Design of Triplate Array Antenna with Suspended Strip line Power divider Feed for Surveillance Radar Application

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***Abstract*—In this paper the design of a planar array of triplate dipole fed with suspended stripline power divider feed network for surveillance radar application is described. The design goal is to achieve side lobe level of -25dB and VSWR less than 2 over the frequency band of 200MHz. It is required to have good mechanical stability offering very low resistance to high wind velocity with reduced weight at L-Band. An innovative method is used in the design of radiating element to maintain the overall size of the ground plane minimum. In order to maintain the spacing between the suspended stripline power divider and ground plane, Teflon supports are used at regular intervals.**

***Index Terms*—Triplate dipole, stripline Power divider, Array design**

I. Introduction

In radar systems, the antenna requires a low side lobe and narrow beam width to avoid the jamming and false detection of target in the field [1]. There are many types of antenna used in radar systems such as Reflector, Slotted waveguide and microstrip printed antennas [1]. Microstrip patch antenna has the limitation of bandwidth and power handling [2]. The type of antenna is decided based on factors such as bandwidth, efficiency, sidelobe levels, weight, size and mounting aspects. The half-wave dipole is the classic type of electromagnetic antenna, whose dimension is one-half of the wavelength. A single dipole is not of much use for radar, since it produces a beamwidth too wide for most applications. Radar requires a narrow beam (a beamwidth of only a few degrees) in order to concentrate its energy and to determine the target location with accuracy. Such narrow beams and better bandwidth can be formed by an array of radiating elements [4] such as triplate dipole in the present case. The Triplate dipole radiating element is designed to get the reduce height of the folded ground plane.

II Pattern Synthesis:

This linear array feed network is designed using Taylor distribution with -35dB sidelobe and n bar = 6. The inter element spacing between the linear array element is taken as 0.75λ with the lambda as the center frequency of operation. The corprate feed network is designed with equiphase distribution. The given specification is synthesized in the matlab and the pattern is predicted as shown in the Fig.1

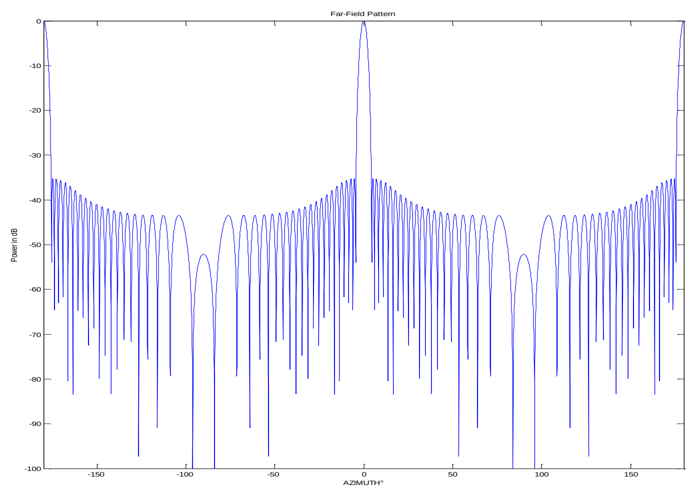

Fig 1. A predicted pattern from synthesized power ratio of 35dB taylor distribution for 16 element with 0.75 λ between the elements

III Array Architecture

A. Single Element Design

In the present case triplate antenna is used because of better bandwidth and impedance matching. The design goal is to reduce the ground plane folded by 30% from that of priviously published dipole array [3] with improved performance in the gain pattern. The single element has the wide bandwidth of 200MHz and gain of 5dBi. Triplate dipole antenna is mechanically found to be rigid and can withstand higher power. The designed single element is shown in Fig. 2.

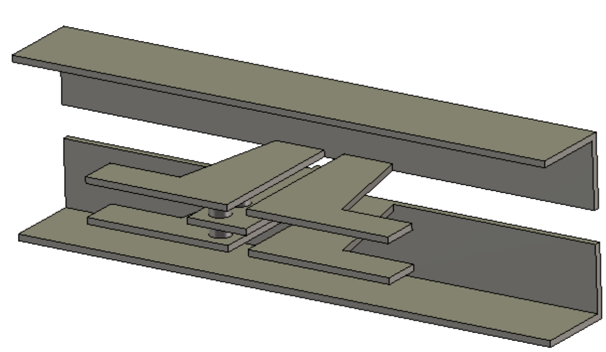

Fig 2.Designed single element with the reduced ground plane of 30%

B.Feed network design

The predicted power distribution from the matlab has been used to model the stripline power divider in the 2D simulation software ADS. Air is taken as a dielectric due to the high power handling capacity and very low losses in the L-Band. Because of air as a dielectric medium the stripline is given support by tefflon material support to maintain the spacing between the two ground plates. The stripline power divider is divided into two 1:8 divider in order to split the full linear array into two equal mechanical half for ease of handling purpose. The final remaning stage is fed with 1:2 equal power dividers. The designed 1:8 power divider is shown in the Fig. 3 and Fig. 4 shows the return loss and the power distribution of the power divider. The equiphase distribution is shown in the Fig. 5.

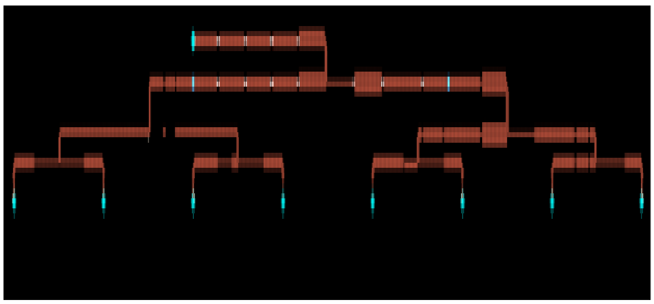

Fig. 3 Design of 1:8 unequal power division power dividers designed in ADS software

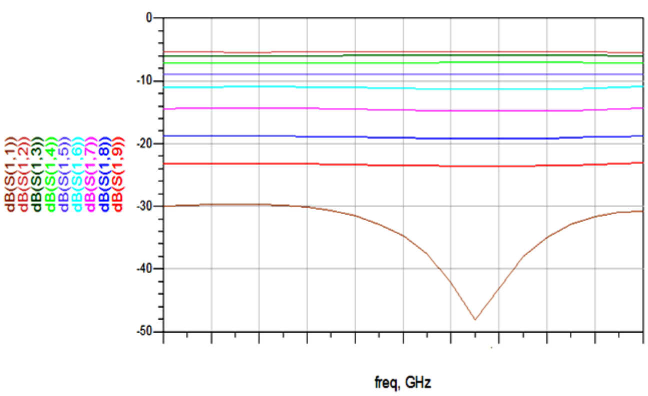

Fig. 4 Return Loss and power division of the power divider with 35dB Taylor distribution

C. Linear array integrated with feed network

The triplate dipole antenna with reduced height folded ground plane integrated with strip line power divider feed network is simulated in 3D EM software CST MSW. The integrated linear array was optimized to get a bandwidth of 15% in L-Band. Single element is modeled in the array background, both linear and unit cell approach to achieve the VSWR of less than 2:1. The simulated layout of power divider is then imported and simulated in the finite ground plane environment. The inter element spacing between the element is 0.75λ in the linear array at the center frequency of f_0. The integrated radiating element and the power divider are shown in the Fig 6. The fabricated antenna is shown in the Fig. 7.

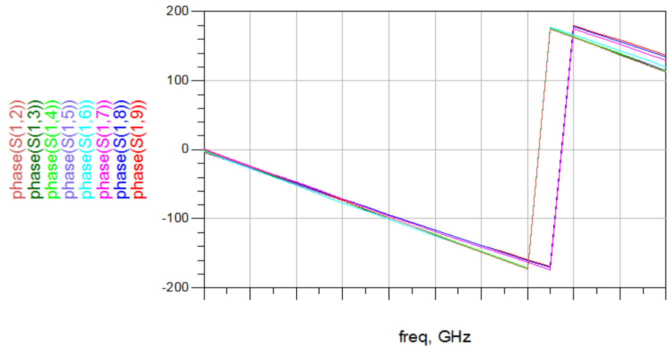

Fig 5. Phase difference between the elements over the band

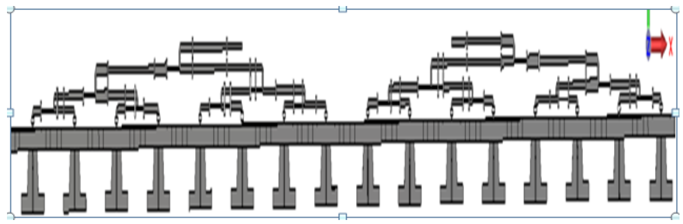

Fig. 6 The power divider and single element triplate integrated together.

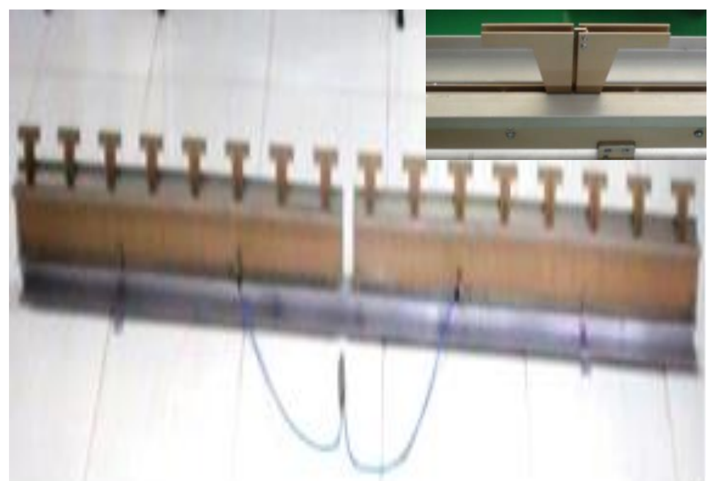

Fig.7 The figure shows the fabricated antenna with 1:2 power divider for measuring return loss, inside figure shows the single triplate dipole antenna.

III Result and Discussion

The 3D simulated pattern of the antenna is shown in the Fig.8. It has the narrow beamwidth of 5°over the AZ plane and broder in the other plane. The simulated gain and beamwidth of the antenna is tabulated in Table 1. The fabricated antenna is tested for VSWR using the Vector Network Analyzer and it is meeting the design goal of 2:1 in the entire frequency band of operation. The pattern measurement carried out in anechoic chamber. The measured result and simulated results are compared in Fig 9. The measured result shows the minimum sidelobe level of -26dB at lower frequency band. The performance of the antenna has been reduced because of the mechanical tolerance while fabricating.

Table I Beamwidth and Gain across the frequenciess

Frequency	Beamwidth	Gain
f_0-100(8% of f_o)	5.7	17.1
F0	5.3	17.2
f_0+del(8% of f_0)	4.7	17.4

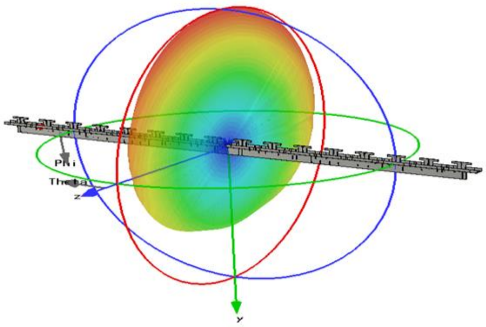

Fig.8 Simulated 3D radiation pattern of the array antenna

IV Conclusion:

This paper presented the design and developement of linear array for -25dB side lobe level with the frequency band of 200MHz. The designed triplate dipole array antenna performance of Beamwidth, Sidelobe Level and gain is as per the design goals.A planar array stacking this linear array is planed for scaning radar application. Each linear array will be fed by a T/R Module in order to increases the power aperture product.

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Author Index

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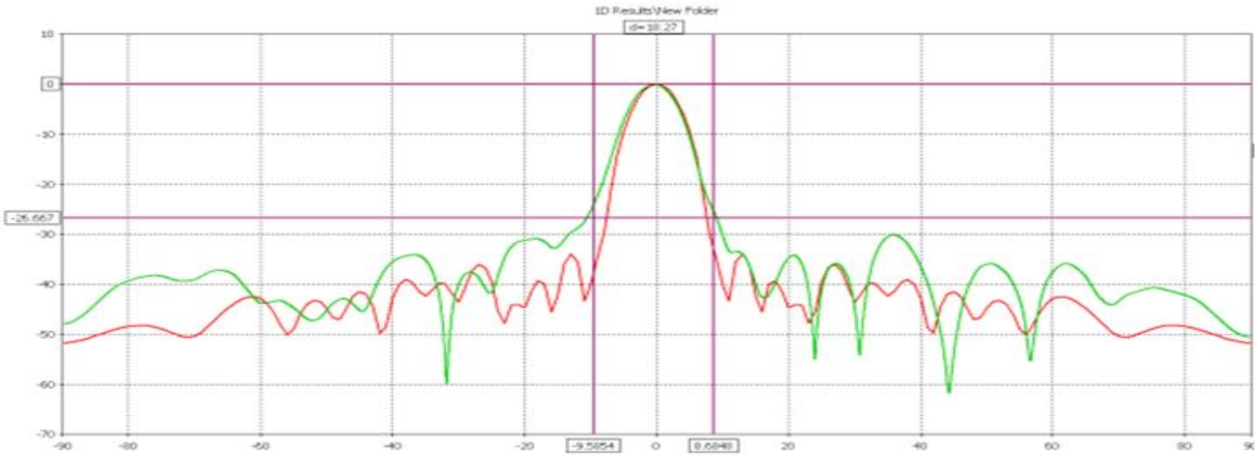

Fig 9 A. Frequency band of f_0-100MHz

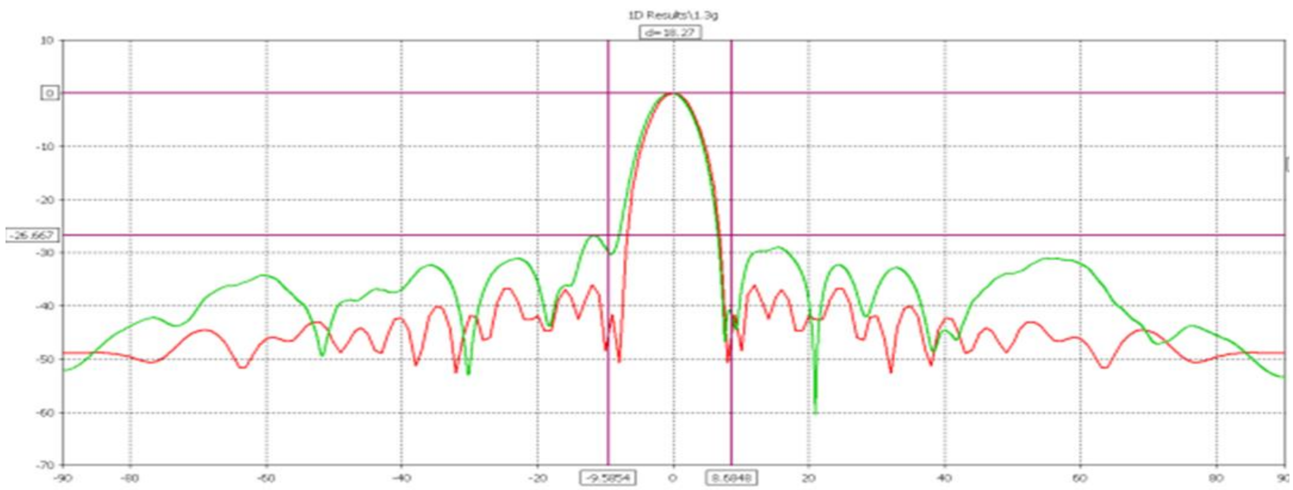

Fig 9 B. Frequency band of f_0

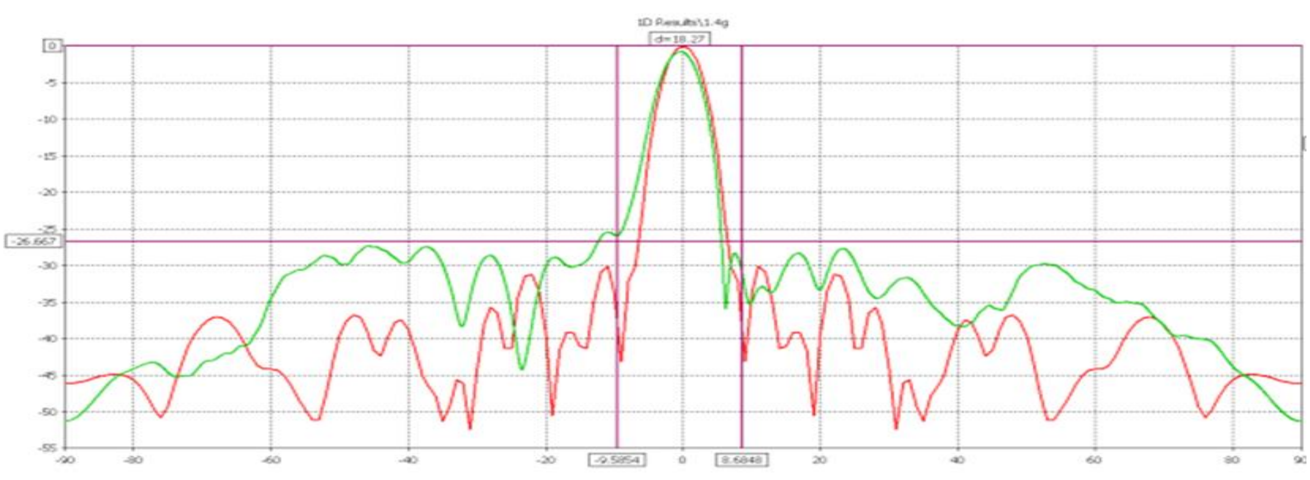

Fig 9 C. Frequency band of f_0+100MHz

Fig9. Shows the simulated and measured pattern of the linear antenna