

USER MANUAL

Solar Panel 40P6 (4S2P Solar Cell Configuration)

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SOLAR PANEL 40P6

USER MANUAL

This user manual details the applications, features and operation of the Solar Panel 40P6.

Please read carefully the manual before unpacking the solar panel in order to ensure safe and proper use.

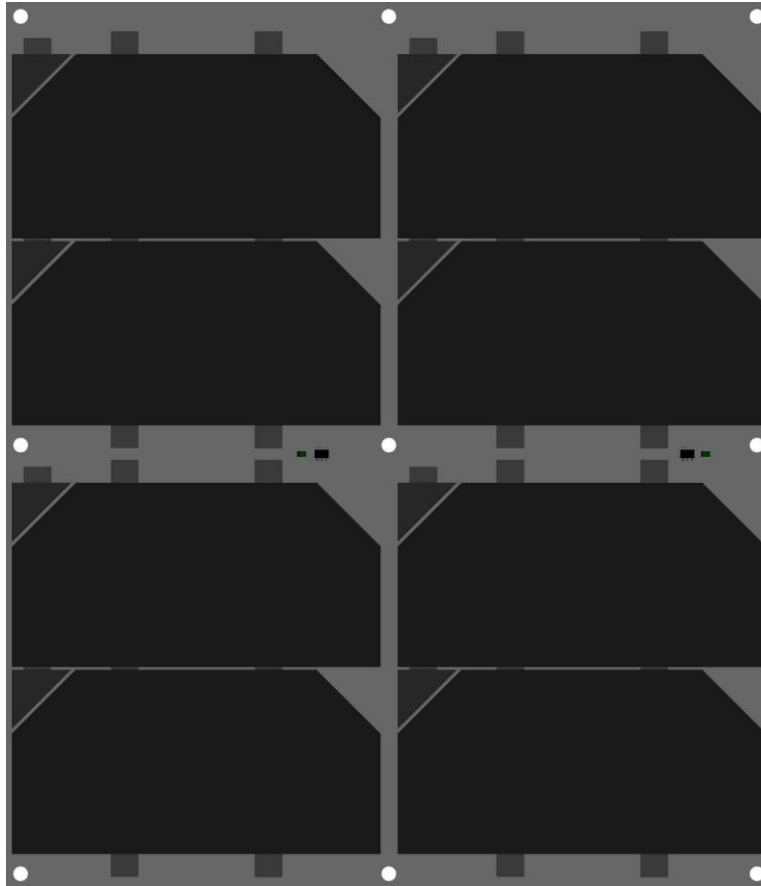


Figure 1: Solar Panel 40P6

1 CHANGE LOG

Date	Version	Note
10/10/2019	Rev 1.0	Document created

2 ACRONYM LIST

4S2P	Four in Series and Two in Parallel
ADCS	Attitude Determination and Control System
CIE	International Commission on Illumination
ECSS	European Cooperation for Space Standardization
EPS	Electrical Power System
ESA	European Space Agency
GEO	Geostationary Earth Orbit
GND	Ground
LEO	Low Earth Orbit
PCB	Printed Circuit Board
RH	Relative humidity
SPI	Serial Peripheral Interface

3 DESCRIPTION

The Solar Panel 40P6 is equipped with two pairs in parallel of four CESI solar cells of type CTJ30 in series with up to a 29.5% efficiency. The total effective solar cell area is 241.2mm² and provides up to 9.63 Watts @AM0, T=25°C.

On the PCB, a network of sensors can be interfaced to an Attitude Determination and Control System(ADCS). The network is a combination of the following: two temperature sensors and two Sun sensors. The temperature sensor and Sun sensor (photodiode) are positioned on the top surface of the solar panel.

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

4 PRODUCT PERFORMANCE AND PROPERTIES

4.1 Solar Panel Features and Characteristics

- Eight CESI CTJ30 solar cells, triple junction with integrated bypass diode, space qualified (specs in the following paragraph)
- Configuration of the solar cells: 4 in Series 2 in Parallel – 4S2P
- Maximum power: 9.63W¹
- Voltage at maximum power: 9.32V¹
- Current at maximum power: 1034mA¹
- 241.2cm² effective cell area (for 8 solar cells)
- Blocking diodes on both solar cell strings
- Gold plated invar interconnectors
- Space-grade silicone adhesive with minimum outgassing behavior
- Two temperature sensors with SPI interface (accuracy: ±1.5°C from -25°C to 85°C (max), ±2.0°C from -55°C to 125°C (max))
- Two Sun sensors (photodiodes)
- Multiple 40P6 solar panels can be connected in series or parallel
- PCB thickness: 1.6mm with two internal 70 µm copper layers and white solder mask
- Countersunk mounting holes as per DIN EN ISO 7046-1 (without grounding)
- Mass: < 170g

¹ @AM0, T=25°C

4.2 Solar Cell Features and Characteristics

- Efficiency up to 29.5%
- Triple junction solar cells InGaP/GaAs/Ge
- Very low solar cell mass (81-89 mg/cm²)
- Thickness: 155 μm \pm 15 μm
- Fully qualified under ESA Standard ECSS E ST20-08C for LEO and GEO
- Internal by-pass diode for optimized output power
- Size: 30.15 cm²
- High radiation resistance
- Coverglass CMG (150 μm thick)

5 CONNECTORS

5.1 Power Output, and Sensors Connectors

The Solar Panel 40P6 has two connectors for power output and one for the sensors:

- 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.

5.2 H1, H2, and H3 Location

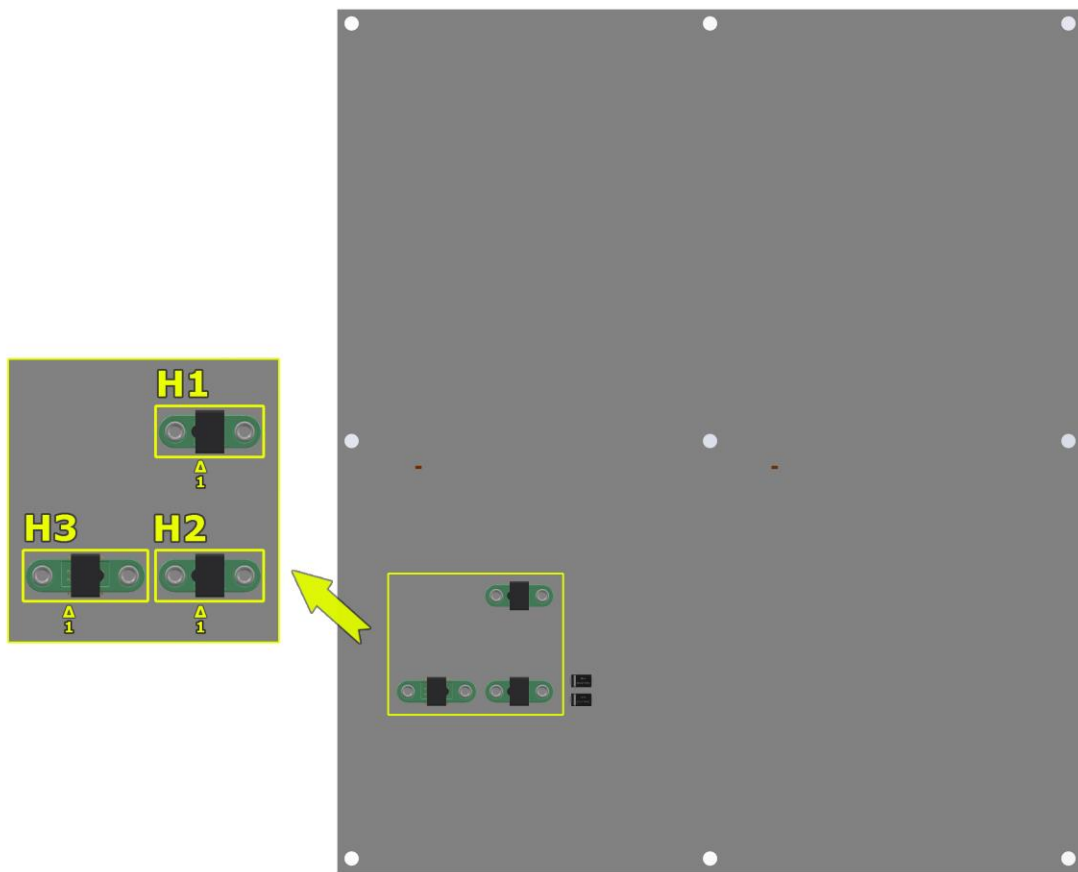
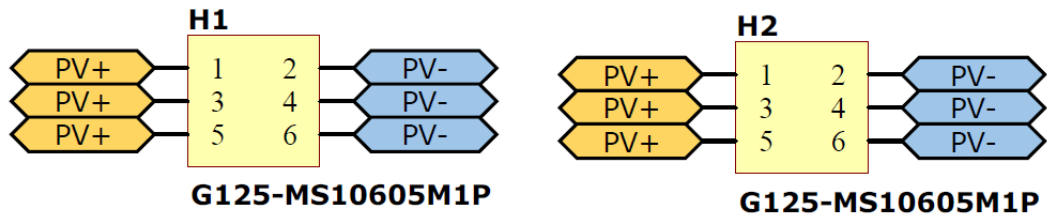


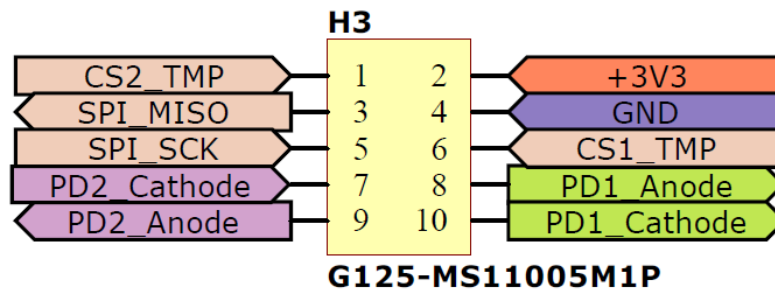
Figure 2: Solar Panel 40P6 – Bottom Side

5.3 H1 & H2 Pinout (Power Output)



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

5.4 H3 Pinout (Sensors)



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

6 SPECIFICATIONS

SOLAR CELL STRING					
Parameter	Unit	Condition	Min	Typ	Max
Voltage	V	25°C		9.32	
Current	mA	25°C		1034	
Power	W	25°C			9.63
Efficiency	%				29.5

TEMPERATURE SENSOR					
Parameter	Unit	Condition	Min	Typ	Max
Range	°C		-55		150
Accuracy	°C	-25°C to 85°C		±0.5	±1.5
	°C	-55°C to 125°C		±1	±2
	°C	-55°C to 150°C		±1.5	
Vcc	V		2.7	3.3	5.5
Quiescent Current	µA			50	75

SUN SENSOR					
Parameter	Unit	Condition	Min	Typ	Max
Reverse Light Current	µA	$E_v = 100\text{lx}$ CIE illuminant A	0.03	0.04	0.09
Range of Spectral Bandwidth ($\lambda_{0.5}$)	nm			430 to 610	
Angle of Half Sensitivity	deg			±60°	

7 PHYSICAL LOCATION OF SENSORS

The physical location of all the sensors are shown in figure 3.

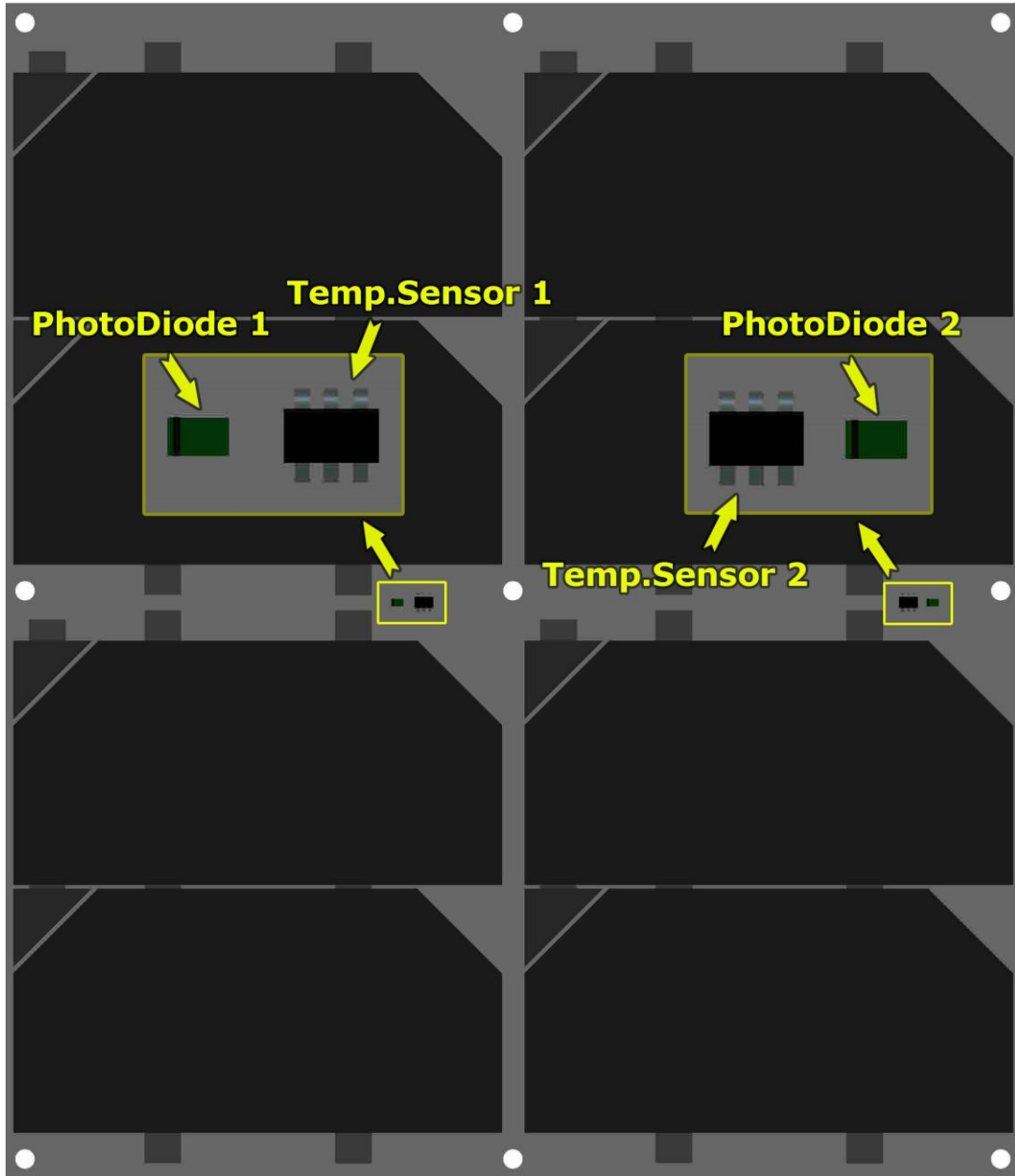


Figure 3: Physical Location of the Sensors

8 MECHANICAL CHARACTERISTICS

The Solar Panel 40P6 should be mounted using bolts of type:

Torx - DIN965/ISO 7046-1 - M3 – Length: 6mm

The important dimensions of the solar panel are shown in figures 4, 5 and 6. All values are in mm.

STEP / PARASOLID files can be provided upon request.

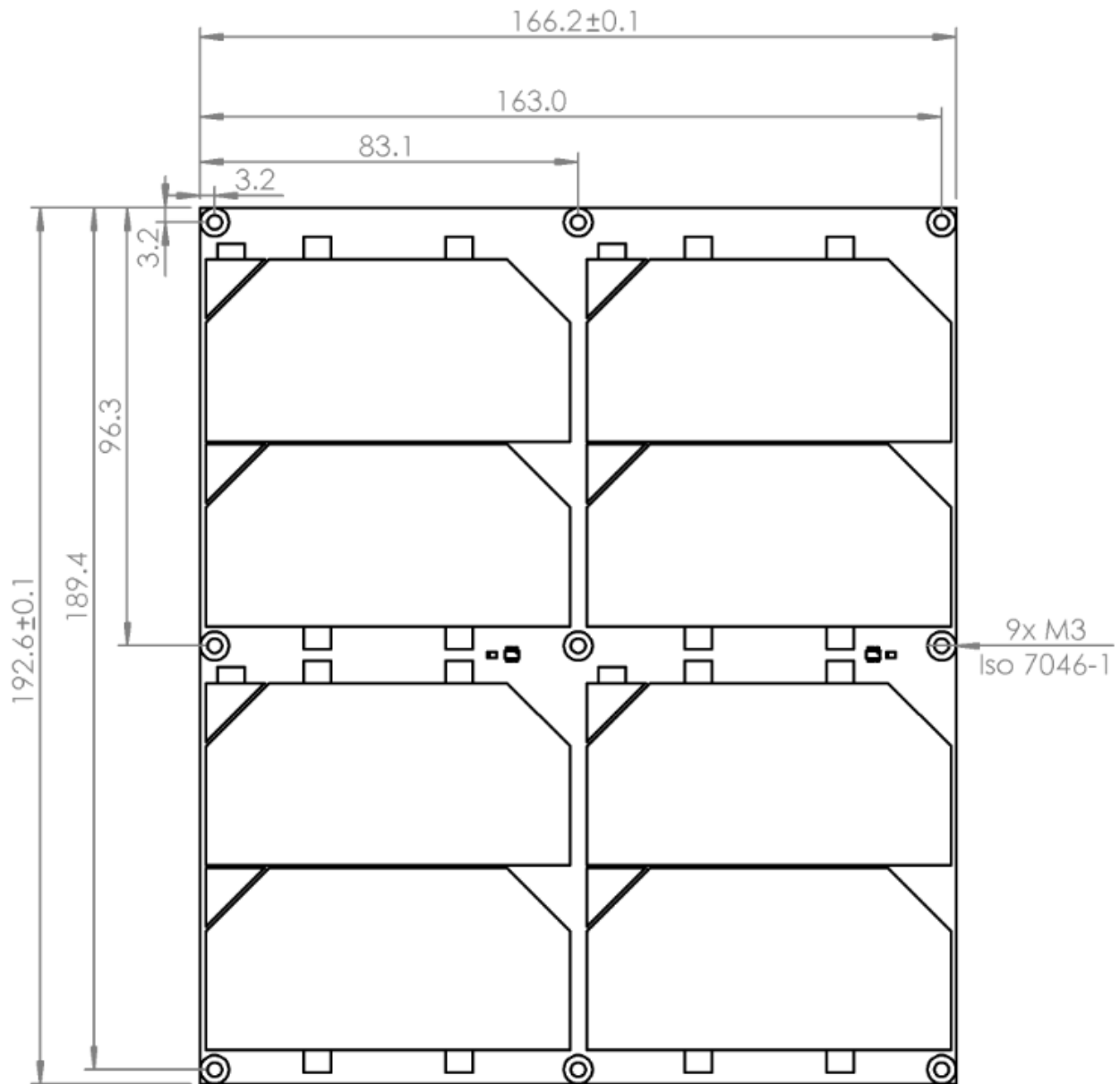


Figure 4: Solar Panel 40P6 - Top Side (dimensions in mm)

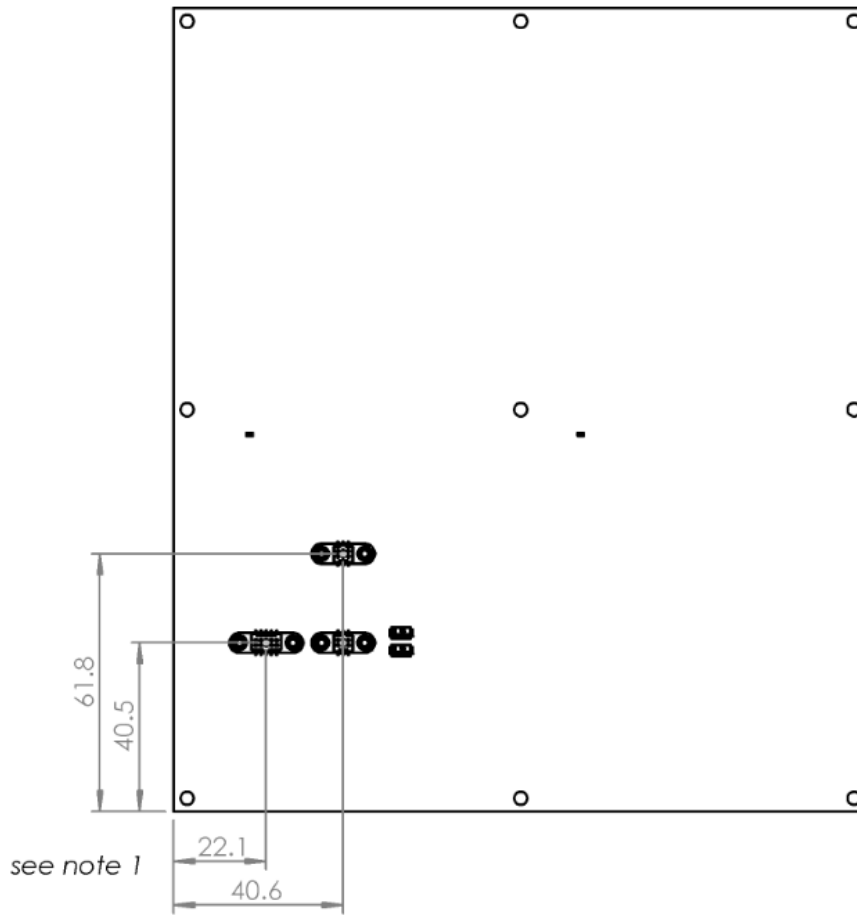


Figure 5: Solar Panel 40P6 - Bottom Side (connector location, dimension in mm)

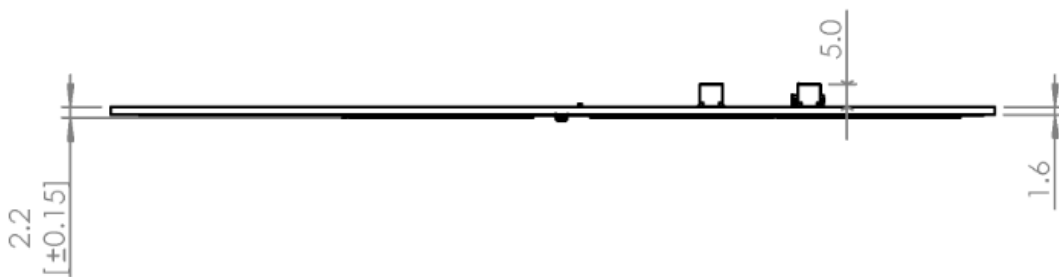


Figure 6: Solar Panel 40P6 - Side View (dimensions in mm)

Note 1: Reference dimensions are taken to the center of the connectors

9 MATERIALS AND ASSEMBLY

The PCB material is FR4-Tg170. The production process follows quality standards:

- IPC-A-600H II (Surface)
- IPC-A-6012 (Function)
- IPC-TM-650 (Test Method)

The component mounting follows quality standards:

- IPC-A-600 Acceptability of Printed Boards
- IPC-A-610E Acceptability of Electronic Assemblies
- J-STD-001 Requirements for Soldered Electrical and Electronic Assemblies
- ISO 14644 Cleanrooms and Associated Controlled Environments
- IEC 61340 Electrostatics ESD: Protection of Electronic Devices from Electrostatic Phenomena

10 HANDLING AND STORAGE

Particular attention shall be paid to the avoidance of damage to the solar panel during handling, storage and preservation. The handling of the solar panel should be performed in compliance with the following instructions:

- Handle using PVC, latex, cotton (lint free) or nylon gloves.
- The environment where the solar panel will be handled shall meet the requirements for a class environment 100,000, free of contaminants such as dust, oil, grease, fumes and smoke from any source.
- Do not touch the solar cells on the solar panel.
- Solar panels must be handled by touching the PCB edges only.
- Solar panels shall be stored in such a manner as to preclude stress and prevent damage.
- To prevent the deterioration of the solar cells, then the solar panel shall be stored in a controlled environment (i.e. the temperature and humidity levels shall be maintained within the proper ranges):
 - Ideal storage temperature range: 15°C to 27°C
 - Ideal storage humidity range: 30% to 60% relative humidity (RH)

11 WARNINGS



This product uses very fragile components. Observe precautions for handling.



This product uses semiconductors that can be damaged by electrostatic discharge (ESD). Observe precautions for handling.



Sensitive electronic device. Do not ship or store near strong electrostatic, electromagnetic, magnetic or radioactive fields.