RF Design of Deployable, Rectangular Feed Slot Array Antenna for MicroXSAR Mission

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Abstract

The design of an X-band array antenna for small SAR sensor onboard a 100kg small satellite will be explained. The antenna system consists of waveguide feeder as the bottom layer and the skin with radiation slots and honeycomb core as the top layer. Simple array analysis of feeder tournament with uniform amplitude and Taylor distribution for sidelobe suppression, waveguide power divider, honeycomb core permittivity measurement and the recent design result of one antenna panel will be discussed.

Keywords : small SAR sensor, Rectangular Feed Slot Array Antenna, X-band antenna

1. Antenna Configuration

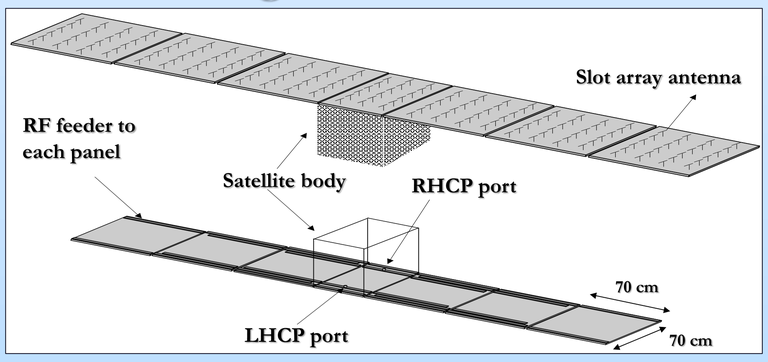


Figure 1 Illustration of top and bottom view of the deployed SAR antenna

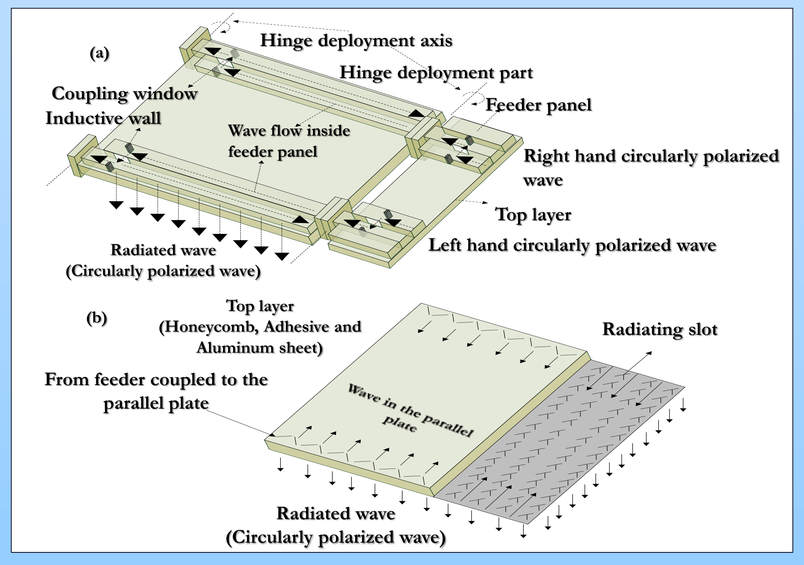


Figure 2 Illustration of: (a) signal flow inside the feeder waveguide (wall for coupling slot and hinge mechanism are omitted) (b) signal flow in the top layer

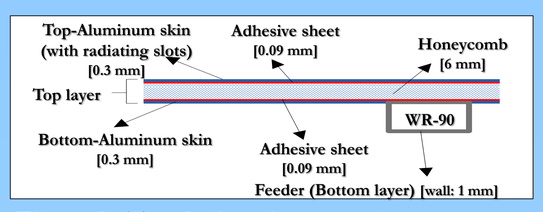


Figure 3 The designed antenna layer structure

2. Research Result

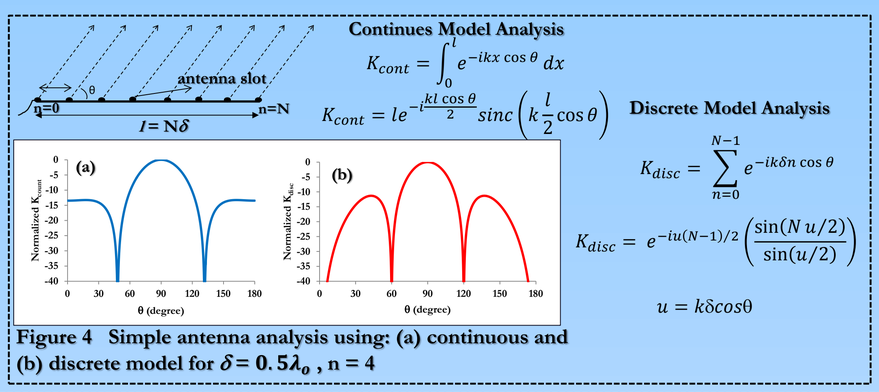


Figure 4 Simple antenna analysis using: (a) continuous and (b) discrete model for $\delta = 0.5\lambda_o$, n = 4

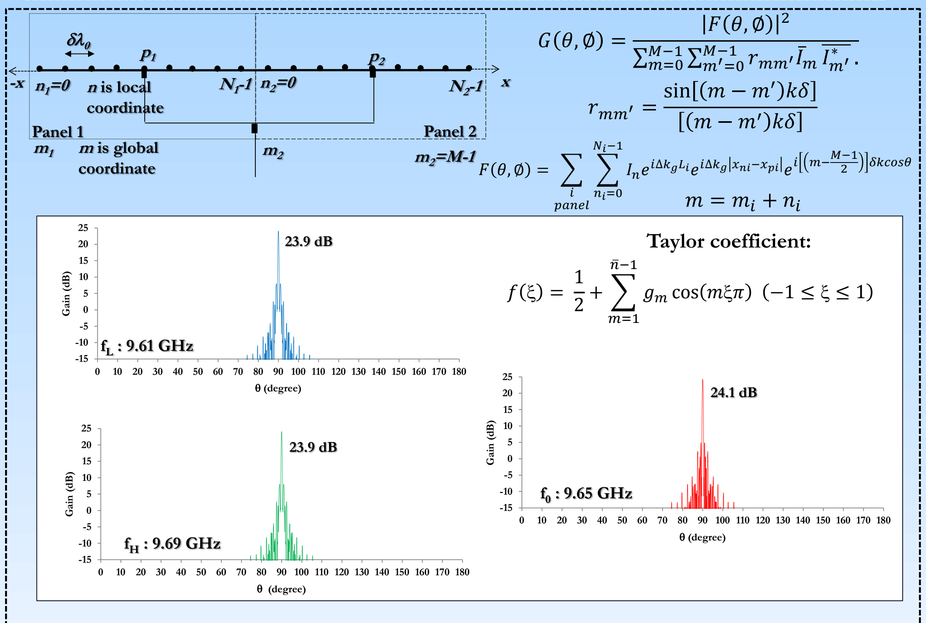
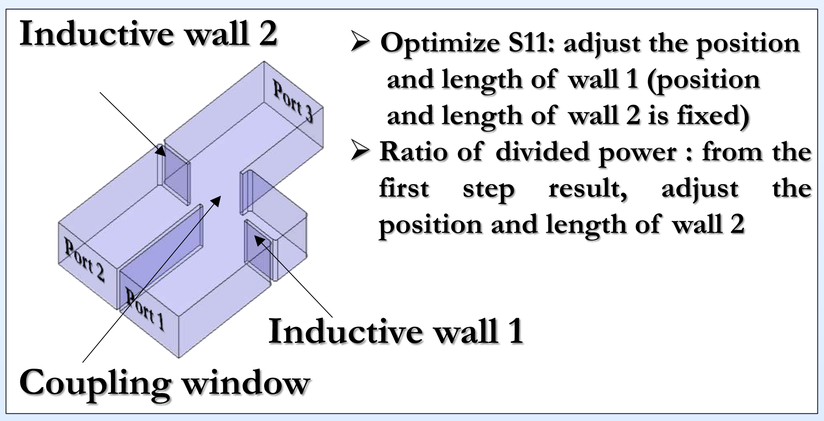


Figure 5 Antenna pattern for 8 panels antenna with feeder tournament configuration that employing 8 Taylor distribution coefficients, side lobe level -25 dB, $\bar{n} = 4$, BW =80 MHz, $\phi = 0°$ and $\delta = 0.5\lambda_o$



- Optimize S11: adjust the position and length of wall 1 (position and length of wall 2 is fixed)
- Ratio of divided power : from the first step result, adjust the position and length of wall 2

Figure 6 The design of power divider in the feeder layer

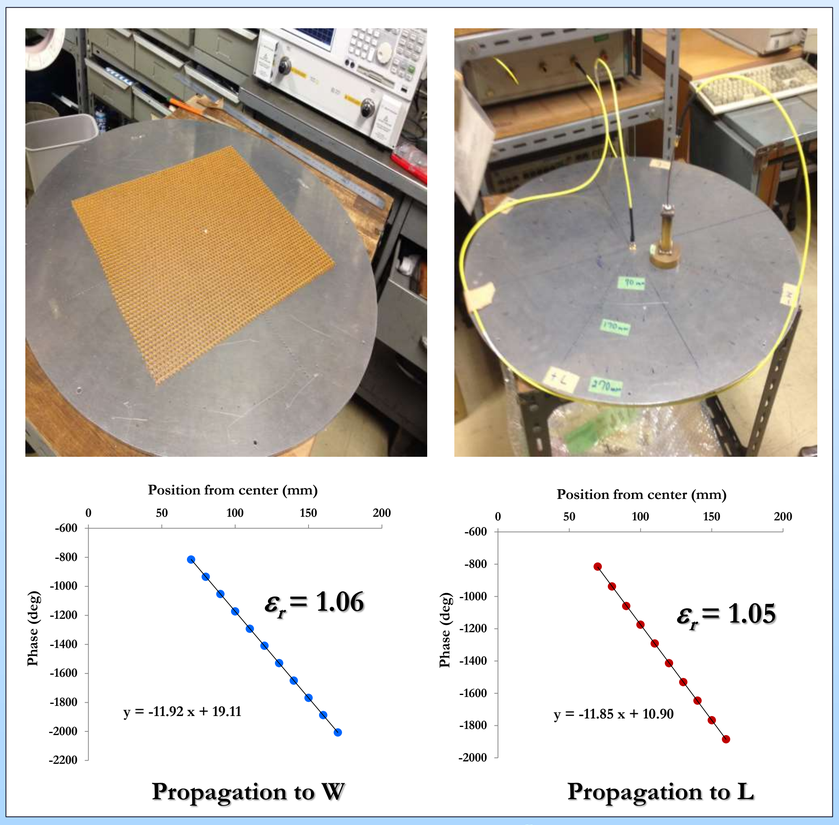


Figure 7 Estimation of $\varepsilon_r \left[\varepsilon_r = \left(\frac{c\beta}{f_0 2\pi}\right)^2\right]$ using inner field measurement method. The measured honeycomb core is SAH-1/4-1.5.

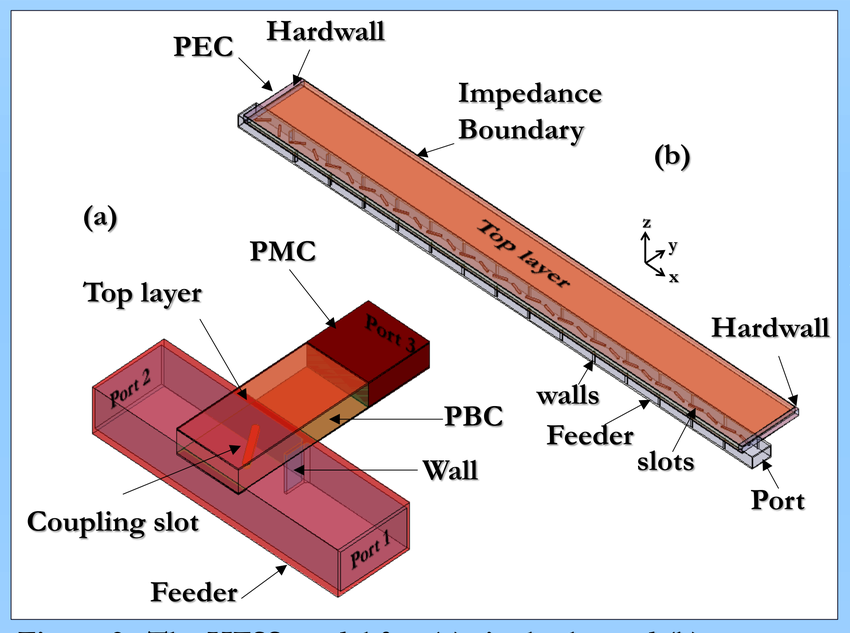


Figure 8 The HFSS model for: (a) single slot and (b) one panel in the feeder design

- Without wall, determine the slot length that gives ∠s21 = 0°, for each step of θ° (every 5°) [Fig. 8 (a)]
- Define the wall length and position to obtain an optimum S11 [Fig. 8 (a)]
- By utilizing each slot's ∠s21 and ∠s31 parameters, rearrange the position of coupling slots in the feeder to have an optimum phase and amplitude distribution of the wave in the parallel plate [Fig. 8 (b)]

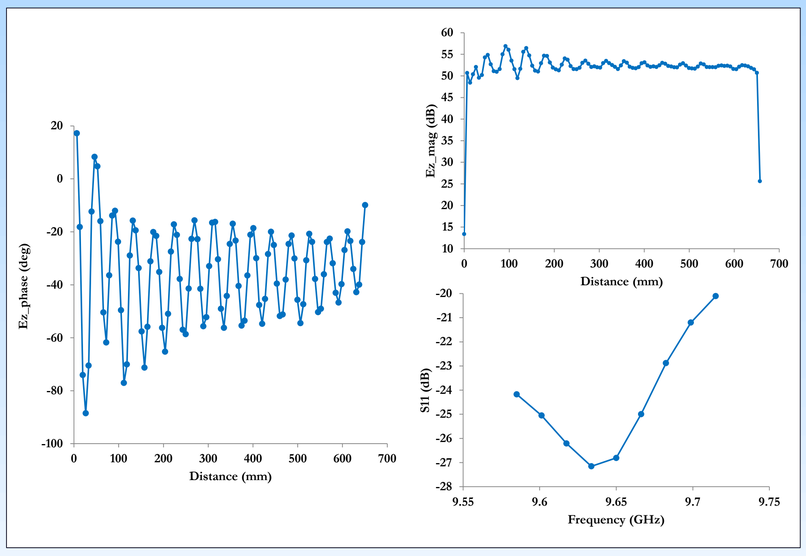


Figure 9 Simulation results using the model in Fig.8 (b), in honeycomb wave propagates in W direction

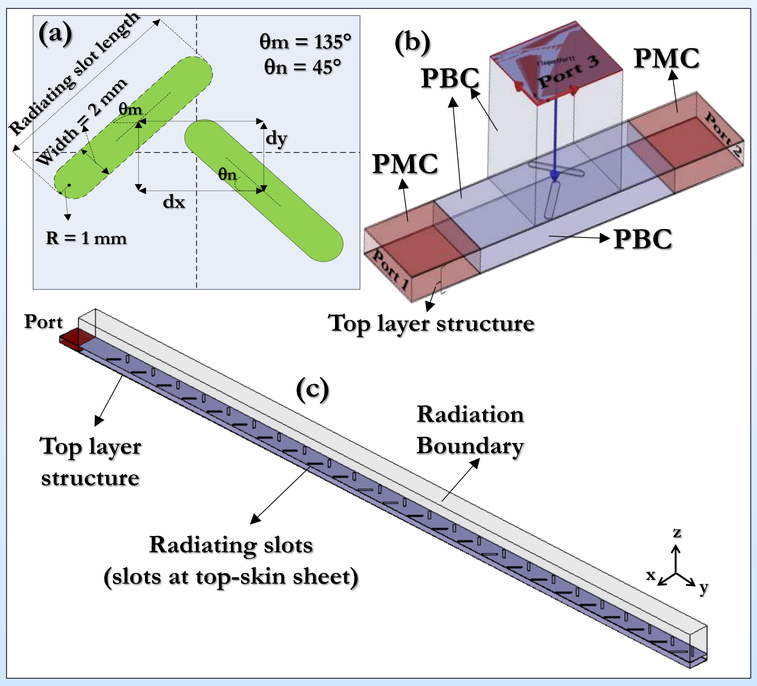


Figure 10 Radiating slot design: (a) radiating slot structure, HFSS model for: (b) one pair of radiating slot (c) one dimensional array radiating slot

- Define the radiating slot length and the related coupled power
- Adjust the distance of dx and dy [Fig. 10 (a)] to have optimum S11 and circular polarization radiation pattern
- By utilizing each slot's ∠s21 and ∠s31 parameters, rearrange the position of radiating slots to have an optimum phase and amplitude distribution of the radiated wave [Fig. 10 (c)]

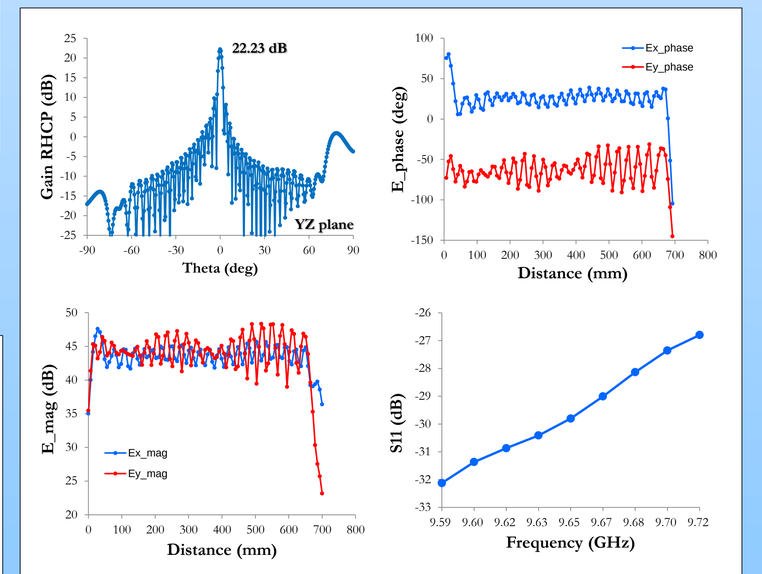


Figure 11 Simulation results using the model in Fig.10 (c)

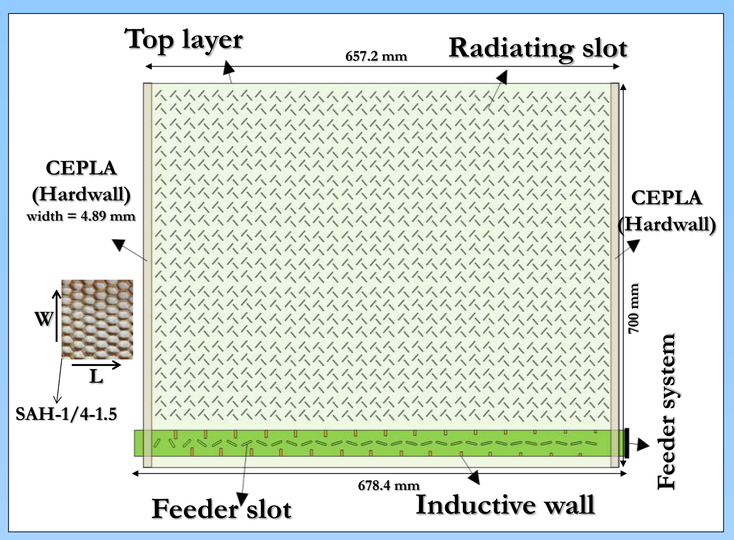


Figure 12 One panel antenna system

3. Conclusion and Future Research

An X-band two layer slot array antenna is currently developed for small SAR on board a small satellite application. One antenna panel is designed and simulated. Further fabrication, measurement and optimization of the antenna system will be conducted.

References

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