A Study on the Effect between Commercial Space Solar Cells and the Antennas Integrated on Their Cover Glass

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Abstract

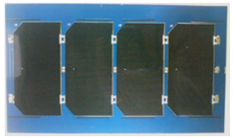
➢ A study to determine how commercial space solar cells affect the functionality of the antenna integrated on top of solar cells has been performed. The measured results show that solar cell affects the antenna gain and decreases it by approximately 3 dB at 5GHz. In addition, the pattern of the antenna was not affected significantly by solar cells whether when they were illuminated and terminated with different loads.

Introduction

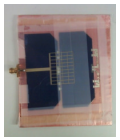
➢ One of the biggest issues of cube satellites is the limited surface area, that makes it challenging to place antenna on cube satellites without competing for the surface area with solar cells. One effective method can be integrate antenna with solar cells.

➢ In the past, two types of this kind of integration has been performed at Utah State University.

➢ As antennas integrated on top of solar cells offers lots of advantages, it is important to determine the effect of solar cells on the antenna.



Slot antenna around solar cells



A 95% transparent antenna

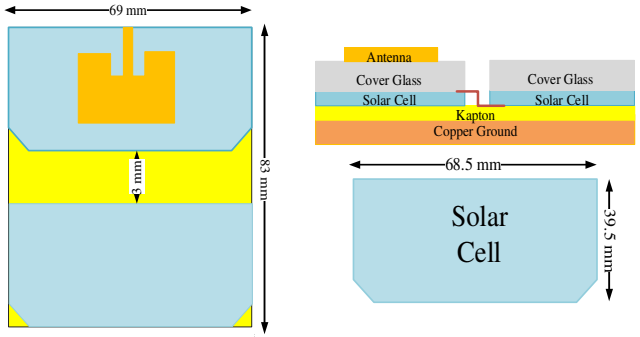
Design Overview

➢ A complete modular fashion design and real world material by using triple junction space solar cells, has been assembled. In this fixture each solar cell has its own cover glass and antenna is printed on cover glass.

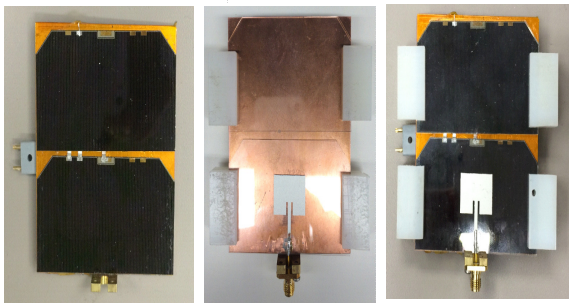
➢ Three sets of measurement have been done for each substrate.

- ✓Antenna on cover glass without solar cells
- ✓Antenna on cover glass above solar cells
- ✓Antenna on cover glass above active solar cells under illumination

Fixture



Schematic of modular design



Assembly of antenna with and without solar cells

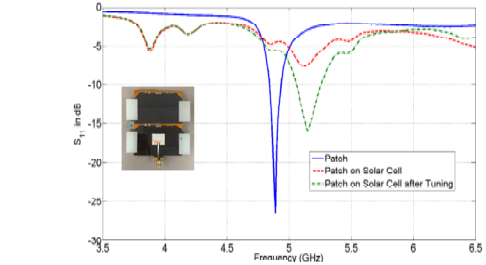
Fabrication

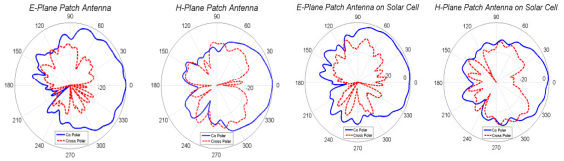
➢AF32 and plexiglass have been used as cover glass. The height of AF32 and plexiglass is 1.3 mm and 1 mm respectively. The design frequency is 4.9 GHz. Also, high conductive silver based ink was printed on cover glass multiple times so that the conductor is thicker than the skin depth.

Printed 4.9 GHz solid patch antenna on two different substrates

Results

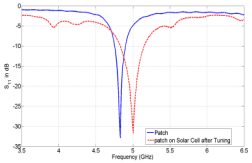
➢AF32 Cover Glass Results:

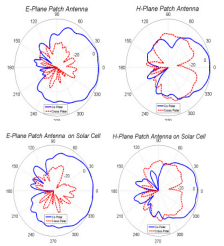




Antenna Number	1	2	3	4	5
Patch Gain (dBi)	6.1	4.9	6.5	5.84	6.1
Patch on Solar Cell Gain (dBi)	3.12	3.32	3.37	3.37	3.32
Gain Difference (dB)	2.98	1.58	3.1	2.47	2.78

➢ Plexiglass Cover Glass Results:





G_{no_solar} =5 dBi

G_{solar} =2.4 dBi

Conclusion

➢ Solar cells decrease 3 dB antenna gain witho disturbing radiation pattern. Also, solar cells affe impedance of feedline and antenna. Finally, the gain patch antenna on solar cell is independent of solar ce loading and activeness.

References

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➢ T. W. Turpin, and R. Baktur, "Meshed patch antennas integrated on solar cells IEEE Antennas and Wireless Propagation Letters. Antennas Propagt., vol. 8, 693-696, 2009.