Observations of Transient ISS Floating Potential Variations during High Voltage Solar Array Operations

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Introduction

• Goal – Determine if observed ISS floating potential transients can be reproduced with current models. Describe the ISS charging process, present transient observations, and show that current models do not reproduce them.

• Method
  • Study the history of solar array charging studies
  • Identify the controlling factors in array induced charging
  • Produce examples of transient charging
  • Describe the current balance model
  • Apply the current balance model to transient conditions
  • Analyze results and suggest future work

• Results
  • Model results

• Conclusion and Forward Work
Outline

• History of solar array charging studies

• Controlling factors in array induced charging

• Examples of transient charging

• Current balance model

• Current balance model applied to transient conditions

• Conclusions and future work

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History of Solar Array Interactions Studies

1960s
• Studies of solar array interactions with the space environment initiated.1-3

1970s
• Studies show that interactions with the space environment are highly dependent on array voltage.4-6

1980s
• Space based experiments confirmed the dependence of environment interactions on solar array voltage.7,8

1990s
• Research initiated specific to ISS solar cell interactions with the space environment.9,10

2000s
• Initial ISS probe data received and studied.11-16

2010s
• Solar array induced transients observed.

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Spacecraft Charging Induced by High Voltage Solar Arrays

“Vf” is the floating potential of the ISS

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Charge Collection through Solar Cell Gaps

plasma electrons

coverglass

Silicon (+160 Volts)

Kapton

coverglass

Silicon (+160 Volts)

coverglass

Silicon (+160 - Vf Volts)

Kapton

coverglass

Silicon (+160 – Vf Volts)
Normal Charging

a) Floating Potential

b) Active Array Strings

c) Array Orientation

d) Plasma Density

e) ISS Latitude

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Each of eight arrays unshunted in full sunlight

close-up

Transients

a) Floating Potential

b) Active Array Strings

c) Array Orientation

d) Plasma Density

e) ISS Latitude

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Spacecraft will float to a potential \( (V_f) \) such that the net current collected is zero\(^{17}\)

\[
0 = \sum_{j} I_j
\]
Current Balance Model for Rapid Charging\textsuperscript{14-16}

Model output agrees well with FPMU data.
Model output does not reproduce FPMU data.

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Conclusions and Future Work

• Floating potential transients attributed to solar array operations have been observed in ISS FPMU data.

• These transients are not reproduced by current balance models.

• Future work: research focused on the time dependent nature of the screening effect and its effect on electron collection to solar arrays.
References


