[Invited Talk] Patch Array Antenna for Coastal Surveillance Radar Application

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Abstract A rectangular patch antenna with aperture coupled feeding technique has been designed as sub array for the coastal surveillance radar application in Indonesia. This antenna consists of 4 x 8 elements with center frequency 9.4 GHz. Simulation results using CST microwave software show an impedance bandwidth of more than 500 MHz is obtained at VSWR < 1.5, the half power beamwidth at phi=0 and phi=90 is 25.4^o and 8.4^o, respectively and the maximum antenna gain obtained is 19.76 dB.

Keyword: patch array antenna, coastal surveillance radar

1. INTRODUCTION

Coastal Surveillance Radar (CSR) for Indonesia is very important due to the geography of Indonesia which consists of more than 17.000 islands. To observe and to monitor the coast for civil and military use in Indonesian territory, the Indonesia government therefore needs CSR.

The idea of the first Indonesian radar was discussed in 2005 and the production started at 2008 [1] named INDRA (Indonesian Radar) for maritime use. INDRA used series-fed microstrip array antenna for X-band [2].

For CSR, the production started in year 2010 and named ISRA (Indonesia Surveillance Radar). The first ISRA product used 1 x 64 elements with series-fed and a parabolic reflector to achieve high gain and suppress side lobe level of the radiation properties of the antenna.

This research, proposes a new design of microstrip array antenna for the Indonesian CSR. The feeding technique proposed is aperture coupled to improve the feeding technique used in [2]. In [2], the feed line is on the same plane with the patch, therefore radiation from the feed can disturb the radiation of the patch. Aperture couple feed can suppress this disturbance because the feed is placed opposite to the patch plane.

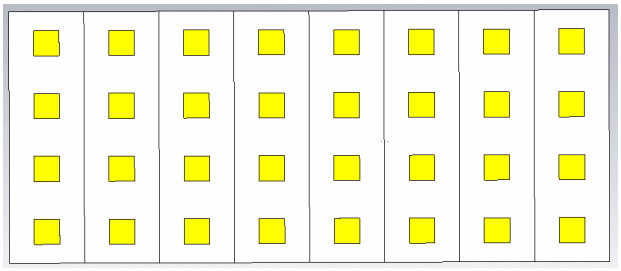
Moreover, side lobe suppression is highly considered in this design to avoid using parabolic reflector to achieve a more compact dimension of the CSR.

2. ANTENNA DESIGN OF 4 X 8 ELEMENTS

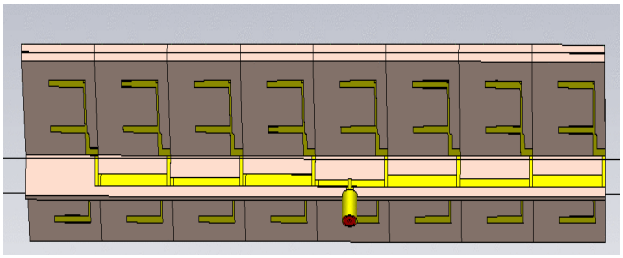
Figure 1 shows the antenna design of the rectangular patch of 4 x 8 elements. This sub array antenna consists of 4x1 elements which are arrayed to become 4x8 elements. The substrate used is Roger 5880 with dielectric permittivity 2.2 and height 1.6 mm.

The top view of the antenna design is depicted in Fig.1 (a). Each rectangular patch has dimension with length 8.15 mm and width 8 mm. The ground plane of the 4x8 element array therefore has length of 202 mm and width of 84.5 mm.

Figure 1(b) shows the bottom view of the second substrate. The bottom view shows that the feed line of the 4 x 1 elements are connected to a feed line which is placed perpendicular to each other. This feed line is designed as power divider to the 4 x 1 elements which is arrayed to 8.



(a)



(b)

Fig. 1. Antenna design 4 x 8 elements (a) top view first substrate (b) 3D bottom view second substrate

Simulation result of the VSWR shown in Fig. 2 shows impedance bandwidth of the antenna at VSWR<1.5 is more than 500 MHz.

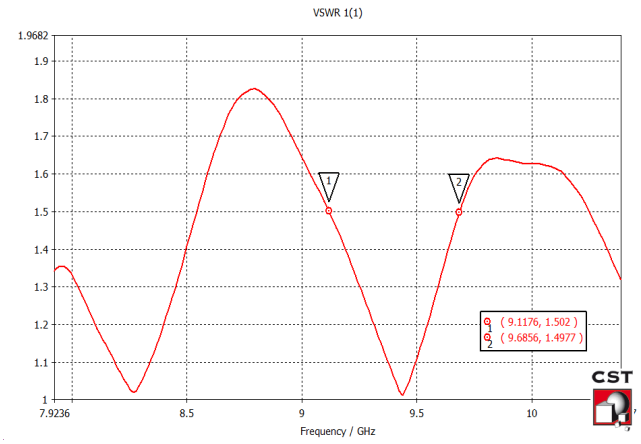


Fig. 2. Simulation result of VSWR 4 x 8 elements

The radiation pattern depicted in Fig. 3 shows that the antenna gain is 19.76 dB with HPBW at phi = 0 and phi = 90 is 25.4^{o} and 8.4^{o}, respectively.

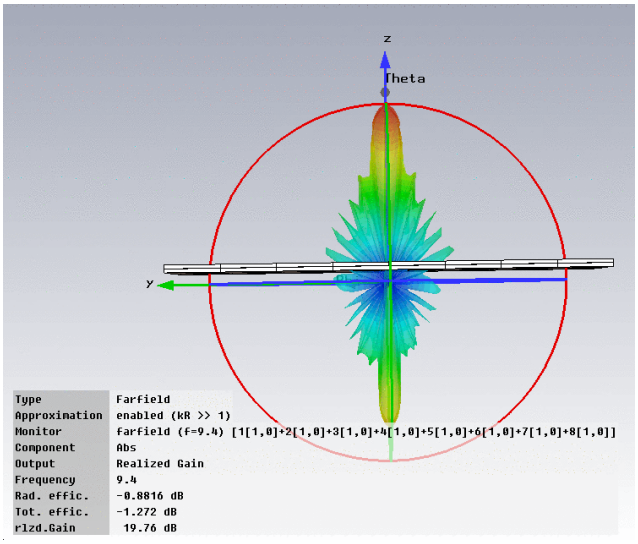


Fig. 3. 3D radiation pattern simulation result of 4 x 8 elements

This design has succeeded in suppressing the side lobe level of both phi = 0 and phi = 90 radiation pattern of the antenna. The side lobe at phi = 0 could be suppressed to 25 dB and for phi = 90, the side lobe level is suppressed to 20 dB. However, the back lobe level is suppressed only 7.4 dB for both phi = 0 and phi = 90.

Due to the high back lobe level of the 4x8 element array antenna, future work of this research is still being carried out.

3. Conclusions

A sub array aperture coupled patch antenna of 4 x 8 elements has been designed for coastal surveillance radar application. The simulated impedance bandwidth of the sub array antenna for 4 x 8 elements are more than 500 MHz at VSWR < 1.5 with maximum antenna gain obtained is 19.76 dB. The HPBW of the antenna at phi = 0 and phi = 90 is 25.4^{o} and 8.4^{o}, respectively.

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