The Design of Wideband X-band Antenna for SAR onboard Small Satellite

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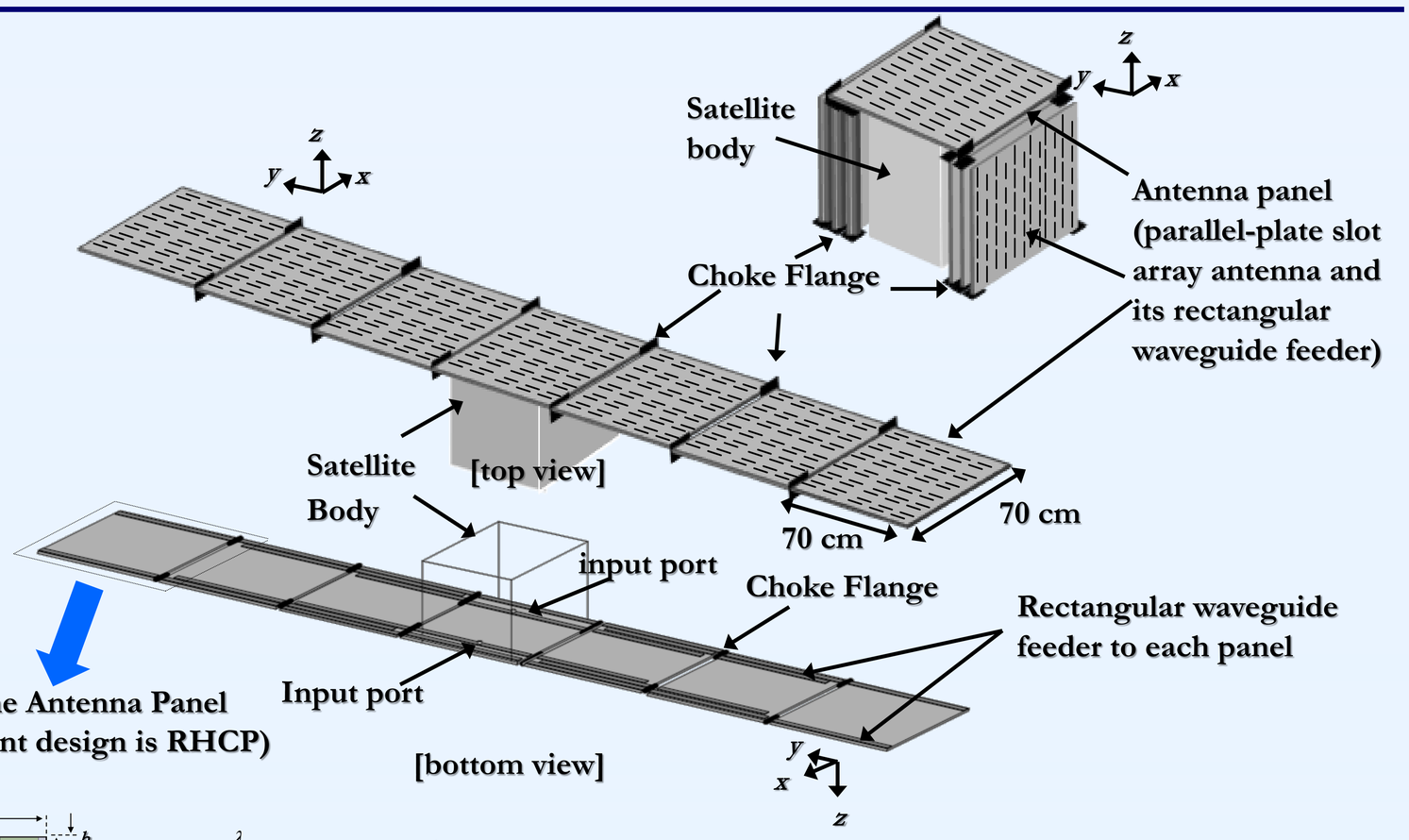
Abstract

The design of an X-band antenna for small SAR sensor onboard a small satellite will be presented. The antenna system consists of rectangular waveguide as its feeder and parallel-plate waveguide as its radiating part. Here, the tournament feeding system with waveguide power divider is applied. The center frequency of antenna is designed at 9.65 GHz with vertical polarization. It is expected that 300 MHz operational bandwidth can be achieved. The recent design results of feeder system, power divider and parallel-plate of one antenna panel will be discussed further.

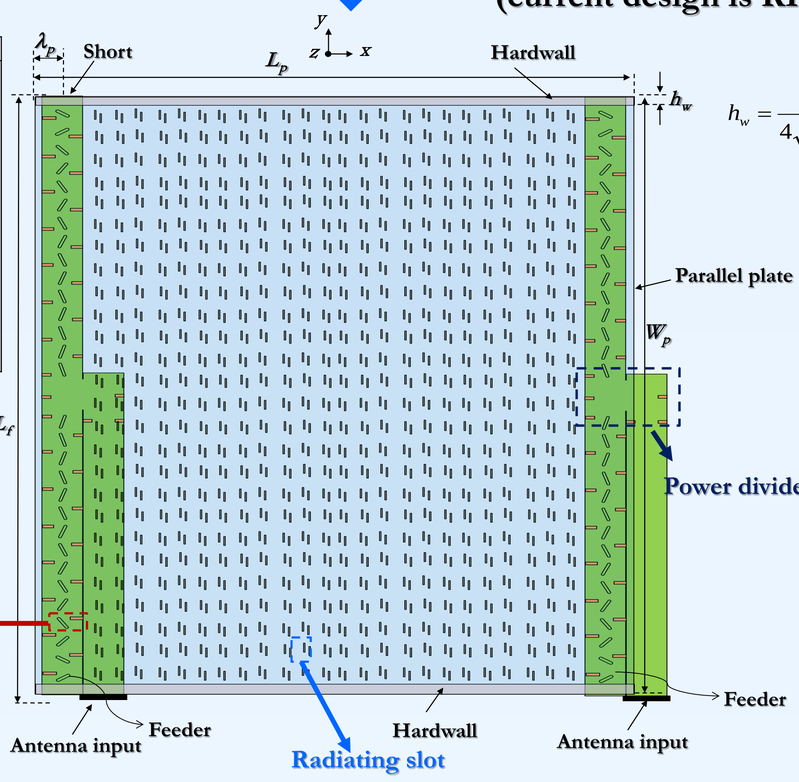
Keywords : small SAR sensor, parallel-plate slot array antenna, X-band antenna



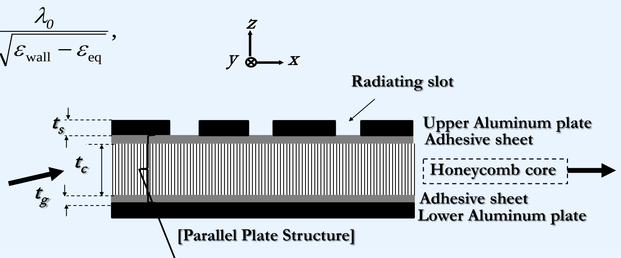
One Antenna Panel
(current design is RHCP)

Parameters	Size (mm)
Parallel-plate (W_p x L_p)	657.2 x 700
Feeder Length (L_f)	678.4
Feeder inner size (a x b)	22.86 x10.18
Inductive wall width, i_w	1
Slot width, s_w	2
Slot round edge radius, r_s	1
Hardwall width, h_w	4.89
The thickness of	
- Aluminum skin sheet, t_s	0.3
- Adhesive sheet, t_g	0.13
- Honeycomb core (SAH-1/4-1.5) , t_c	6
- Hardwall	6.26
- Feeder broad wall	1

Item	Mass (gram)
Upper parallel aluminum plate	344
Lower parallel aluminum plate	358
Honeycomb core sheet	65
Adhesive sheet	138
Hard Surface wall	57
Aluminum Frame	24
Feeder waveguide (2x)	324
Total antenna system	1310



$$h_w = \frac{\lambda_0}{4\sqrt{\varepsilon_{wall} - \varepsilon_{eq}}},$$

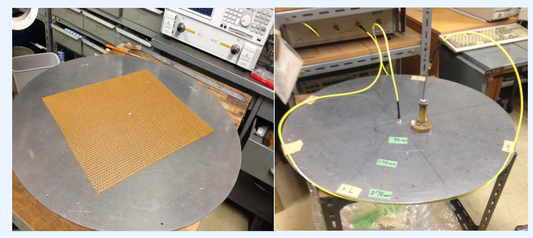


$$\varepsilon_{eq} = \frac{(2t_g + t_c)(\varepsilon_{rc}\varepsilon_{rg})}{2t_g\varepsilon_{rc} + t_c\varepsilon_{rg}}.$$

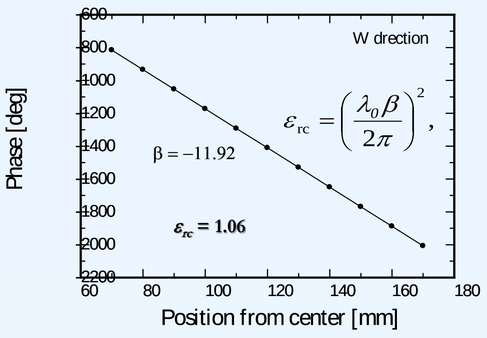
ε_{rg} = adhesive permittivity
ε_{rc} = honeycomb permittivity
ε_{wall} = hardwall permittivity
λ_0 = free space wavelength

- The TE10 mode wave propagates in the feeder to *y* direction.
- Then the wave in the feeder is coupled to the parallel plate by the coupling slots.
- The coupled wave travels in the parallel plate to *x* and - *x* direction.
- Then this wave is coupled to z direction by the radiating slots and becomes the radiated wave.

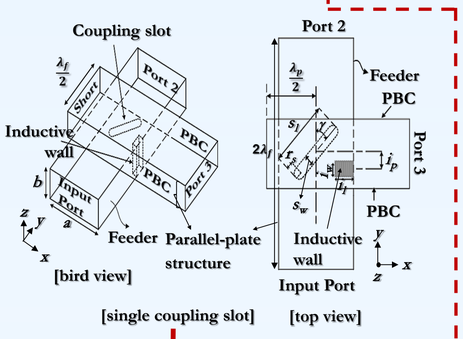
Honeycomb core properties



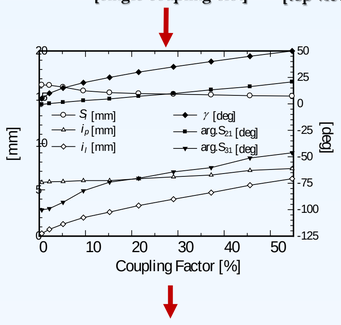
[Inner field measurement]



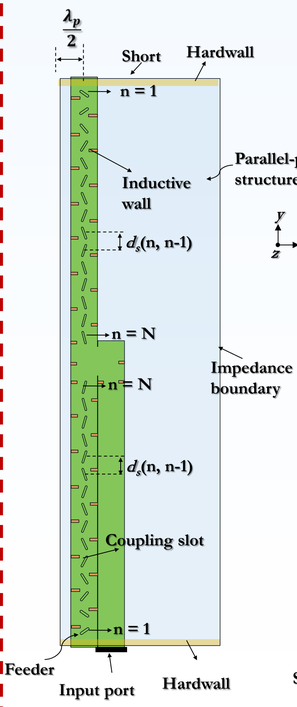
Coupling Slot Design



[single coupling slot]

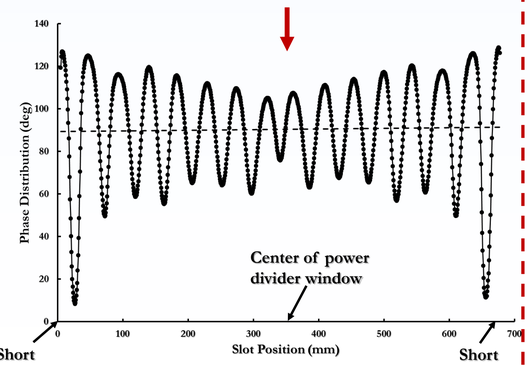


Results of single coupling slot simulation are used in the design of feeder of one antenna panel.



Spacing of coupling slots are adjusted to obtain optimum in-phase excitation

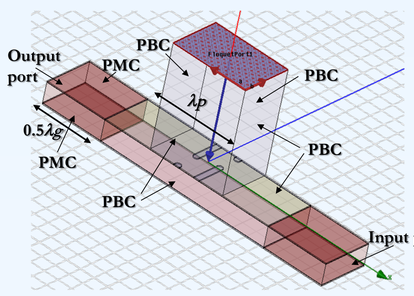
Example of spacing adjustment result of coupling slot at antenna feeder

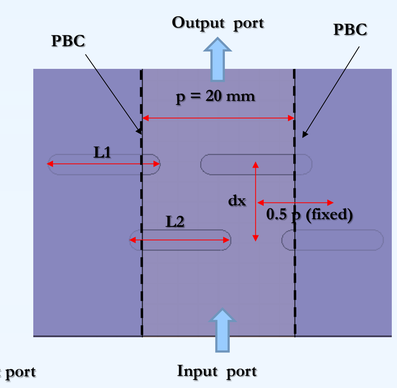


Total Variation of Phase from Center of the Window to the end slot = 2.1 degrees

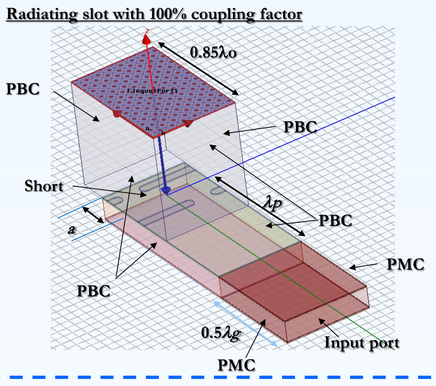
Radiating Slot Design

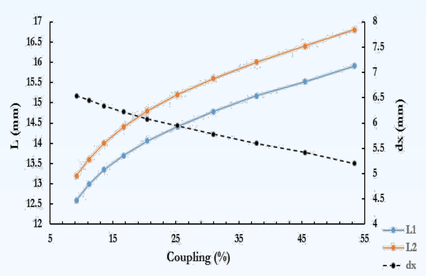
Radiating slot with 50% coupling factor



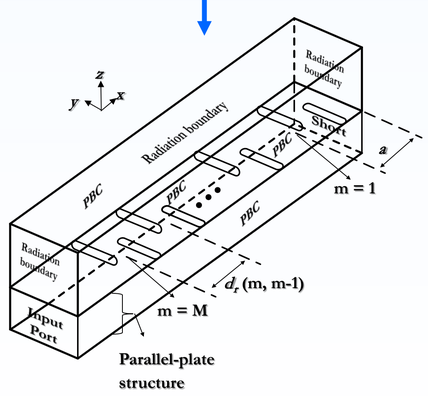


Radiating slot with 100% coupling factor





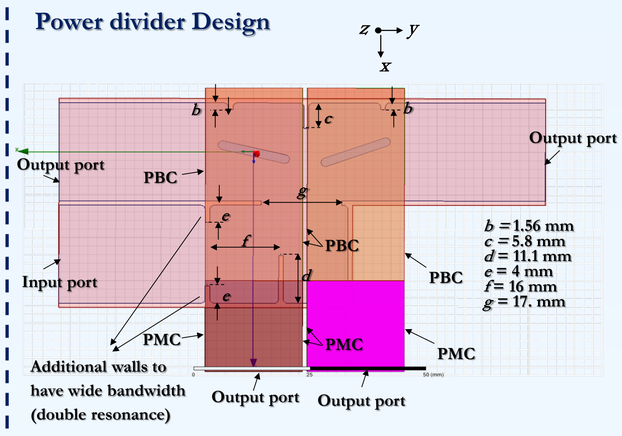
Results of one radiating slot pair simulation are used in the design of one dimensional array of radiating slot.

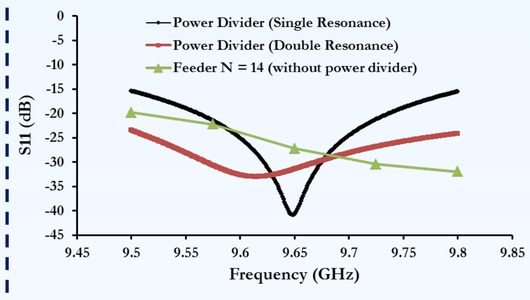


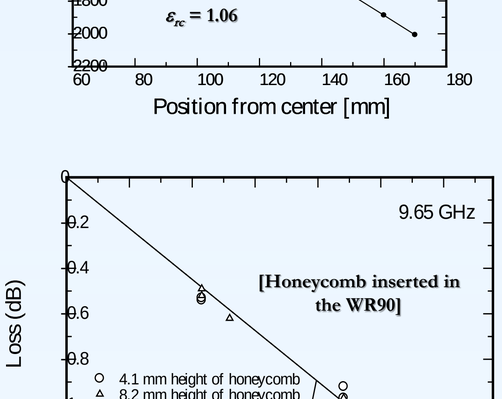
[1 dimensional array of radiating slot]

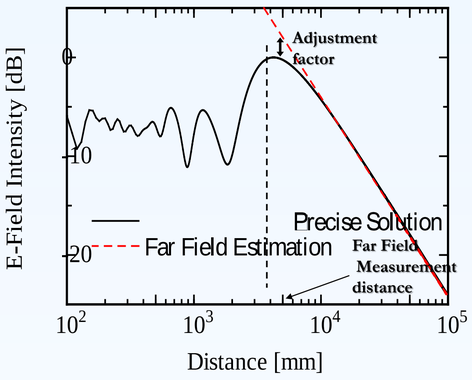
Spacing of radiating slot pair are adjusted to obtain optimum in-phase excitation.

Power divider Design



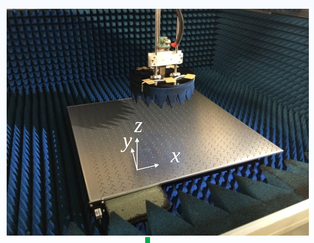






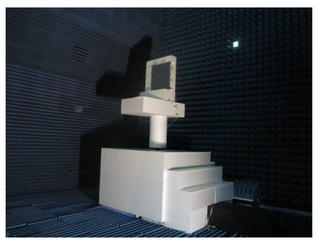
Future Research

Near Field Measurement



- Aperture distribution
- Antenna pattern

Far Field Measurement



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