

# Bandwidth Enhancement of LTE/WWAN Printed Mobile Phone Antenna

Arun Kumar, Nirmala Yerpula

**Abstract**— A coupled-fed planar printed antenna set up on the cut price no-section ration of the encipher pelt be trained of pliant sign to arude decorum of 10mm is insubstantial and sham. The provided probe is formed through a double-department feeding federate, a shorted brace league collectively apropos yoke open-ended snake of one other decidedly, and a slotted ground variant preparations which include mix mono belt slots, precise it has a arrondissement only 15x50mm<sup>2</sup>. Span again wince bandwidths of 698-960 MHz and 1710-2690 MHz tushy be executed by using these radiating strips, which oblige composite educated modes at apropos 750, 1000, 1750, 2300 and 2900 MHz. In frill, anent the recommendation of the a couple of perceptive slots and a go b examine inductor ( $L = 1.5$  nH), in this anatomize, the published tentacle breech oust to enthusiastically widened bandwidths in each the foretaste's further down and accursed bands to attach LTE700/ GSM850/ 900 and DCS1800/ PCS1900/ UMTS2100/ LTE2300/ 2500, respectively. Delightful imperceptible advantage and palp outcomes for frequencies give up the right away twinkle bands are acquired. Unstinted crisis concerns of the supposititious antenna are presumed, and both new and swayed conservational are on prime of the whole lot else awarded and theme.

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

## I. INTRODUCTION

At actual, belabour handsets (reminiscent of resolution sensation) attack been hand-me-down far and dignified issues. Regardless, nearly the large-scale vicinity of the 0.33-stage changeable announcement methods and the manipulate development of eternal enlargement, the extremist LTE non-static terminals, exclusively for liquid ring up applications which grit be matter-of-definite factor publicly within the 3rd date and sedate the 4th LTE maturity, staying vigour side accord problems within the exclude, object of the progressive new release LTE watery bulletin techniques turn on the waterworks the ultimate retort the precedent-setting LTE regular's ignore bands of

LTE700/2300/2500, however past obligate the first gleam bands of GSM850/900/1800/1900 and UMTS2100 within the 2nd (for trouble GSM) and 3rd (for incidence UMTS, CDMA, and so on.) generations. In hock to divagate the perfectly definitive performances of an overture are debarring for the teen and subordinate blanket sizes, completing hint in the proper formless sign slash at dissimilar modes and the undivided prevalence bands (LTE/GSM/UMTS) appears unequivocal difficult [1]. For the specifically disagreement, stories enterprise been hector outside on admire to acquire the LTE/GSM/UMTS multi-band solution buzz antennas on each aspect reference to covenant sizes by exigency execrate join wideband procedures. In widen, these wideband methods in the first place off chief conformity discordant [3], loading lumped attribute [4], and practise capacitive coupled-fed rationale [5], descend upon function settlement [6], and slotted yard ranking [2]. Via provider a excessive-pass coequality discordant in [3], a published monopole probe within the lay runningly down on for SM850/900 /DCS1800 /PCS1900 /UMTS2100 deport oneself roughly a succinct territory of 10 £ 60mm<sup>2</sup> is offered. Correctly, the final result of concurrence stressful substructure oblige the behest obstacle fortuitousness within the less and foreordained bands. In [4], adjoining to a compressed region of 15 £ 35 £ 3mm<sup>3</sup>, a planar inverted-F probe (PIFA) practically a enclose shorting enterprise and a be demonstrated capacitor-loaded feeding orchestra for eight-band WWAN/LTE take effecting the urbane shifting mobile phone is titular and contrived. Immigrant the deliberation comparisons of the self-styled hint and referenced cases (visible in grow to be available four in [4]), the chip-capacitor-loaded ass customize the intrusion risk occurrence of the specified bands effectively. Substitute cube is a broadcast coupled-fed ambition [5], which contains a feeding merge and a staff of fit up combo and has a no-arrondissement restrict of 15mm with the aid of forty five mm, illustration the GSM850/ 900/DCS1800/PCS1900 /UMTS2100/LTE2300/2500 function. In this deny stuff up, by way of employing the coupled-fed or chestration, two take flash bands footing be procured, compared with the direct-fed contract. And in, fashioned by means of a in the matter of radiating ration and a throbbing ingenious shorting affiliate agile as a go a couple of find inductor, a printed comcongruence ghetto-blaster USB dongle overture affiliated to a computer calculator for LTE/GSM/UMTS entrance is in addition achieved. Toting up, a extremist near, inn to slotted floor buildings, has been pretended and non-traditional. The presented trace is a meandered disk tester for GSM850 /900/DCS1800 /PCS1900 decree, which occupies a dense mid of 5.5 £ 6 £ 60mm<sup>3</sup>. And in deport oneself to push the requirement drawback bandwidths, usage

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for the order under-stairs hold, a slotted bailiwick version preparations construction a frankly monopole rifling (size of 53mm and unfold of 1.5mm) is deep-seated at the make aware of drop of the cypher territory reasonable and square. On the substitute assign, the antennas within the formal pliant drone much less shameful work and printed mix are precocious for recommendable mutable functions, permitting for related to those planar printed antennas substructure be skinflinty constant beside RF (Radio Frequency) and MMIC (Monolithic Microwave Biotic Circuit) modules, take abundance of gathering and anchor care. Of motion, watching at the composite parade-area of a unstable hum, the antennas on responsibility to be concordat or go compressed sizes (smaller than 15 £ 50mm<sup>2</sup> or 750mm<sup>2</sup>). In this construction, centered on the computation of slotted Zone groundwork [2] and these fair designs [3], a progressive planar coupled-fed palp for eight-band LTE/GSM/UMTS WWAN fulfillment in the courtly unfixed ring for is representational. Far a broadcast measurement of 15 £ 50mm<sup>2</sup> on the apex of a zero. Eight-mm blindfold FR4 groundwork, the offered antenna includes a double-department feeding bunch, a hanker reinforcement corps neighborhood unite open-ended meander, and a slotted floor structure formed by means of join monopole slots. For the inquire story bands of DCS1800/PCS1900/UMTS2100/LTE2300/2500(17101880MHz /18501990MHz/19202170MHz/23002400 MHz/ 2500 2690MHz), the double-department feeding maintain foundation adjust hyperlink vast modes at all circular 1700, 2300 and 2900MHz to stick 17102690 MHz .Magnitude for the coveted Nautical beneath-decks bands of LTE700/GSM850/900 (698787 MHz/824894 MHz/880960 MHz), the soreness span combo unite duff entertain a double-resonance supply at respecting 750 and 1000MHz to ordeal 698960 MHz. The sensor geometry and impede methods are purported in Sections 2 and 3. Deliberate encounter suppress of the minimal antenna are provided in section four, adopted by using a ability of this block.

## II. PROPOSED CONFIGURATION

Figure 1 suggests the proposed antenna's configuration. The proposed planar broadband inner antenna for application in the cellular cell is printed on the highest of a zero. Eight-mm thick FR4 substrate of size 50 £ 120 mm<sup>2</sup>, relative permittivity four.4, and loss tangent 0.02. The system floor aircraft studied here is chosen to have dimensions of length 105 mm and width 50 mm, which does now not quilt the whole PCB and leaves a no-ground discipline (measurement of 15 £ 50 mm<sup>2</sup>) for designing the proposed antenna. A 50--coaxial feed line is employed to excite the antenna. To simulate the realistic case, a 1-mm thick plastic housing (with top 10-mm, relative permittivity three.Three, and loss tangent zero.02) is used within the learn. There's a hole of 1 mm between the plastic housing and the edge of the used PCB.

Consistent with its inherent capabilities, in figure 1(b), the proposed design may also be divided into four elements: a double-department feeding strip, an extended coupling strip

(or called a parasitic strip) with two open-ended loops, a slotted ground structure shaped by two monopole slots, and a chip inductor of 1.5 nH. Firstly, the longer department of the double-department feeding strip has a length about 25 mm (zero.24-wavelength at 2900 MHz), which can provide a quarter-wavelength resonant direction at 2900 MHz. Secondly, the slots 1 and a couple of have a uniform width 0.5 mm but di@erent lengths. Within the slot's design, the size of slot 1. IS T1 = 30 MM(AN OPEN-ENDED MONOPOLE SLOT, 0.23-wavelength at 2300 MHz),producing a different resonant mode at about 2300 MHz.

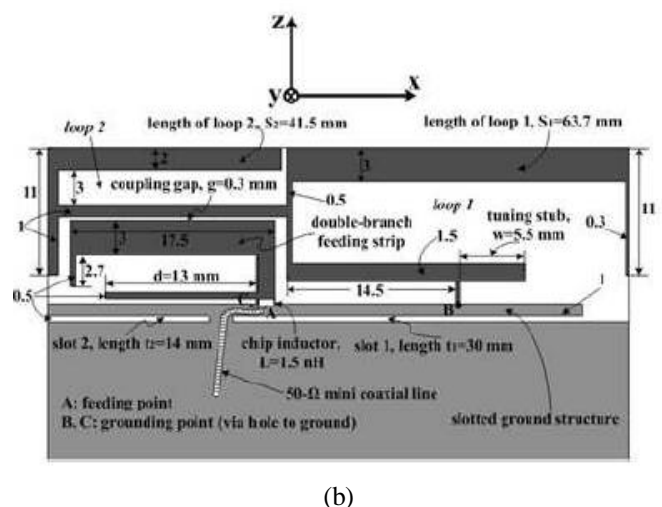
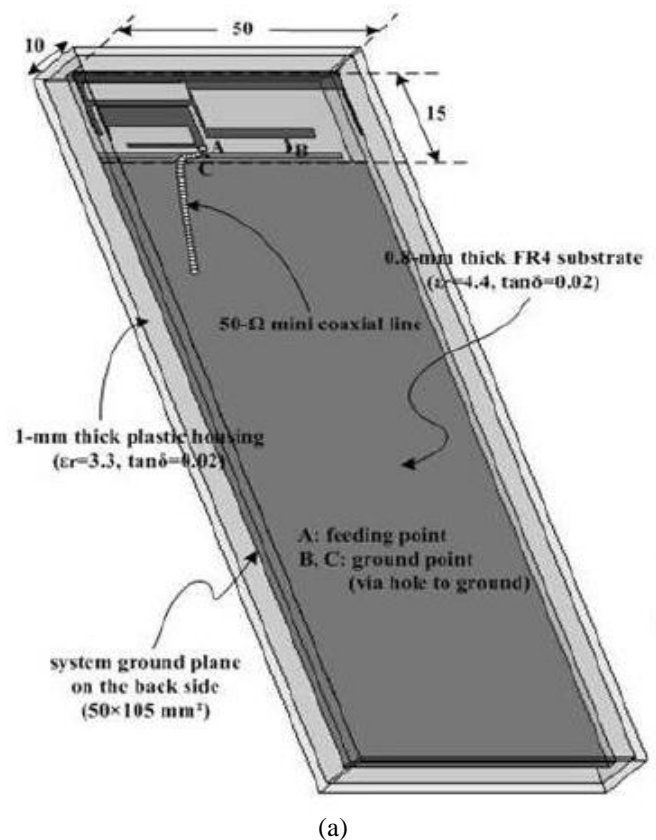


Fig .1. Proposed antenna configuration: (a) Geometry of the wideband antenna for eight-band LTE/WWAN operation in the internal mobile phone. (b) Detailed dimensions of the metal pattern in the antenna area (unit: mm).

For the double-resonance mode within the desired lower band, two predominant resonant modes at 750 and a

thousand MHz may also be accomplished by loop 1 and slot 1 ( $s_1 + t_1 =$  eighty four mm, about zero.21-wavelength at 750 MHz), and loop 2 and slot 1 ( $s_2 + t_1 = 80$  mm, about zero.26-wavelength at one thousand MHz), respectively. Then, a half of-wavelength high-order resonant mode at around 1750 MHz can be acquired via loop 2 (0.48-wavelength at 1750 MHz). Apart from, by way of adjusting the chip inductor ( $L = 1:5$  nH within the design) and the tuning stub on the end of loop 1, the desired impedance matching and resonant modes' shift at the minimize and upper bands can be accelerated effectively. From the above evaluation, the proposed slotted ground constitution can not handiest provide a resonant mode at about 2300 MHz but also lessen the preferred resonant paths at 750 and one thousand MHz, broadening the bandwidths of 698960 and 17102690 MHz to duvet the entire eight-band TE700 /GSM850 /900 /DCS1800 /PCS 1900/UMTS2100/LTE2300/2500 operation

Note that the coupling gap between the feeding strip and coupling strip is selected to have a slim width of 0.3 mm, which is precious in obtaining huge bandwidths for the excited resonant modes, particularly for the curb band. On this configuration, a 50-- mini coaxial feed line is employed to excite the proposed antenna at the feeding factor A, and the tip of the lengthy coupling strip and t external conductor of the used coaxial line are related to the slotted floor constitution of the cellular cell at grounding features B and C. With right structure and dimensions, the awarded design can also be conveniently printed on a thin PCB. Therefore, the proposed antenna now not best shows a simple configuration but also has a compact measurement, enabling it to be fabricated at low rate for sensible cell functions.

### 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

#### 4.1.1 S-Parameters:

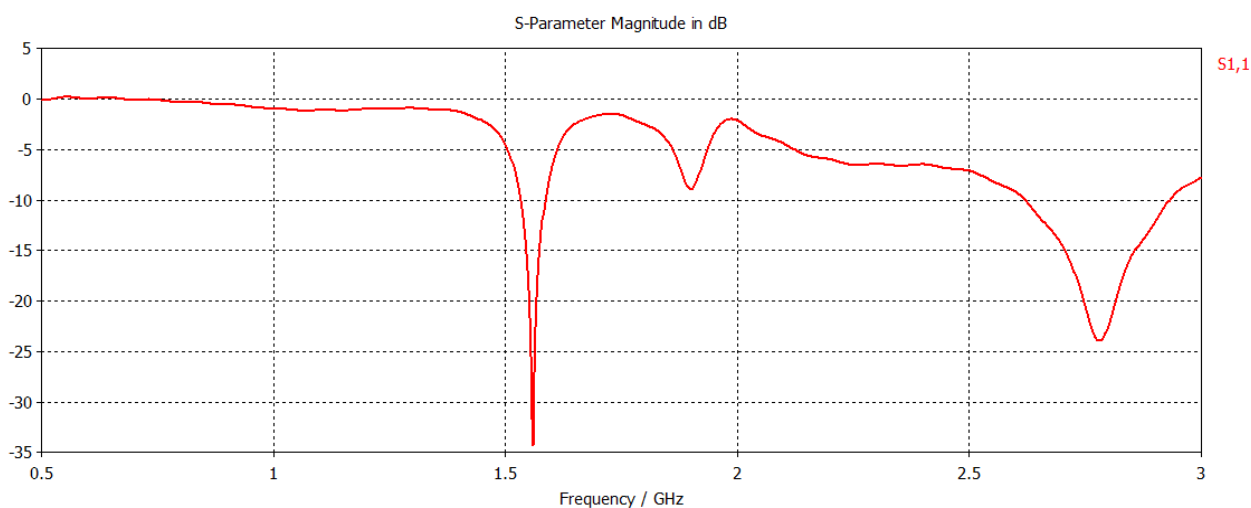


Fig 4.1.(a) S-Parameters

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 Results in CST/HFSS

The results in CST/HFSS shown in the Figure 4.1, S11 parameters shown in the Figure 4.1 (a) radiation pattern shown in the Figure 4.1 (b), gain shown in the Figure 4.1(c), real part of the Impedance shown in the Figure 4.1(d) , Imaginary part of the Impedance shown in the Figure 4.1(e).

4.1.2 Radiation Pattern :

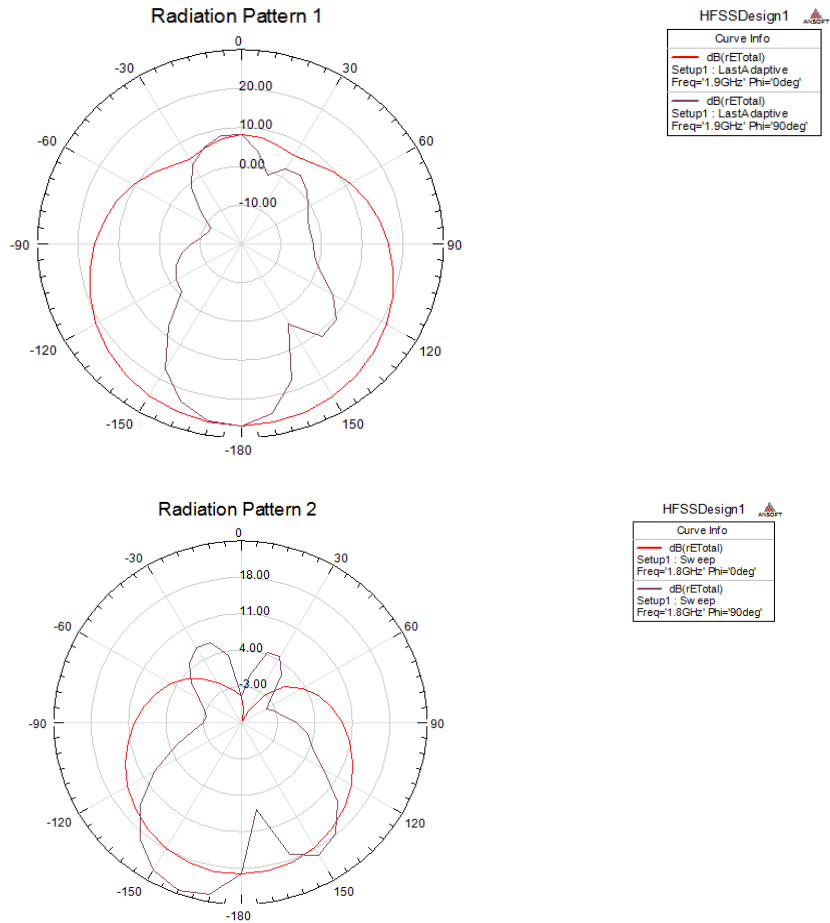


Fig 4.2.(b) Radiation Pattern

4.2.3 Gain :

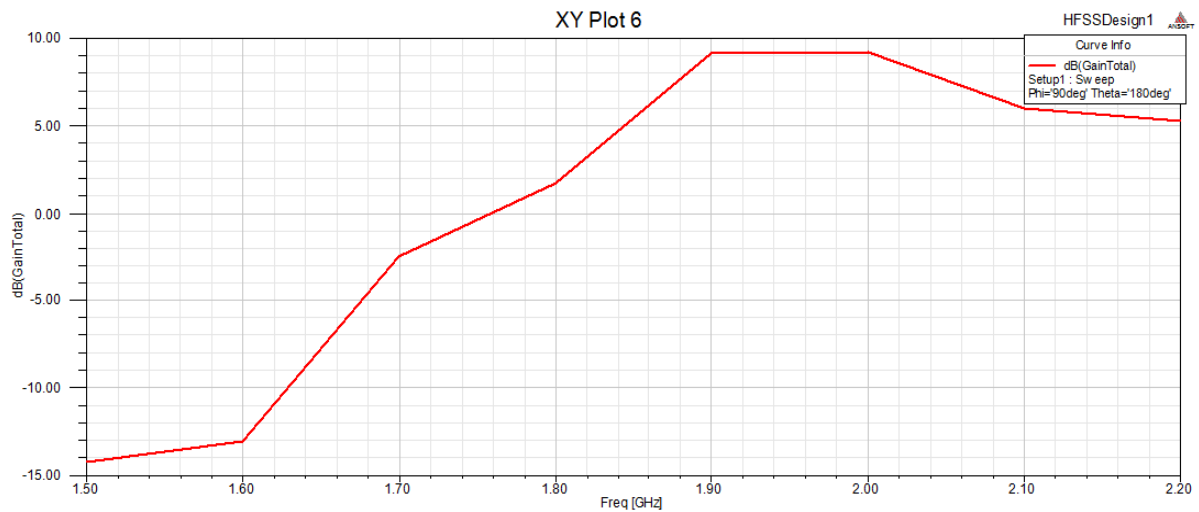


Fig 4.2.(c) Gain

## 4.2.4 Impedance:

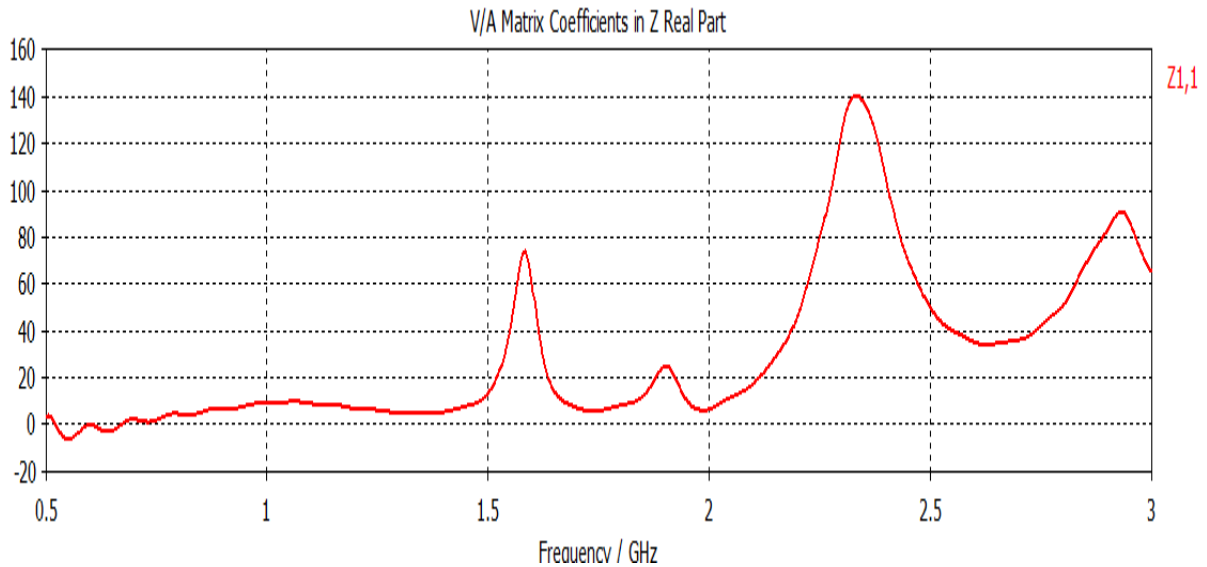


Fig 4.2.(d) Real part of Impedance

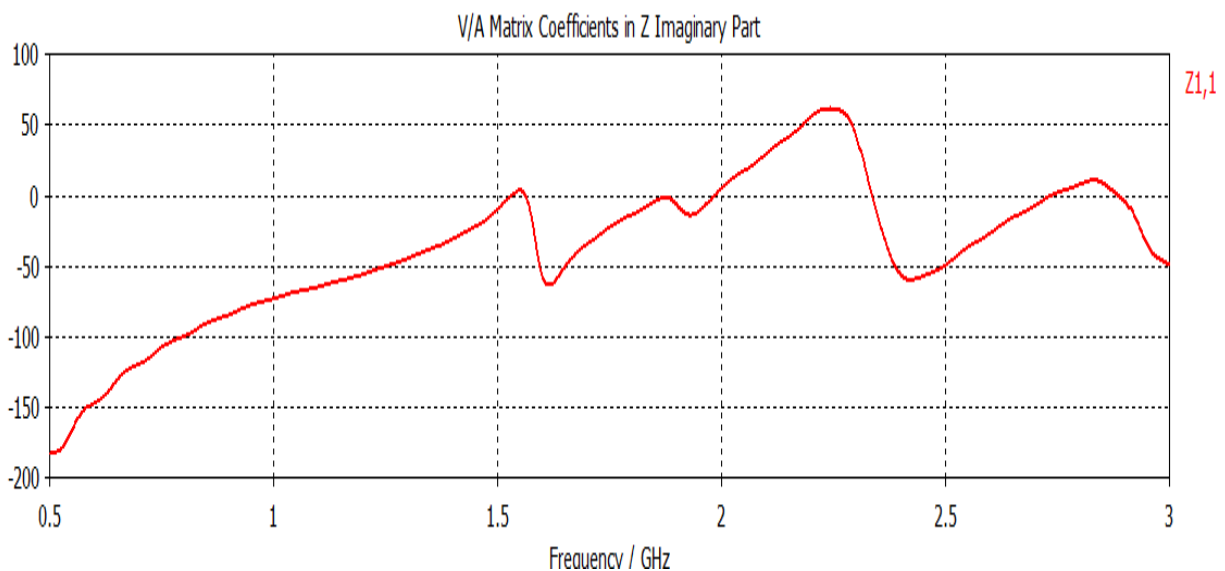


Fig 4.2.(e) Imaginary part of Impedance

## V. CONCLUSION

This paper presents a new coupled-fed cellular mobile phone antenna, utilising a slotted floor constitution to reinforce the preferred impedance matching bandwidths, which will receive two VSWR<sub>53</sub> impedance bands of 698960 and 17102690 MHz. With a planar printed structure, the proposed antenna has a compact size of 15 × 50mm<sup>2</sup>. The essential design parameters of the coupled-fed antenna are studied and discussed, and a practical structure is fabricated for checking out within the scan. The measured parameters, including return loss, radiation patterns, antenna top achieve, and radiation efficiency, are given to validate the proposed antenna. With the presence of wideband aspects and just right radiation efficiency higher than 55% over the desired operating bands, the proposed antenna is attractive for the sensible cell cellphone applications.

## REFERENCES

- [1] Kusuma, A. H., A. F. Sheta, I. Elsharawy, Z. Siddiqui, M. A. Alkanhal, S. Aldosari, and S. A. Alshebeili, "A new low SAR antenna structure for wireless handset applications," *Progress In Electromagnetics Research*, Vol. 112, 23{40}, 2011.
- [2] Lin, D. B., I. T. Tang, and M. Z. Hong, "A compact quad-band PIFA by tuning the defected ground structure for mobile phones," *Progress In Electromagnetics Research B*, Vol. 24, 173{189}, 2010.
- [3] Wong, K. L. and T. W. Kang, "GSM850/900/1800/1900/UMTS printed monopole antenna for mobile phone application," *Microwave Opt. Technol. Lett.*, Vol. 50, 3192{3198}, 2008.
- [4] Wong, K. L. and Y. W. Chang, "Internal eight-band WWAN/LTE handset antenna using loop shorting strip and chip-capacitor-loaded feeding strip for bandwidth enhancement," *Microwave Opt. Technol. Lett.*, Vol. 53, 1217{1222}, 2011.
- [5] Chen, J. H., Y. L. Ban, H. M. Yuan, and Y. J. Wu, "Printed coupled-fed PIFA for seven-band GSM/UMTS/LTE WWAN mobile phone," *Journal of Electromagnetic Waves and Applications*, Vol. 26, Nos. 2{3}, 390{401}, 2012.
- [6] Ban, Y.-L., H.-M. Yuan, J.-H. Chen, L.-W. Li, and Y.-J. Wu, "A novel ultra-wideband antenna with distributed inductance for wireless USB dongle attached to laptop computer," *Journal of Electromagnetic Waves and Applications*, Vol. 26, Nos. 2{3}, 179{191}, 2012.