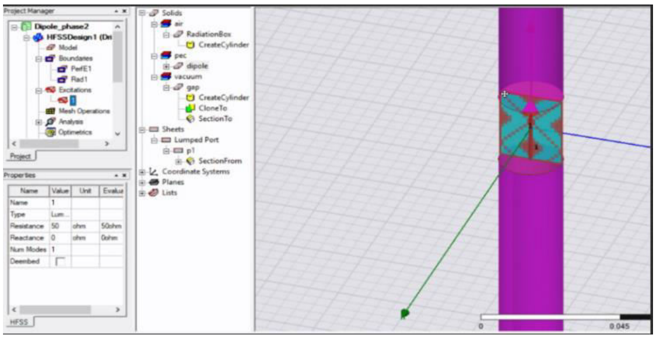

Fig:6**Excitation state of the lumped port**

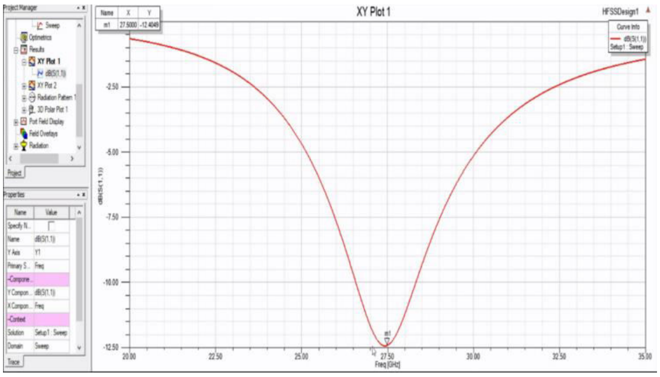

Fig 7Applying frequency sweep to lumped port and Before stimulation checking for the green signal

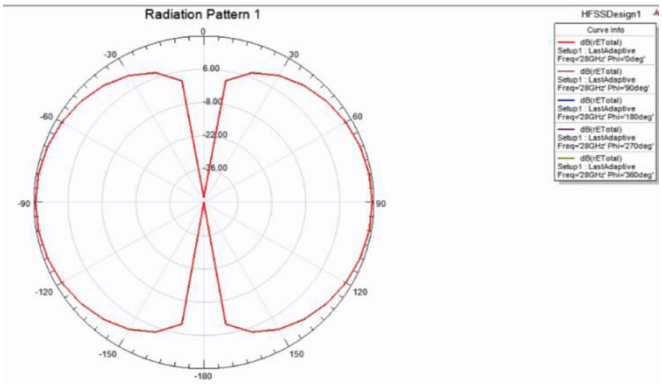

Fig 8 Output of resonating frequency from the dipole antenna, VSWR Output, and Radiation pattern of the dipole antenna and 3D Model of the radiation pattern

V. CONCLUSION

From this research, we have successfully designed and investigated the performance of a dipole antenna using a pure electric conducting material as a substrate and a resonating frequency of 28Ghz.In Stimulation, the gain of conducting material bigger than aluminum with the value is getting an increase from lower to upper frequency. The gain of iron is lower than copper or PEC material. The resonant frequency of 27.5 from the dipole antenna is propagating very well and perfect boundaries for excitation of electromagnetic waves from the two different conductors From this research we have successfully designed and Investigate the performance of a dipole antenna using aluminum and iron at 644-736 MHz. In a simulation, the gain of iron is bigger than aluminum with the value of directivity getting an increase from lower to upper frequency. The gain of iron in lower, middle, and upper frequency is 2.02, 2.06, 2.11 dB andthedirectivity 2.04, 2.07, and 2.1 dBi. On the other hand, the gain and directivity for aluminum are 2.01, 2.06, 2.1 dB and2.03, 2.06 and 2.09 dBi respectively. It is contrary to the real fabrication as aluminum has better quality.

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