

NanoPower P110 Series Solar Panels Datasheet

Highly Efficient Solar Panel with Integrated Magnetorquer, Sun Sensor,
Gyroscope and Thermistor for CubeSats

NanoPower P110 Series Solar Panels

The NanoPower P110 CubeSat solar panels are designed and built to the highest standards for a maximum reliability power plant for any CubeSat. Reliability and performance are combined into a highly efficient panel that offers both energy production and means of attitude determination and control.

Feature Overview

- 30% efficiency
- Up to 2.3 Watt in LEO
- Two series-connected AzurSpace 3G30A space qualified triple junction solar cell assemblies
- CMX 100 cover glass - 100um
- 60.36 cm² effective cell area
- Cell base material: GaInP/GaAs/Ge on Ge substrate
- Panel base material: Space qualified glass/polyimide laminate with 2 internal 70um copper ground planes (10 planes in panels with magnetorquer)
- Cell bonding substrate: 1mil polyimide film with silicone pressure sensitive adhesive
- Plated, countersunk mounting holes with ground connection
- Silver-plated kovar interconnectors - 3 parallel interconnectors per string
- Integrated magnetorquer of 1.55 m²
- Coarse sun sensor
- Temperature sensor
- Gyro-scope model ADIS16251 (0.004 °/s)
- Operational temperature: -40 C to +85 C
- Available in 6 variants

Applications

- Power supply and attitude control for CubeSat satellites

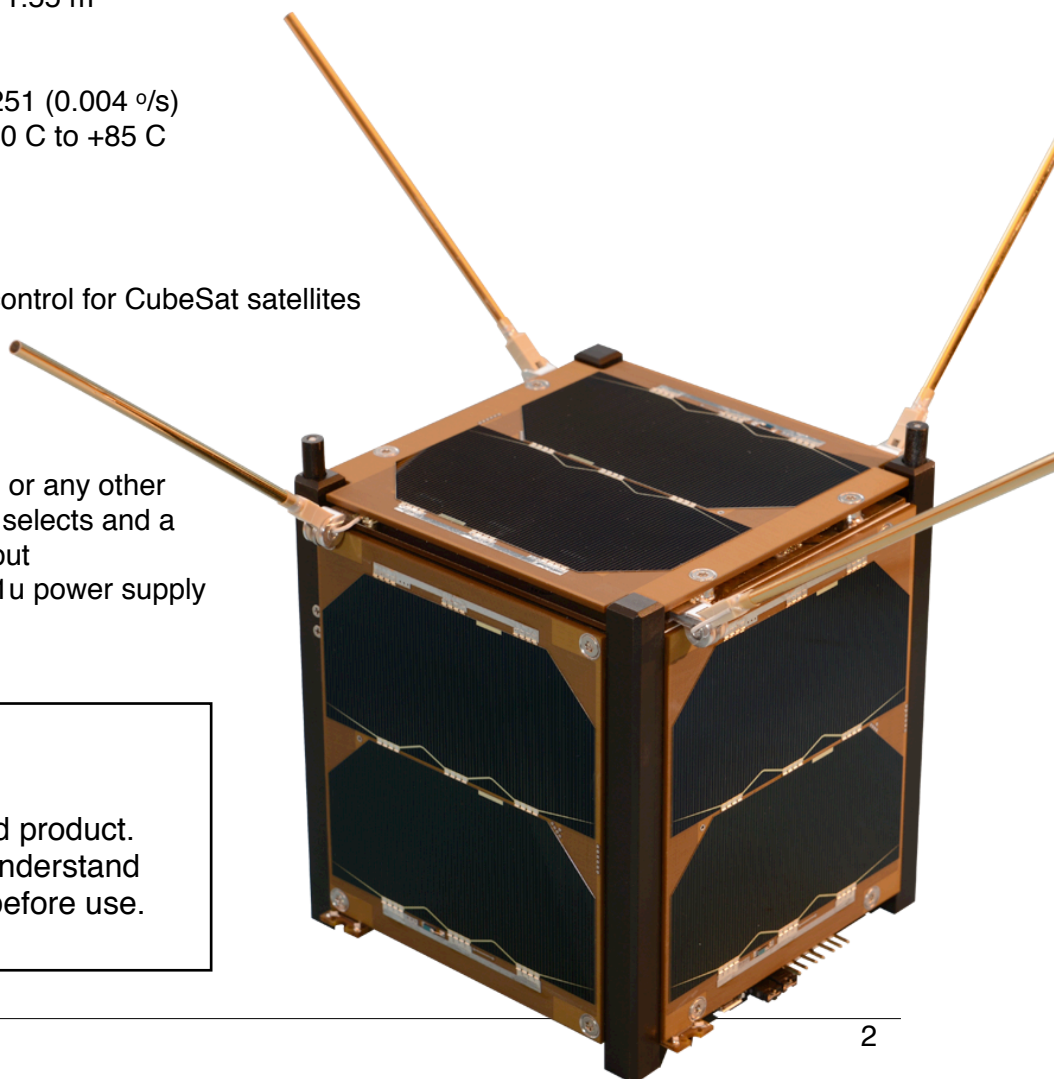
Compatibility

- ISIS CubeSat structures
- GomSpace NanoMind OBC or any other computer with two SPI chip selects and a 0-1 mA current sampling input
- GomSpace NanoPower P31u power supply



Use

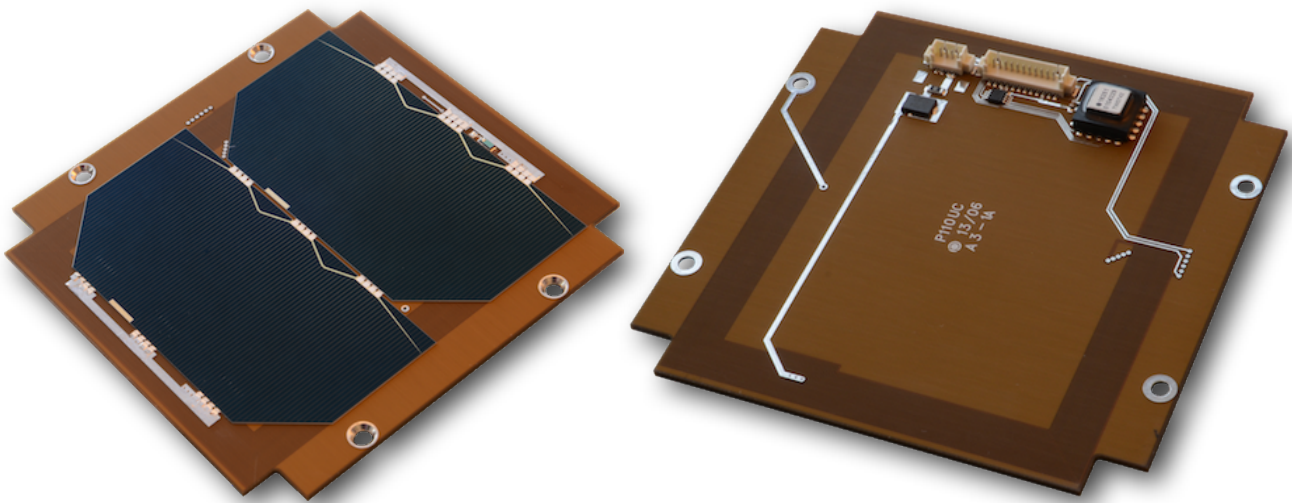
This is a highly advanced product. Make sure to read and understand product documentation before use.



General Description

NanoPower P110 Series solar panels is an integrated side panel solution for CubeSat satellites which provides both solar cells, magnetorquer, sun sensor, gyroscope and temperature sensor all on a single PCB 1.6 mm thick.

The photovoltaic string consist of two series-connected AzurSpace 3G30A space qualified triple junction solar cell assemblies with CMX 100 cover glass. The cells are interconnected by three welded, silver plated kovar interconnectors, and the same type of interconnectors are used to connect the anode and cathode to 70um copper tracks on the panel front. The interconnectors are welded to the top of the cells by the manufacturer of the cells (AzurSpace) using a classified process, and the welds are covered by adhesive and cover glass. The rear-side welds are preformed by GomSpace using an ultra-sonic heavy-bonder applying 12 welds per interconnector.



The anode of the PV string is routed on the rear side of the panel and connected to a Schottky blocking diode which allows parallel-connection of multiple P110 panels. It is also possible to omit the blocking diode and mount an extra connector to enable series connection of P110 panels.

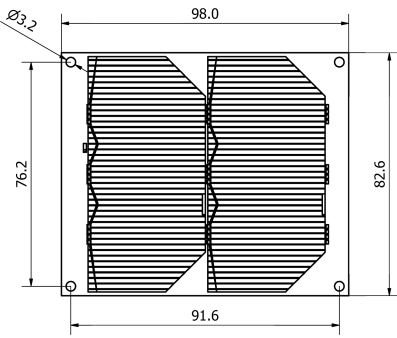
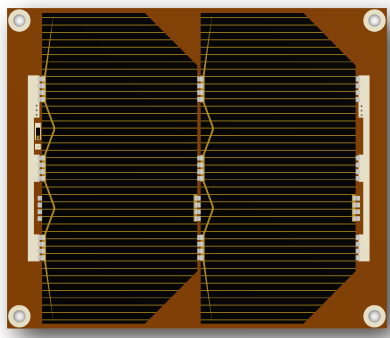
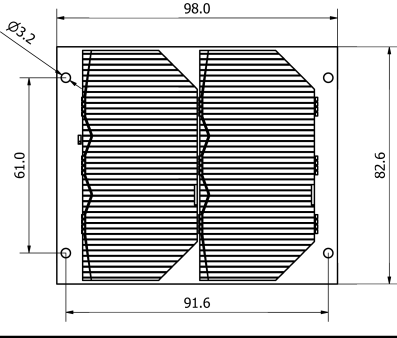
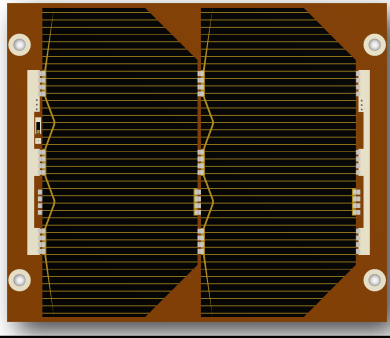
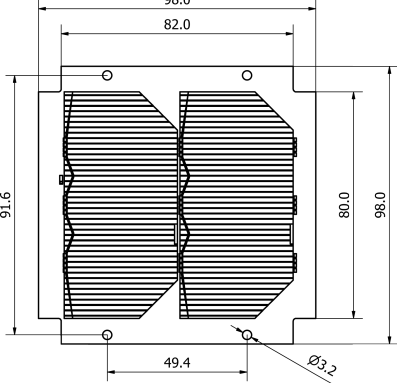
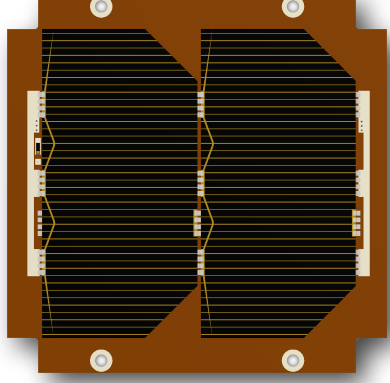
On “U”-models a magnetorquer is integrated into the PCB in 10 internal layers thus taking up no extra space inside the spacecraft, and with an effective area of 1.55 m² it is comfortably over-dimensioned w.r.t. detumbling and attitude control of a CubeSat.

To assist in attitude determination, the panel also features a photo diode intended to be used as a coarse sun sensor. A temperature sensor is mounted close to the diode to enable compensation for its temperature drift. In addition, a MEMS gyroscope is mounted on the “U”-models on the inward-facing side of the panel giving a rotational resolution of 0.004 °/s.

The attitude determination electronics on the panel interfaces seamlessly to the NanoMind A712D on-board computer via a single connector including power supply and SPI bus for temperature sensor and gyro, output from sun sensor. The solar cells use a separate connector to connect to the power supply system.

Configurations

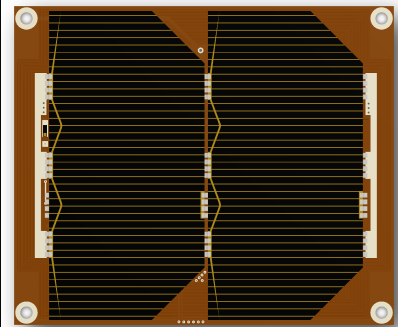
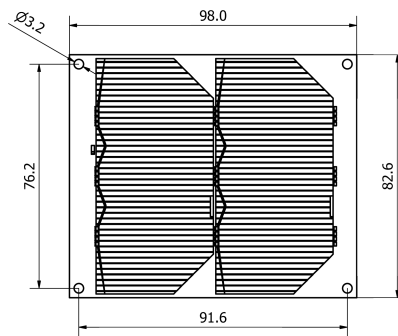
The NanoPower P110 comes in six standard configurations in order to populate all six faces of a 1U CubeSat. Three of these variants, the “U”-models, have ADCS capabilities (integrated magnetorquer and gyroscope). Refer to the table below for descriptions and dimensions of the different panel types.

Panels without ADCS		
P110A - 2 pcs. 3G30A SCA - Blocking diode - Sun sensor - Temperature sensor - Mass: 26 gram - PCB thickness: 1.1mm		
P110B - 2 pcs. 3G30A SCA - Blocking diode - Sun sensor - Temperature sensor - Mass: 26 gram - PCB thickness: 1.1mm		
P110C - 2 pcs. 3G30A SCA - Blocking diode - Sun sensor - Temperature sensor - Mass: 29 gram - PCB thickness: 1.1mm		

Panels with ADCS

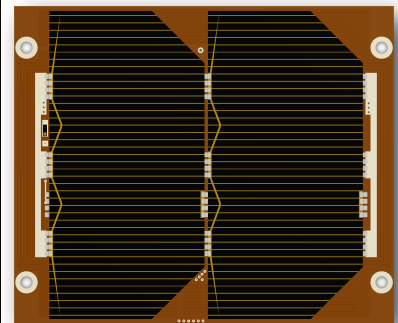
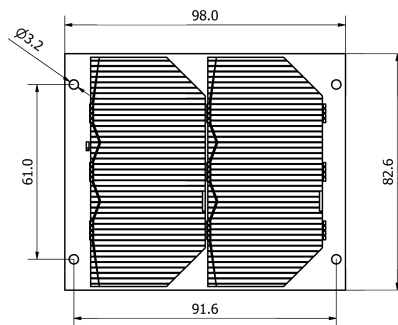
P110UA

- 2 pcs. 3G30A SCA
- Blocking diode
- Magnetorquer
- Gyroscope
- Sun sensor
- Temperature sensor
- Mass: 57 gram
- PCB thickness: 1.6mm



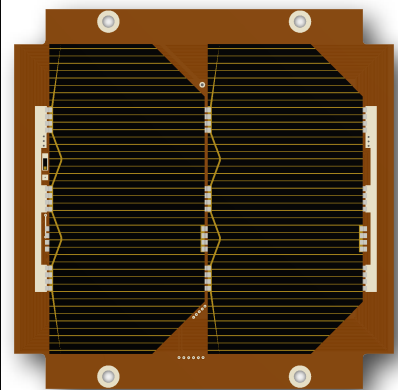
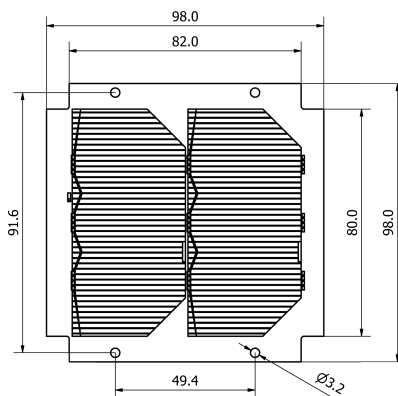
P110UB

- 2 pcs. 3G30A SCA
- Blocking diode
- Magnetorquer
- Gyroscope
- Sun sensor
- Temperature sensor
- Mass: 57 gram
- PCB thickness: 1.6mm

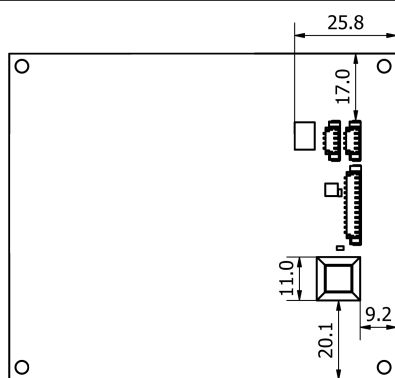


P110UC

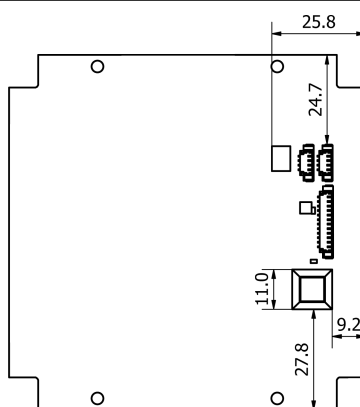
- 2 pcs. 3G30A SCA
- Blocking diode
- Magnetorquer
- Gyroscope
- Sun sensor
- Temperature sensor
- Mass: 65 gram
- PCB thickness: 1.6mm



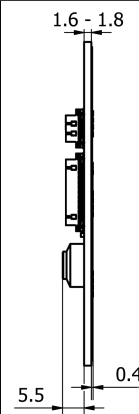
Rear view A and B



Rear view C



Side view all



Characteristics

Parameter	Condition	Min	Typ	Max	Unit
Solar Cell string	Full sunlight in LEO				
- Voltage	Optimal voltage	4.64		4.84	V
- Current	Current at optimal voltage	490		508	mA
- Power	Maximum power	2270		2400	mW
- Efficiency		29.8	30%	30.2	%
Sun Sensor					
- Current	Short current at 1367 W/m ²		930		uA
- Cosine error			1.85	3.5	°
Temperature Sensor					
- Range		-55		150	°C
- Resolution		1.5		3.5	°C
- Vcc			3.3		V
- Current			260	490	uA
- Temperature coefficient		0.21	0.233	0.25	%/°C
Gyroscope					
- Range				80	°/s
- Sensitivity			0.00458		°/s
- Bias stability			0.016		°/s
- Vcc			5		V
- Current			44		mA
Magnetorquer					
- Area			1.55		m ²
- Resistance		120	135	150	Ohm
- Current	Absolute maximum rating			1	A
- Dipole momentum	Dipole momentum at 3.3V	0.034	0.038	0.043	A m ²

Construction

The photovoltaic cells are combined into a string by means of welding the SCA cathode interconnectors to the anode of the adjacent cell. From this point on, the cells are handled as one unit and only handled using a fixture ensuring that no force or torque is transferred to the welds. The panel is prepared for bonding by joining a 1mil polyimide film with 2 x 1.5 mil silicone pressure sensitive adhesive to the front face of the panel. This film is precision cut to the shape of the cells in a string, and it has cutouts to accommodate the interconnectors welded to the rear side of the cells. Once bonded to the surface, the front liner of the film is removed and the SCA string is optically aligned and placed onto the adhesive and then pressed to activate the adhesive. The electrical terminals are soldered to the PCB tracks which concludes the solar cell lay-down procedure.

The EEE components are mounted in a procedure where all parts are cleaned with IPA and then soldered in an anti-static environment by an ECSS-Q-ST-70-38C certified soldering operator to meet the stringent space quality requirements. All solder-work is done with tin-lead 63/37 using rosin flux. All solder joints are re-checked for compliance and the PCB is finally cleaned with IPA. The performance of the finished panel is verified before packaging and shipping.

Connections

The solar panel employs two or three Molex PicoBlade(tm) 1.25mm pitch male connectors designated H1, H2 and H3.

H1: Solar Cell output

Molex PicoBlade 53398-0471. Pinout:

1. Positive
2. Positive
3. Negative
4. Negative

H2: Solar Cell chain (optional)

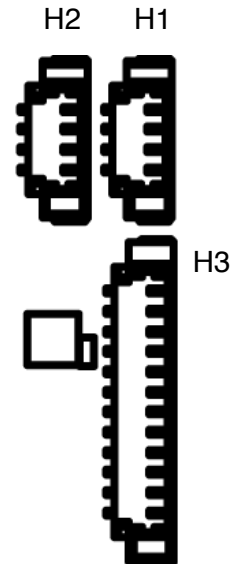
Molex PicoBlade 53398-0471. Pinout:

1. Negative
2. Negative
3. Positive
4. Positive

H3: ADCS

Molex PicoBlade 53398-1271. Pinout:

1. Magnetorquer +
2. Magnetorquer -
3. Digital ground
4. 5V dc gyro supply voltage
5. SPI Chip Select gyro (active low)
6. SPI MOSI
7. Sun sensor cathode
8. Sun sensor anode
9. PSI SCLK
10. SPI MISO
11. 3.3V dc digital supply
12. Chip Select temp. sensor (active low)



Protocols

For information regarding the communication protocols for the gyro and temperature sensor please refer to their datasheets provided by the manufacturers of these parts.

Gyro: Analog Devices ADIS16251:

http://www.analog.com/static/imported-files/data_sheets/ADIS16251.pdf

Temperature sensor: National Semiconductor LM70:

<http://www.national.com/ds/LM/LM70.pdf>

GomSpace recommends using the NanoPower P110U panels with a NanoMind A712D on-board computer which includes all interfaces and software drivers get the sensors and actuator up and running simply by plugging in the connector.

Custom Panels

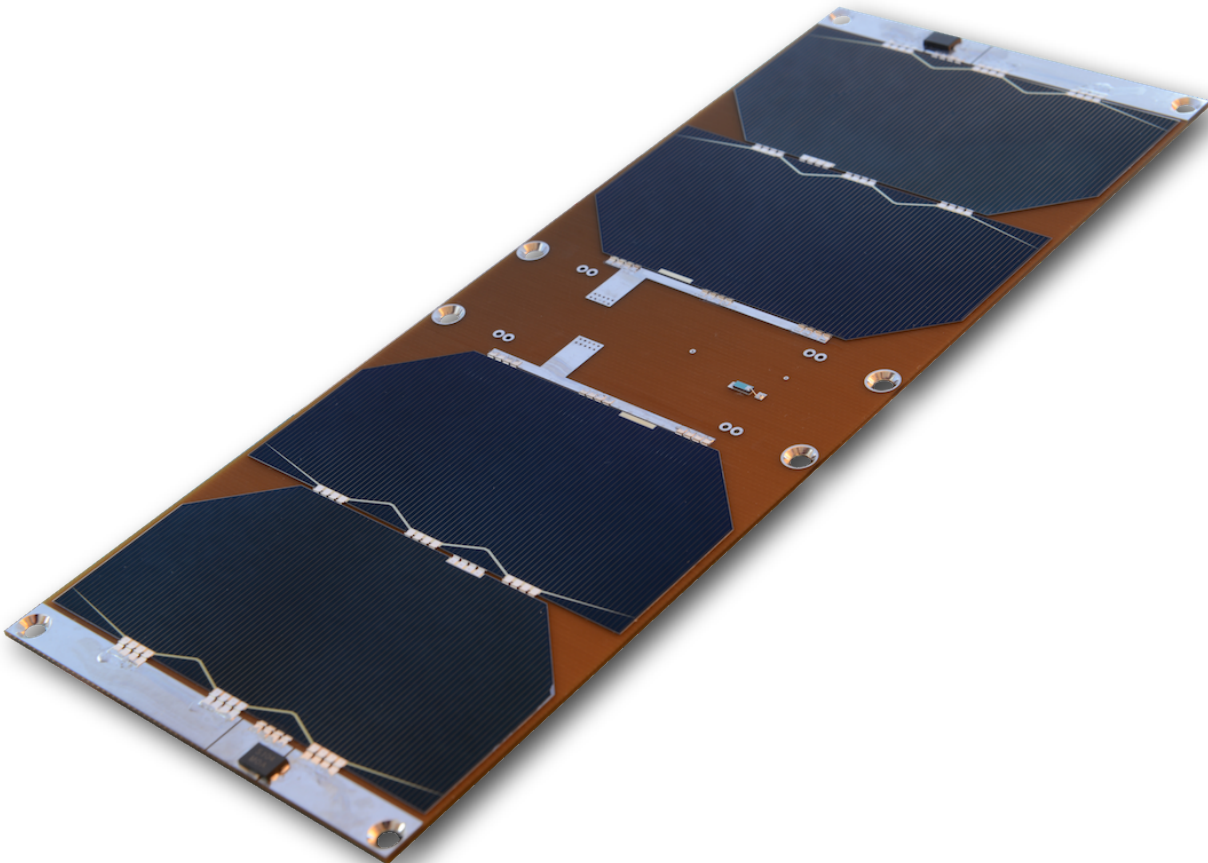
In many cases it may be desirable to use a custom structure rather than a standard configuration for a specialized CubeSat, and in these cases, a custom solar panel solution may be required. The design and production process surrounding the NanoPower P110 solar panels allows tailoring of both the form factor and string layout of the panel to meet specific customer requirements. As long as some basic guidelines are met, a custom panel can be designed, produced and qualified in as little as 10 weeks. The cost of a custom panel is very dependent on the requirements, but a price quote can be obtained within a few days of inquiring.

The main guidelines for fast turn-around custom panels are:

1. The cells must be AzurSpace 3G30A SCA. If bypass diodes are required then cost and lead time will increase. Bypass diodes are recommended for strings of more than 3 cells.
2. The panel base material should be same as P110, i.e. glass/polyimide PCB appr. 1mm thick for panels without magnetorquer and 1.6-1.8mm thick for panels with magnetorquer.
3. Connectors and sensors should be the same as P110, otherwise extra cost and lead time may be required.

Case

The photo below shows an example of a completely custom solar panel for a 2-Unit CubeSat. This panel employs two photovoltaic strings with bypass diodes and redundant blocking diodes on both strings. The materials and components are the same as a standard P110 panel.



Warnings



Handling

This product uses advanced solar cells that are fragile. Do not touch solar cells.

Only handle solar panels by touching PCB edges!

Never place anything on solar cells!



ESD

This product uses semiconductors that can be damaged by electrostatic discharge (ESD). When handling, care must be taken so that the devices are not damaged. Use appropriate precautions.



Use

This is a highly advanced product. Make sure to read and understand product documentation before taking it into use.

GomSpace ApS • Niels Jernes Vej 10 • 9220 Aalborg E • Denmark
Tel: +45 9635 6111 • Fax: +45 9635 4599 • Web: www.gomspace.com

The information furnished by GomSpace in this data sheet is believed to be accurate and reliable. However, no responsibility is assumed by GomSpace for its use. GomSpace reserves the right to change circuitry and specifications at any time without notification to the customer. Current sale and delivery conditions are available on the homepage of GomSpace

© 2013 GomSpace ApS.