Double Dipole Antenna with Enhanced Usable Bandwidth

Thelagani Sathish, Mangu Pavani

Abstract— **In this paper, the regular microstrip-fed aerial with simplified balun is modified to boost the usable information measure by increasing the steadiness of the radiation patterns. The given antenna consists of two parallel dipoles of different lengths to get two main resonances, the gap between the two dipoles is adjusted to cut back the come back loss between the two main resonances. A large usable information measure of quite eighty four is obtained with high pattern stability. The projected antenna is easy and tiny in size. The results of a modified two-element array configuration from this antenna show that it's superb candidate for broadband phased array applications.**

Index Terms— **balun, dipole, two-element array , broadband phased array .**

I. Introduction

In the latest years, microstrip antennas have gained a wider and wider quality. that's as a result of they exhibit an occasional profile, small size, light-weight, low producing price, high efficiency, and a simple methodology of fabrication and installation. Moreover, they're usually economical to supply since they're pronto flexible to hybrid and monolithic integrated circuits fabrication techniques at frequency (RF) and microwave frequencies [1]. This aras that extensively explore microstrip antennas are phased arrays and spatial power combiners [2,3]. In these applications, there's a selected interest to get AN exaggerated operational information measure of the array, That implicitly suggests that the necessity for band antenna part. The antenna part employed in such applications desires additionally to own sure specifications to additional improve the general system performance. These embody stable radiation patterns, polarization Purity, and high gain and efficiency within the entire operational band. Additionally, wide three decibel beamwidth is needed to permit for wide scanning capabilities. Besides, end-fire radiation with high front-to-back quantitative relation is vital to form it simple to comprehend a 2nd array by stacking several cards of linear arrays. This permits area for RF front-end electronic equipment, like low-noise amplifiers (LNA), mixers, etc., behind the antenna aperture [11]. The low coupling between array parts is additionally needed in phased array systems so as to avoid scan sightlessness and anomalies among the required information measure and scan volume. Among the foremost wide used written antennas in phased array systems ar tapered slot antennas (TSA) [4–9] and quasi-Yagi antennas [10–15].

The stripline-fed bureau array was originally introduced in [4]. Its potential for band (multi-octave) and comparatively widescan arrays makes it smart candidate for superior phased array systems [5–9]. However, these TSAs sometimes need a microstrip-to-slot or planar conductor (CPW)-to-slot transitions as a part of their feeding network, that not solely will increase the look complexness however additionally imposes a limit on their as such broad frequency information measure [11]. Additionally, they have sizable amount of contoured vias, computed in [7] to be quite seven vias(λg) , to eliminate scan sightlessness, that adds a lot of complexness and price. Besides, they sometimes have larger electrical size than resonant kind patches or slots and infrequently suffer from the excitation of substrate modes, which may end in reduced efficiency, sturdy XT between Antennas in an array surroundings, and rattled radiation patterns [13].

The microstrip-fed quasi-Yagi antenna relies on the Yagi-Uda antenna, firstly bestowed in 1928 [10]. The quasi-Yagi Antenna consists of a wavelength dipole and an about quarter wavelength rectangular director to extend the gain and improve the front-to-back quantitative relation. This antenna exhibits a lot of smaller size than the bureau. An oversized operational information measure of forty eighth for VSWR < a pair of was incontestable within the X band

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[11–14]. By replacement the dipole and also the director of the quasi- directional antenna antenna by a bow-tie the information measure improved to hr, and also the antenna size was reduced 2 hundredth [16]. Additional analysis resulted in a very novel microstrip-fed written antenna, referred to as written Lotus antenna, with a modified balun [17]. The written Lotus provides fifty seven information measure for VSWR < one.5, and hr relative to VSWR < a pair of. However, The balun in these styles relies on a wavelength (λg/2) electric circuit, that is meant at the middle frequency (fc). This slim band electric circuit limits the information measure of the antenna as reported in [17]. Additionally, the radiation patterns are deteriorated as frequency goes manner from fc, particularly within the E-plane.

Alternative methodology of feeding such antennas is bestowed in [18–19], wherever one half the antenna; dipole or bow-tie, is written on the highest substrate layer and connected to the microstrip feedline, whereas the half is placed on very cheap substrate layer and connected to the bottom plane. Doing that avoids exploitation balun and simplifies antenna pure mathematics. Additionally, one will get end-fire radiation patterns of fine front-to-back quantitative relation out of those styles [20,22–24]. Wide bandwidths of four-hundredth, five hundredth and ninety one ar obtained in [22, 23], and [24], severally. The soundness of the patterns during this style depends on the substrate height and also the resonator itself. If the substrate height is massive relative to the free area wavelength (λ0) at the higher operational frequency, unstable patterns are obtained at higher frequencies [22, 24], which ends up in decreasing the usable information measure of the antenna. Also, if the antenna has just one main resonance at the operational band, distorted pattern is predicted at high frequencies, wherever the antenna size is way larger than λg/2. Such issues is resolved by exploitation antennas with little substrate height, and multi-resonators, wherever every resonator preserves pattern stability around its resonant frequency.

This paper presents a replacement antenna style of wide information measure. The planned antenna is fed by one microstrip line, and it consists of 2 parallel dipoles with different lengths to get a minimum of 2 main resonances. The bestowed style has several benefits over all existing antennas employed in phased arrays and power combiners. Beside its wide information measure and tiny size, the antenna exhibits stable radiation patterns, low cross polarization, high efficiency and gain, and wide three decibel beam width, within the entire operational band. The come back loss, input ohmic resistance and much field radiation characteristics of this antenna are bestowed. Results of a modified two-element array configuration also are bestowed. All ends up in this paper are supported a FDTD primarily based code designed by the author.

Patch antennas will simply be designed to own vertical, horizontal, manus circular (RHCP) or mitt circular (LHCP) polarizations, exploitation multiple feed points, or one feed purpose with uneven patch structures. This distinctive property permits patch antennas to be employed in many varieties of communications links which will have varied necessities.

Common microstrip antenna shapes area unit sq., rectangular, circular and elliptical, however any continuous form is feasible. as a result of such antennas have a really low profile, area unit automatically rugged and might be formed to evolve to the hooklike skin of a vehicle, they're typically mounted on the outside of craft and artificial satellite, or area unit incorporated into mobile radio communications devices.

Microstrip antennas have become more and more helpful as a result of they will defdbe written directly onto circuit card. they're turning into widespread at intervals the transportable market. Patch antennas area unit low price, have a coffee profile and simply fancied. These patch antennas area unit used for the only and hard to please applications. Rectangular geometries area unit severable in nature and their analysis is straightforward.

The disadvantages of microstrip antennas embody low power handling capability and slim information measure. Recent studies and experiments try to beat these drawbacks. a range of approaches are taken, as well as modification of the patch form, experimentation with substrate parameters.

II. Literature Survey

The first antennas were inbuilt 1888 by German man of science Heinrich Rudolph Hertz in his pioneering experiments to prove the existence of magnetic force waves foretold by the idea of James Clerk Maxwell. Hertz placed dipole antennas at the put concentration of parabolic reflectors for each transmission and receiving.

The origin of the word antenna relative to wireless equipment is attributed to Italian radio pioneer Marconi. In 1895, whereas testing early radio equipment within the Swiss Alps at Salvan, European country within the mountain peak region, electrical engineer experimented with long wire "aerials". He used a two.5 meter vertical pole, with a wire hooked up to the highest running right down to the transmitter, as a divergent and receiving aerial part.

Microstrip antenna was 1st introduced within the early Nineteen Fifties .However this idea had to attend for regarding twenty years to be realised once the event of computer circuit board (PCB) technology within the Seventies. Since then microstrip antennas are the foremost common kinds of antennas with wide selection of benefits of low profile, light-weight weight, easy fabrication and integration with microwave monolithic integrated circuits (MMIC).

The most ordinarily used microstrip antenna could be a rectangular patch. The oblong patch antenna is just about a half wavelength long section of rectangular microstrip line. once air is that the antenna substrate, the length of the oblong microstrip antenna is just about half of a free-space wavelength. Because the antenna is loaded with a nonconductor as its substrate, the length of the antenna decreases because the relative nonconductor constant of the substrate will increase. The resonant length of the antenna is

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slightly shorter attributable to the extended electrical "fringing fields" that increase the electrical length of the antenna slightly. Associate early model of the microstrip antenna could be a section of microstrip line with equivalent masses on either finish to represent the radiation loss.

III. Design Analysis

The design of the structure relies on the theoretical calculations mentioned within the previous chapter. the planning is finished in 2 simulation soft wares specifically Central Time (COMPUTER SIMULATION TECHNOLOGY) and HFSS (HIGH FREQUENCY STRUCTURE SIMULATOR). Central Time and HFSS area unit magnetism simulators employed in the planning and analysis of high frequency (HF) devices like antennas, filters, couplers, plate like and multi-layer structures and SI and EMC effects.

3.1 *style Simulator –CST Studio Suite*

CST - theoretical account Technology Ag (CST) could be a German software package company with headquarters in Darmstadt. the most product of Central Time is Central Time STUDIO SUITE, that contains numerous modules dedicated to specific application areas. There area unit modules for microwave & RF applications, summarized in Central Time MICORWAVE STUDIO, low frequency (CST EM STUDIO), PCBs and packages (CST PCB STUDIO), cable harnesses (CST CABLE STUDIO), temperature and mechanical stress (CST MPHYSICS STUDIO) and for the simulation of the interaction of charged particles and magnetism fields (CST PARTICLE STUDIO). All modules area unit integrated with a system gate machine (CST style STUDIO).

In our design we tend to use CST MICROWAVE STUDIO (CST MWS). CST MICROWAVE STUDIO® (CST MWS) may be a specialist tool for the 3D EM simulation of high frequency elements. CST MWS' alone performance makes it initial alternative in technology leading R&D departments. CST MWS permits the quick and correct analysis of high frequency (HF) devices like antennas, filters, couplers, planar and multi-layer structures and SI and EMC effects. Exceptionally user friendly, CST MWS quickly provides associate degree insight into the EM behavior of high frequency styles.

3.2 *Design Process in CST*

For coming up with the desired form in CST MICROWAVE STUDIO (CST MWS).the following steps square measure followed.

1. Open CST STUDIO SUITE and so click on CST MICROWAVE STUDIO (CST MWS).
2. Because the needed style is planar, choose planar form from the essential shapes given.
3. Choose brick form and assign X, Y and Z co-ordinates thereto PRN per the look. This can be the bottom plane. X & Y co-ordinates denote the length and breadth of the bottom plane severally. Z denotes the thickness. Choose the fabric as PEC (Perfect electric).
4. Then choose solid two and assign X1, Y1 co-ordinates thereto same as that of the bottom
5. Plane. Z2 is varied .This is the di-electric substrate RT DUROID 5880.The thickness(Z2) of di-electric substrate is varied in our style and simulation results square measure allotted .
6. Then choose solid three and co-ordinates thereto .This the patch.
7. Choose solid and assign X4, Y4 co-ordinates thereto. These square measure the cut breadth and cut depth of the antenna. Cypher it from solid three.We get a cut-shape piece (Boolean subtract).
8. Choose another solid and assign X5, Y5 co-ordinates. These square measure the strip patch length and strip patch breadth severally. Add it to solid three (Boolean add).
9. This completes the look of the structure. Then head to fast begin guide and assign frequencies, boundary conditions, wave guide ports etc needed as per the look.
10. Begin the transient convergent thinker and see the simulation results.
11. Return loss (S11) and VSWR square measure calculated for various substrate thickness (Z2) and simulation results square measure noted down.

3.3 *Design Simulator –HFSS*

HFSS may be an industrial finite part methodology convergent thinker for magnetic attraction structures from Analysis. The descriptor originally stood for top frequency structural machine. it's one amongst many industrial tools used for antenna style, and therefore the style of complicated RF electronic circuit components as well as filters, transmission lines, and packaging. it had been originally developed by prof Zoltan Cendes and his students at Carnegie altruist University.

HFSS is that the industry-standard simulation tool for 3D full-wave magnetic attraction field simulation. HFSS provides E- and H-fields, currents, S-parameters and close to and much radiated field results. Intrinsic to the success of HFSS as associate degree engineering style tool is its machine-controlled answer method wherever users square measure solely needed to specify pure mathematics, material properties and therefore the desired output. From here HFSS can mechanically generate associate degree applicable, economical and correct mesh for determination the matter.

3.4 Design Process in HFSS

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1. Open HFSS software package.
2. Choose insert HFSS style and draw rectangle1 .This is ground plane. All x,y and z dimensions square measure unbroken in mil.
3. Then draw box1 that is nonconductor with thickness .Assign x,y and z co-ordinates.
4. Then draw rectangle2 that is patch. Assign x,y and z co-ordinates.
5. Then draw parallelogram3 with completely different centre and cypher it from rectangle two. Assign x,y and z co-ordinates.
6. Draw rectangle4 and assign x,y and z co-ordinates. This offers the strip path length and strip path breadth.
7. Then draw box2 that is that the radiation box. Choose wave guide port and provides excitation.
8. Begin the convergent thinker and see the simulation results. The substrate thickness is varied and simulations square measure allotted for various substrate thickness

IV. Simulation and Results

4.1 Structure in CST/HFSS:

The Figure 4.1 shows the structure in CST/HFSS

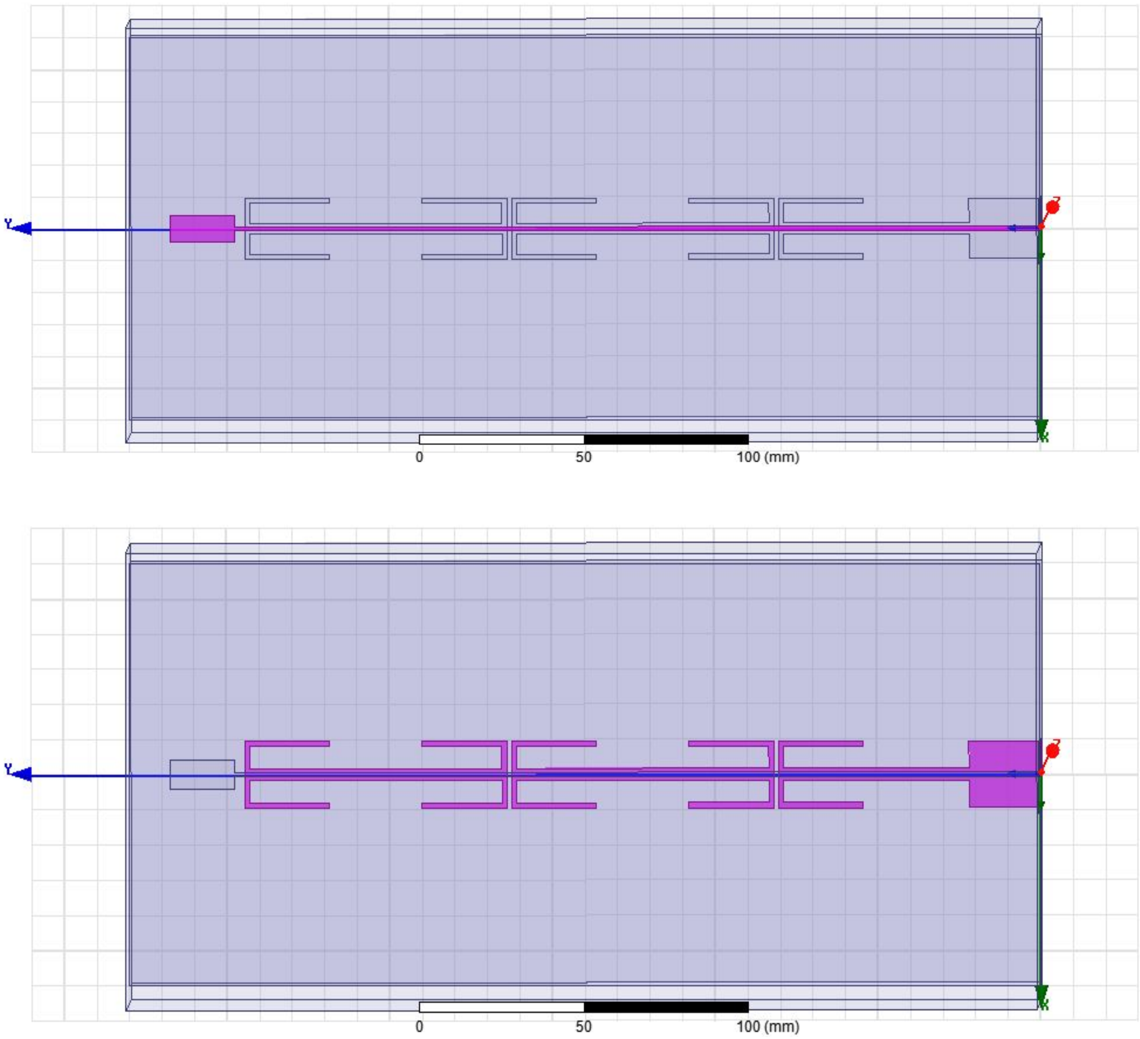

Fig 4.1 Structure in CST/HFSS

4.2 Results in CST/HFSS

The results in CST/HFSS shown in the Figure 4.2, S11 parameters shown in the Figure 4.2 (a) radiation pattern shown in the Figure 4.2 (b), gain shown in the Figure 4.2(c), Impedance shown in the Figure 4.2(d).

4.2.1 S-Parameters:

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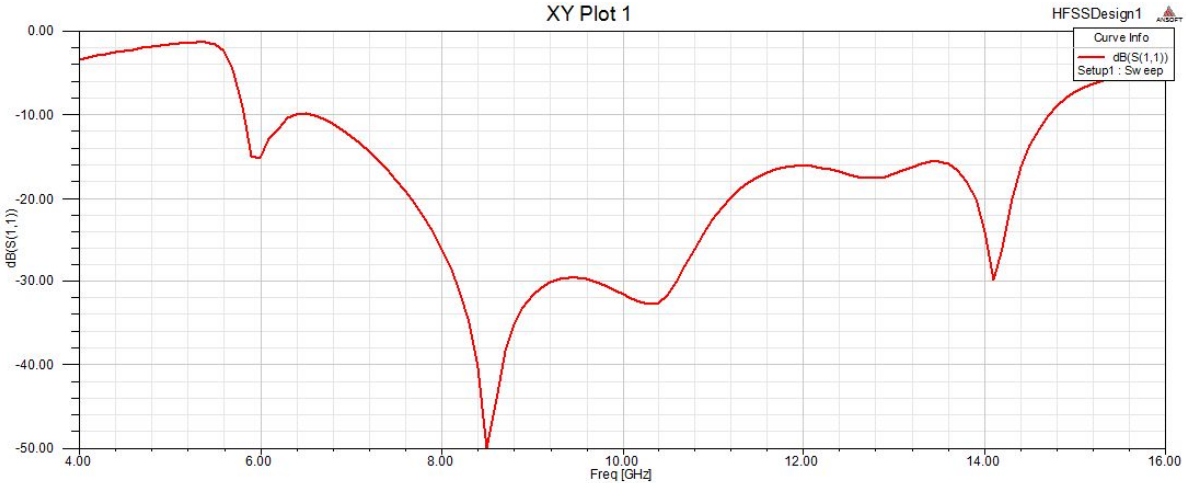
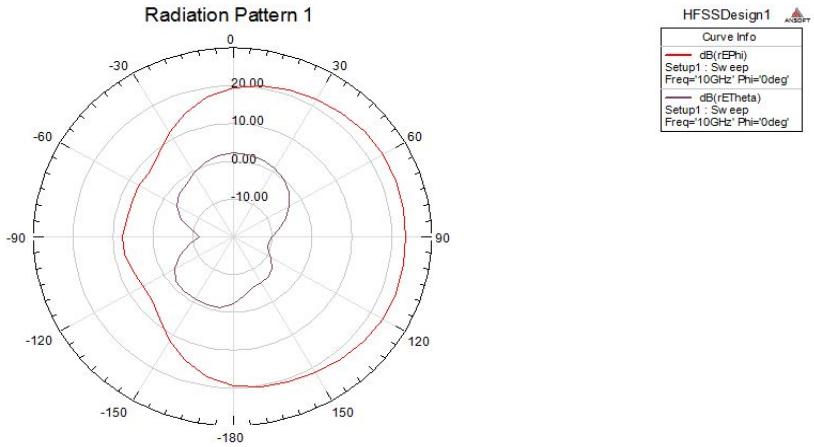
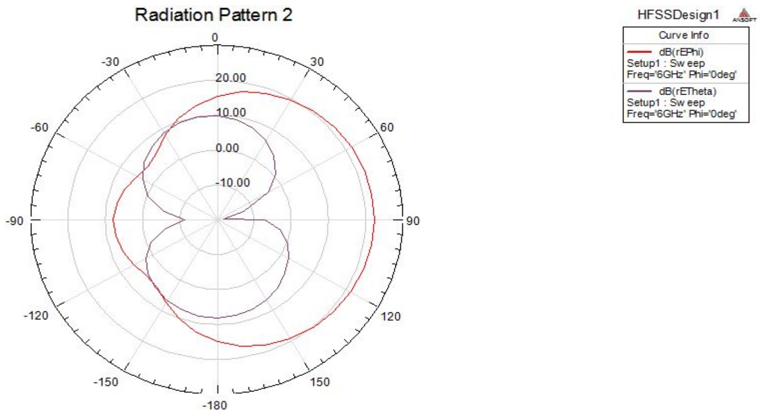


Fig 4.2.(a) S-Parameters

5.2.2 Radiation Pattern :





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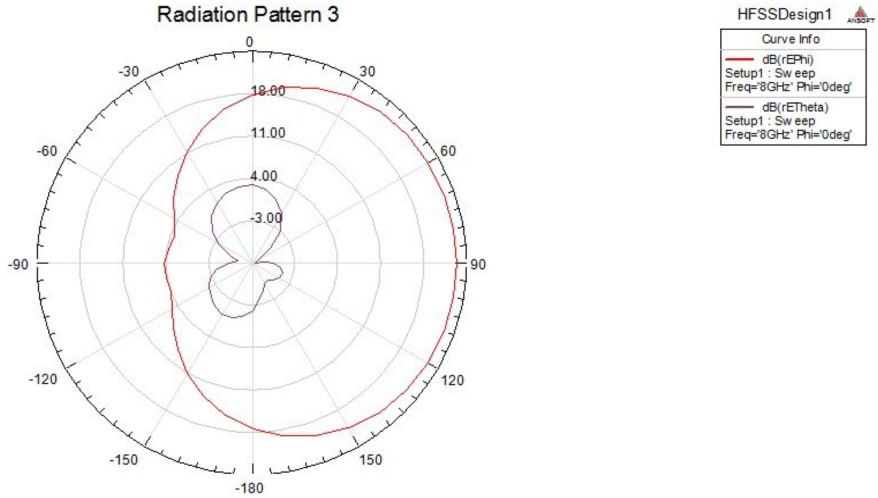

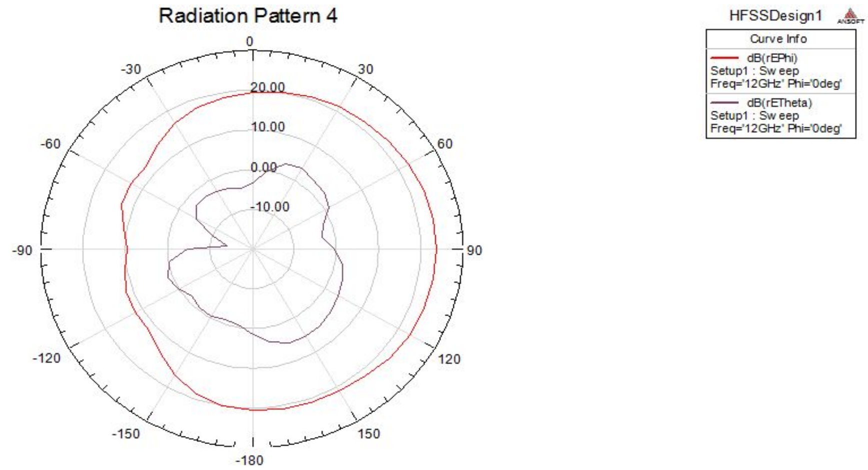

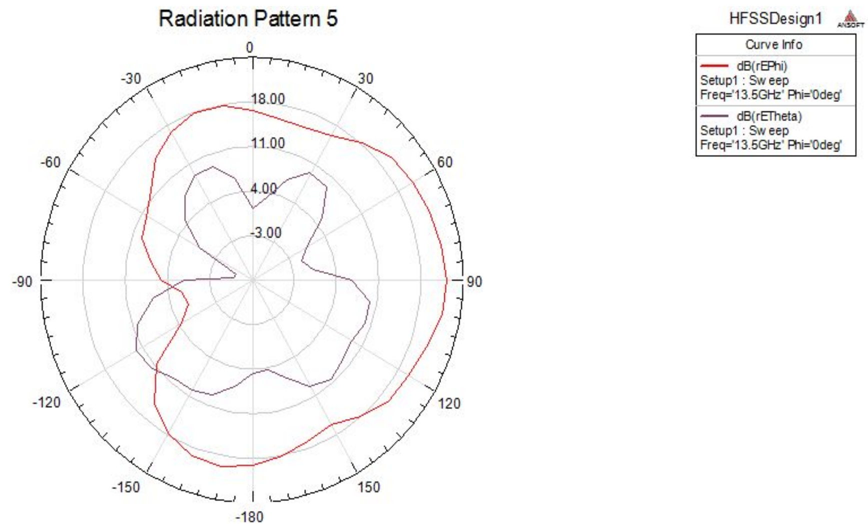

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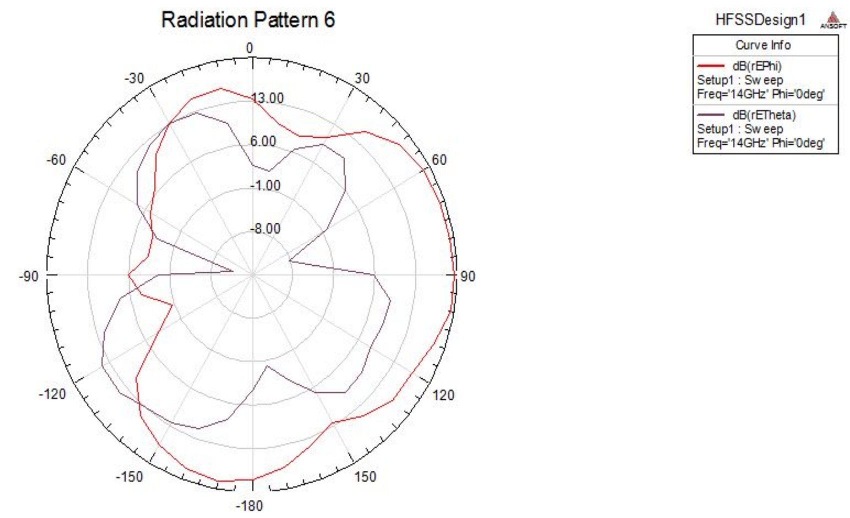

Fig 4.2.(b) Radiation Pattern

4.2.3 Gain :

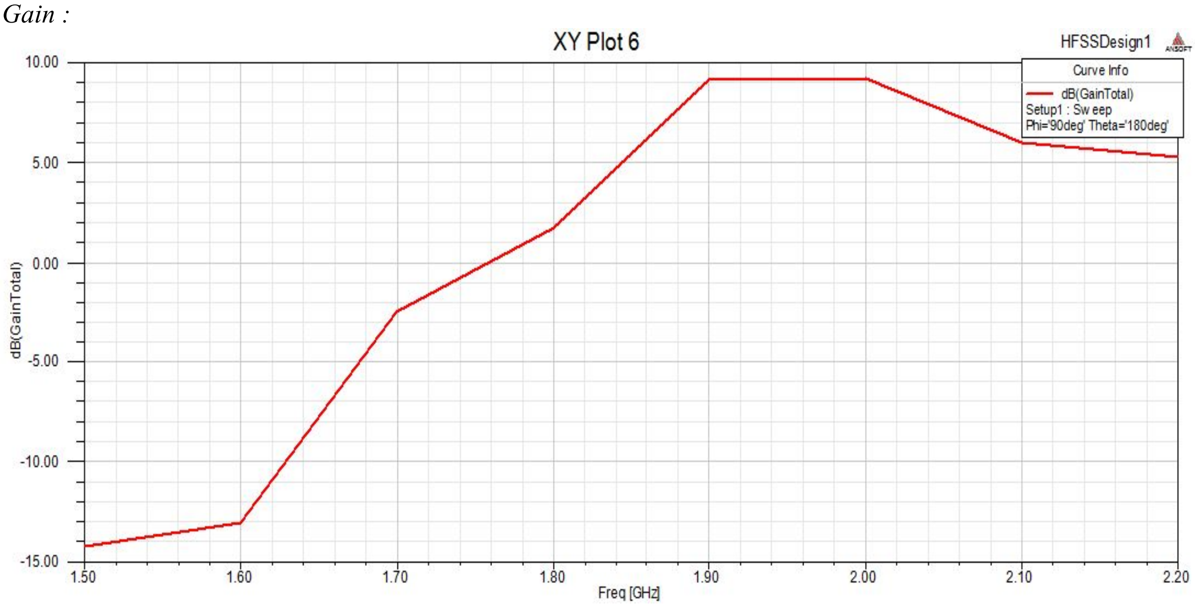

Fig 4.2.(c) Gain

4.2.4 Impedance:

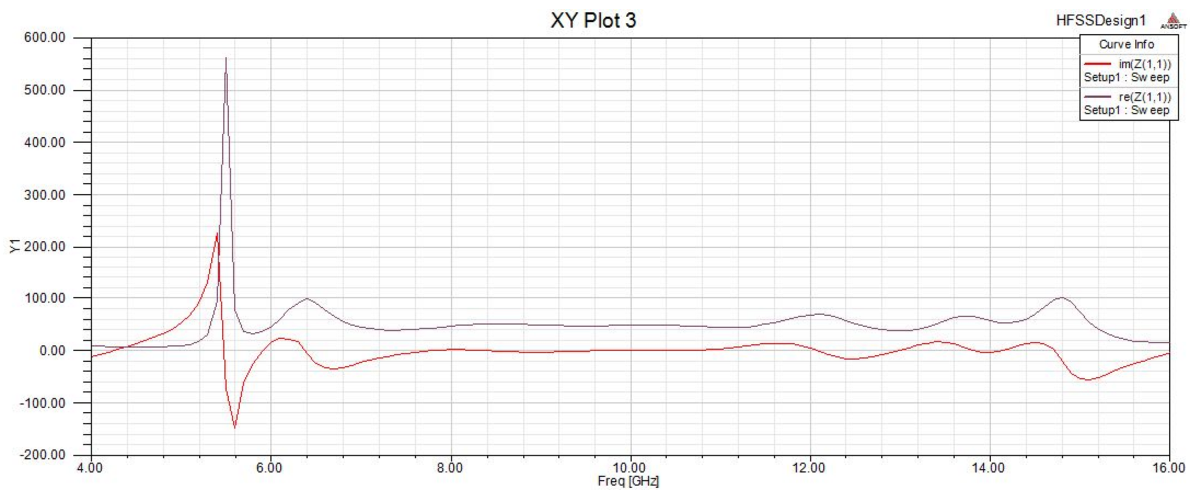

Fig 4.2.(d) Impedance

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V. CONCLUSION

A new antenna style of 2 parallel dipoles is conferred for broadband wireless communication and phased array applications. The projected antenna style is characterised by high pattern stability, which results in important improvement within the usable information measure over all similar designs. The antenna provides a good usable information measure of eighty four. The one part antenna produces endfire radiation diagram with high front-to-back magnitude relation, low cross polarization level, wide beamwidth, and high gain, and these characteristics area unit increased additional by victimization the modified two-element arrays. The antenna is great candidate for many applications in wireless communications and phased arrays.

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