DESIGN & SIMULATION OF 5G MULTIBAND ANTENNA WITH PHASE SHIFT OPERATION

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Introduction:

5G is the fifth-generation mobile communication technology. 5G technology is the next generation of wireless communications. It is expected to provide Internet connections that are least 40 times faster than 4G LTE due to its wider bandwidth. 5G technology may use a variety of spectrum bands, including millimetre wave (mm Wave) radio spectrum, which can carry very large amounts of data for a short distance. 5G will use spectrum in the existing LTE frequency range (600 MHz to 6 GHz) and also in millimetre wave bands (24-86 GHz). 5G will revolutionize the world more than 3G or 4G. 5G means a world where not only people but all the things are also connected. This new version of wireless technology gives us a lot of advantages which includes a boost in speed, reduce reluctance and it provides a more reliable connection for a wide range of users. In the world of mobile communication, 4^{th} Generation (4G) technology has been a huge successful and trend. But for a large amount of data and wider bandwidth still there is a need of faster way of communication. So, we propose a dual band 5^{th} Generation (5G) antenna of frequencies 28Giga Hertz (GHz) and 38GHz.

Objectives:

Major objective of project is to create a novel model for 5G antenna which can provide a phase shift operation without any additional circuitry. The antenna also has an objective of increasing its bandwidth and gain by designing antenna array with proper power divider circuit calculation in microwave frequency. Proposed antenna is assumed to perform with proper phase shift by including left and right shift operation using narrow designed antenna. The initial stages of single patch antenna to improve the antenna necessary slots are added to enhance its antenna parameters. The main patch is designed for the frequency of 28GHz and 38GHz is achieved through slots on patch. The

dielectric substrate used in the proposed design is Rogers RT 5880(lossy) which has dielectric constant (ε_r) of 2:2 with loss tangent (tanδ) of 0:0009 and thickness (h) of the substrate is taken as 0:381mm. The main patch has achieved the impedance matching(S-Parameter) of -43:33dB at 28:405GHz and -28:695dB at 37:75GHz and at -10dB bandwidth of 755MHz at 28GHz and 645MHz at 38GHz. The patch has been arranged into 4array antenna using quarter-wave transform power divider with left and right phase shift.

Methodology:

Selection of substrate is very important while designing of a Microstrip patch. An antenna cannot be designed without appropriate choice of substrates parameters like Width, Length, Dielectric Constant and height. There are different kinds of materials are accessible and are utilized as a substrate depending upon the prerequisite and performance. Here substrate, FR4 epoxy of thickness 1.6mm with a relative permittivity of 4.4 is utilized. The dimensions of the patch are designed using below given formulas. The antenna feeding is structured cautiously to give a proper or exact impedance matching. At high-signal frequencies taking care of feed line likewise assumes a significant job for radio wire execution. For good outcomes taking care of line ought to have impedance equivalent to qualities impedance of fix. For appropriate feeding of antenna Inset Feeding Method is utilized in this project. A point inside patch where the input impedance is 50Ω, the patch antenna is feed with a microstrip line. Antenna array is a antenna formed by multiple of antenna. Basically it increases gain of antenna and have narrow beam. In most cases elements of an array are identical. This is not necessary but it is convenient, simpler and more practical.

Phase shifts in array MSA plays a very important role in differentiating each patch with different phase. They are used to shift the direction of the beam or main lobe. The main lobe is deviated from the original angle to defined phase shift in order of degree. The equations below defines the design of phase shift based on transmission line load using varactor diode.

Design and simulation is done using CST Microwave Studio.

Conclusion:

The dimensions of the antenna L and W are calculated to obtain resonant frequency of 28 GHz and the H-shaped slot in the patch is made to obtain the other operating band of 38 GHz. The feed line (50) excites the antenna by gap-coupling (gap = 0:05 mm) to enhance the antenna bandwidth. The simulated results of H-shaped slot on patch MSA of S_{11}parameter shows that good matching is achieved at both desired frequencies (-21:19 dB at 28 GHz and -19:523 dB at 38 GHz) as

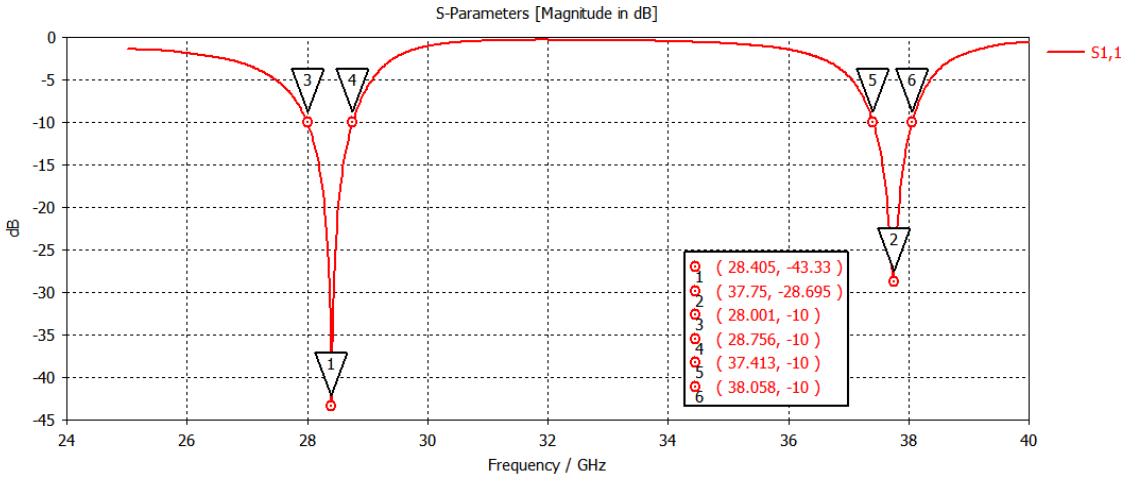

Figure 1: S11 Parameter of Single Element 5G MSA

A 4 Sub-Array antenna is designed based on the single element antenna in figure to satisfy 5G system requirement of realized $gain > 12dBi$. The patch elements are fed using conventional corporate feeding network utilizing quarter-wavelength transformers to achieve good matching.

The simulated results of 4 sub-Array 5G MSA of S_{11} parameter shows that good matching is achieved at both desired frequencies (-42:369 dB at 27:43 GHz) as presented in figure below. The bandwidth of the antenna at -10 dB is about 1109 MHz at 26 - 27 GHz.

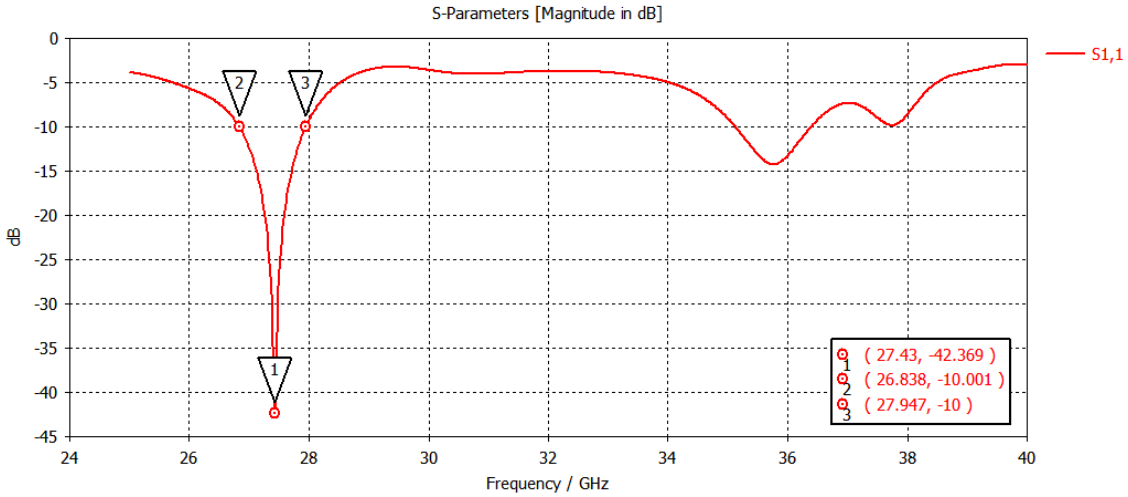

Figure 2: S_{11}Parameter of 4 sub-array 5G MSA

The purposed design has meet with the industrial standards. The single element microstrip patch antenna has meet perfect impedance matching (S_{11}parameter) of -43.33dB at 28.405GHz and -28:695dB at 37.75GHz. The bandwidth availability at 28GHz is 757MHz and at 38GHz is 645MHz. The Voltage standing wave ration (VSWR) of 1.9257 is achieved at 28GHz and 1.17068 is achieved at 38GHz. The far-field gain of single element microstrip patch antenna at 28GHz is 6.75dBi and 7.37dBi at 38GHz.

Table 1: Results of H-Slot design on Patch

Parameter	Frequencies (GHz)	Values
S_{11}	28.405	-43.33db
S_{11}	37.75	-28.695db
Bandwidth	28	757 MHz
Bandwidth	38	645 MHz
VSWR	28	1.9257
VSWR	38	1.17068
Far-Field Gain	28	6.75dBi
Far-Field Gain	38	7.37dBi

Scope for future work:

The proposed project work can be enhanced as follows:

1. Design of structure can be improved to provide a omni directional radiation pattern.
2. The design antenna interconnected properly with proper calculation it can work as a 5G base station antenna.
3. The designed parameters can meet to industrial standards with careful observation on geometrical design of antenna.
4. Proper funding of project can be tested and implemented in real time environment as 5G frequency designed is for 28GHz which needs a sophisticated testing lab.