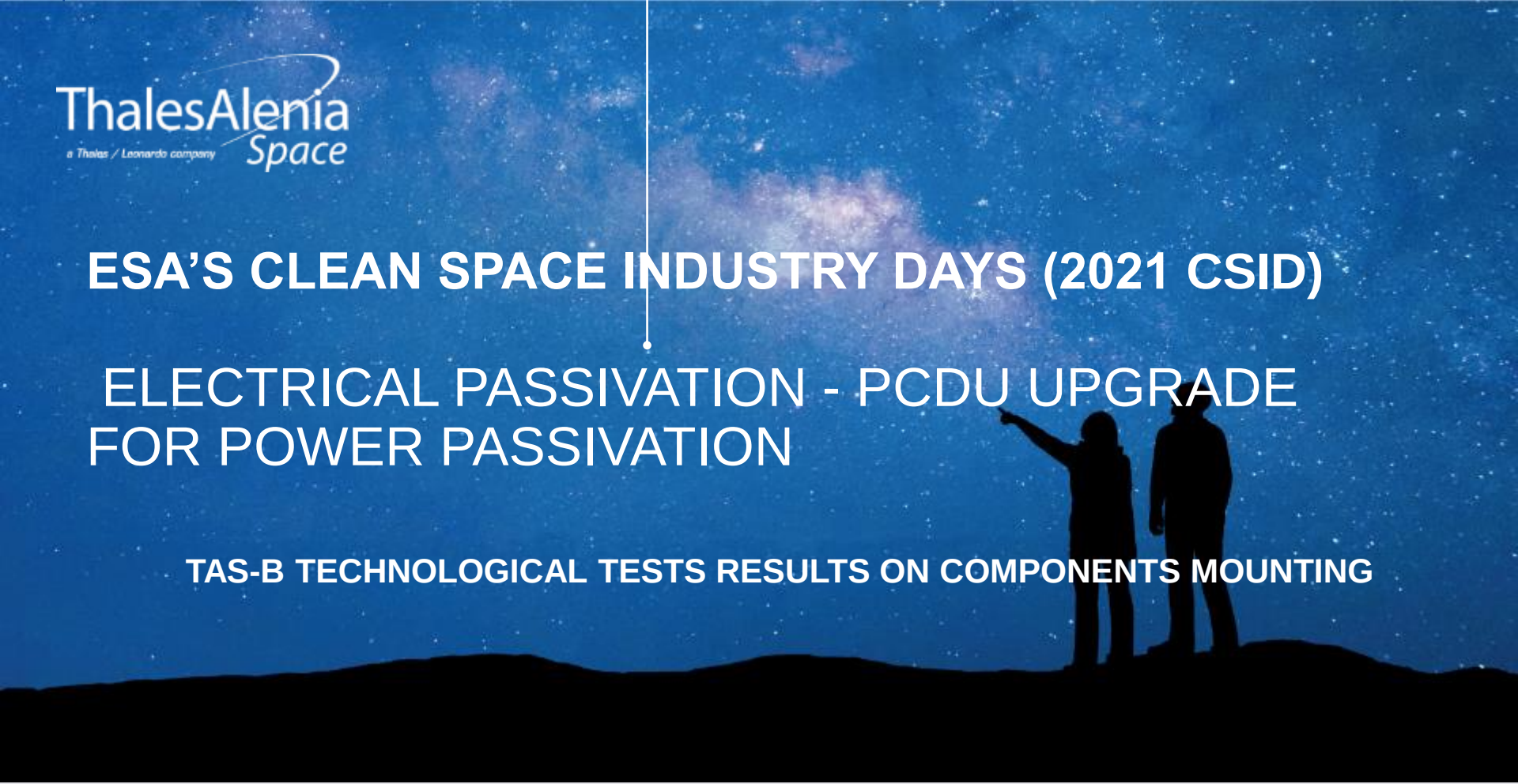
# ESA'S CLEAN SPACE INDUSTRY DAYS (2021 CSID)

# ELECTRICAL PASSIVATION - PCDU UPGRADE FOR POWER PASSIVATION

## TAS-B TECHNOLOGICAL TESTS RESULTS ON COMPONENTS MOUNTING



**Date:** 20/09/2021
**Ref:** PCDU-CLEAN-TASB-PPT-0044
**Template:** 83230347-DOC-TAS-EN-010

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# SCOPE AND OBJECTIVES

/// Objective : Isolation of the solar arrays embedded in the PCDU

- Identification of the components involved in the isolation of the solar array during the disposal phase.
- Manufacturing of technological breadboards and technological test evaluations

# MAIN REQUIREMENTS

## A2. Specific requirements

| | |
|---|---|
| A2-010 | The isolation of the solar array shall be designed to be implemented within the Power Conditioning (and Distribution) Unit. |
| A2-020 | The isolation of solar array shall remain active even in case of a main power bus powered down to 0V as by a depleted battery. |
| A2-030 | The isolation of solar array shall provide a SA passivation capability by short-circuiting or open-circuiting all SA sections, so that SA power is no more transferred to the main bus and battery charge becomes impossible. |
| A2-040 | Two fully independent commands shall be used for passivation (for example arming command and firing command). At least one of the commands shall be a direct command from ground (HV-HPC as per AD10). |

# MAIN REQUIREMENTS

<table>
<tr><td>A2-240</td><td>During the satellite operational phase the following temperature range at TRP shall be considered:
<table>
<tr><th>°C</th><th>Min Op</th><th>Max Op</th><th>Min Non-Op</th><th>Max Non-Op</th><th>Min Start up</th></tr>
<tr><td>Design Temperature limits</td><td>-20</td><td>+50</td><td>-30</td><td>+60</td><td>-30</td></tr>
<tr><td>Acceptance Temperature</td><td>-25</td><td>+55</td><td>-35</td><td>+65</td><td>-30</td></tr>
<tr><td>Qualification Temperature</td><td>-30</td><td>+60</td><td>-40</td><td>+70</td><td>-30</td></tr>
</table></td></tr>
<tr><td>A2-250</td><td>During the satellite operational phase the solution shall be able to withstand 15 thermal cycles per day between 20°C and 40°C.</td></tr>
<tr><td>A2-260</td><td>During the disposal phase the solution shall be able of keeping the SA isolation considering a temperature range of -50 °C to 80°C.</td></tr>
<tr><td>A2-270</td><td>During the disposal phase the solution shall be able to withstand 15 thermal cycles per day between 60°C and 80°C.</td></tr>
<tr><td>A2-280</td><td>The passivation function shall be testable during the AIT phase at satellite level without the use of any specific test command.</td></tr>
</table>

# TRADE-OFF

Trade-off results for Isolation of the solar array in the PCDU:

- S3R : shunting solution
- S2R : opening solution
- MPPT : opening/shunting solution

| 50V (un)regulated bus plateform | | Passivation reliability | Mission reliability | Market coverage | Mass | Price | Efficiency | |
|---|---|---|---|---|---|---|---|---|
| Weight | | 10 | 40 | 10 | 15 | 15 | 10 | Results |
| S3R | Commun Relay Shunting | 9 | 10 | 8 | 0 | 3 | 10 | 716 |
| | Shunting Relay (1 contact per section) | 10 | 10 | 6 | 2 | 4 | 10 | 743 |
| | Series Relay | 10 | 7 | 10 | 0 | 2 | 6 | 563 |
| | Relays passivation main bus regulation | 5 | 7 | 2 | 9 | 3 | 10 | 637 |
| | MOSFET D-G S/C | 4 | 7 | 3 | 9 | 6 | 10 | 680 |
| | Serial Electronic Switch | 0 | 4 | 10 | 8 | 0 | 0 | 374 |
| S2R | Serial Relay | 10 | 7 | 10 | 4 | 6 | 4 | 658 |
| | Serial Electronic switch | 3 | 10 | 10 | 9 | 5 | 10 | 828 |
| MPPT | Serial Relay | 10 | 7 | 10 | 8 | 10 | 0 | 740 |
| | Common SA shunt | 10 | 10 | 8 | 8 | 10 | 10 | 940 |
| | Electronic input switch | 9 | 10 | 10 | 10 | 9 | 10 | 970 |
| | 1 buck per SA section | 9 | 10 | 3 | 10 | 9 | 10 | 900 |
| | Galvanic Insulation | 6 | 5 | 3 | 0 | 0 | 0 | 288 |
| Passivation module | | 10 | 10 | 10 | 0 | 0 | 10 | 700 |

**Table 65 - Tradeoff summary for 50V (un)regulated bus platform**

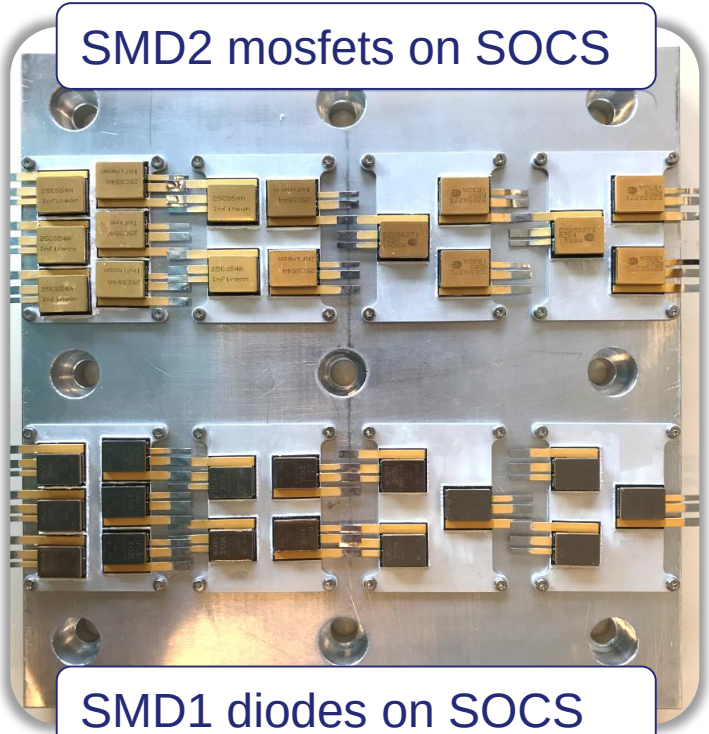
# TECHNOLOGICAL TESTS – TESTED COMPONENTS

/// List of packages submitted to technology evaluation

- SMD2 MOSFET
- SMD05 MOSFET
- SMD1 DIODE
- TO258 DIODE
- POWER RELAYS
- HIGH POWER TRANSFORMER
- LOW LEVEL RELAY
- FP14 COMPARATOR

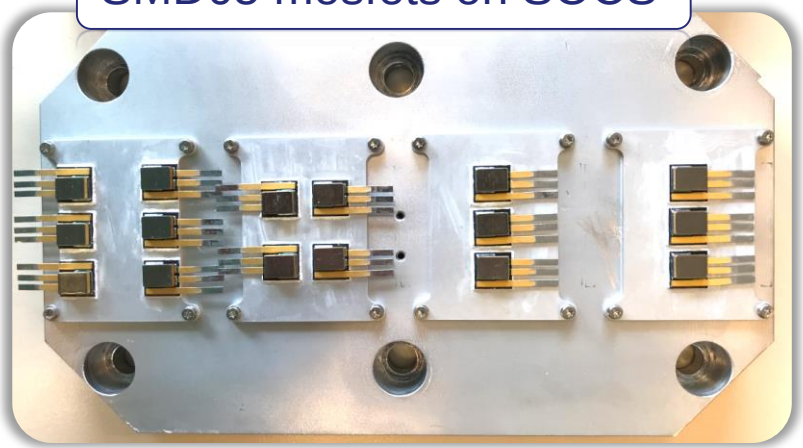
# TECHNOLOGICAL TESTS - TESTS VEHICLES

SMD2 mosfets on SOCS



SMD1 diodes on SOCS

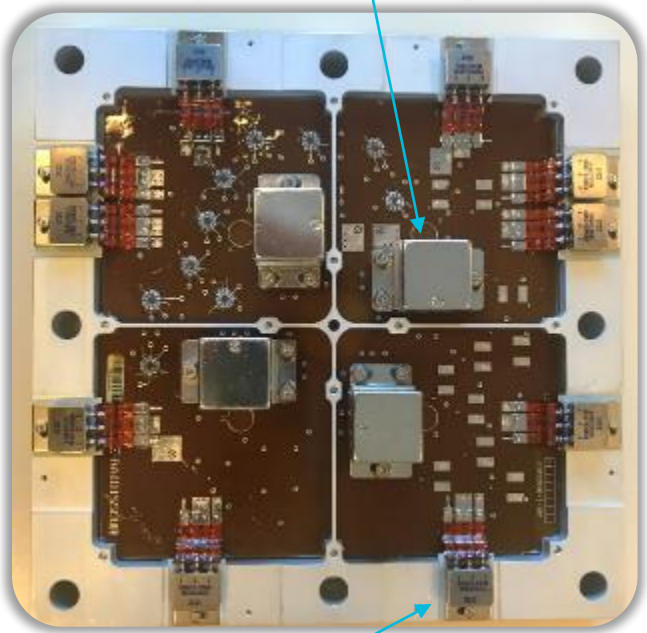
SMD05 mosfets on SOCS

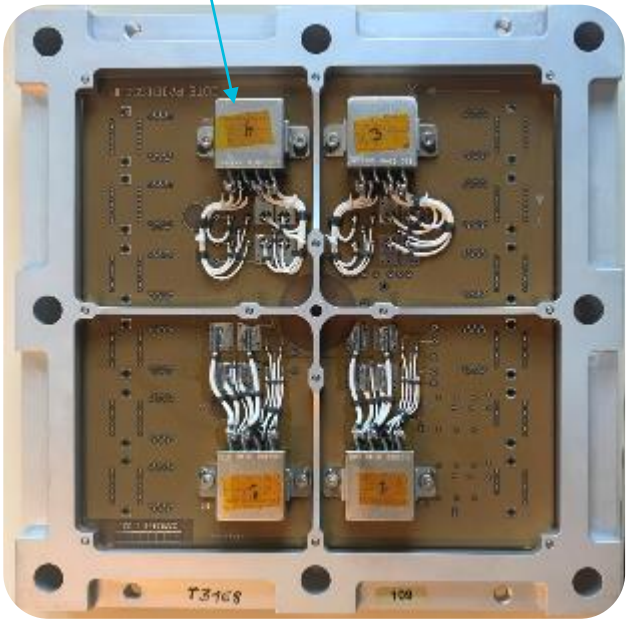


# TECHNOLOGICAL TESTS - TESTS VEHICLES

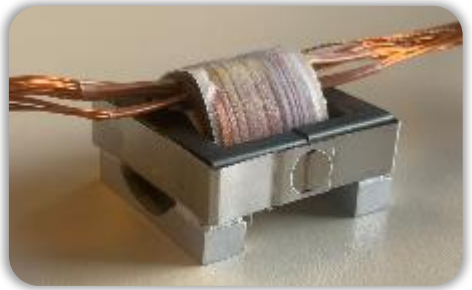
EL415 relays

EL215 relays





Power transformer



TO258 diodes

# TECHNOLOGICAL TESTS - TESTS DESCRIPTIONS

## /// Mechanical tests

**/ VIBRATIONS**

- High level sine vibrations
- Random vibrations

**/ SHOCKS**

## /// Thermal cycling tests file

**/ MISSION PHASE**

**/ DISPOSAL PHASE**

Electrical monitoring performed on all components during all the thermal cycling with low current (100 mA)

Mission phase :

| | Components on PCB | Components on SOCS |
|---|---|---|
| Temperature range | -55 °C / +110 °C | -55 °C / +110 °C |
| Number of cycles | 1337 | 2741 |

Disposal phase :

| | Components on PCB | Components on SOCS |
|---|---|---|
| Temperature range | -55 °C / +110 °C | -55 °C / +110 °C |
| Number of cycles | 1217 | 2050 |

## /// Power cycling tests file

**/ MISSION PHASE**

**/ DISPOSAL PHASE**

Electrical monitoring performed with specific test set-up depending of mission or disposal phase

Parameters :

- SA current
- V0C
- VBus

All the tests were performed in order to cover mission and disposal phase needs in term of ageing, electrical functionality, mechanical and thermal stress



**Date:** 16/12/2020
**Ref:** PCDU-CLEA-TASB-PPT-0038
**Template:** 83230347-DOC-TAS-EN-010

# TECHNOLOGICAL TESTS - TESTS RESULTS

## /// Power components

| | Component to evaluate | Mounting | Quantity & quality definition | result |
|---|---|---|---|---|
| **Power relay** | EL415 | on PCB | 4 : thermal cycling, EM grade<br>4 power cycling, grade 3+ | Succeed |
| | EL215 | on PCB | 4 : thermal cycling<br>4 : power cycling | Succeed |
| **Power diode** | SMD1<br>TO-258 | on SOCS<br>on PCB (mechanical structure + flex) | 10 : thermal cycling, grade 1<br>6 : power cycling, grade 1<br>10 : thermal cycling, grade 1<br>6 : power cycling, grade 1 | Succeed<br>Succeed<br>Succeed<br>Succeed |
| **Electronic switch** | SMD2<br>SMD05 | on SOCS<br>on SOCS | 10 : thermal cycling, EM grade<br>6 : power cycling, grade 1<br>10 : thermal cycling, grade 1<br>6 : power cycling, grade 1 | Succeed<br>Succeed<br>Failed<br>Results under analysis |
| **Galvanic isolation** | ETD transformer | on mechanical structure | 2<br>2 | Succeed |

# CONCLUSION

/// All the technological test  evaluation are done successfully except SMD05 mosfet.