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Solar Array Passivation based on the galvanic isolation

TAS-Belgium

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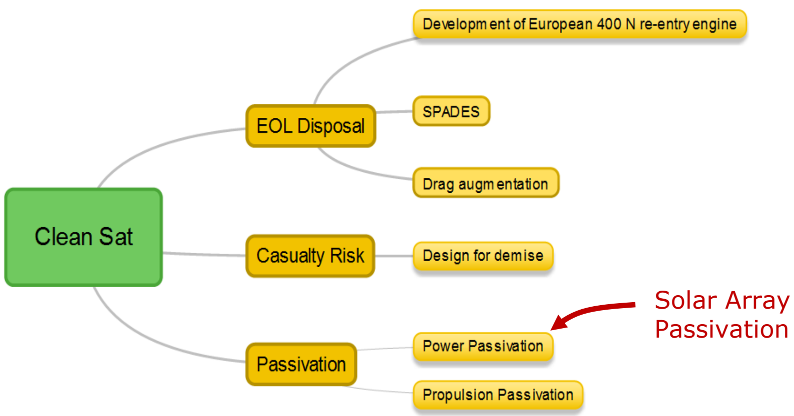
Agenda

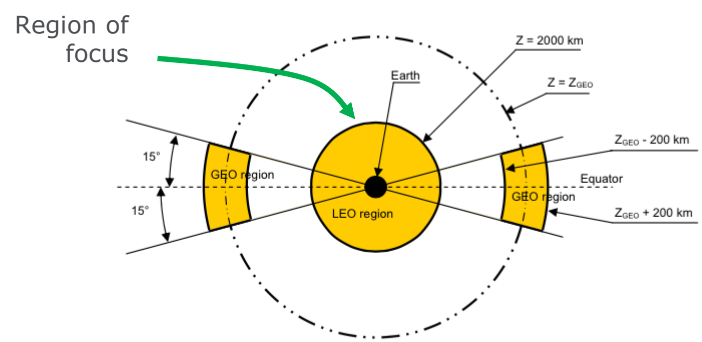
1. Context of the study
2. Scope & Objectives
3. Galvanic Isolation Main Features
4. Suitable isolated topologies
5. Impacts at platform
6. Galvanic Isolation Analysis
7. Conclusions

1. Context of the Study

The presentation is focused on the most promising solution to effectively **passivate the solar array** with a minimum impact to platform performances. Passivation of the Solar Array is accomplished if power flow to the platform is no longer possible.

From CleanSat BBK27, the most promising identified solution is the passivation through **Galvanic Isolation** of the Solar Array





2. Scope and Objectives

Scope: Analyze promising isolated topologies to cover all LEO applications

Objectives:

- Analyze the impacts at platform level of the Galvanic Isolation Solution
- Identify promising topologies for different target missions

Studies are focused on LEO region but concepts could be applicable to GEO missions.

3. Galvanic Isolation Main Features

Advantages

- Robustness of the isolation through isolation between Solar Array (primary) and Power Bus (secondary).
- The transferred power to the main bus can be managed by
    - MPPT regulation
    - Battery Charge Management
    - Regulated bus Mean Error Amplifier.
- The ON/OFF command of the converter is guaranteed by the ON/OFF command of the Auxiliary power supply which supply the entire converter low level.
- Suppression input switch protections
- No need of additional elements (as power relays).

3. Galvanic Isolation Main Features

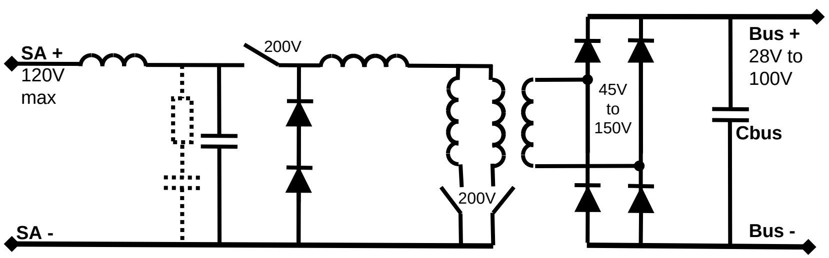
Drawbacks

- Need for high frequency switching
- Need of a Transformer
  - High Complexity (leakage inductance, high current…)
  - Additional Mass
  - Additional Cost

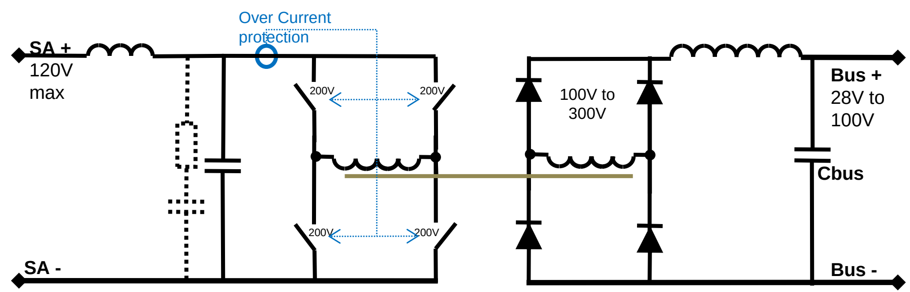
4. Suitable isolated topologies

- Depending on power output, several converter topologies may suit better.

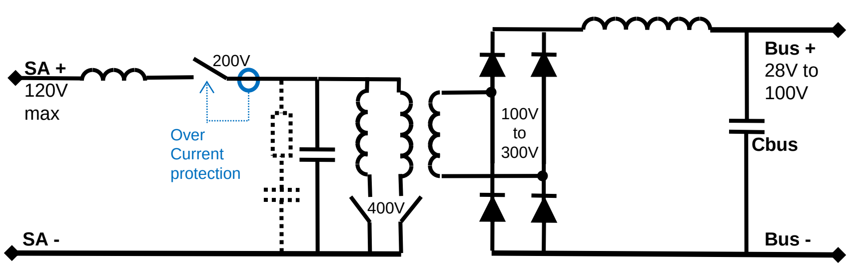
SMART



Forward full bridge



Forward



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5. Impacts at platform level 1/2

- Solar Array IF.
  - Simplified by protections suppression. Efficiency Improvement
  - Compatible with all bus voltages.
- Bus IF
  - Compatible with regulated and non-regulated bus. Control loops adaptation
  - All bus voltages compatible architecture.
- Auxiliary Power supply
  - Low level electronics supplied by the bus and the Solar Array
  - Off-commandable as main passivation method
- TM/TC IF
  - Compatible with HPC + 1553 to passivate

5. Impacts at platform level 2/2

- Reliability

  Slight reduction linked to increased complexity

- Operational Impact

  Restricted to passivation procedure

- AIT Impact

  No particular precaution or procedures identified

- Efficiency :

  No degradation with respect to the current solutions

- Mass And Size

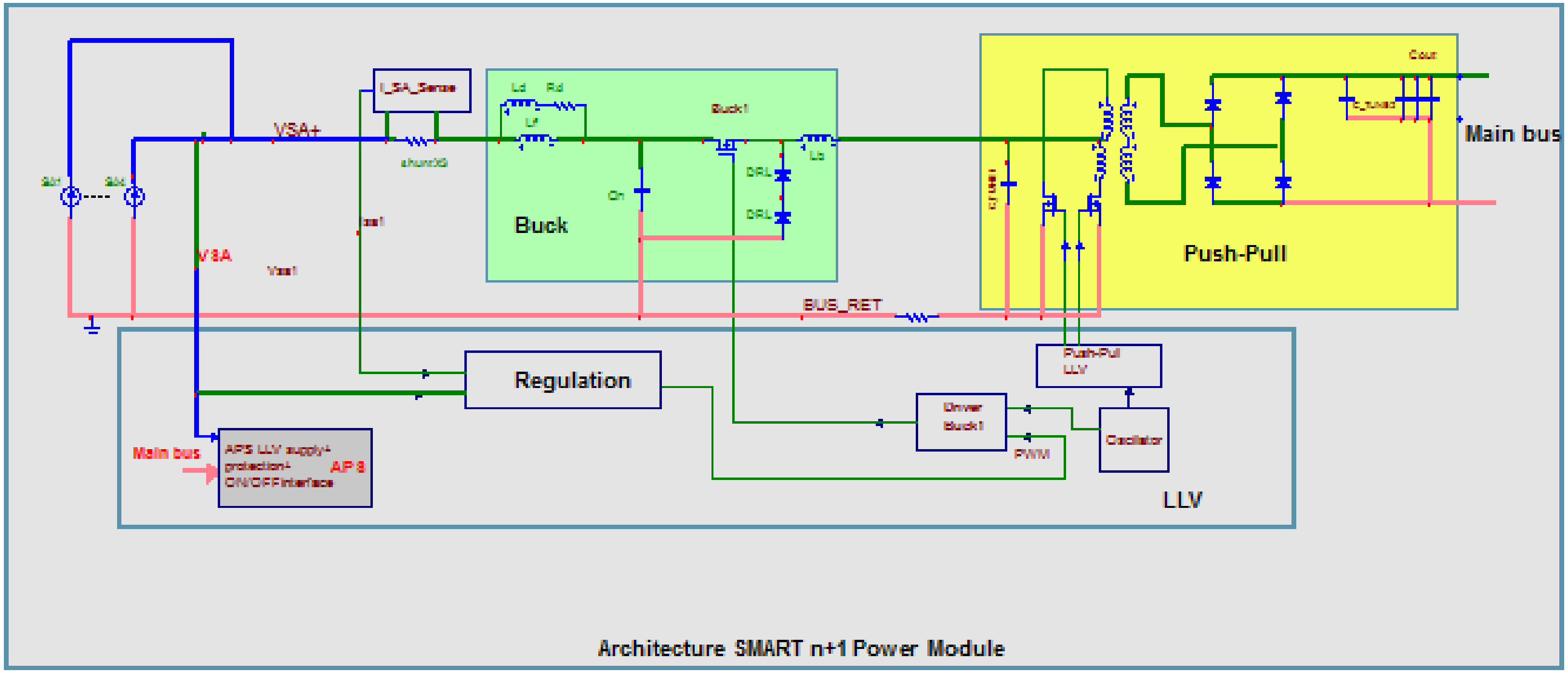
  Mass: between 100g and 300g per kilowatt

  Size: from 0 to 5% strongly dependent on actual design and power.

6. Galvanic Isolation Analysis

This presentation will focus on the SMART topology:

- Presence of Gavanic Isolation
- Adequacy to LEO missions
- Flight Heritage



6. Galvanic Isolation Analysis

- Compatible avec all bus voltages
- Control simplicity
- Passivation is robust even after failure.

- Components stress during passivate period limited to EoL solar array characteristics even after one failure.

	No failure	Buck Mosfet Short circuit	Buck Diode and Mosfet Short circuit	Push-Pull and Buck Mosfets Short circuit
Stress at Input Filter	Solar array voltage	Solar array voltage	Solar array current	Solar array current
Stress at Buck Mosfet	Solar array voltage	Failed	Failed	Failed
Stress at Buck Diode	None	Solar array voltage	Failed	None
Stress at Transformer	None	Solar array voltage	None	Solar array current
Stress at Push-Pull Mosfets	None	Solar array voltage	None	Failed

7. Conclusions

- Galvanic Isolation is a robust and reliable way to isolate the solar array
- Negative impacts on platform are limited and within defined requirements
- Only a few components behavior during passivated period shall be qualified

Components	Maximum SA voltage	Maximum SA current	Thermal cycling
Latching Relay (TL26 type)	x	x	x
Transformer (max power of 1KW)			x