ARRAY OF PATCH ANTENNA WITH HYBRID PHASE SHIFTER

Alpesh Dhukia
Sobhasaria Engineering College, Sikar, Rajasthhan

The project focuses on design of phased array antenna using planar microstrip patch antenna and phase shifter that will work for C band applications. Here the operating frequency for calculation is 3Ghz and 5Ghz and substrate material used is FR4 with dielectric constant of 4.4 and height of 1.6mm. In antenna theory, a phased array is an array of antennas in which the relative phases of the respective signals feeding the antennas are varied in such a way that the effective radiation pattern of the array is reinforced or directed in a desired direction and suppressed or neglects in undesired directions. A phased array antenna is composed of lots of radiating elements like patch each with a phase shifter. Beams are formed by shifting the phase of the signal emitted from each radiating element, to provide constructive or destructive interference so as to control the beam in the desired direction. Antenna arrays can be designed to control their radiation characteristics by properly selecting the phase and/or amplitude distribution between the patch elements. It has already been shown that a control of the phase can significantly alter the radiation pattern of an array antenna. In fact, the principle of scanning arrays, where the maximum of the array pattern can be pointed in different directions, is based primarily on the control of the phase excitation of the patch elements. In addition, it has been shown that a proper amplitude excitation taper between the elements can be used to control the beam width and side lobe level. The phased array antenna is a candidate for implementing the beam forming antenna. The large insertion loss of the RF phase shifter is a significant barrier to implement beam forming antennas in the millimetre wave band communication systems and therefore a beam forming antenna with discrete phase shifter. The C band is a name given to certain portion of the electromagnetic spectrum, including wavelengths of microwaves that are used for long distance radio telecommunications. The IEEE C band (4 GHz to 8 GHz) and its slight variations contains frequency ranges that are used for many satellite communication transmission, some wi-fi devices, some cordless telephones and weather radar systems and navigation.

I. MICROSTRIP PATCH ANTENNA

Here patch is designed two different plane top plane and ground plane separately. For top plane two square slots of size 5mm x 5mm are made on upper portion of the rectangular patch antenna. Also a rectangular notch is made at a distance of 16.75 mm from top margin. Dimension of this slot is 1 mm x 12.75mm.Ground plane is made defected. Here ground plane is shifted beneath the micro strip line feed with dimension of 30.6 mm width and 25.936 mm length. A rectangular defected structure of dimension 10 mm width and 18 mm length is made in the ground plane. There is no ground plane apart from this mentioned above. Figure shows the pictorial diagram showing various dimensions of top and bottom plane. Also the position of feed line was changed from centre to lower edge. This will help in impedance matching helping to improve the performance of patch antenna. By changing the position of the line feed location there occur variations in the impedance on smith chart. It also varies the return loss of the antenna which affects the bandwidth of the antenna. Polarization is linear as feed was not placed diagonal corner but lower corner of patch. The notch or shape which cuts in the patch affects the antenna parameter. By cutting the notch in the patch parallel to the current lines introduces reactive loading in the antenna.

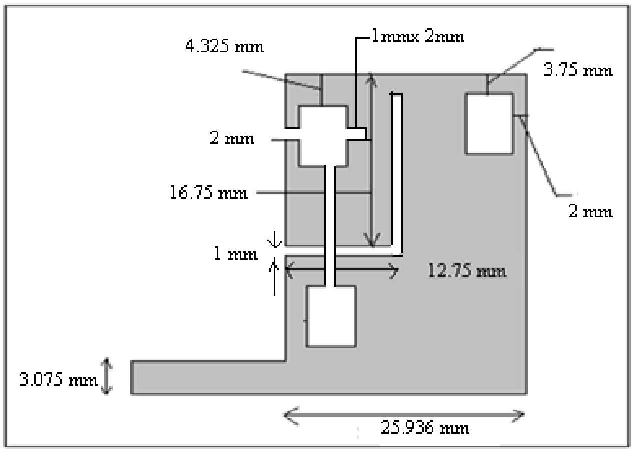

Figure1. Dimensions of patch antenna

Diffrent Parameters Of Patch Antenna:

Freq. (GHz)	S11 (dB)	VSWR	Impedance [Z(1,1)]
2.75	-8.01	3.005	37.33
3.	-11.11	1.77	42.98
3.25	-6.279	2.986	30.05
3.5	-4.148	3.473	97.52
5	-18.26	1.33	46.71
6.5	-10.265	1.874	55.97

Branch Line Coupler

Generally Branch line coupler are 3dB, four ports directional couplers having a 90° phase difference coupled arms shown in the figure. Branch line couplers (also named as Quadrature Hybrid) are often made in microstrip form. Quadrature hybrids are a good example that provides equal amplitude and quadrature phase outputs at the desired frequency band. They are commonly used in balanced amplifiers and mixers for achieving good return loss, as well as spurious signal rejection. Impedance of arm a= $Z_o/\sqrt{2}$ = 35.4 ohm and b=$Z_0 = 50$ ohm, Electrical length= 90 degree.HereZ_0 is the characteristic impedance of transmission line. This is the formula for 3dB branch line coupler.

Diffrent S Parameters Of 5GHz Branchline Coupler

FREQ [GHz]	dB(S11)	dB(S12)	dB(S13)	dB(S14)
2.4	-4.37	-5.55	-7.79	-7.28
3	-4.76	-4.85	-7.78	-7.73
4	-8.45	-3.41	-5.24	-10.11
4.8	-22.46	-3.06	-3.12	-22.54
5	-44.53	-3.05	-3.02	-47.1

II. ULTRA WIDE BAND POWER DIVIDER

Bandwidth of conventional divider can be increased using multi section and using stubs. Multi section however increases the size of circuit. Apart from this insertion loss increases and requires many resistors for isolation between output ports. In divider bandwidth can be easily adjusted. Here divider is divided into two sections. The first section Z1, θ1 can control the lower cut-off frequency and the second section Z2, θ2 can control the upper cut off frequency. The four short circuited stubs of Z4, θ4 & Z5, θ5 help to improve insertion loss and return loss in the mid band. Stubs reduce the size of power divider. Proposed divider is combination of two different techniques to improve the performance of power divider.

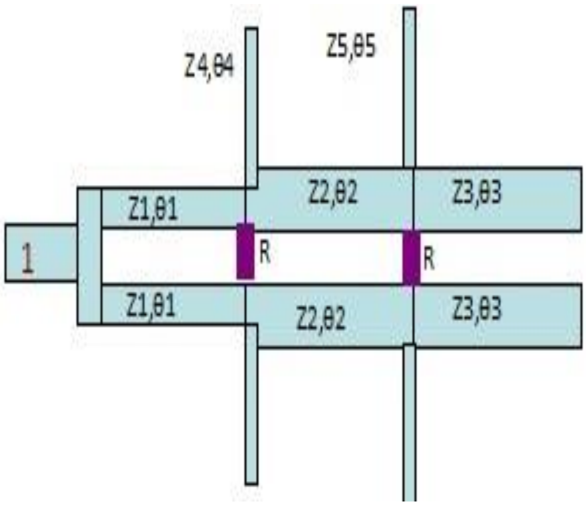

Figure 2. UWB Wilkinson power divider

Length & width of different sections and stubs are calculated by optimization. It has low dissipation loss over a broad frequency range. Two resistors of 100 ohm are used for isolation purpose. Impedance of Z3 is 50 ohm for impedance matching. Length and width of first section 4.20mm, 1.67mm, length and width of middle section 5.82 mm, 3.16mm, short circuited stub length and width 6.26 mm, 0.3 mm, R=100 Ohm.

III. VARIOUS S PARAMETERS FOR DIFFERENT FREQUENCIES FOR THE ARRAY

Frequency (GHz)	S_{11} (dB)	S_{21} (dB)	S_{12} (dB)	S_{13} (dB)	S_{22} (dB)	S_{23} (dB)	S_{33}(dB)
3.1	- 14.682	-3.1975	-3.1975	-3.1975	-11.7200	-20.0435	-11.7200
5.1	-12.4492	-3.2981	-3.29812	-3.29812	-23.3819	-12.9631	-23.3819
5.5	-12.9329	-3.2713	-3.27130	-3.27130	-18.0221	-13.5715	-18.0221
8.6	-10.9220	-3.4235	-3.42354	-3.42354	-12.1703	-15.9828	-12.1703
9.1	-10.4958	-3.4670	-3.46701	-3.46701	-13.7159	-14.9362	-13.7159
10.1	-11.4181	-3.3967	-3.39677	-3.39677	-20.4378	-14.7313	-20.4378

From these results isis clear that power divider shows desirable response under the range 3.1 GHz upto 10.1 GHz. For observation of the S parameters for UWB power divider different frequencies are selected. S12, S21 and S13 shows coupling between input and output port. Insertion loss is minimum in this case. S11, S22, S33 shows good response for return loss. S23 shows good isolation between two output ports. S23 denotes isolation loss.

