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# NEXTSat-1 Solar Array Design for Mission of Scientific and Space Core Technology Payloads

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## ABSTRACT

The NEXTSat-1 program was kicked off in 2012 considering a modular-type structure, a standard bus configuration and compact spacecraft in dimensions by using FPGAs, a spacecraft electronics module, Mg alloys and so on. Although the volume of NEXTSat-1 is small, the NEXTSat-1 has two scientific payloads and seven space core technologies for space verification on orbit. Therefore, a solar array shall generate a certain power by the effect of photovoltaic using the art of triple junction solar cell technology and support sufficient power for the payload mission and bus power. Currently, we are developing the spacecraft bus and payloads in an engineering and qualification model and measured the power consumption not only the spacecraft bus, but also two scientific payloads and seven space core technology payloads. Those measured results shall be referenced in power and energy balance analysis for obtaining the solar array size and calculating the optimal solar cell for power generation on orbit. In this work, we present the design and analysis results of power generation of the NEXTSat-1 spacecraft considering on-orbit mission operation.

## 1. INTRODUCTION

There are nine payloads in the NEXTSat-1 program for two scientific missions and seven technology demonstrations in orbit, which has been kicked off since 2012 (Goo-Hwan SHIN 2014-1). We have two scientific payloads such as ISSS (Instruments for the Study of Space Storms) and NISS (NIR Imaging Spectrometer for Star Formation History) and have seven technology demonstration payloads which consist of SDT (S-band Digital Transponder), SDR-10 (High Speed Data Storage), 3DMM (3

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Dimensional Mas Memory), STR (Star Tracker), FOG (Fiber Optic Gyro), RWA (Reaction Wheel Assembly), OBC (On-board Computer). In order to support the payloads in orbit, the NEXTSat-1 shall generate the electrical power by using photovoltaic effects from the solar cells. In this mission, we will use the triple junction solar cells which were populated on the composite panels and design the electrical circuits for proper power generation. So as to comply with the NEXTSat-1 requirements, we have collected the power consumption of each unit including payloads and performed the power budget analysis and energy balance based on the operational concept (Goo-Hwan SHIN 2014-2) of the NEXTSat-1. In this work, we presented the solar array design and performance analysis results in terms of an electrical and mechanical point.

## 2. SOLAR ARRAY PANELS DESIGN AND SIMULATION

### *2.1 System Requirements*

In order to provide electrical power with payloads and bus, we have performed the power budget analysis and required electrical energy using test results. Thus, the system requirements were given as follows.

- Output power of –Z solar array panel: > 100W at 25 ˚C and BOL
- Output power of +Z solar array panel: > 100W at 25 ˚C and BOL
- Output power of –X solar array panel: > 100W at 25 ˚C and BOL

In addition, an electrical resistance for each solar array panels should be larger than 10MΩ. And also, the solar array panels' output voltage shall be complied with the following conditions.

- Open circuit voltage: 65 Vdc at 25 ˚C and BOL
- Maximum power voltage: 56 Vdc at 25 ˚C and BOL

### *2.2 Solar Array Design and Configuration*

The NEXTSat-1 solar array has a configuration shown in Fig. 1, which includes a thermistor onto the rear side of solar array panels for detecting a thermal environmental condition in orbit during operation. Each solar array panel has a same electrical configuration. In other words, each string has 24 solar cells in series to make proper operating voltage via a power controller. And also, each solar array panel consists of four strings in parallel to make a required power. Thus, each solar array panel has a 96 solar cells and the total amount of 288 solar cells for generating power will be applied on the panel substrate. So as to comply with the requirements of the NEXTSat-1 system performance, the triple solar cells will be applied on the each panel with the size of 40 mm x 80mm with a thickness of 140 μm, the cell technology is InGaP and with a protection diode.

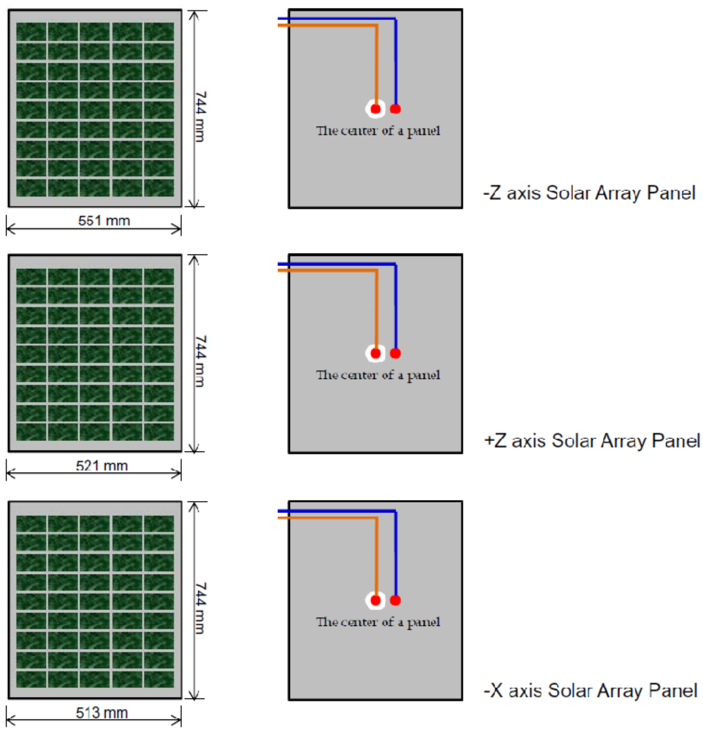


Fig. 1 NEXTSat-1 solar array panels: front side (left) and rear side (right)

### *2.3 Solar Array Simulation*

The solar array panel per each has an electrical performance as shown in Fig. 2 (Ferrando Emanuele 2015), which was simulated at 25 ˚C and BOL. The output performance of each panel has a greater than 100W. Thus, total power considering three panels shall be over 300W. It means that the electrical performance meets the system requirements.

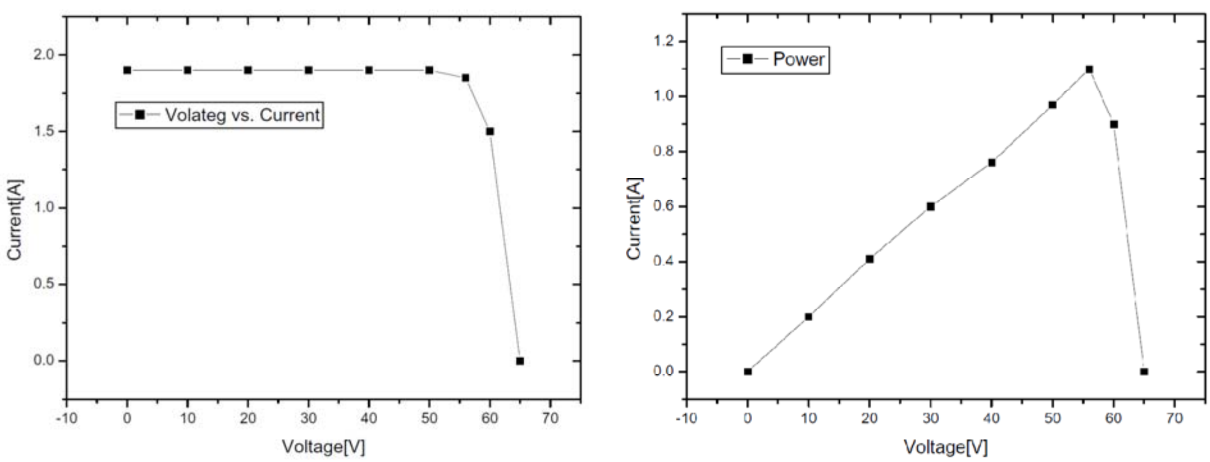


Fig. 2 NEXTSat-1 solar array performance: voltage vs. current (left) and power (right)

However, the NEXTSat-1 will be performing the mission in orbit for two years. Thus, we have to check the electrical performance at the end of life time. The following Fig. 3 (Ferrando Emanuele 2015) shows the total performance after two years at 80 ˚C.

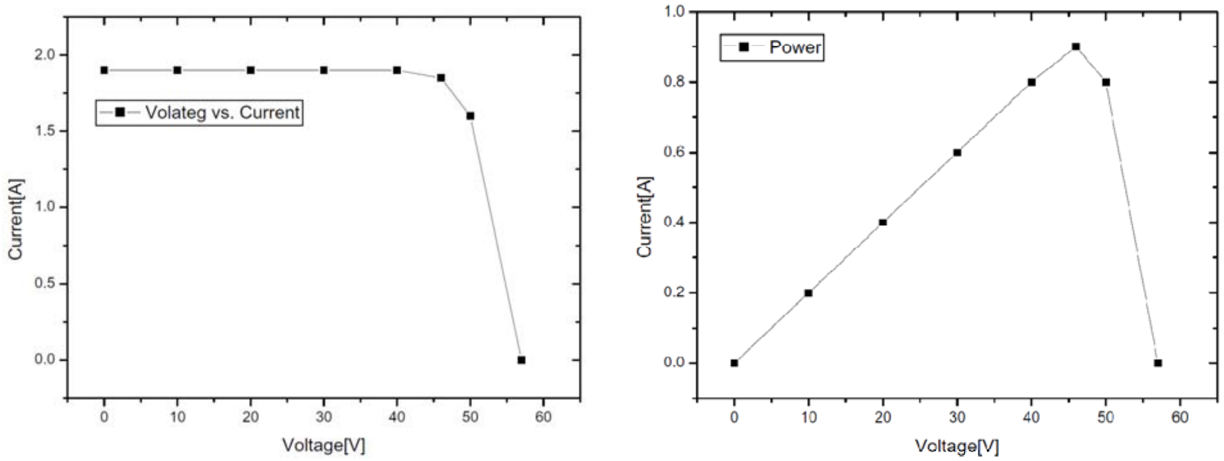


Fig. 3 NEXTSat-1 solar array performance: voltage vs. current (left) and power (right)

From Fig. 3, we figured out the electrical performance, which will produce the 87 W per each panel at 80 ˚C for two years. Thus, as we mentioned, the system requirements shall be over 250 W at EOL. At EOL, total power will be generated by 250 W @ 80 ˚C.

## 3. CONCLUSIONS

In this work, we found the solar array performance versus requirements considering the operational concept. In order to support the NEXTSat-1 missions in orbit, the required solar array power is around 250W, which shall be converted from the solar cells by photovoltaic conversion effects in orbit. Thus, we have designed the quantity of solar cells on the each panel and presented the how the electrical string could be configured in the point of optimal power generation. And also, we have obtained the electrical string configuration and how to interconnect between each solar array panel. In this study, we have finally presented the whole configuration of the NEXTSat-1 solar array panel and design guidelines for successful mission in orbit.

## REFERENCES

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