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NANOSATC-BR2 - ANALYSIS OF PAYLOAD DUTY CYCLE CHANGE DURING ITS OPERATIONAL LIFE TIME

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INTRODUCTION AND OBJECTIVES

This paper presents the estimation of the duty cycle changes in the NANOSATC-BR2 CubeSat – the second nanosatellite from the UFSM & INPE's NANOSATC-BR, CubeSats Development Program - payloads during its operational lifetime in space. The UFSM & INPE's NANOSATC-BR, CubeSats Development Program is a Capacity Building Integrated Program (CBP) on Space Science, Engineering and Computer Sciences for the development of space technologies using CubeSat satellites. Currently, the Program has two CubeSats:

- NANOSATC-BR1, (1U), launched in 2014 and still in operation;
- NANOSATC-BR2, (2U), under development and expected to be launched in 2019.

Figure 1 shows the engineering models of the programs nanosatellites.

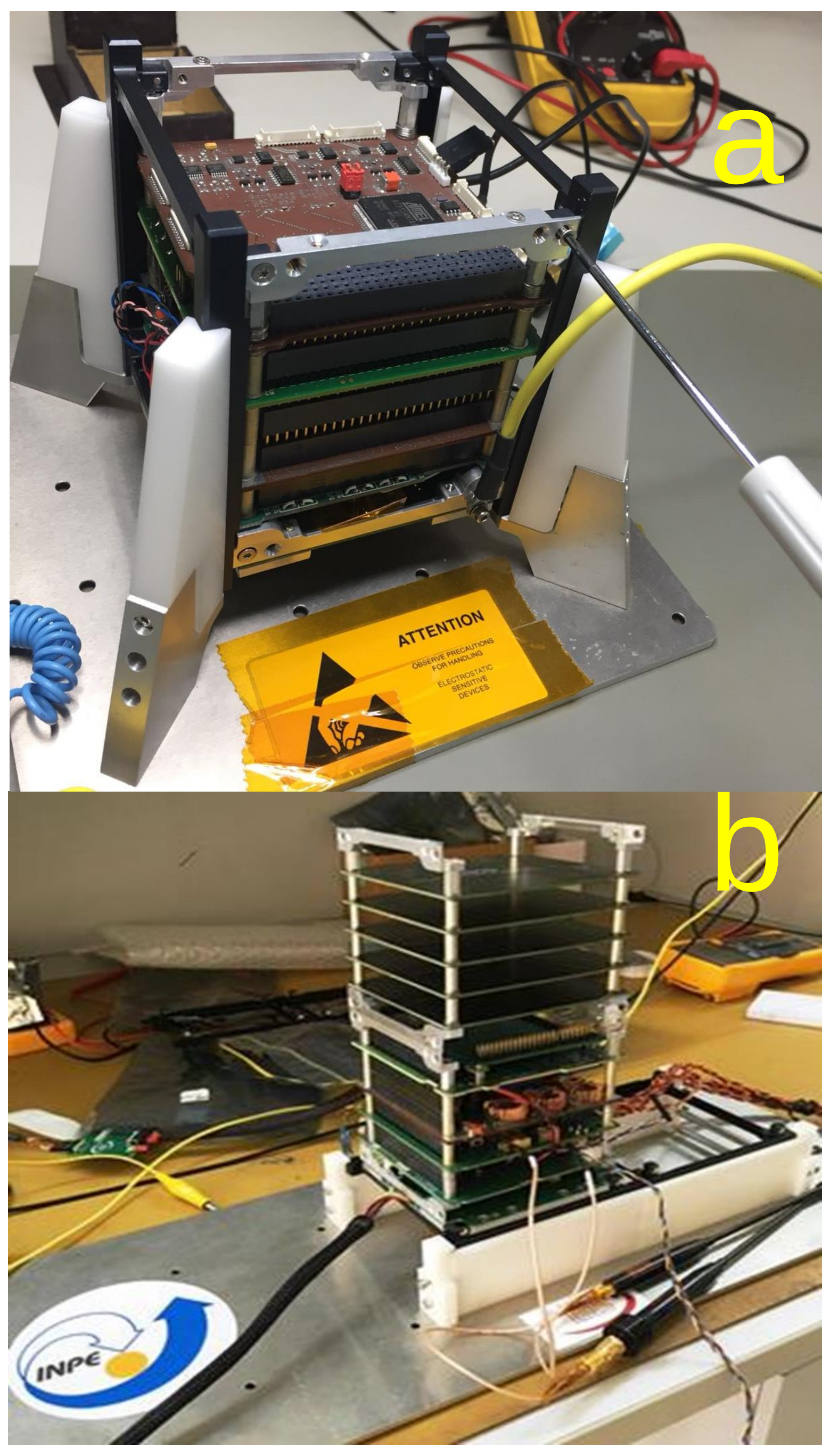

Figure 1: Engineering models of the NANOSATC-BR1 (a) and NANOSATC-BR2 (b).

INSTRUMENTATION AND METHODOLOGY

The NANOSATC-BR2 (NCBR2) is a 2U CubeSat (10 x 10 x 22.6 cm) with several Scientific and Technologic objectives including analysis of the dynamics of the Ionosphere plasma using a Langmuir probe and validation of an attitude determination system with triple redundancy.

Quevedo Mantovani et al. (2017), shows the Power Balance necessary to determine the best operation range for the NCBR2. This Power Balance allows the regulation of the operational cycle for each payload, which yields to a positive energy balance. Table 1 shows the power determined by taking in account the beginning of life efficiency of the power generation subsystem and the total power consumption for duty cycle of the satellite.

Components	Maximum Consumption	Duty Cycle	Consumption for duty cycle
Electric Power Subsystem	0.249 W	100 %	0.249 W
Board Computer	0.380 W	100 %	0.380 W
Receptor (TRXUV RX)	0.237 W	100 %	0.237 W
Transmitter (TRXUV TX)	0.787 W	4.2 %	0.033 W
Antenna System	0.040 W	100 %	0.040 W
2 Magnetometers (XEN 1210)	0.031 W	100 %	0.031 W
FPGA	0.049 W	100 %	0.049 W
2 SMDH ICs	0.030 W	100 %	0.030 W
Langmuir Probe	0.800 W	85.3 %	0.683 W
Attitude Determination System SDATF	0.271 W	100 %	0.271 W
TOTAL			2.003 W

Table 1: NCBR2 beginning of life power balance. Reference: Quevedo Mantovani et al., 2017.

Although accurate for the beginning of the nanosatellite mission, this power balance is not able to determine the regulation of the operational cycle for each payload for the entire mission. This happens due to the efficiency over time decay of the Power Generation System. The efficiency is estimated considering the solar cells' power generation. The decay is estimated considering the cumulative radiation dose due to radiation particles in GaInP/GaAs/Ge triple junction cells – used in NCBR2.

RESULTS AND DISCUSSIONS

The estimated reduction for solar cells maximum current generation per year is shown in Table 2 (Meng et al., 2015).

Years	Maximum current efficiency
1	99%
2	98.5%
3	98.1%
4	97.7%

Table 2: Solar cells maximum current generation per year. Reference: Meng et al., 2015

The power output efficiency can be considered similar to the current efficiency (Jianmin et al., 2008). In order to achieve the new positive power balance considering maximum decay- 4 years in space -, Langmuir's probe duty cycle can be reduced from 85.3% to 79.9%. The total power consumption is then reduced by 0.046 W.

CONCLUSION

The power balance considering efficiency decay has small changes when compared to the beginning of life power balance. As a result, the Langmuir probe duty cycle declines from 85.3% to 79.9%. In effect, the security margin considered in the original power balance (12.5%) would be enough to assure enough energy for the satellite. Future values from NCBR2 voltage and current generation in orbit may be used to validate and analyze the whole EPS system's efficiency estimation decay over time.

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