

4U SOLAR PANEL

DATASHEET

DESCRIPTION

The 4U Solar Panel is equipped with 2 Pairs in parallel of 4 Solar Cells connected in series with efficiency $\geq 30\%$. The overall effective solar cell area 241.2mm^2 and provides up to 9.78 Watt @ AM0, $T=25^\circ\text{C}$

On the PCB, a network of sensors can be interfaced to the flight altitude system and ADCS. The network is a combination of the following: 2 temperature sensors and 2 sun sensors (photodiodes). The temperature sensor and the solar sensor are located on the top surface of the solar panel

The configuration of the solar panels on the outside of the satellite can be simple or complex. Therefore, using the connector system on the PCB, multiple solar panels can be easily connected in an electrical series and parallel. The solar panels are then typically connected to the Electrical Power System Module (EPS)

1 PRODUCT PERFORMANCE AND PROPERTIES

1.1 Solar Panel Features and Characteristics

- Space qualified triple junction Solar Cell Assembly with integrated bypass diode
- Solar Cells Configuration: 4 in Series 2 in Parallel (4S2P)
- Maximum Power: 9.78 Watt
- Voltage at maximum Power: 9.10V
- Current at maximum Power: 1070mA
- Effective Cell Area (8 solar cells): 241.2cm^2
- Blocking diodes on both solar cell strings
- Two Temperature Sensors with SPI Interface
- Two Sun Sensors (photodiodes)
- Overall Panel Dimensions: $192.6\text{mm} \times 166.2\text{mm}$
- PCB Thickness: 1.6mm
- Weight: $\leq 210\text{g}$

1.2 Solar Cell Features and Characteristics

Table 1: Solar Cell Main Characteristics

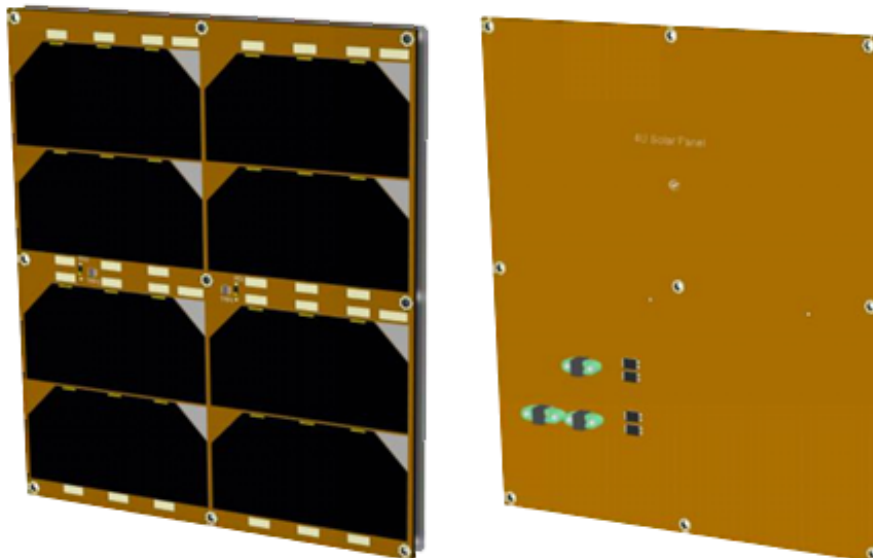
Parameter	Value
Material	GaInP/GaAs/Ge
Efficiency (%)	≥ 30
Effective area (cm ²)	30.15
Dimensions (mm)	40.0 x 80.0
As	≤ 0.92
ϵH	0.84 ± 0.03
Voc (mV)	2660
Jsc (mA/cm ²)	18.7
Vmp (mV)	2350
Jmp (mA/cm ²)	18.0

Table 2: Solar Cells Loss factor (1 year)

Parameter	Voltage Loss	Current Loss
Radiation	0.98	0.99
UV	1	0.98
Thermal Cycle	1	1
Serial Match	1	0.99
Temperature	-6.80mV / -	+0.009mA/cm ² --

1.3 Solar Cells Layout

Figure 1: 4U Solar Panel



2 ELECTRICAL OUTPUT

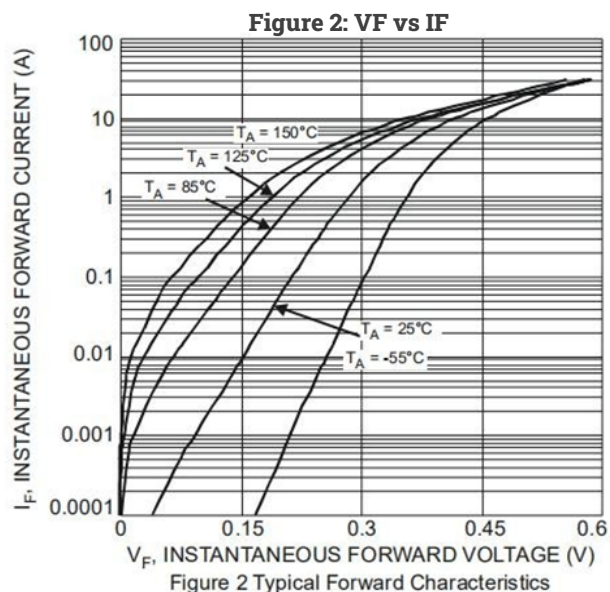
The BOL power of 4U Solar Panel is calculated at 25°C. Results are shown below

Table 3: Electrical Output @ $\eta=3.15\%$, AM0

x	Symbol	25-		80-	
BOL	Vmp	9.10	V	7.60	V
	Voc	10.34	V	8.84	V
	Isc	1.12	A	1.13	A
	Imp	1.07	A	1.10	A
	Pmp	9.78	W	8.40	W
EOL	Vmp	8.87	V	7.37	V
	Voc	10.07	V	8.58	V
	Isc	1.08	A	1.11	A
	Imp	1.04	A	1.07	A
	Pmp	9.24	W	7.89	W

3 REVERSE CURRENT PROTECTION

To protect solar cells from reverse current, the solar panel uses Schottky Barrier Diode as blocking diode, because this diode has very low forward voltage drop $\leq 0.3V@1A$ 25°C and very high junction temperature tolerance (up to 200°C). For better reliability, two parallel diodes are connected to each string of solar cells



4 PCB SUBSTRATE

- The PCB material is FR4-Tg170
- The Interfaces correspond to the data specified in the reference document
- PCB Thickness: 1.6mm
- The Copper Thickness: 70 μ m
- PCB Surface Finish: white reflective emission enamel
- Thermal Control Coating: white paint S781, $\varepsilon = 0.87 \pm 0.02$, $\alpha = 0.18 \pm 0.02$
- Countersunk mounting holes as per DIN EN ISO 7046-1 (without grounding)

5 POWER OUTPUT AND SENSORS CONNECTORS

4U Solar Panels provide two connectors for power output from the solar cells and one for the sensor communication:

- H1 - Output Power Bus Connector (Harwin G125-MS10605M1P)
- H2 - Output Power Bus Connector (Harwin G125-MS10605M1P)
- H3 - Sensors (Harwin G125-MS11005M1P)

The H1 and H2 connectors are connected to the same power bus and are electrically identical. Having the two connectors (H1 and H2) allows other solar panels to be easily connected in either an electrical series or parallel configuration

5.1 H1 & H2 Pinout (Power Output)

Table 4:H1, H2 Connector Pin Map

Pin	Mnemonic	Description
1	PV+	Photovoltaic Positive Output
2	PV-	Photovoltaic Negative Output
3	PV+	Photovoltaic Positive Output
4	PV-	Photovoltaic Negative Output
5	PV+	Photovoltaic Positive Output
6	PV-	Photovoltaic Negative Output

5.2 Sensors

- On-board temperature sensor TMP121
- Sun sensor (photodiode) SLCD-61N8

Table 5: Temperature Sensor Characteristics

Parameter	Unit	Conditions	Min	Typ	Max
Temperature range	°C		-40		+125
Accuracy	°C	-25°C to +85°C		±0.5	±1.5
	°C	-40°C to +125°C		±1.0	±2.0
	°C	-40°C to +150°C		±1.5	
Supply voltage range (Vcc)	V		2.7		5.5
Quiescent current (I _Q)	µA			35	50

Table 6: Photodiode Characteristics

Parameter	Unit	Conditions	Min	Typ	Max
Reverse Dark Current	µA	V _R =5V, E _e =0		1.7	
Sensitivity Spectral Range (λ _R)	nm		400		1100
Angle of half sensitivity	deg			60	

5.3 H3 Pinout (Sensors)

Table 7: H3 Connector Pin Map

Pin	Mnemonic	Description
1	+3V3	+3.3V Power Supply for the Temp. Sensors
2	CS2_TMP	Chip Select - Temperature Sensor 2
3	GND	Ground for the Temperature Sensors
4	SPI_MISO	SPI - Master Input Slave Output
5	CS1_TMP	Chip Select - Temperature Sensor 1
6	SPI_SCK	SPI - Serial Clock (Output from Master)
7	PD1_Anode	Photodiode 1 - Anode
8	PD2_Cathode	Photodiode 2 - Cathode
9	PD1_Cathode	Photodiode 1 - Cathode
10	PD2_Anode	Photodiode 2 - Anode

6 WEIGHT AND OPERATING TEMPERATURE

Table 8: Single panel weight data

Components	Weight (g)	Remarks
Substrate	130	PCB
PVA	50	CICs, RTV, etc.
Electronics	20	Connectors, Sensors
Other	10	
Total	210	

Table 9: On-board components thermal ratings

Components	Operating Temperature	Remarks
PVA & Substrate	-90°C to +125°C	
Temperature Sensor	-40°C to +125°C	
Sun Sensor (Photodiode)	-40°C to +125°C	
G125 Series connectors	-65°C to +150°C	