DESIGN OF A BROADBAND LOW SIDE LOBE ARRAY ANTENNA

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ABSTRACT:

A broadband array configuration with low back radiation can be designed using stacked patches with electromagnetic coupling (EMC) mechanism. In this paper a simple multi- layer broadband EMCP structure[1] has been used as a building block of a large array where the other antenna parameters have been optimized to suit a particular requirement of a Side lobe level and Gain. In the chosen configuration bandwidth will be maintained in the array environment and fabrication tolerances can be minimized for large array structure.

INTRODUCTION:

Researchers have been successful in achieving impedance bandwidth of up to 90% and gain bandwidth up to 70% in separate antennas[2]. But most of these innovations involves more than one mode, give rise to increase in size, height or volume and are accompanied by degradation of the other characteristics of the antenna. Alternatively increase in bandwidth can also be achieved by a suitable choice of feeding technique and impedance matching network.

In this work, configuration based on electromagnetic coupling mechanism has been chosen where bottom patch is fed with a coaxial line and the top parasitic patch is excited due to electromagnetic coupling with the bottom patch[2]. A suitable air gap is maintained between the substrate to increase the bandwidth. The antenna dimensions can be optimized so that the resonant frequency of the two patches is close to each other to yield broad bandwidth. The increase in the bandwidth is obtained due to an increase in the overall height of the antenna, a decrease in the effective dielectric constant and the multi-resonator effect.

A corporate feed network that supplies excitation individually to each array element is chosen as a feeding mechanism of our array. Since a corporate fed array usually have good pattern and gain bandwidth, but the impedance bandwidth of the overall array is limited to that of single patch element [3]. If losses are significant the bandwidth may appear larger, but this is at the expense of efficiency. So the above element impedance bandwidth enhancement method may be applicable if broader array bandwidth is needed.

UTILITY:

The stacked patch design is attractive for several reasons. Since it does not increase the surface area occupied by the element, a stacked patch can be used in array configuration without the need for increased element spacing and the concomitant danger of grating lobes. The close proximity of the stacked patch element remains symmetric over its operating band, which is an important consideration for reflector feed or array applications.

THEORY:

Proximity coupled feeds are difficult to analyze using the approximate model of microstrip antenna. [3]. Transmission model or multiple network models uses single mode analysis and made of a number of simplifying assumptions. Hence they suffer from a number of limitations, which can be overcome in full wave moment method technique that maintains rigor and accuracy at the expense of numerical simplicity. The formulation of the solution is based on rigorously enforcing the boundary condition at the air dielectric interface and at patch metalization leading to an integral equitation. This is done by using the exact Green`s function for the composite dielectric which include the effect of dielectric loss, conductance loss, surface modes and space wave radiation. In our analysis numerical computation has been done using commercially available software (IE3D) where full wave technique has been used to predict near field and far field characteristic of the array antenna.

DESIGN :

A single electromagnetically coupled patch was designed at Ku & K band(fig 1a) and simulated and found to give 11.5 % impedance bandwidth(1.5:1) over center frequency. A 2x2 module of the antenna with the corporate feed is then designed and fabricated(fig 1b&1c). The following parameters are used for design.

Top and Bottom substrate thickness is 20 mil and dielectric constant 2.2

Ratio of top and Bottom patch length is 0.94.

Air gap between the two layer is 1.0 mm.

Element spacing is $0.8\lambda_{0.}$

Using the same configuration one 16x16 EMCP array(fig 3a & 3b) has been designed where tapered amplitude distribution has been given to the feed network for achieving low sidelobelevel (30 dB). Here Taylor distribution has been chosen with nbar=5 and implemented with unequal T-junction power divider.

RESULTS :

Measurement results of 2x2 array(fig2a) show impedance bandwidth of 10.93% around center frequency. Far field radiation pattern of E plane and H plane(fig 2b) over the bandwidth is measured and found to agree with simulated results. Beam width obtained from radiation pattern is 29.6 & 31.8 in E plane and H plane respectively. The gain is calculated to be 11.6 dB.

One 16-x16 EMCP array has been fabricated and top and bottom layer was aligned properly.Impedance measured result (fig 4a)shows an impedance bandwidth of 12.43% around center frequency. Beamwidth obtained from far field radiation pattern(fig 4b) is approximately 6.0° x 6.2°.Measured sidelobe level is 22 dB (average) in H plane and 20 dB (average) in E plane. Measured gain is 24.3 dB at centre frequency with this antenna.Gain variation with frequency is shown in fig5).

We could not achieve our desired sidelobe because unwanted radiation from feed network is detoriating the desired amplitude distribution through proximity coupling. This problem will be taken care in near future.

CONCLUSION :

In this work our goal was to achieve low sidelobe level while maintaining the bandwith and gain. The configuration chosen for this purpose is easily reproducible and has a vast application in radar,missiles, tracking antenna system and many more. By modifying the design properly ultralow side lobe level can be achieved .

REFERENCES:

- [1] *Ramesh Garg, Prakash Bhartia, Inder Bahl "Microstrip Antenna Design Handbook". - Artech House.*
- [2] *R.Q. Lee, K.F.Lee, and J. Bobinchak "Characteristic of a Two-layer Electomagnetically Coupled Rectangular patch antenna" Electonics Letters, vol 23, no. 20, pp 1070-1072, Sept. 1987.*
- [3]*Girish Kumar & K.P Ray "Broadband MicrostripAntenna" –Artech House.*
  [4]*Georg Splitt & Marat Davidovitz, "Guidelines for Design of Elctromagnetically coupled Microstrip Patch Antennas on Two-layer Substrates" IEEE Trans AP-38, no. 7, pp. 1136-1140, July 1990.*

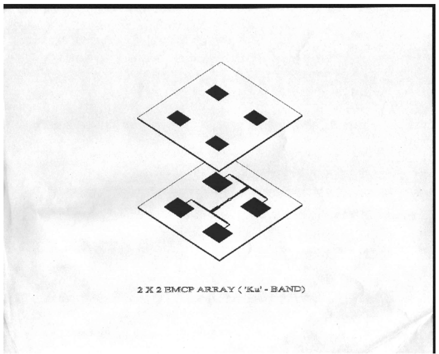


Fig 1a)

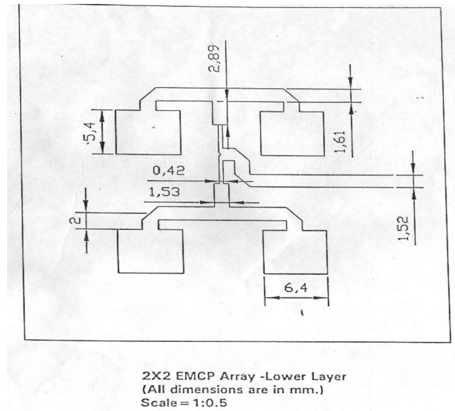


Fig 1b)

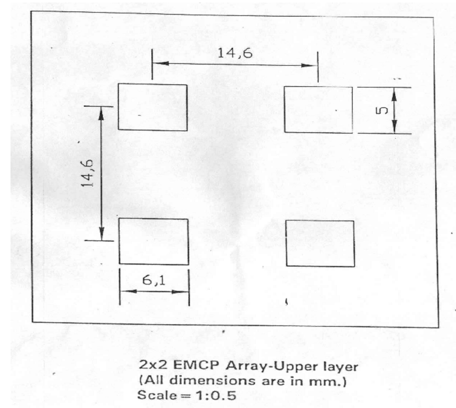


Fig 1c)

Fig 1) schematic diagram of 2x2 array antenna

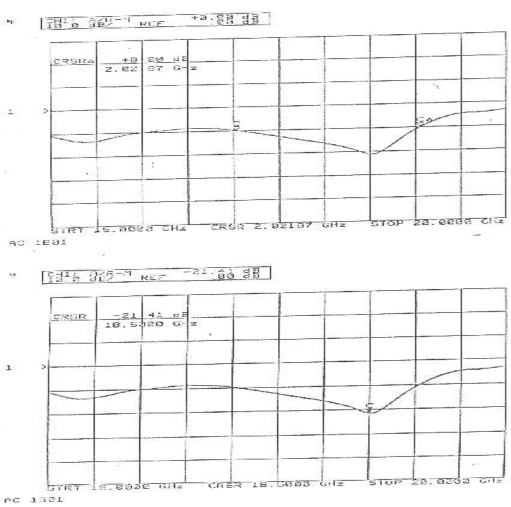


Fig 2a) Return loss plot for 2x2 array

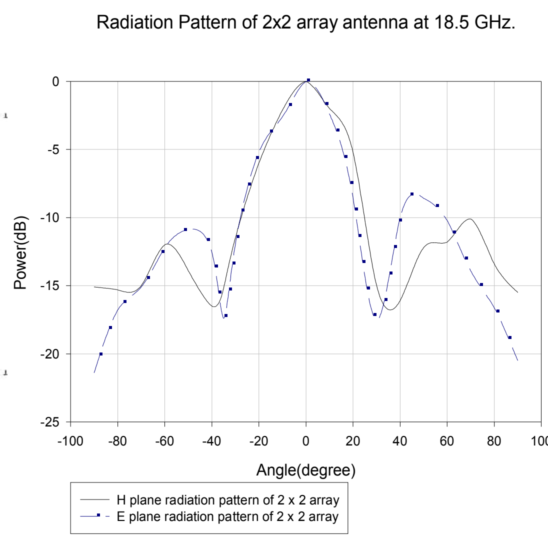
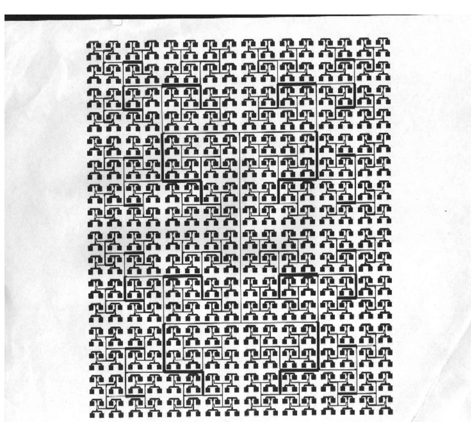


Fig 2b)



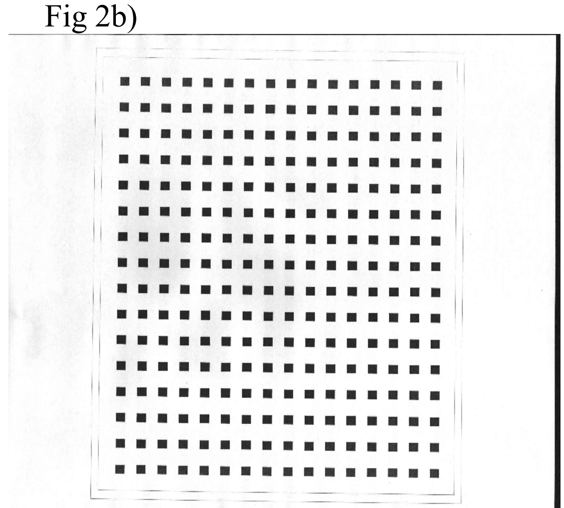
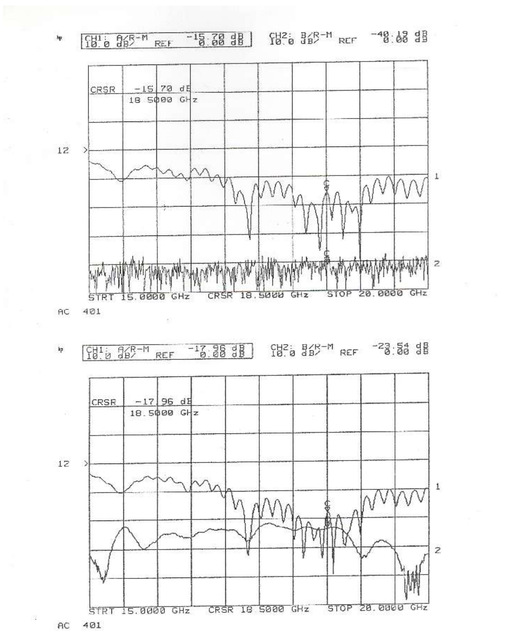


Fig 3)16X16 array antenna layout

Fig 3a)Bottom layer

Fig 3b)Top layer



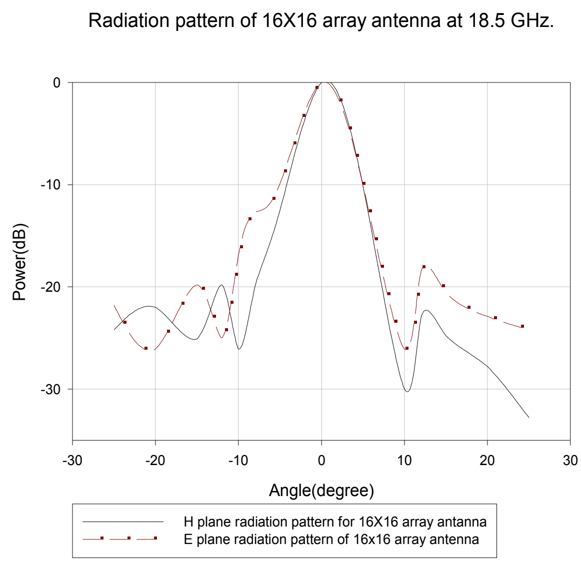


Fig 4a) Return loss plot for 16X16 array   Fig 4b)

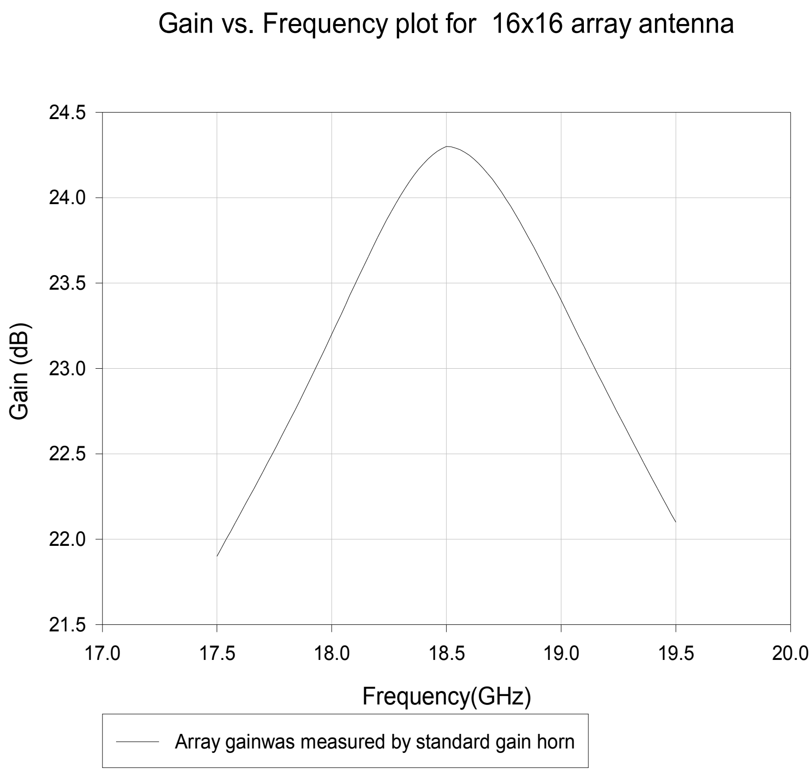


Fig5)