

SM Solar Panels



DESIGN

SM-SP is a family of Solar Panels designed by NPC Spacemind in order to provide a modular and flexible solution for nanosatellite applications. The product is designed to be fully compliant with SM Cubesat Structures as well as with commercial of the shelf and custom-made cubesat components.

The product family includes panels for X/Y/Z sides of 1U/2U/3U Cubesats.

As standard, SM Solar panels include a set of sensors such as thermal sensor, coarse sun sensor, IMU9DOF and a user definable communication port. As option, embedded configurable magnetorquer providing up to 6 power levels (MTQ) and up to 4 separate RBF circuits can be included.

In case of specific mission requirement specific solutions can be realized both in terms of electrical performances and specific panels shape and cutout. For additional info technical@npcspacemind.com

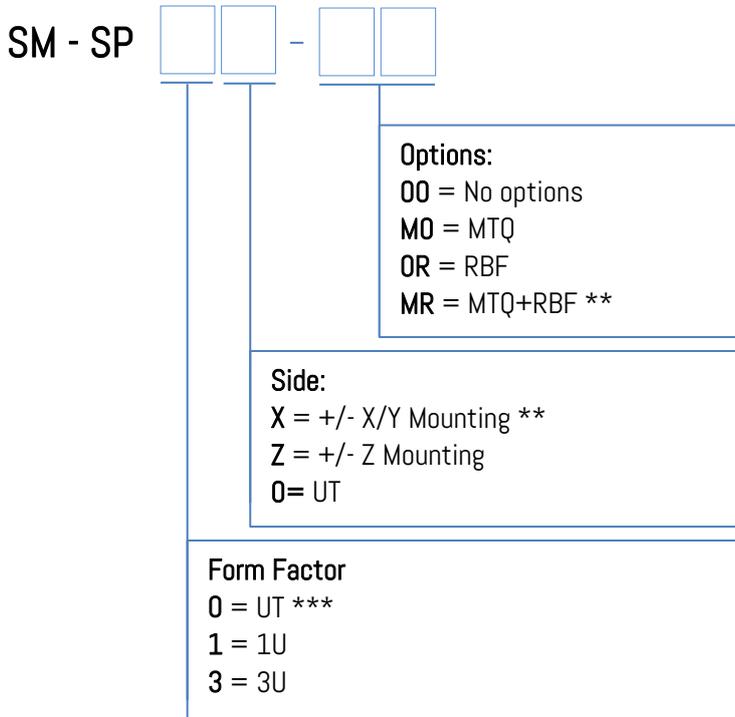
QUALITY ASSURANCE

NPC is a company certified ISO9001 for Quality management system. Qualification process has been pursued for each SM Solar Panels (QT). Product Assurance protocols are applied to each delivered SM Product (AT).

Qualification Test	QT	AT
Pre-production control	✓	✓
In-take quality control	✓	✓
Acceptance quality control	✓	✓
Vibration test	✓	-
Mechanical Shock	✓	-
TVAC Test	✓	-
Surface Treatment Test	✓	-
Functional and assembly test	✓	✓

PRODUCT CONFIGURATION

SM Solar panels are directly compatible with SM Structures; nevertheless the design aims to ensure compatibility with a wide range of commercial components. The present document will include solar panels for complete 1U/2U/3U set.



* Available only as SM-SPOX -00 / SM-SPOX -0R

** Only for 1Z and 3X

Available solar panels configurations are outlined below:

Code	Form Factor	Side	MTQ	RBF	SENSORS	EXT COM	Compatible with
SM-SP1X-00	1U	XY	-	-	✓	✓	1U-2U-3U
SM-SP1X-M0	1U	XY	-	-	✓	-	1U-2U-3U
SM-SP1Z-00	1U	Z	-	-	✓	✓	1U-2U-3U
SM-SP1Z-M0	1U	Z	✓	-	✓	✓	1U-2U-3U
SM-SP1Z-OR	1U	Z	-	✓	✓	✓	1U-2U-3U
SM-SP1Z-MR	1U	Z	✓	✓	✓	✓	1U-2U-3U
SM-SP3X-00	3U	XY	-	-	✓	✓	3U
SM-SP3X-M0	3U	XY	✓	-	✓	✓	3U
SM-SP3X-OR	3U	XY	-	✓	✓	✓	3U
SM-SP3X-MR	3U	XY	✓	✓	✓	✓	3U
SM-SPOX-00	Interstage	XY	-	-	-	✓	2U-3U
SM-SPOX-OR	Interstage	XY	-	✓	-	✓	2U-3U

Different form factors of SM Solar Panels are available upon request:

- **SP2X** – 2U Solar Panel
- **SP5X** – 1.5U Solar Panel

Custom form factor different than those presented in the document can be realized on the basis of customer specific requirements. For information contact technical@npcspacemind.com

SP1X

Product Code: SM-SP1X

- Solar panel for XY side
- Compatible with 1U/2U/3U SM Cubesat structure
- High efficiency triple junction UTJ solar
- Mass: 24 gr
- 2300 mW Peak Power
- 494 mA Peak Current
- 5,2 V Open circuit voltage
- 2 parallel picoblade power connectors
- IMU 9DOF – 3xAcc/3xGyro/3xMag Sensors
- Coarse sun sensors
- 2x Thermal sensor
- External Communication port
- Improved efficiency solar cells available



Product items included in standard version

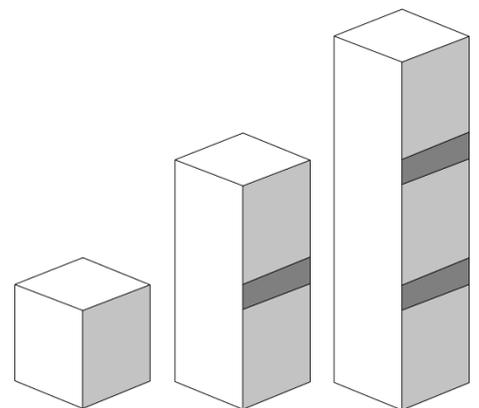
- SP1X
- Standard cable harness

Options and customization

- Up to 2 independent RBF circuits
- User configurable magnetorquer: 6 power/performance level
- Custom cut-out and electrical performances

For integration with SM Cubesat Structure:

- SM01 – 1U Cubesat Structure
- SM02 – 2U Cubesat Structure with SM00 Interstage
- SM03 – 3U Cubesat Structure with SM00 Interstage



SP1Z

Product Code: SM-SP1Z

- Solar panel for Z side
- Compatible with 1U/2U/3U SM Cubesat structure
- High efficiency triple junction UTJ solar
- Mass: 24 g
- 2300 mW Peak Power
- 494 mA Peak Current
- 5,2 V Open circuit voltage
- 2 parallel picoblade power connectors
- IMU 9DOF – 3xAcc/3xGyro/3xMag Sensors
- Coarse sun sensors
- 2x Thermal sensor
- External Communication port
- Improved efficiency solar cells available



Product items included in standard version

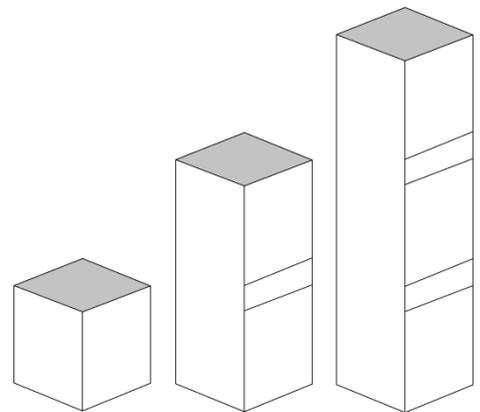
- SP1Z
- Standard cable harness

Options and customization

- Up to 4 independent RBF circuits
- User configurable magnetorquer: 6 power/performance level
- Custom cut-out and electrical performances

For integration with SM Cubesat Structure:

- SM01 – 1U Cubesat Structure
- SM02 – 2U Cubesat Structure
- SM03 – 3U Cubesat Structure



SP3X

Product Code: SM-SP3X

- Solar panel for XY side 3U Cubesat
- Compatible with 3U SM Cubesat structure
- High efficiency triple junction UTJ solar
- Mass: 63 g
- 8 W Peak Power
- 494 mA Peak Current
- 18.2 V Open circuit voltage
- 4 parallel picoblade power connectors
- IMU 9DOF – 3xAcc/3xGyro/3xMag Sensors
- Coarse sun sensors
- 2x Thermal sensor
- External Communication port
- Improved efficiency solar cells available

Product items included in standard version

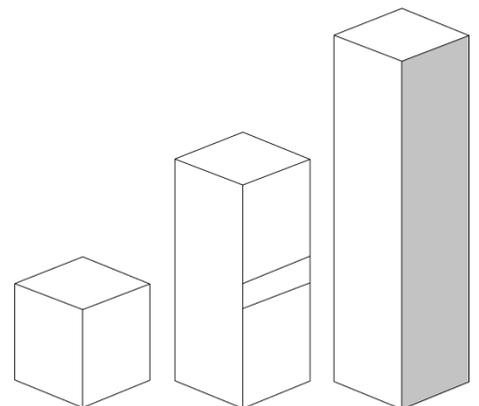
- SP3X
- Standard cable harness

Options and customization

- Up to 4 independent RBF circuits
- User configurable magnetorquer: 6 power/performance level
- Custom cut-out and electrical performances

For integration with SM Cubesat Structure:

- SM03 – 3U Cubesat Structure



SP00

SP00 is an interstage to be integrated in 2U Cubesat Structure **between 2 single SP1X Solar panel** on XY side. The product is conceived to fit between the panels and provide an external communication interface as standard. As option, 4 RBF circuit can be added on SP00 (2 Physical and 2 Electrical).

SP00 Interstage can be included also in 3U Structure in case single SP1X Solar Panels are exploited: in this case 2 SP00 shall be integrated on each XY side. The product can be highly customized and realized ad hoc for specific application requirements.

Product Code: SM-SP00

- 2U/3U Cubesat solar panel interstage
- Compatible with 3U/2U SM Cubesat structure
- To be integrated with use of SM1X
- Mass: 10 g
- External Communication port



Product items included in standard version

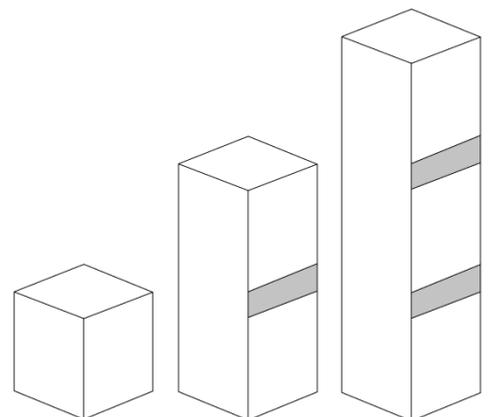
- SP00
- Standard cable harness

Options and customization

- Up to 4 independent RBF circuits

For integration with SM Cubesat Structure:

- SM02 with SM-SP1X
- SM03 with SM-SP1X (2x)



PRODUCT FEATURES

In order to provide the customer with a performant and flexible solution, SM Solar panels include following subsystems:

- Solar Cells
- Sensor Package
- External Communication (where present)
- Magnetorquer (where present)
- Remove Before Flight (where present)

All product present identical connector type and pinout for the above mentioned subsystems. Data in this section are therefore applicable to all SM Solar panels provided that the relative subsystem is present on the product version and unless otherwise specified.

Location of subsystem connectors is identical in each SM Solar Panels product version.

SOLAR CELLS

SP1X and SP1Z panels integrate as standard 2x triple junction solar cells connected in series. Available on request SM panels can be configured with:

- Improved efficiency cells (>29%)
- Alternative parallel connection

Each panel is equipped with two parallel power connectors (PWR-1 / PWR-2) in order to allow the possibility to combine different panels of the spacecraft in series or in parallel.

	SPIX / SPIZ	SP3X
Cells Type	InGaP/InGaAs/Ge	InGaP/InGaAs/Ge
Efficiency	28%	28%
Cells connection	Series	Series
OC Voltage Panel	5,2 V	18.2 V
Peak Power	2300 mW	8000 mW
Peak Current:	494 mA	494 mA

SENSORS PACKAGE

All SM-SP are equipped with a standard sensor package including:

- Accelerometer, Gyroscope, Magnetometer, Temperature sensor:
NOTE: LSM9DS1 – 9DOF inertial measuring unit is mounted on SM Solar panels. Users can refer directly to components datasheet provided by the OEM to retrieve detailed data and performance characteristics
- Sun sensor
- External Temperature sensor

IMU Model	LSM9DS1
Supply voltage VDD [V]	3.3 (2.8 < VDD < 4.8)
Communication	SPI
Connector Type	12-pin Picoblade pitch 1,25 mm
IMU DOF	3x acceleration (X,Y,Z) 3x angular rate (X,Y,Z) 3x magnetic field (X,Y,Z)
IMU Data Output	16 bit
Thermal Sensor Measuring Range	-40°C to +85°C (-55°C to +125°C)
Thermal Sensor Measuring Accuracy	<2° (<3°)
Thermal Sensor Data Output	10 bit
Sun sensor Output	Frequency
Sun sensor irradiance responsivity	3.4 kHz/(μ W/ cm ²)
Peak response wavelength	700 nm
Current consumption accelerometer/magnetometer [mA]	0,6
Current consumption gyroscope [mA]	4
Thermal sensor current consumption	0,4
Sun sensor current consumption	2
Sensors operating temperature range [°C]	40° < T < 85°

EXTERNAL COMMUNICATION

Each panel is equipped with a communication/programming connector accessible from the outside and available to the user access subsystems when the satellite is integrated in the deployer. External Comm Interface is made available as standard on all SM Solar panels providing a 5 pin connector per side (including GND).

MAGNETORQUER

Embedded magnetorquer are available for all SM Panels as selectable option. Embedded magnetorquers are designed to allow the user to configure it according to the mission requirements: 3 available functional regimes can be obtained properly soldering the configuration pattern on the back of the board. Customer can require the pattern pre-soldered in the required configuration. Magnetorquer can be supplied with 3,3V and 5V according to performance requirements. Performance of magnetorquer differs between 1u form factor and 3U form factor.

Product Version	Configuration	Dipole/Power (@3.3V)	Dipole/Power (@5V)
SP1X SP1Z	LP - Low Power	0,034 Am ²	0,052 Am ²
	MP - Mid Power	0,070 Am ²	0,103 Am ²
	HP - High Power	0,153 Am ²	0,230 Am ²
SP3X	LP - Low Power	0,012 Am ²	0,018 Am ²
	MP - Mid Power	0,05 Am ²	0,07 Am ²
	HP - High Power	0,19 Am ²	0,3 Am ²

REMOVE BEFORE FLIGHT

RBF add-on includes inhibition circuit accessible from the outside while satellite is integrated into the deployer. Due to the variety of available deployers and differences in access ports, RBF add-on can be included both in XY and Z side panels for all product versions accordingly with available add-ons.

Inhibition is made by physical switches and electrical switches (by means of short circuit of transistor). In both cases a physical plug shall be removed from the external to uninhibited/switch the circuit.

	SP00	SP1X	SP1Z	SP3X
Number of physical RBF - P	2	1	2	2
Number of Electronic RBF - E	2	1	2	2
Connector type (each RBF circuit)	3 pin	3 pin	3 pin	3 pin

PRODUCT FEATURES

SM Solar Panels are conceived to allow the customer to create its own set according to mission requirements: this ensure multiple solutions in terms of platform layout, compatibility different launch provider interfaces, etc.

As example, complete mission solar panel sets for 1U, 2U and 3U including full functionalities is provided (3axis magnetorquer and RBF interfaces).



RBF/COM Access on XY panel

1U Suggested set

- X+: SP1X-00
- Y+: SP1X-0R
- X- : SP1X-M0
- Y- : SP1X-M0
- Z+: SP1Z-00
- Z- : SP1Z-M0

2U Suggested set

- X+: SP1X-00 (2x) + SP1Z-0R
- Y+: SP1X-00 (2x) + SP00-00
- X- : SP1X-M0 (2x) + SP00-00
- Y- : SP1X-M0 (2x) + SP00-00
- Z+: SM-SP1Z-00
- Z- : SM-SP1Z-M0

3U Suggested set

- X+: SP3X-00
- Y+: SP3X-0R
- X- : SP3X-M0
- Y- : SP3X-M0
- Z+: SP1Z-00
- Z- : SP1Z-M0

RBF/COM Access on Z panel

1U Suggested set

- X+: SP1X-00
- Y+: SP1X-00
- X- : SP1X-M0
- Y- : SP1X-M0
- Z+: SP1Z-0R
- Z- : SP1Z-M0

2U Suggested set

- X+: SP1X-00 (2x) + SP00-00
- Y+: SP1X-00 (2x) + SP00-00
- X- : SP1X-M0 (2x) + SP00-00
- Y- : SP1X-M0 (2x) + SP00-00
- Z+: SP1Z-0R (2x)
- Z- : SP1Z-M0 (2x)

3U Suggested set

- X+: SP3X-00
- Y+: SP3X-00
- X- : SP3X-M0
- Y- : SP3X-M0
- Z+: SP1Z-0R
- Z- : SP1Z-M0