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Antenna Deployment System (ADS)

Driving Requirements

- FUNCTIONNAL REQUIREMENTS
  - **Antenna Position**
    - The ADS shall maintain the antennas in a stowed position until it receives the command to deploy the antennas.
  - **Deployment**
    - ADS shall deploy the two antennas.

- MISSION & PERFORMANCE REQUIREMENTS
  - **Fixed Position**
    - After deployment, the antennas shall be locked in a fixed position, with a precision of less than [20] deg. compared to their designed position.
  - **System Power**
    - The deployment of the antennas shall take less than [40] sec (20sec for each wire) after reception of the deployment command or signal.

Interface Requirements

- **Mechanical requirements:**

1. Max. Weight = 25 gr.
2. Max. Interior volume = 0.082 x 0.106 x 0.009 m^3
3. Max. Height going out of the rails = 6.5 mm

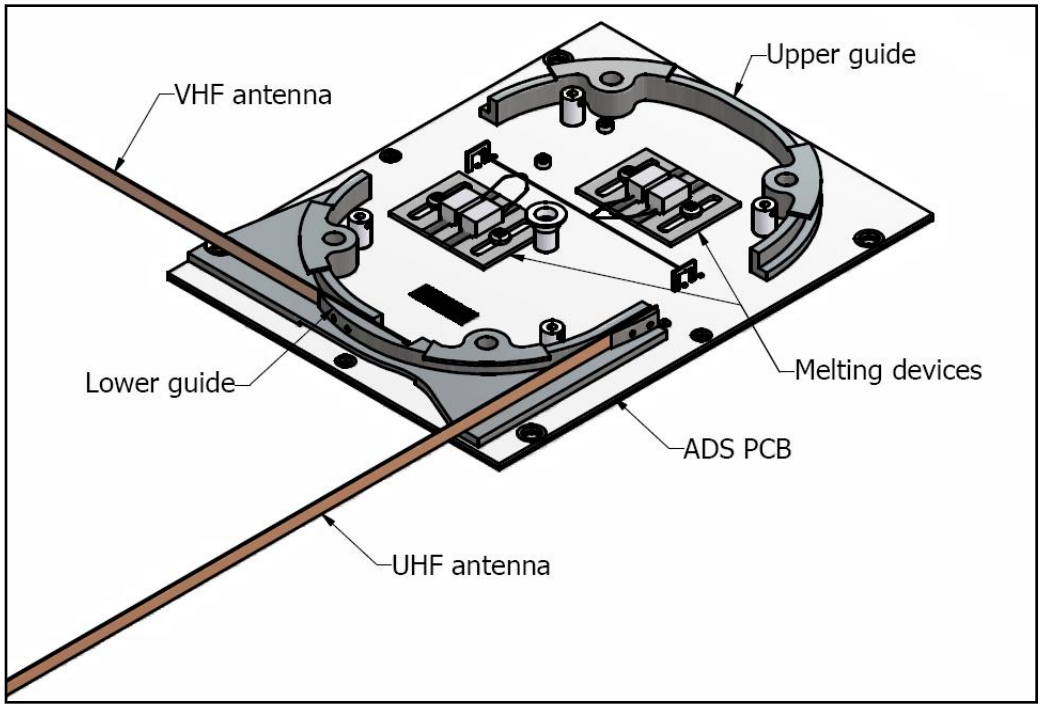
- **Electrical requirements:**

1. Voltage = 2 x 3.3 V
2. Current = 2 x 4 Watts

- **Boundary requirements:**

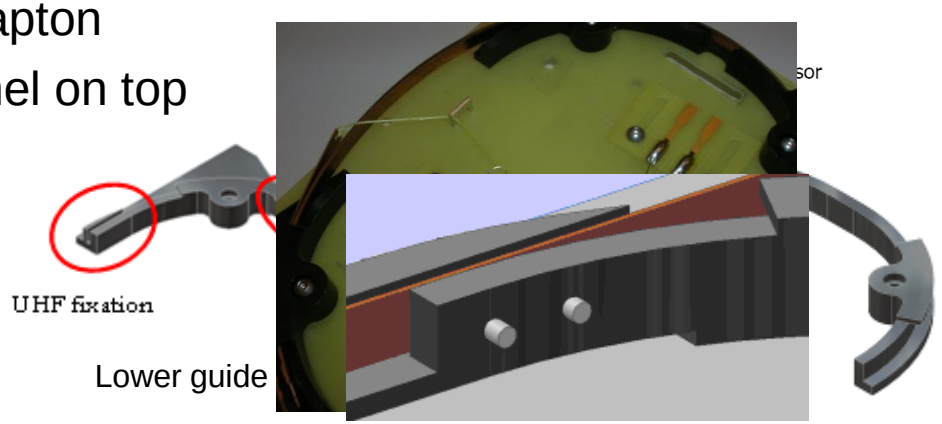
1. Temperature range = -50°C / +70°C
2. Pressure = Vacuum conditions

Design Description



Design Description

- PCB plate
- 2 flat cupper-beryllium antennas orthogonal to each other
- 2 POM guides
- Antennas glued and locked to the guides and connected to the PCB
- Dyneema fiber holding the antennas
- 2 nichrome wires to melt the fiber (redundancy)
- Moving melting devices to ensure contact between nichrome and dyneema
- Electrical connections directly on the plate
- Electrically isolated antennas by Kapton
- Enough space to add solar cell panel on top



Operational scenario

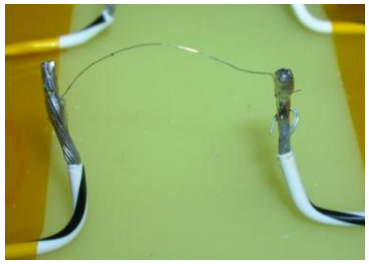
1. Kill-switch activated when expelled from P-POD
2. Current passes through 1st wire
3. Wire heats up and melt fibre
4. Current passes through 2nd wire
5. Wire heats up and melt fibre (if 1st one didn't work, REDUNDANCY)
6. Once antennas free, they deploy (own spring force)

Fabrication of Qualification and Flight Models

- PCB: fabricated by MicroPCB, already 1 in house, waiting for the second
- Guides: fabricated by Dynatec, already 5 pairs in house
- Melting devices: fabricated by Atelier Circuit Inprimés (ACI) at EPFL
- Antennas: 0.037m wide and 2.8m long copper-beryllium sheet from “NGK Berylco” (France) in house
- Resistances: bought at Distrelec

Tests Description and Results

- ADS HEATING TEST (January-February 2008, RUAG Nyon)
  - Verify that nichrome wires melt the dyneema and the antennas deploy
  - Vacuum / -50ºC and ambient temp.



- Heating system characterization
  - Heat 6 nichrome wires increasing the current.
  - Observe the colour of the wire and the time needed to reach the colour
  - Temperature of the wire must be at about 300°C to guaranty a melting of the dyneema
  - Choose best adapted current
  - Nichrome wire doesn't melt while heated during 30 sec.
  - Same behaviour at different temperatures (-50°C / +70°C)

Best option = 180 mA current (Light orange). Wire at 600 – 800°C

Tests Description and Results

- ADS HEATING TEST (January-February 2008, RUAG Nyon)
  - Verify that nichrome wires melt the dyneema and the antennas deploy
  - Vacuum / -50ºC and ambient temp.

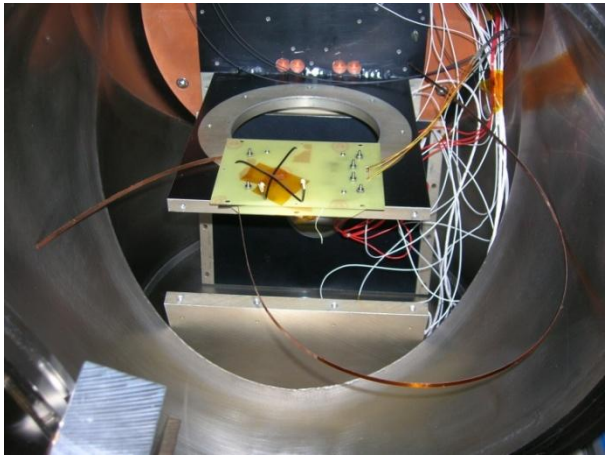
- Deployment test

-50[°C]

$U_{applied}$ [V]	$I_{measured}$ [mA]	R_{tot} [Ω]	Deploying time [sec]	Total powered time [sec]
3.26	183	17.8	4	10

Ambient temperature

$U_{applied}$ [V]	$I_{measured}$ [mA]	R_{tot} [Ω]	Deploying time [sec]	Total powered time [sec]
3.28	170	18.3	5	8



The new melting system design of the ADS has been validated.

The current must be set at 180±20[mA].

The melting time must be set at 16 seconds.

Test/Analysis Description and Results

- VIBRATION TEST (30-31 January 2008, EPFL-LMAF lab.)
  - Demonstrate the ability of the solar cells and ADS to withstand random excitations of the launcher increased by a qualification factor
  - Ambient pressure / 23ºC / <60% humidity / 2 minutes for each axis

Table 1 Level of the random vibration test.

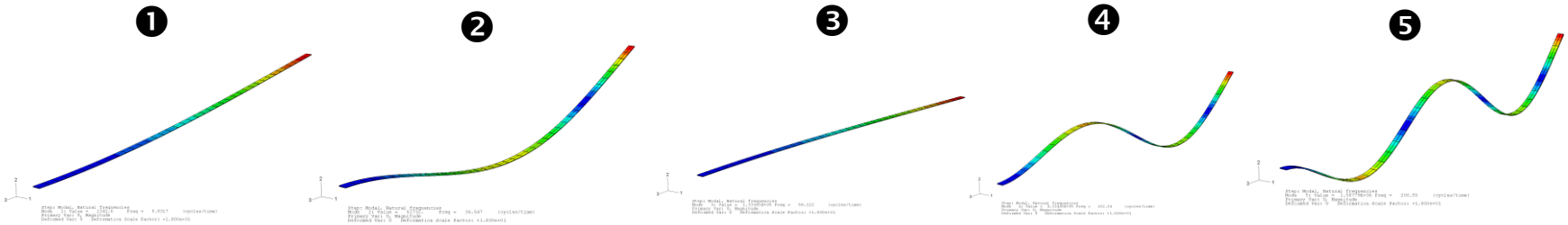
Frequency [Hz]	20	35	50	800	1500	2000	G_{rms}
PSD [10^{-3} g^2/Hz]	100	100	200	200	100	100	17.4

The nichrome and dyneema wires withstand the random vibration

Analysis Description and Results

- ANTENNA'S EIGEN FREQUENCIES ANALYSIS (ANALITICALLY & EFM)

EIGEN FREQUENCY (HZ)	SHORT ANTENNA	LONG ANTENNA
1	5.8	0.5
2	36.5	3.1
3	58.1 (lateral mode)	5.1 (lateral mode)
4	102.3	8.9
5	200.5	17.4



The frequencies at which the antennas could disturb the attitude control of the satellite are characterized

Conclusions and Future Work

- Design requirements are fulfilled with a 20.8 gr weight
- Done tests show that the Antenna Deployment System works
- Ready for qualification