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RADIAN SYSTEMS

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Abstract: Radian is a cloud-based software that performs thermal analyses for nanosatellites.

Keywords: thermal analysis, nanosatellites, temperatures

1. INTRODUCTION

Radian is a cloud-based software that performs *thermal analyses for nanosatellites*, simulating accurate in-orbit conditions throughout a given mission.

Subsystems aboard a nanosatellite are designed to operate within a safe range of temperatures. Out of that range, they may get permanent damage, leading to mission failure and substantial economic losses. Therefore, previous thermal analyses that simulate these subsystems' temperatures are mandatory to prevent such issues.

In Radian Systems we want to contribute to the democratization of space, providing a more agile and efficient thermal analysis tool for satellites. Our thermal and orbit simulator is based in a simple and intuitive web application, that provides automated designs that reduce the design phase 30 times and smart diagnostics that speed up post-analysis 10 times, supporting decision making and reducing labour cost overruns.

2. COMPARING FOSSASAT-1 TEMPERATURES WITH THERMAL ANALYSES

In December 2019, FossaSat-1 was successfully launched into space, becoming our first case study to reach orbit. FossaSat-1 is a 5-cm sided PocketQube designed to create a global, low-cost IoT network.

All systems are operational to this day. However, the superior panels did not deploy, preventing the folded antennas from deploying too. Nonetheless, the

packets received so far have been conclusive enough to validate our thermal analyses.

FossaSat-1 is equipped with three temperature sensors (see Fig. 1), one on the outside and two on the inside. T_{EXT} is attached to the superior panel, T_{CPU} belongs to the onboard computer, and T_{BATT} measures the battery temperature. It is worth mentioning that the telemetry from T_{CPU} has been discarded, as Fossa Systems recommended, because of a lack of data integrity.

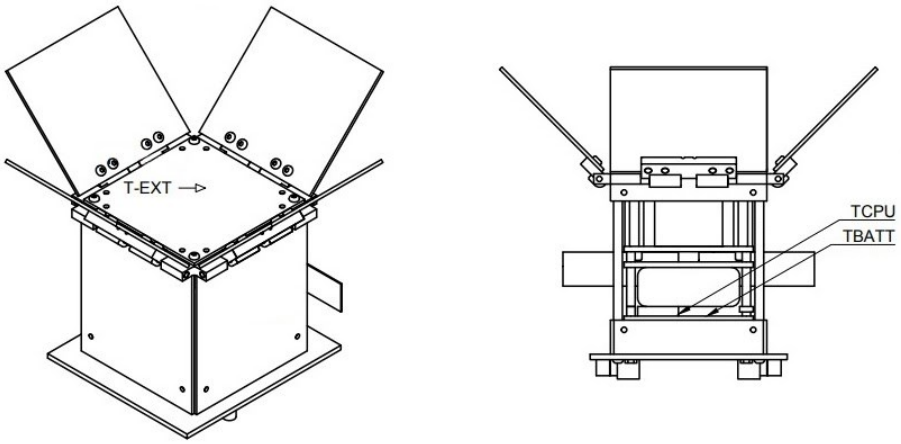

Figure 1: FossaSat-1 temperature sensors

The thermal analyses carried out by Radian Systems comprised a hot case and cold case, derived from the solar irradiance and FossaSat-1 operational modes. They were simulated assuming the deployment of the folded elements, thus deviating from the actual radiative heat fluxes. The degree of detail matched a feasibility study for the thermal subsystem.

Taking into account the extreme temperatures for both cases, the predicted range for T_{EXT} and T_{BATT} is shown in Fig. 2 and Fig. 3. In addition, a 15ºC uncertainty margin is included due to the preliminary character of the modelling assumptions, and a 10ºC environmental margin for mission deviations (see European Cooperation for Space Standardization: Thermal Analysis Handbook and Thermal Control General Requirements). No further adjustments were made, even though correlation activities from both testing and flight data are considered for future study.

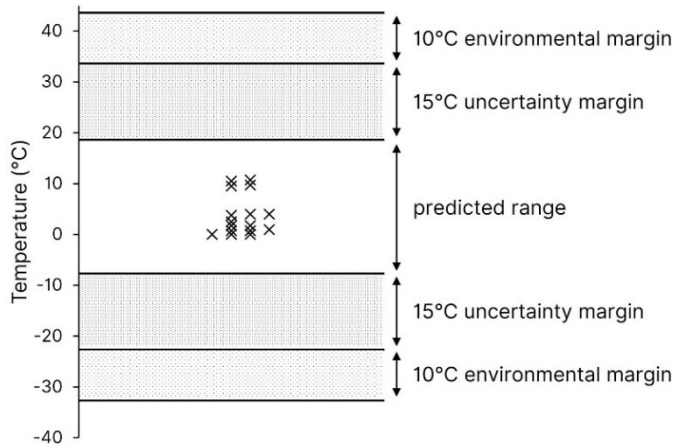

Figure 2: Temperature data from TBATT compared with analysis ranges.

The telemetry data sets comprise 16 samples from T_{BATT} and 20 samples from T_{EXT}, between 7 December 2019 and 26 January 2020. It is worth noting that 2 T_{EXT} measures lie within the mission margin, and 6 measures lie within the uncertainty margin.

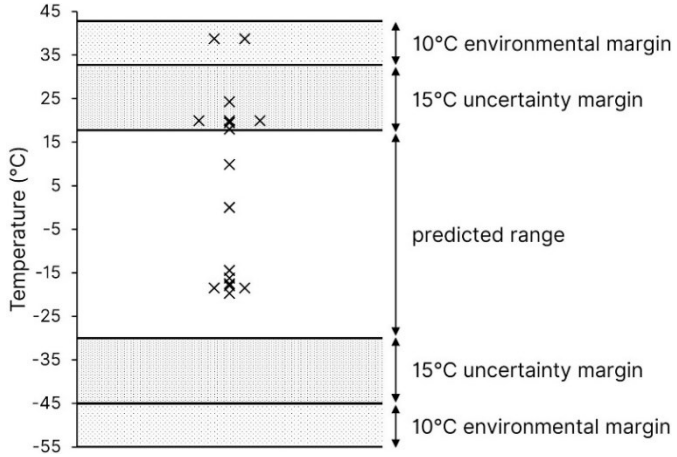

Figure 3: Temperature data from TEXT compared with analysis ranges

As it is presented in both figures, FossaSat-1 flight temperatures lie within the predicted ranges and margins calculated from Radian's thermal analyses.

References

European Cooperation for Space Standardization: 2008, *Thermal Control General Requirements*, E-ST-31C.

European Cooperation for Space Standardization: 2016, *Thermal Analysis Handbook*, E-HB-31-03A.