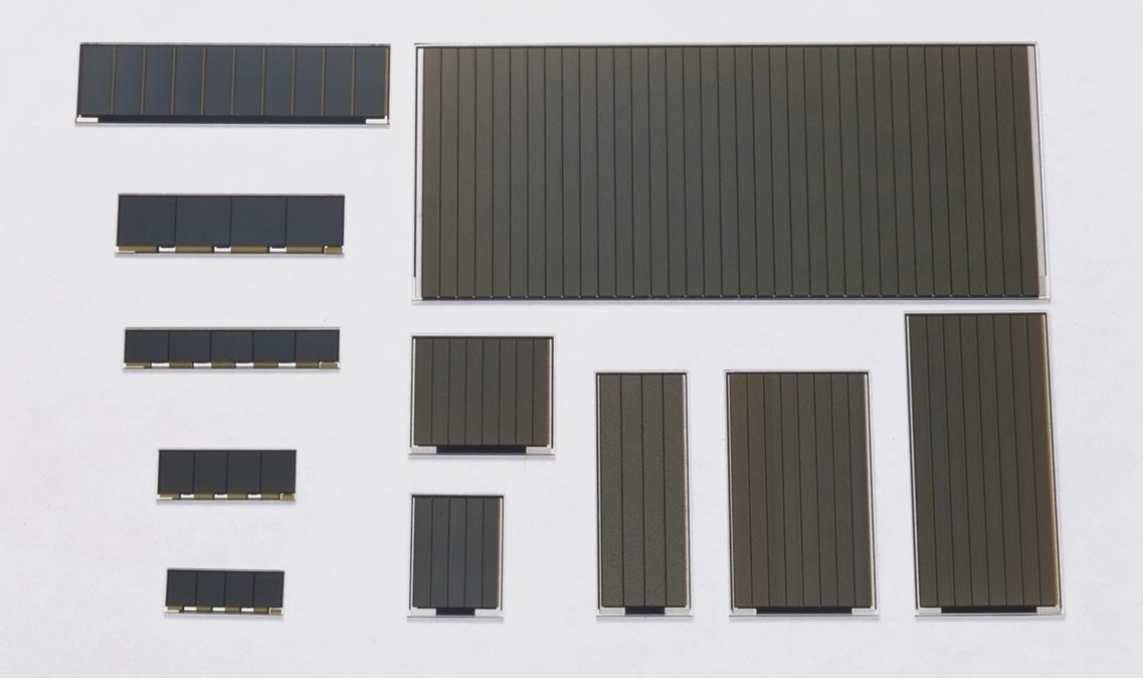
Panasonic

Solar Cells
Technical Handbook '98/99



PDF File Technical Handbook

NOTICE TO READERS

It is the responsibility of each user to ensure that each battery application system is adequately designed safe and compatible with all conditions encountered during use, and in conformance with existing standards and requirements. Any circuits contained herein are illustrative only and each user must ensure that each circuit is safe and otherwise completely appropriate for the desired application.

This literature contains information concerning cells and batteries manufactured by Matsushita Battery Industrial Co., Ltd. This information is generally descriptive only and is not intended to make or imply any representation guarantee or warranty with respect to any cells and batteries. Cell and battery designs are subject to modification without notice. All descriptions and warranties are solely as contained in formal offers to sell or quotations made by Matsushita Battery Industrial Co., Ltd. Panasonic Sales Companies and Panasonic Agencies.

Matsushita Battery Industrial Co., Ltd.

August 1998

SOLAR CELLS: TABLE OF CONTENTS

Thin-Film Solar Cells (Sunceram II)

Silicon Solar Modules

1. THIN-FILM SOLAR CELLS (SUNCERAM II)

1.1. General Information

Research conducted by Panasonic over many years on solar cells and the application of this new technology culminated in 1984 with the successful development of the world's first thin-film solar cell using compound semiconductors. The company named these cells Sunceram II.

The Sunceram II cells have good weatherproof properties and high spectral sensitivity characteristics over a wide wavelength range. Furthermore, since the entire film-forming process involves only screen-printing and since belt sintering is employed, these cells are very amenable to mass production. It also means that high-voltage type solar cells can be formed at a high density on a single glass substrate, and that it is easy to produce them with larger surface areas.

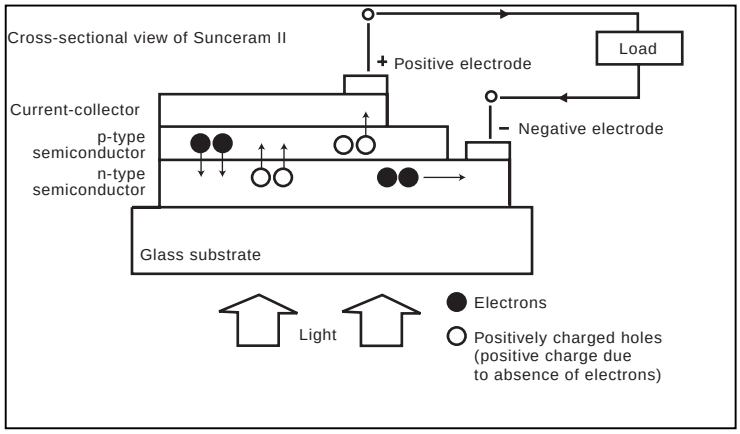
Besides developing compact and lightweight Sunceram II modules for outdoor use which maintain a stable performance over prolonged periods, Panasonic has developed compact, high-performance Sunceram II sign units which are used in combination with the company's own coin-type rechargeable batteries.

With its sights firmly fixed on power sources for the new forms of soft energy which will be abundant in the twenty-first century, Panasonic is committed to developing new products which will fill the needs of the market.

1.2. Principle of Power Generation

The principle of power generation behind the Sunceram II solar cells consists of the utilization of the photovoltaic effect of semiconductors. When such a cell is exposed to light, electron-hole pairs are generated in proportion to the intensity of the light. Solar cells are made by bonding together p-type and n-type semiconductors. The negatively charged electrons move to the n-type semiconductor while the positively charged holes move to the p-type semiconductor. They collect at both electrodes to form a potential.

When the two electrodes are connected by a wire, a current flows and the electric power thus generated can be transferred to an outside application.

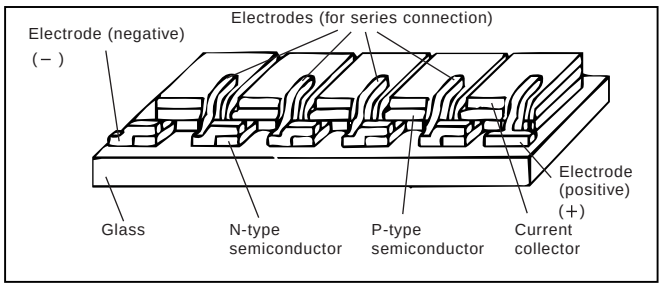


1.3. Construction

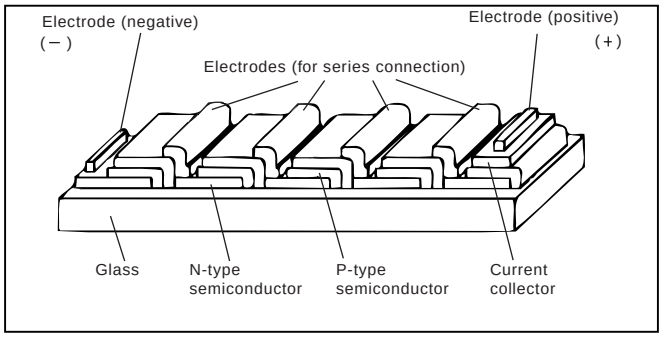
Since screen printing is used for the entire film-forming process, the Sunceram II cells with a large surface area can be made relatively easily, while any number of cells in any required shape can be connected in series or in parallel on the glass substrate at the same time as the films are formed. The figures below show two typical examples of the construction of cells connected in series. When the cells are used in calculators and other applications involving relatively faint currents, connection method (a) is mainly used; when they are used in high-brightness conditions with high currents, method (b) is used.

1.3.1. Construction of Sunceram II cells connected in series

(a) Connection at lower edge of each cell



(b) Connection along entire length of cell sides

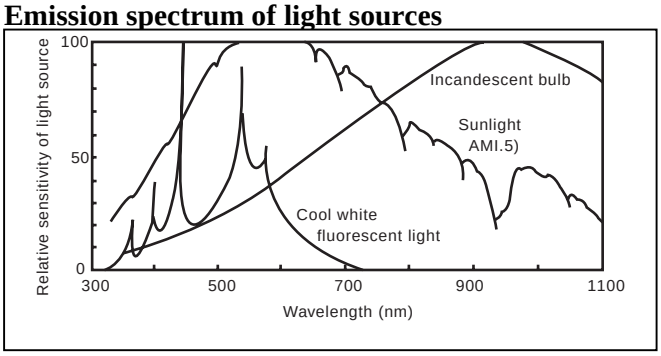


1.4 Sunceram II Features

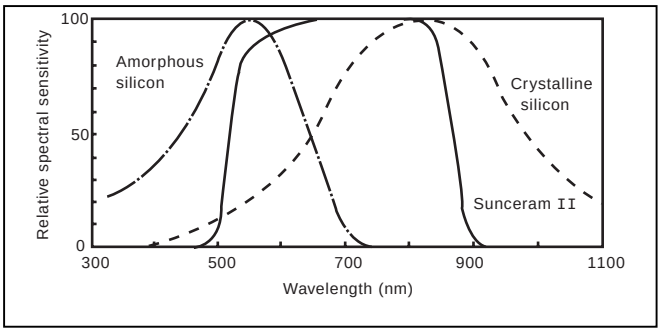
1. High, wide-ranging spectral sensitivity characteristics

The cells have wider spectral characteristics in various wavelength regions than crystalline silicon and are more sensitive over a wider wavelength region than amorphous silicon.

Emission spectrum of light sources

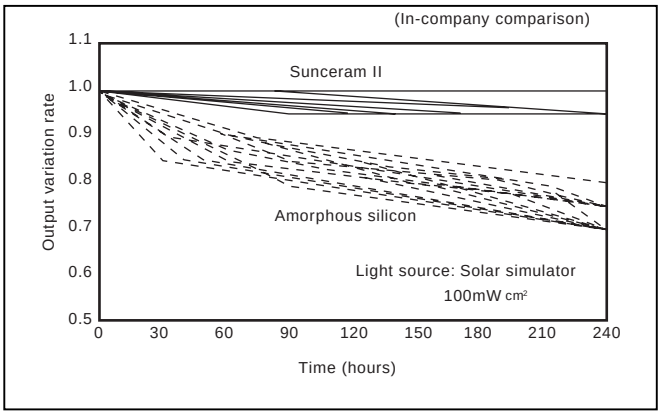


Spectral sensitivity characteristics of solar cells



2. Excellent sunlight irradiation characteristics

Compared with amorphous silicon, Sunceram II operates more stabile over longer periods of time when irradiated by sunlight.



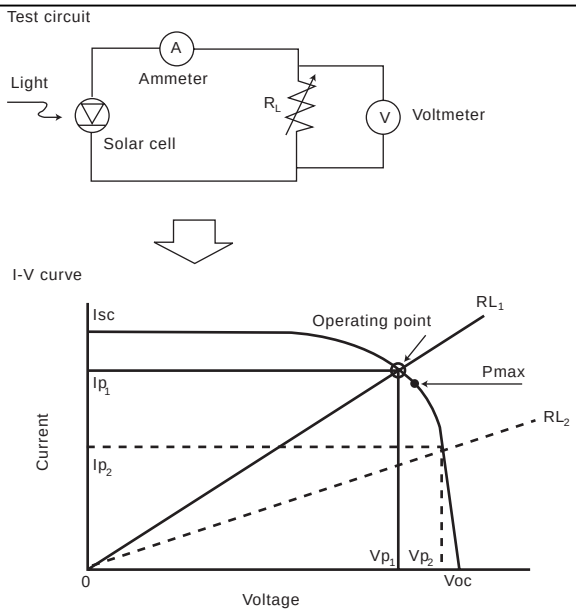
3. Easily accommodated by high-voltage equipment
A printing method is used for the entire film-forming process of the Sunceram II, with the result that solar cells with the desired high voltage can be formed very densely and thinly on a single substrate. This, in turn, fulfills the need for cells with various voltages.

4. Easy increase in surface area
The printing and sintering methods used enable a uniform film to be produced, which means that it is easier to increase the surface area of each cell than with crystalline silicon. It also means that it is possible to produce any shape of cell with relative ease.

1.5. Output characteristics of solar cells

The output characteristics of solar cells are expressed in the form of an I - V curve. An I - V curve test circuit and typical I - V curve produced by the circuit are shown below.

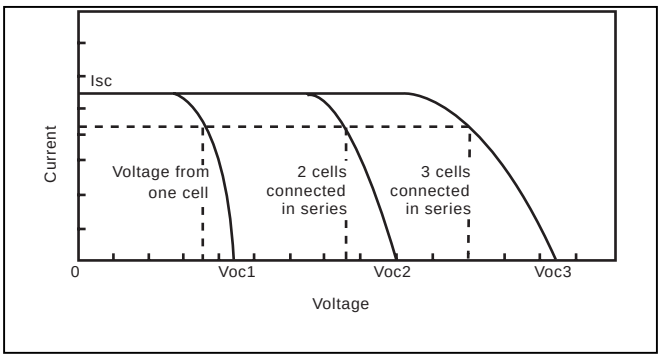
- The I-V curve is produced by varying R_L (load resistance) from zero to infinity and measuring the current and voltage along the way. The point at which the I-V curve and resistance (R_L) intersect is the operating point of the solar cell. The current and voltage at this point are Ip and Vp, respectively. The largest operating point in the square area is the maximum output of the solar cell.



Isc : Short-circuit current
Voc : Open-circuit voltage
Ip : Operating current
Vp : Operating voltage
R_L : Load resistance
Pmax : Maximum output

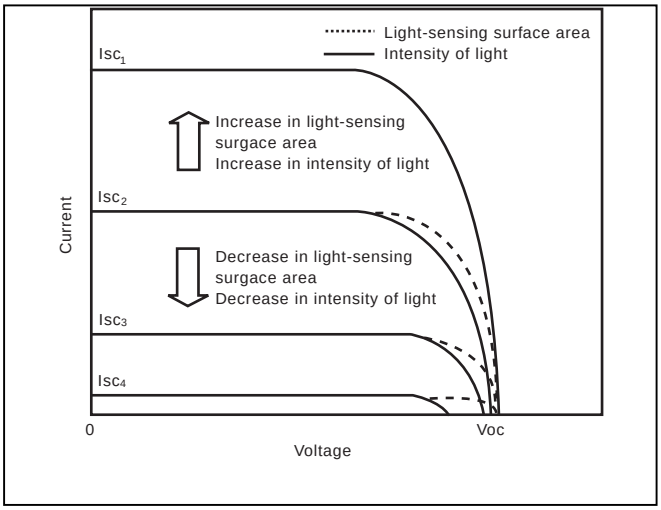
1.6. Dependence of cells on series connection

When single solar cells are connected in series, the voltage increases in proportion to the number of solar cells which have been connected, as with ordinary batteries. (Single cell voltage x number of cells)



1.7. Light-sensing area and dependence on light intensity

Increasing the light-sensing area or light intensity per single solar cell produces a proportionate increase in the short-circuit current. The open-circuit voltage remains constant regardless of the light-sensing surface area, and is hardly changed at all even by the intensity of light. (However, it will drop drastically if the intensity of light is reduced in the extreme.)

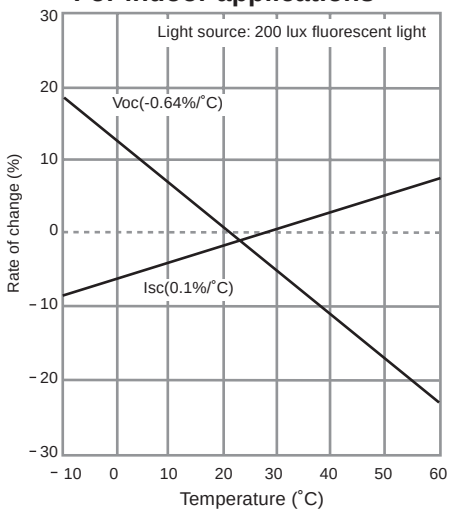


1.8. Temperature characteristics

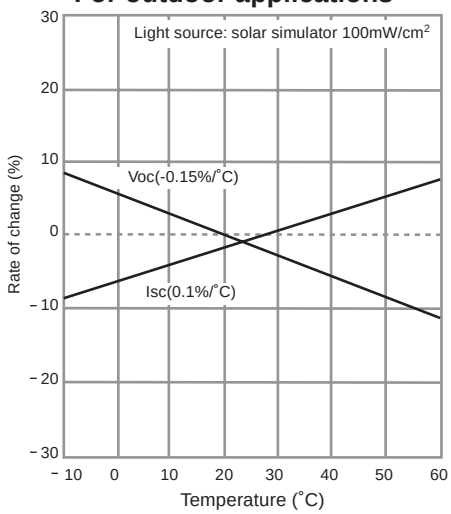
The performance of solar cells is such that the short-circuit current increases and the open-circuit voltage decreases as the temperature rises. Since the rate at which the open-circuit voltage decreases is higher than the rate at which the short-circuit current increases, the maximum output is also reduced.

However, as far as the operating current is concerned, since the operating voltage is generally set slightly toward the short-circuit current side from the maximum output operating point, the operating current peaks at around room temperature and gently falls both below and above the temperature.

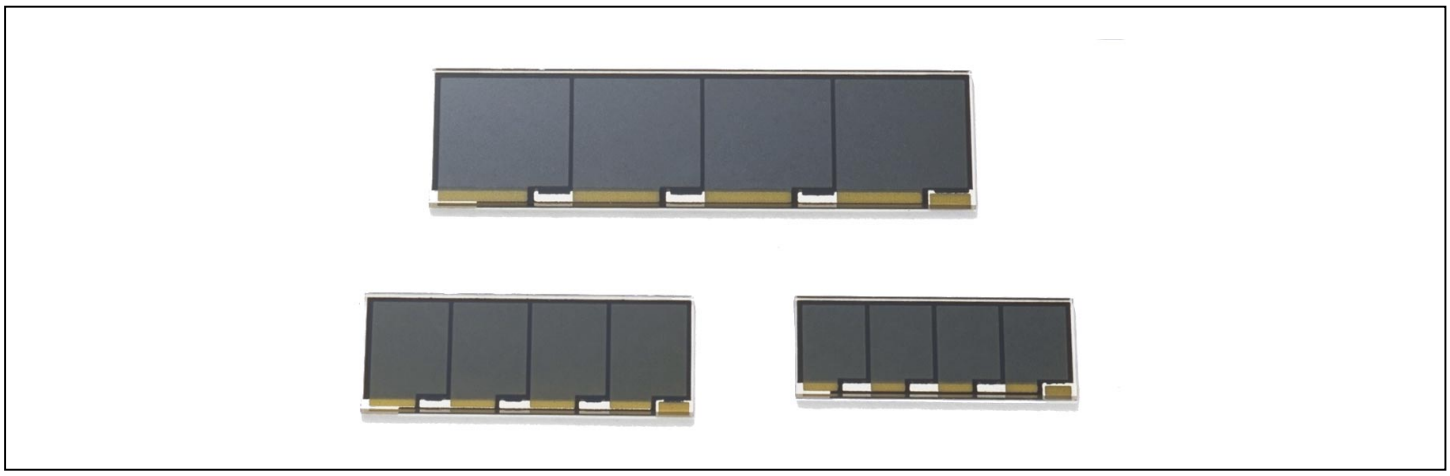
For indoor applications



For outdoor applications



2. SUNCERAM II CELLS FOR INDOOR USE



2.1. General Information

The Sunceram II cells for indoor use thin-film compound semiconductors, and they are ideal for powering loads such as calculators which use very low levels of power and which are used under other types of indoor lighting. In particular, they deliver a high power output under long-wavelength light from incandescent lamps, etc., and they can power calculators even under low brightness levels of 10 lux and below. Their unique and original pastel shades of color produced by the fabrication methods involving printing and sintering lend an added softness to the products in which they are used.

2.2. Features

- These cells have a high spectral sensitivity to light ranging over a broad wavelength spectrum. When they are used in a product under an incandescent light, they deliver 5 times more power than amorphous silicon solar cells (in internal testing).
- It is possible to set an operating voltage that suits the application at hand because the solar cells are formed on the glass substrates and also because any number of series connections can be made.
- Due to the printing type production method, it is possible to produce solar cells with sizes that match their applications.
- These cells are highly reliable as solar cells for indoor consumer products.

2.3. Applications

- Calculators
- Indoor clocks
- Remote control units
- Indoor digital thermometers
- Other indoor consumer products which have a low power consumption

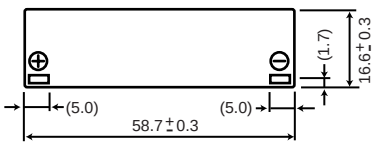
2.4. Specification Table for Indoor Use

Operating voltage *vp=1.3V

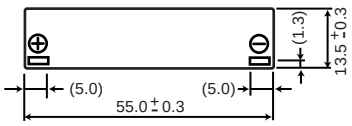
Model No.	Dimensions (Min) t=1.4Min (Max)	Fluorescent lamp : 200 (lux)						Incandescent lamp 40 (lux)					
		Operating Current Ip (μA) *		Open-circuit voltage Voc(V)		Short-circuit current Isc (μA) *		Operating Current Ip (μA) *		Open-circuit voltage Voc(V)		Short-circuit current Isc (μA) *	
		Min	Typ	Min	Typ	Min	Typ	Min	Typ	Min	Typ	Min	Typ
BP-5917C40	58.7X16.6	20.0	24.0	1.70	1.80	20.0	27.5	20.0	28.0	1.70	1.80	20.0	32.0
EP-5513C4C	55.0X13.5	13.5	18.0	1.70	1.80	13.5	20.0	13.5	21.0	1.70	1.80	13.5	23.5
BP-5313C4C	53.0X13.8	13.5	18.0	1.70	1.80	13.5	20.0	13.5	21.0	1.70	1.80	13.5	23.5
BP-4114C4C	41.5X14.7	11.0	15.0	1.70	1.80	11.0	16.5	11.0	17.5	1.70	1.80	11.0	19.5
BP-5511C4C	55.0X11.0	11.0	14.5	1.70	1.80	11.0	16.0	11.0	17.0	1.70	1.80	11.0	19.0
BP-3513C4C	35.0X13.7	8.5	11.0	1.70	1.80	8.5	12.0	8.5	13.0	1.70	1.80	8.5	14.5
BP-3812C4C	38.0X12.5	8.0	11.0	1.70	1.80	8.0	12.0	8.0	13.0	1.70	1.80	8.0	14.5
BP-2911C4C	29.6X11.6	6.0	7.5	1.70	1.80	6.0	8.0	6.0	8.5	1.70	1.80	6.0	9.5
BP-2510C4C	25.0X10.0	4.0	5.4	1.70	1.80	5.2	5.8	4.0	5.8	1.70	1.80	5.2	6.5
Operating voltage *Vp=1.55V													
BP-5513C5C	55.0X13.5	10.5	14.0	2.10	2.25	10.5	15.5	10.5	16.5	2.10	2.25	10.5	18.0
BP-551105C	55.0X11.0	8.5	11.5	2.10	2.25	8.5	12.5	8.5	13.5	2.10	2.25	8.5	15.0
Operating voltage *Vp=3.2V													
BP-5323CAC	53.0X23.5	7.5	10.0	4.00	4.30	7.5	10.0	7.5	10.0	4.00	4.30	7.5	10.0

Note 1) Measurement temperature 20°C l68°F)
Note 2) Light source and intensity are specified by Panasonic's standard.
Note 3) Standard units come with copper electrodes.

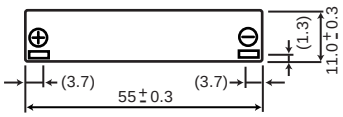
2.5 Dimensions (Indoor use) thickness: 1.1(max1.4) _____ Unit : mm



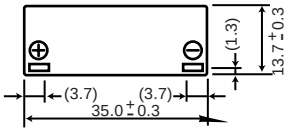
BP-5917C4C



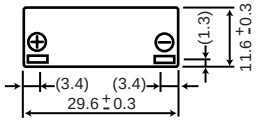
BP-5513C4/BP-5513C5C



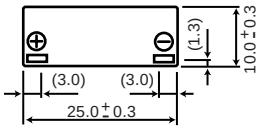
BP-5511C5C



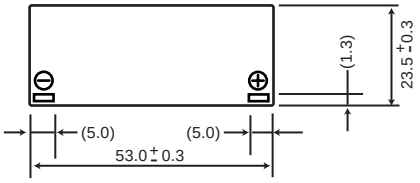
BP-3513C4C



BP-2911C4C



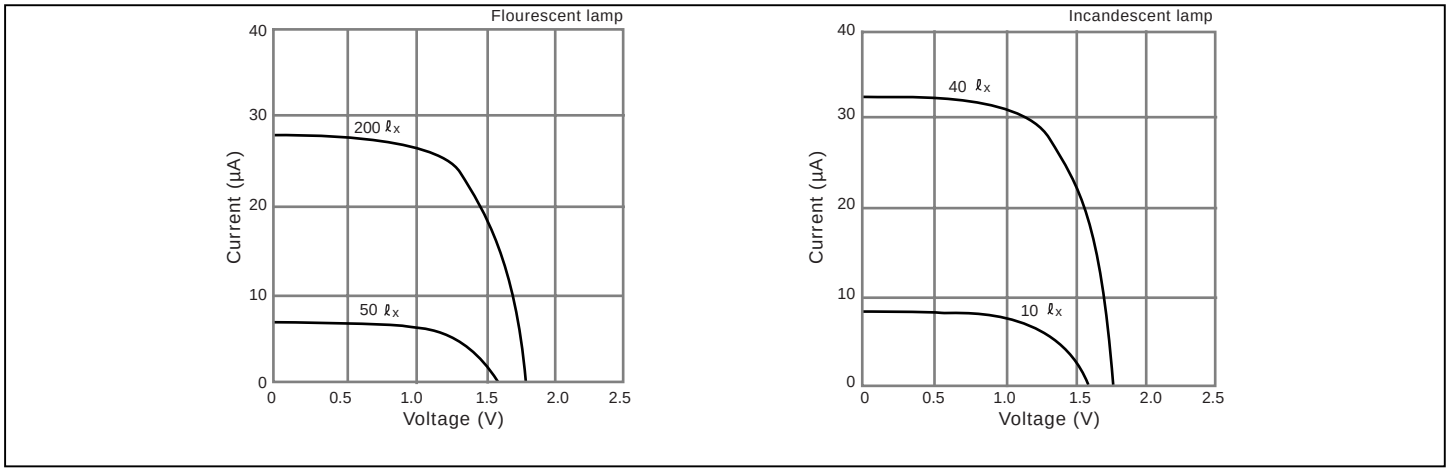
BP-2510C4C



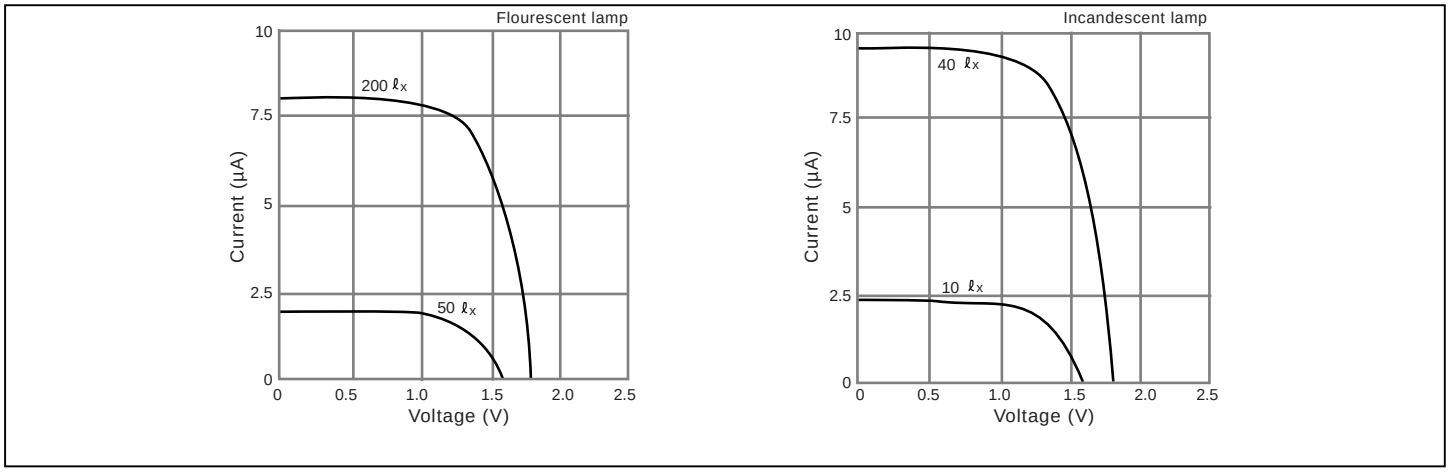
BP-53223CA

2.6. Operating-Current vs. Operating-Voltage

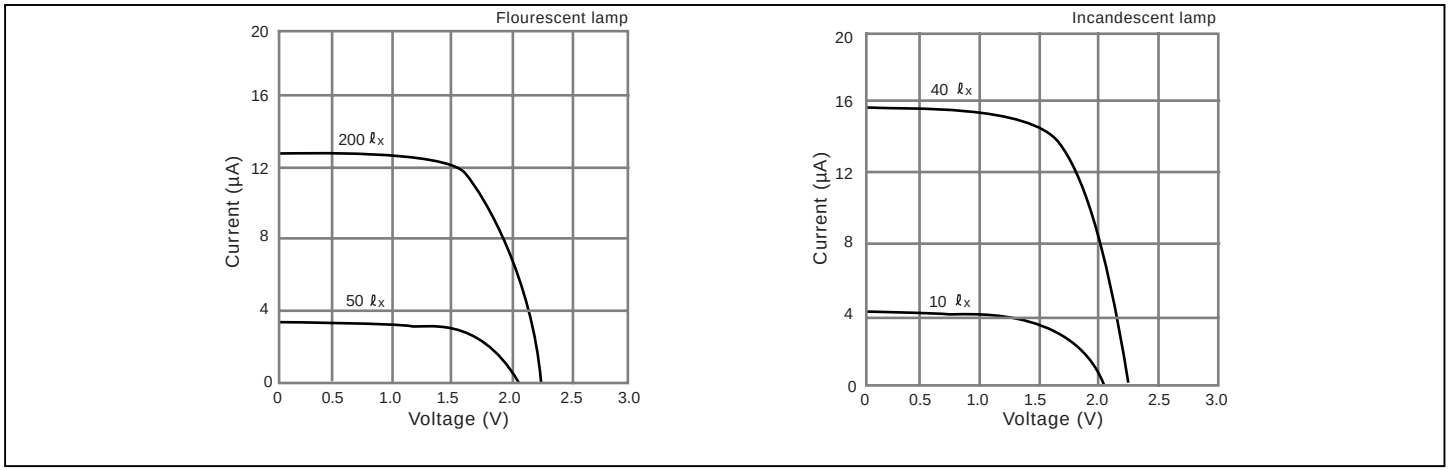
BP-5917C4C



BP-2911C4C



BP-5511C5C



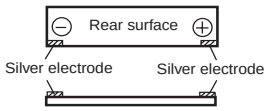
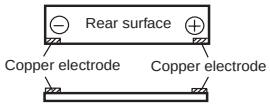
2.7. Precautions for use

[Adhere strictly to the guidelines below since mishandling the cells may impair their performance.]

2.7.1. Handling precautions when installing cells in equipment

The method of installing the Sunceram II cells for indoor use in a product is selected by the construction of the output terminal areas as shown in the table below. Standard models come with silver or copper electrodes. When it comes to the actual method of installation in the product, please contact Panasonic.

Construction of output terminals and precautions for installing cells in equipment

Electrodes	Type of Construction	Installation method	Features and precautions
Silver electrodes		* Zebra connecting method * Heat seal connecting method	* These have a low contact resistance and are thus suited to the zebra or heat seal connecting method. * Their contact resistance is not increased by oxidation, etc. of the electrode surfaces.
Copper electrodes (C type)		* Zebra connecting method * Heat seal connecting method * Soldering method	* The zebra connecting method, heat seal connecting. * Soldering or other such method may be used, making available a wide-ranging power output supply method. * Temperature of soldering Iron: 220 to 280°C; when soldering time is within 3 seconds. * Use a soldering flux which complies with JIS class B or milder or with MIL class RA or milder. * There is no need to provide reinforcement with resin after the leads have been attached by soldering.

* Copper electrode: type is designated by the suffix not added to the model number "C". Standard units come with copper electrodes.
* When the output terminal areas are to be reinforced by resin, use a soft resin. Please contact Panasonic when selecting the resin.

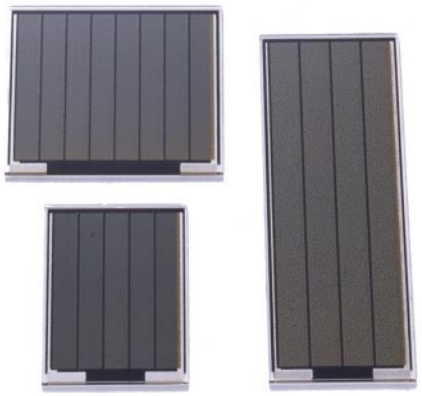
2.7.2 General precautions

(1) The Sunceram II cells for indoor use employ glass for the substrate and could result in injury. Licking the cells or putting them in your mouth is dangerous and should not be done.
(2) Do not drop Sunceram II cells for indoor use from high places nor subject them to a strong impact. They may suffer damage or their performance may be impaired.
(3) Since the electricity is generated by the irradiation of light from the light-sensing side (glass surface), do not make this surface dirty with oil or other substances. If this surface becomes dirty, wipe off the dirt before use.
(4) The rear surface of the Sunceram II cells for indoor use is coated with resin for protection. Bear in mind that wiping this surface with a cloth moistened with paint thinner or some similar substance will wear away the resin and, in severe cases, this may result in impaired performance.
(5) Do not make marks or scratches with a knife or other pointed object since the rear side of the Sunceram II cells for indoor use is soft and the cells themselves are formed with a thin film several dozen micrometers thick. Marks and scratches may damage the exterior and impair the performance.
(6) Do not pull the leads with a force exceeding that required. Damage may occur as a result.
(7) See Notice to Readers (on the back cover).

2.7.3 Storage Precautions

Normal storage does not entail any special requirements. Avoid storage in extremely high (over 70°C) or extremely low (under - 20°C) temperatures for long term. Also avoid storage in places where both the temperature and humidity are high (over 60°C and over 80% RH).

3. SUNCERAM II CELL FOR OUTDOOR USE



3.1. General Information

The Sunceram II cells for outdoor use thin-film compound semiconductors, and they serve as an ideal power supply for the kind of consumer products and equipment which are used under sunlight. The use of a production method involving printing makes it easy to expand the surface area of the cells and also enables the cells to be wired very densely for high-voltage loads. The cells can be combined with different kinds of storage batteries without the need for special charge control circuitry.

3.2. Features

- The specifications of these cells which are capable of utilizing sunlight irradiation make them ideal for outdoor use.
- The cells have a special construction to enable higher currents to be transferred to outside applications than those generated by cells for indoor applications.
- A variety of sizes and outputs can be supported by the production method applying screen-printing.
- It is possible to set an output voltage to suit the application at hand because the solar cells are formed on the glass substrates and also because any number of series connection can be made.

3.3. Applications

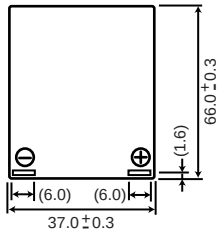
- Back-up power for automotive batteries
- Power supplies for radios and other consumer products
- For teaching aids and toys
- For bicycle headlights
- Power supplies for products installed in vehicles, etc.

3.4. Specification Table for Outdoor Use

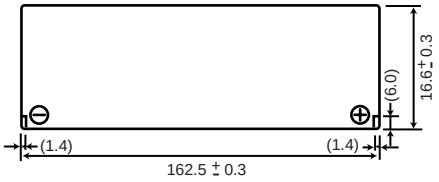
Model No.	Dimensions (mm) t =1.4mm (Max.)	light source AM=1.5 : 100mW/cm			
		Operating voltage Vp (V)	Operating current Ip (mA)	Open-circuit voltage Voc (V)	Short-circuit current Isc (mA)
			Average	Average	Average
BR-243318C	24.0X33.0	1.8	16.4	3.45	17.5
BR-246618C	24.0X66.0		35.0	2.80	39.0
BR-242221C	24.0X22.0	2.1	6.6	4.15	7.0
BP-372234C	37.0X22.0	3.4	8.5	5.50	9.0
BP-373334C	37.0X33.0		14.5	5.50	15.5
BP-376634C	37.0X66.0		31.5	5.50	33.0
BR-378234C	37.0X82.0		40.0	5.50	43.0
BR-160334C	165.0X27.0		650	5.50	71.5
BR-748264C	74.0X82.0	6.4	40.0	11.0	43.0
BR-111108C	110.0X110.0	8.0	76.0	12.0	84.0
BR-160416C	162.5X41.0	16.0	19.1	24.0	20.5
BP-160516C	162.5X48.0		22.1	24.0	23.5
BR-160716C	162.5X73.0		34.0	24.0	36.0

Note 1) Measurement temperature 25°C (77°F)
Note 2) Light source and intensity are specified by Panasonic's standard.
Note 3) Standard units come with copper electrodes.

3.5. Dimensions (Outdoor use) thickness: 1.1(maxl.4) _____ Unit: mm



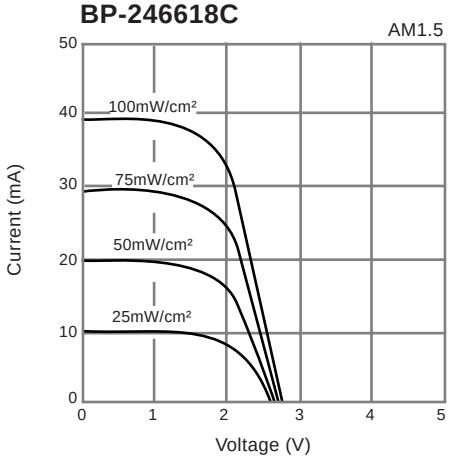
BP-376634C



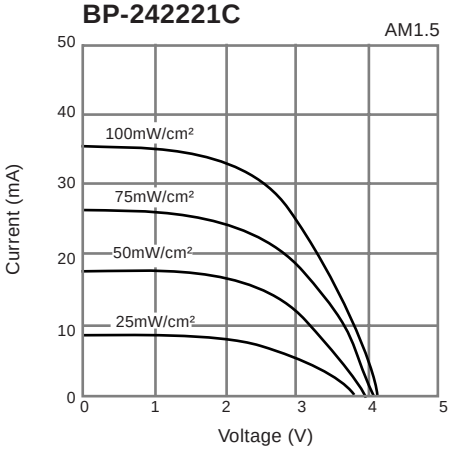
BP-160716C

3.6. Operating-Current vs. Operating-Voltage

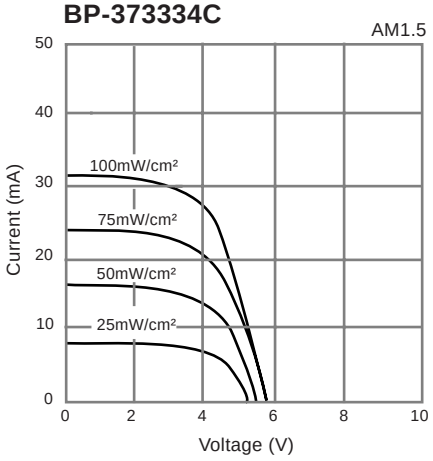
BP-246618C



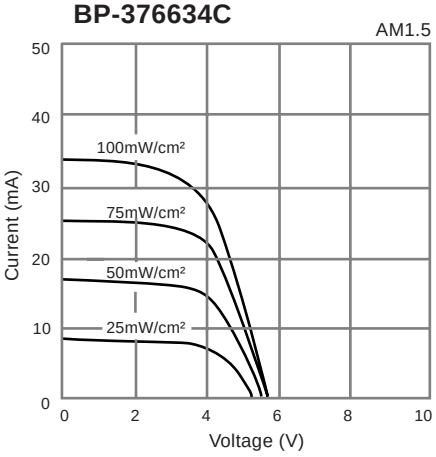
BP-242221C



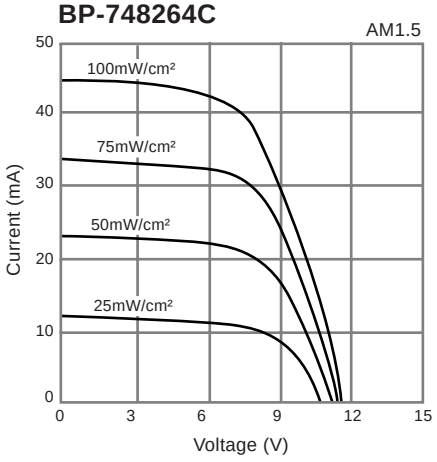
BP-373334C



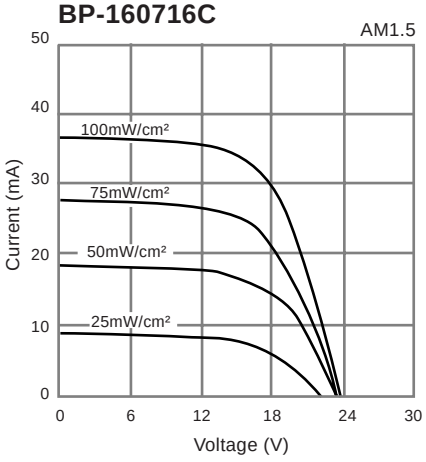
BP-376634C



BP-748264C



BP-160716C



3.7. Precautions for use

[Adhere strictly to the guidelines below since mishandling the cells may impair their performance.]

3.7.1. Handling precautions for installation

It should be borne in mind that the Sunceram II cells for outdoor use applications are energized by sunlight and not by fluorescent or incandescent lights. For applications such as back-up power for car batteries, in vehicle-mounted products such as ventilator fans, radar detectors and deodorizers, and in teaching aids and toys, these cells are designed to be suitable for uses which do not involve direct and/or continuous exposure to rain and wind. This not withstanding, they are used in all-outdoor environments, (eg: garden lights, bicycle headlights, outdoor clocks powered by solar cells, and work indicator lights). If the cells are to be employed in such ways, the following handling precautions must be strictly adhered to.

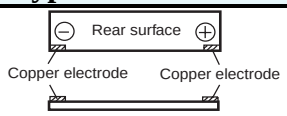
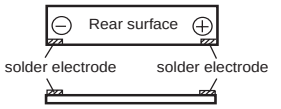
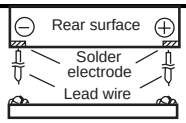
See Notice to Readers (on the back cover).

3.7.2. Handling precautions when installing cells in appliances

1. Connecting the leads

The table below shows the output terminal choices available for the electrodes of the Sunceram II cells for outdoor applications. (The standard units have copper electrodes.)

Construction of output terminals and precautions for installing cells in equipment

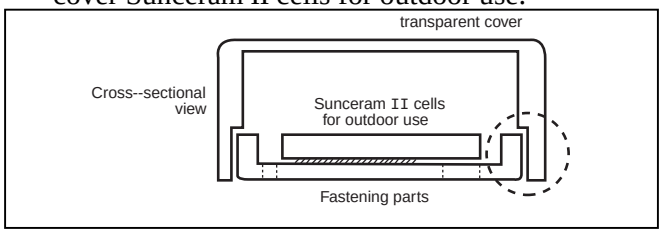
Electrodes	Type of Construction	Features and precautions
Copper electrodes (C type)		* Temperature of the soldering iron tip 220 to 280°C * Completion of soldering within 3 seconds. * Soldering flux: Must comply with JIS class B or milder or with MIL class RA or milder.
Pre-Soldered electrodes (S type)		* Temperature of the soldering iron tip 220 to 260°C * Completion of soldering within 3 seconds. * Soldering flux Must comply with JIS class B or milder or with MIL class RA or milder.
With lead wire (L type)		* Do not pull the leads beyond what is required.

* Copper electrodes type is designated by the suffix not added to the model number "C". Standard units come with copper electrodes.
* When the output terminal areas are to be reinforced by resin use a soft resin. Please contact Panasonic when selecting the resin.

2. Installing Sunceram II cells for outdoor use in appliances

Improper installation of Sunceram II cells for outdoor use in appliance may impair proper functioning of the units.

- Protecting Sunceram II cells for outdoor use with a transparent cover
  Protect Sunceram II cells for outdoor use from the element with a transparent cover. Weatherproof materials such as acrylic resin and polycarbonate are recommended for this purpose. As shown in the figure below, ideally, the shield should completely cover Sunceram II cells for outdoor use.

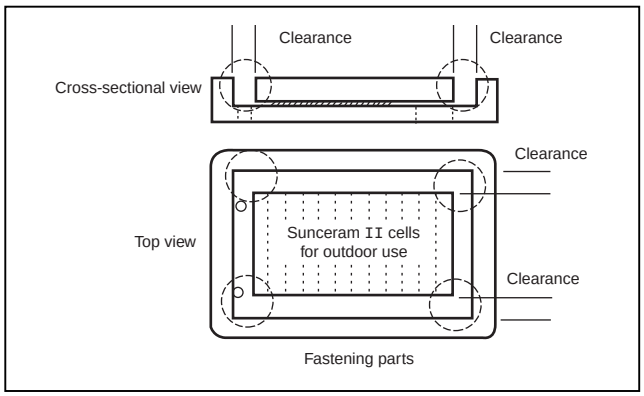


Mounting Sunceram II

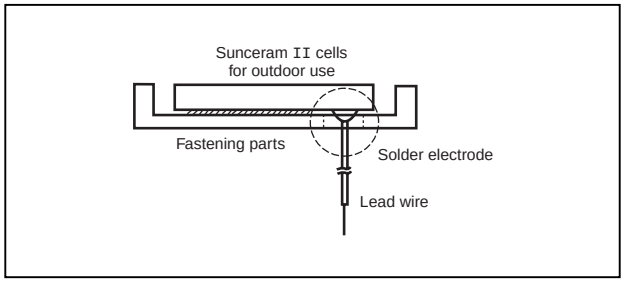
(1) To mount Sunceram II cells for outdoor use to appliances, use a flexible means of a attachment which will not accumulate heat, such as double-sided adhesive tape.

(2) In mounting Sunceram II cells for outdoor use, do not press down on the unit from above. If pressure is absolutely necessary, press on the edge of Sunceram II cells for outdoor use without compressing the entire unit and use a soft material to grasp it.

(3) In mounting Sunceram II cells for outdoor use onto appliances, allow some space between the appliances and Sunceram II cells as shown in the picture below. If no space is left, Sunceram II cells for outdoor use may break through expansion and contraction caused by heat. Use heat and weather-proof materials for installation.

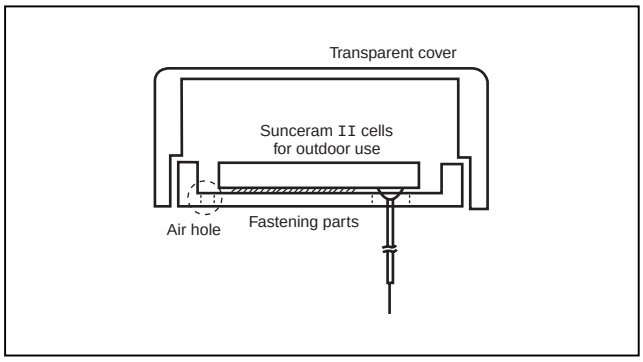


(4) The Sunceram II cells for outdoor use are provided with leads or solder electrodes on the rear, and these protrude. Grooves or holes should be provided in the area of the product where the cells are to be secured. The cells should be fastened in such a way that the leads or solder electrodes will not be brought into close contact with the fastening parts, thereby preventing distortion or deformation.



3 Condensation

Condensation may form when the Sunceram II cells for outdoor use are encased and assembled into a product. Droplets of water from condensation on the cover may corrode the Sunceram II cell electrodes and other parts. These droplets can be eliminated for the most part by making an small hole in the circumference of the cells' fastening parts as shown in the figure below.



4 Covering the cell surfaces

Directly covering the top and/or bottom surfaces of the Sunceram II cells for outdoor use with PVC or some other transparent film will impair the performance of the cells.

3.7.3. General precautions

(1) The Sunceram II cells for indoor use employ glass for the substrate and could result in injury. Licking the cells or putting them in your mouth is dangerous and should not be done.
(2) Do not drop Sunceram II cells for outdoor use from high places or subject them to a strong impact. They may suffer damage or their performance may be impaired.
(3) Since the electricity is generated by the irradiation of light from the light-sensing side (glass surface), do not make this surface dirty with oil or other substances. If this surface becomes dirty, wipe off the dirt before use.
(4) The rear surface of the Sunceram II cells for outdoor use is coated with resin for protection. Bear in mind that wiping this surface with a cloth moistened with paint thinner or some similar substance will wear away the resin and, in severe cases, this may result in impaired performance.
(5) Do not make marks or scratches with a knife or other pointed object since the rear side of the Sunceram II cells for outdoor use is soft and the cells themselves are formed with a thin film several dozen micrometers thick. Marks and scratches may damage the exterior and impair the performance.
(6) Do not pull the leads with a force exceeding that required. Damage may occur as a result.
(7) See Notice to Readers (on the back cover).

3.7.4. Storage precautions

Normal storage does not entail any special requirements. Avoid storage in extremely high (over 70°C) or extremely low (under -20°C) temperatures for long term. Also avoid storage in places where both the temperature and humidity are high (over 60°C and over 80% RH).

4. SUNCERAM II MODULES FOR OUTDOOR USE

4.1. General Information

The Sunceram II modules for outdoor use are the first highly dependable solar cell modules to be developed anywhere in the world, and they are ideal for applications in independent power supply Systems which are used in severe outdoor environments. Featuring weatherproof resin frames, these modules can be used as compact and lightweight power supplies for battery back up and outdoor applications.

4.2. Features

- Long life even under extreme environmental conditions.
- Highly resistant to intense sunlight.
- The resin frame is well suited to the environment.
- The shape of the frame enables easy installation

4.3. Applications

- Roadway markation lights.
- Outdoor clocks.
- Garage and storeroom ventilation and lighting systems.
- Battery Chargers
- Other outside power applications.

4.4. Specifications

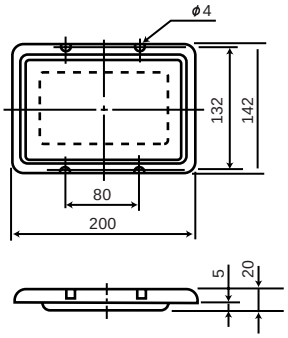
Light source: AM=1.5, 100mW/cm^2

Model No.	Dimensions (mm)	Vp (V)	1p (mA) Average	Voc (V) Average	1sc (mA) Average	Weight (g)
BP-181234M	142X200	3.4	230	5.5	255	350
BP-181248M		4.8	165	7.5	185	
BP-181208M		8.0	100	13.0	110	
BP-181216M		16.0	50	26.0	55	
BP-181834M	200X200	3.4	345	5.5	383	500
BP-181808M		8.0	150	13.0	165	
BP-181816M		16.0	75	26.0	83	

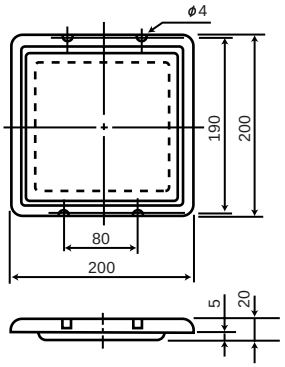
Note 1) Measurement temperature 25°C (77°F)
Note 2) Light source and intensity are specified by Panasonic's standard.

4.5. Dimensions (mm)

BP-1812M Series

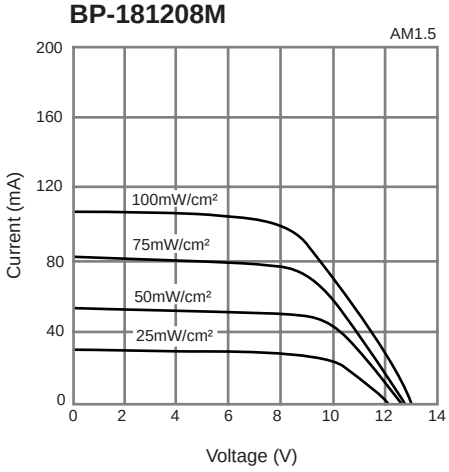


BP-1818M Series

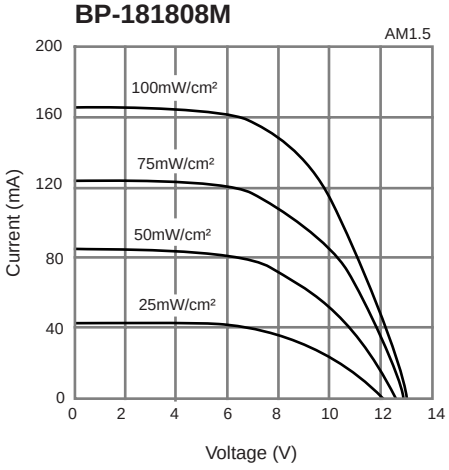


4.6. Voltage-Current Characteristics (25°C)

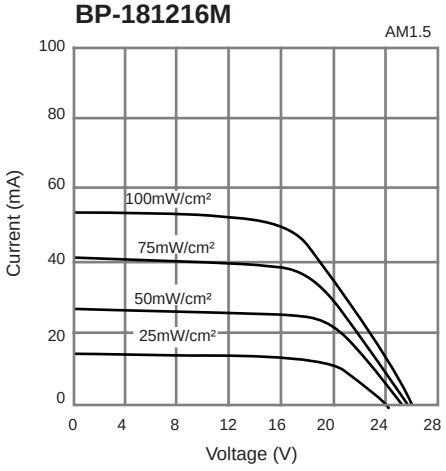
BP-181208M



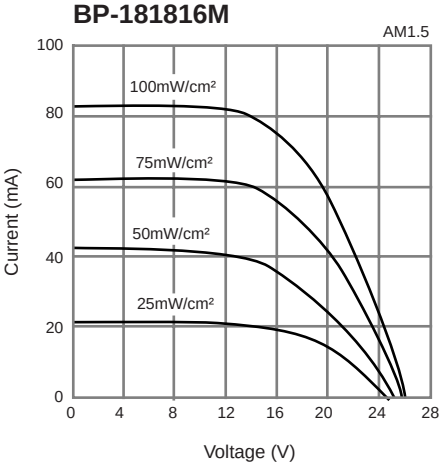
BP-181808M



BP-181216M



BP-181816M

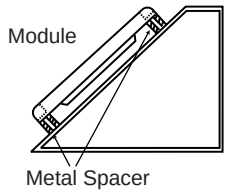
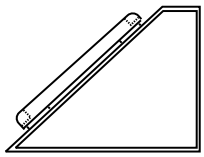
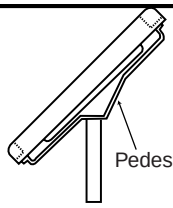


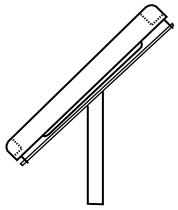
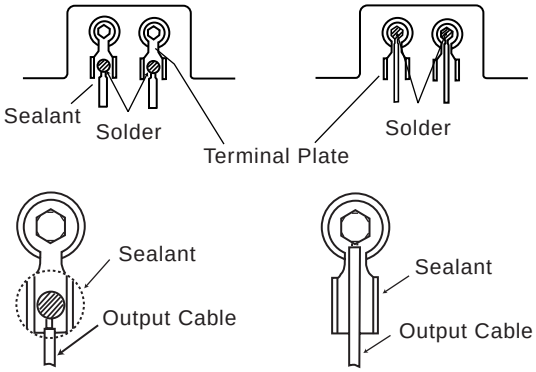
4.7. Precautions for Use

(Damage caused during handling may compromise the module's efficiency. Please be sure to follow the guidelines given below.)

4.7.1. Installation Precautions

Install the solar cell module and output cable as shown below. Contact us for specific installation methods.

<table>
<tr><th></th><th>Good Example</th><th>Bad Example</th><th>Comments</th></tr>
<tr><td rowspan="2">Module Installation</td><td> 
</td><td>  </td><td rowspan="2">* When directly installing a module in its installation location, ensure that it is not subjected to stress. Use spacers made of a hard material with a height of at least 5 mm or make the center part of the supporting stand where the module is to be installed indented so as to prevent the supporting stand from making contact with the bulge on the module's back surface.</td></tr>
<tr><td> 

The rear cover does not make contact with the supporting stand.</td><td>  </td></tr>
<tr><td>Output Cable Installation</td><td> 
</td><td></td><td>* Apply solder to the terminal.
* Do not use a crimping tool.
* Seal the soldered parts with silicone</td></tr>
</table>

4.7.2. General Precautions

(1) Avoid using paint thinner or other organic solvents to clean the Sunceram II modules for outdoor use. Under normal operating conditions, grainy debris (i.e. dirt dust) will not significantly degrade performance. However, efficiency could be reduced if the module surface becomes extremely dirty. If module becomes soiled, wipe it using a cloth moistened with water.

(2) For safety, the glass covering the module's collecting panel has a glass shattering prevention sheet attached. Do not cut or scratch the module face with sharp objects.

(3) Be careful not to drop the Sunceram II modules for outdoor use or subject them to hard shock. The modules may break if struck by stones or other hard objects.

(4) Contact Panasonic if the module is to be used near the ocean or for marine applications, as special precautions may be required.

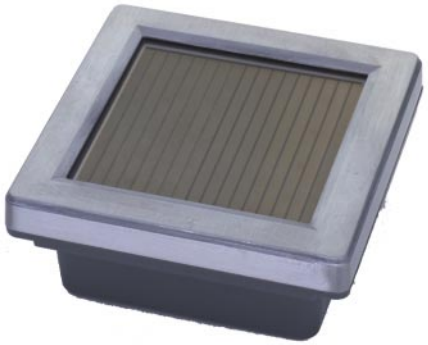
4.7.3. Storage Precautions

Under normal storage conditions there are no particular problems.

Avoid storage in extremely high (over 80°C) or extremely low (under -40°C) temperatures for long term.

5. THIN FILM SOLAR CELL SUNCERAM II OUTDOOR SOLAR POWER SUPPLY

New! Solar Cell Power Supply Unit With Microcontroller



5.1 General Information

The Sunceram II Solar Power Supply Unit is a solar cell power supply unit for LED nighttime lighting, integrating the Sunceram II Solar Cell Module, a microcontroller circuit, and a miniature Ni-Cd battery in its sturdy aluminum die-cast frame.

Its step-up voltage function makes it compatible with LEDs of all colors, and when connected with full-color LEDs, it can control the illumination of up to nine different colors. The unit can be installed in combinations to provide a broad variety of lighting methods and flash intervals such as simple flashing, chasing, etc. These can be set using external switches.

The control circuitry and the Ni-Cd batteries are water resistant, and the external terminal parts can also be treated to make them resistant to water, producing a high-reliability power supply unit.

5.2 Features

- The aluminum die-cast frame provides long-term reliability for the solar cell module.
- The power supply unit, which is sealed in resin, can provide high levels of reliability in outdoor use environments.
- The step-up voltage circuit enables illumination control of LEDs of all colors.
- The illumination methods and the flash frequency can be combined at will.
- The sunlight identification function enables the unit to turn on automatically at night.

5.3 Applications

Landscape ornamentation, outdoor signs, traffic signs, outdoor displays, etc.

- **Standard Specifications**

Solar cell output: 3.4 V 80 mA (AM 1.5, 100 mW/cm^2)
Ni-Cd battery rating: 2.4 V 500 mAh (5 hour ratio)
No. of outputs (maximum number of LED line connectors)
For monochrome LED use: 6 lines (2 lines per terminal)
For full-color LED use: 3 lines (2 lines per terminal)
Illumination Method:
For monochrome LED use: Continuous illumination, flashing, chasing, alternating, fluorescent flashing
For full-color LED use: Continuous, flashing, multi-color chasing
Flash Interval: 0.1 sec., 0.5 sec., 1.0 sec., 2.0 sec. (the fluorescent light flash interval is fixed at 3.0 sec.)
Duty cycle:
Flashing, chasing, alternating, and multi-color chasing: Approx. 5%
Fluorescent flashing: Approx. 15%
LED Operating Current:
Flashing, chasing, alternating: max 40 mA/ch
Multicolor chasing: max 40 mA/ch
Fluorescent flashing: max 20 mA/ch
Continuous illumination: max 3 mA/ch
Control Method: External switch
Sunlight Identification Level: 20 to 200 Lx

- **Guidelines for the Useable Consumption Current**

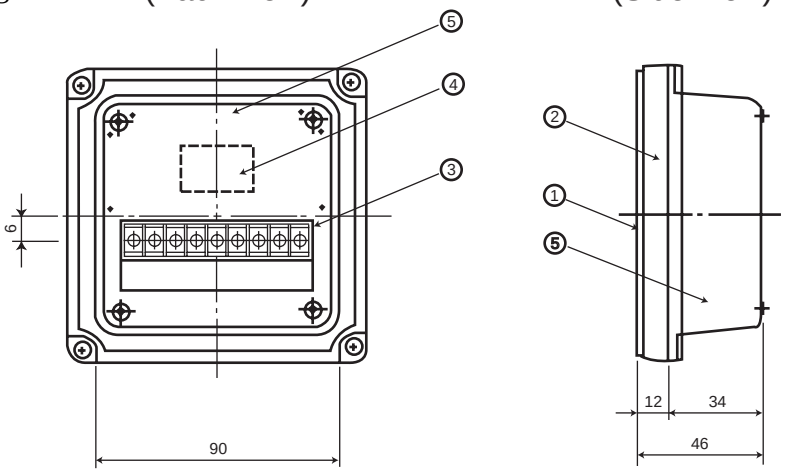
Region and Time of Use	Daily Sunlight (average installation)	Useable Consumption Current
Winter in the cold regions of Japan	1.2 kWh/m^2	80 mAh/day
Winter in the Pacific Ocean side of Japan	2.0 kWh/m^2	130 mAh/day
Japanese average throughout the year	3.5 kWh/m^2	240 mAh/day
Japan in the summer.	4.5 kWh/m^2	310 mAh/day

* This assumes 85% charge and discharge efficiency.

(Notes and Cautions Regarding Use)
(1) When the photoreceptor side of the solar cell is installed at an angle of 45◦ facing south, the useable electricity in the average installation in the winter time will increase by a factor of approximately 1.5 relative to a horizontal installation; however, the power in the summer time will fall approximately 15%.
(2) Be aware that the amount of electricity produced may suffer due to the proximity of trees and buildings.
(3) Be aware that the night light may not turn on if the unit is exposed to strong external lights such as street lights.
(4) If the units are stored for an extended period of time, use the unit only after fully charging in direct sunlight.
(5) See the user specifications for other details and cautions.

- **External Dimensions**

①	**SOLAR CELL PHOTORECEPTOR SURFACE**
②	Aluminum die-cast frame
③	7-pin terminal block (M3)
④	Name plate
⑤	Box with Ni-cd and circuit



6. SUNCERAM II POWER UNITS FOR OUTDOOR USE

6.1 General Information

The Sunceram II power units for outdoor use are made up of two main components; a Sunceram II modules for outdoor use and nickel cadmium batteries. Electricity collected by the solar cells is stored in the nickel cadmium batteries and power is supplied directly from the batteries enabling use at night or daytime. Continuous power supply "U-type", night time power supply "N-type" and night time flashing "F-type" are all available. The Sunceram II power units for outdoor use can also be custom made according to the required specifications.

6.2 Features

- Built-in Ni-Cd batteries and control circuit.
- Solar cell distinguishes between night and day (N-type, F-type).
- Short-circuit protective device built-in.
- This unit can provide power output for automatic flashing of LED, etc, during nighttime (F-type)

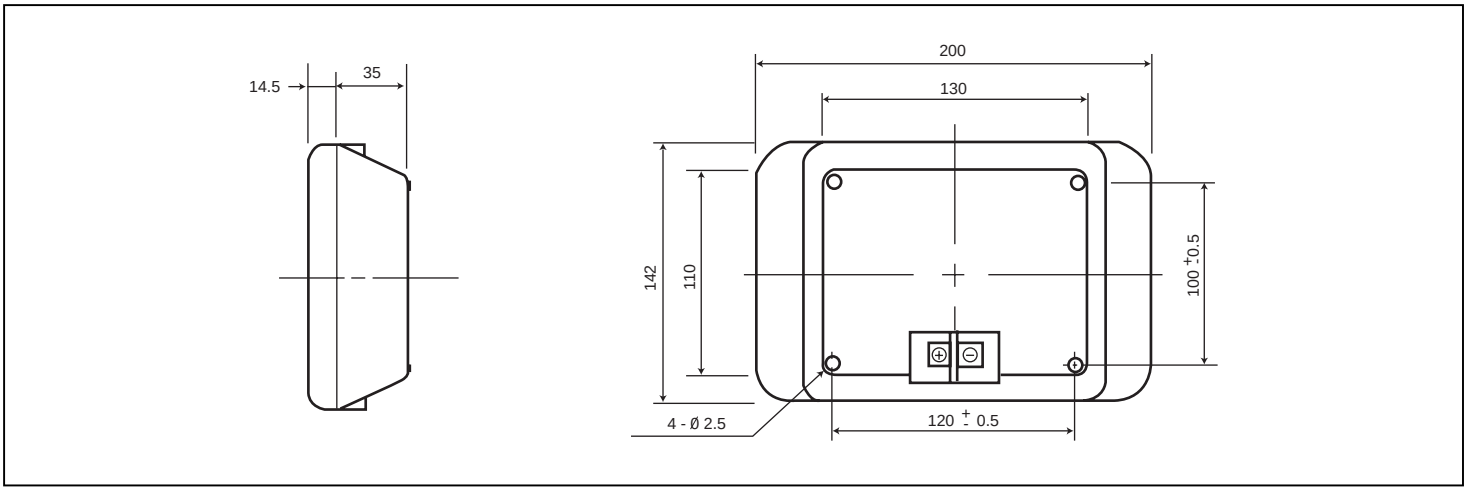
6.3 Applications

BP-1812P5U U Type (usually)	BP-1812P5N N Type (night)	BP-1812P5F F Type (flashing)
Outdoor clock	Storage lighting	Road sign
Transceiver	Garage lighting	Delineator
Pump	Sensor lighting	Pole sign
Portable power unit	Alarm	Alarm sign

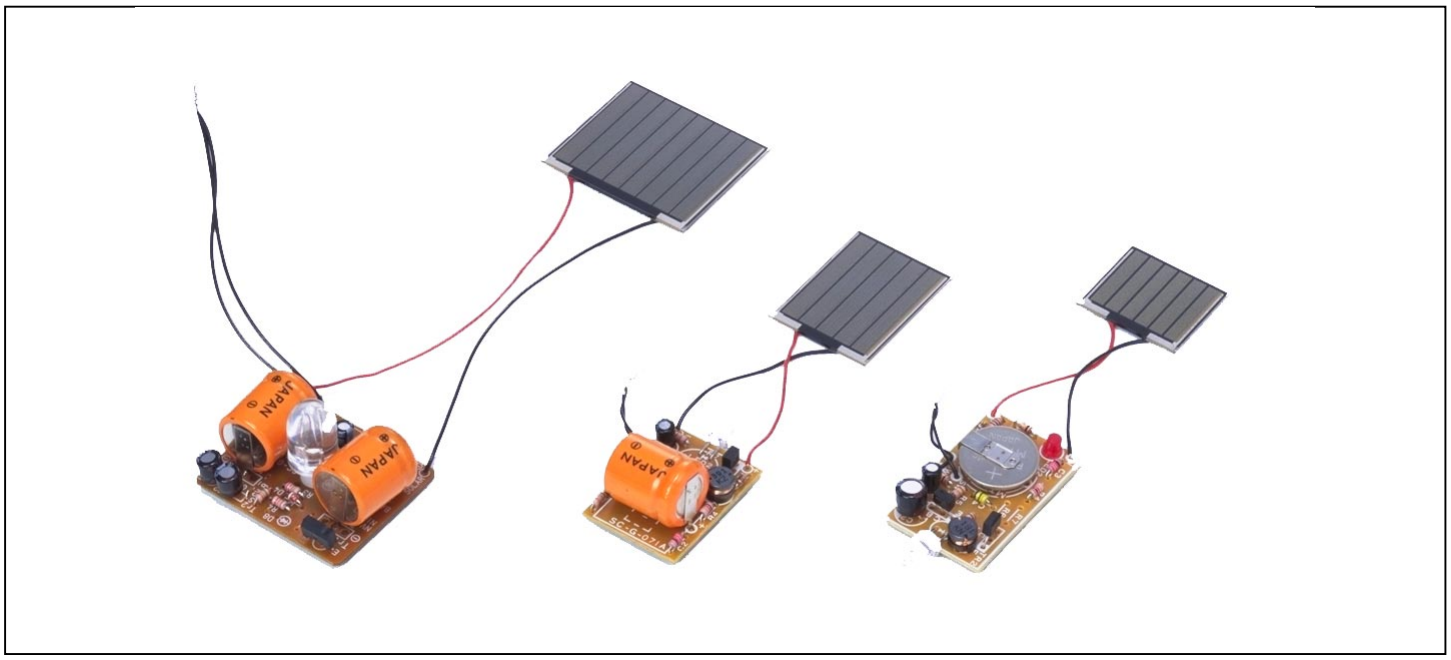
6.4 Specifications

(All types)	Rated voltage	6V
	Ni-Cd battery storage capacity	1200mAh (1/5C)
	Operating voltage, and current of solar cell (BP-181208M)	8V, Average l00mA (Light intensity: AM 1.5,l00mW/cm^2)
	Load current	1.5A Max
	Weight	800g
(N-type and F-type)	Illumination of switching	20-200 lux
(F-type, standard setting)	Flashing cycle	1 second
	Duty ratio	5%

6.5 Dimensions (mm)



7. MICRO-POWER SIGN UNIT



7.1 General Information

This is a sign unit featuring high visibility, using a compact, highly reliable micro-power supply, which combines the outdoor type Sunceram II cell with lithium rechargeable batteries or nickel-cadmium batteries, the unit incorporates a high-luminance LED and an on-off flashing circuit. The unit automatically discriminates day from night, automatically lighting the LED at night. The solar cell charges the rechargeable batteries in daylight even in cloudy or rainy weather, lighting the unit automatically every night. Specifications such as continuous lighting or flashing, type of LED, and flashing cycles are designed to meet users' needs.

7.2 Features

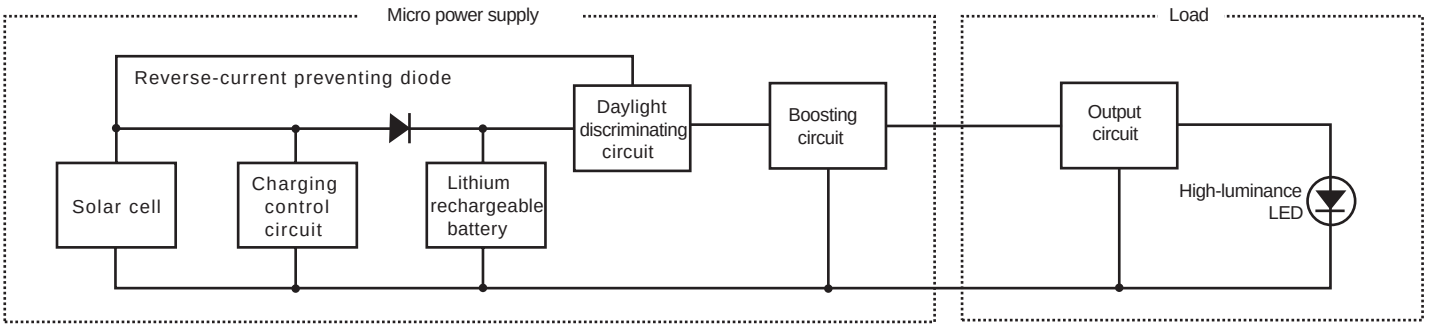
Compact structure comprising a control circuit and rechargeable batteries; Easy-use design with solar cell and day-night discriminating function, long-life, high-reliability design combining solar-ray resistant solar cell with lithium rechargeable batteries or nickel-cadmium batteries with excellent temperature characteristics and charging/discharging characteristics.

7.3 Applications

- *Facilities*
  Marker poles in parking lots
  Warning lights on construction sites
  Road marker lights
  Keyhole markers
  Doorbell markers
  Outdoor decorative illuminations
  Other marker lights
- *Vehicles*
  Clearance lamps of automobiles
  Identification lamps of bicycles
- *Sports*
  Identification lamps for nighttime jogging; Marker lights for camping and nighttime flashing

7.4 BP-6B172UA (Lithium rechargeable battery type)

- **Circuit structure**



- **Main Specifications**

Unit model number	Rechargeable battery model number	Rechargeable battery nominal voltage	Rechargeable battery capacity	Solar cell model number	* Solar cell output	Lighting mode	Duty ratio	Peak current
BP-6B172UA	MT-1620/H9A	1.5V	11mAh	BP-242221L	2.1V, 6.6mA	Fashing	2.5% (approx.)	20mA (approx.)

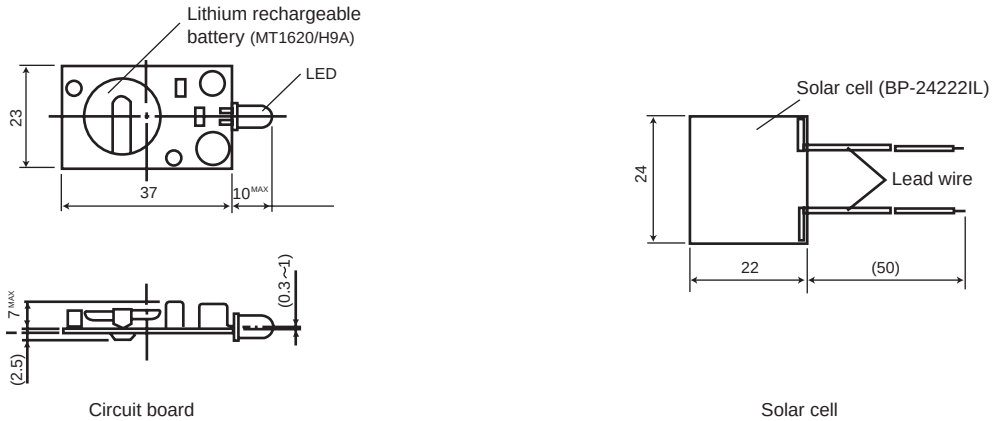
* Solar light = AM 1.5, 100mW/cm^2

- **Specifications**

Charging time	approx. 1.5 hours (clear outdoor;70mW / cm^2 or more)
	approx. 10 hours (cloudy outdoor; 10mW / cm^2 or more)
Illuminance to trigger lighting	30 to 300 ℓ x, outdoor light (standard design)
Lighting duration	approx. 14 hours (standard design)
Flashing cycle	approx. 1.0 second (standard design: battery voltage 1 .3V)
LED	High-luminance 5ϕ, red (standard design)
Service temperature range	-10°C to 50°C
Weight	approx.5g (circuit board)

- **Dimensions (unit : mm)**

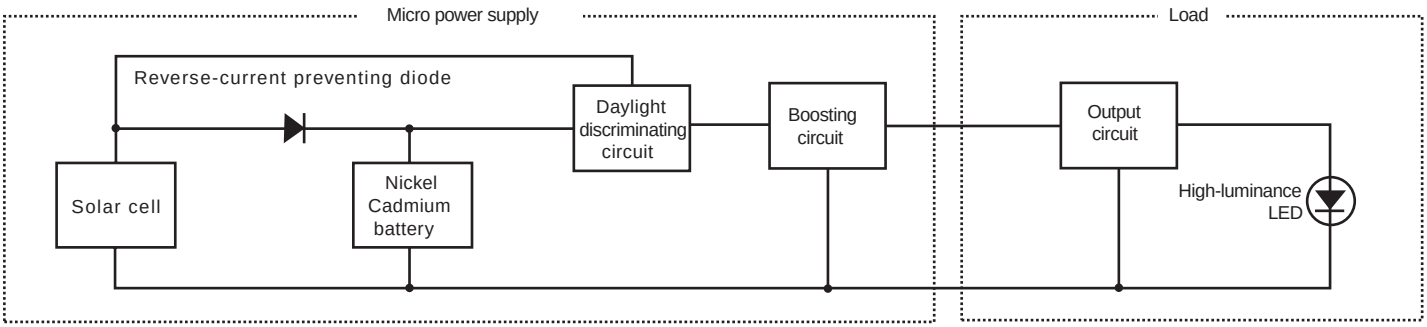
〈**BP-6B172UA**〉



(Note) For detailed dimensions of the solar cell, refer to the Sunceram II Cell for Outdoor Use section.

7.5. BP-6B142UA (Nickel-Cadmium battery type)

- **Circuit structure**



- **Main Specifications**

Unit model number	Rechargeable battery model number	Rechargeable battery nominal voltage	Rechargeable battery capacity	Solar cell model number	* Solar cell output	Lighting mode	Duty ratio	Peak current
BP-6B142UA	P-01H/1P29	1.2V	110mAh	BP-243318L	1.8V, 16.4mA	Fashing	5% (approx.)	20mA (approx.)

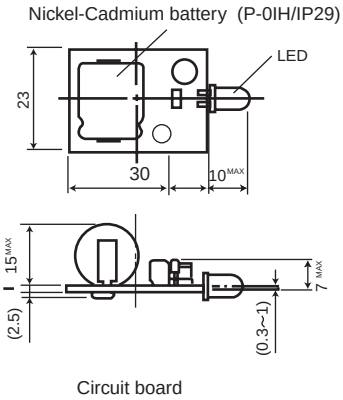
* Solar light = AM 1.5, 100mW/cm^2

- **Specifications**

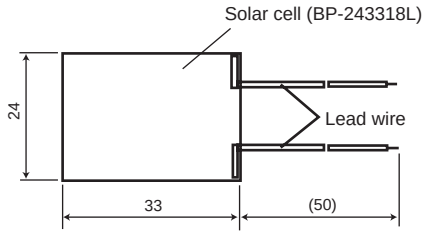
Charging time	approx. 1 hour (clear outdoor;70mW / cm^2 or more)
	approx. 10 hours (cloudy outdoor; 10mW / cm^2 or more)
Illuminance to trigger lighting	30 to 300 ℓ x, outdoor light (standard design)
Lighting duration	approx. 14 hours (standard design)
Flashing cycle	approx. 1.0 second (standard design: battery voltage 1 .25V)
LED	High-luminance 5ϕ, red (standard design)
Service temperature range	-10°C to 50°C
Weight	approx.5g (circuit board)

- **Dimensions (unit : mm)**

〈**BP-6B142UA**〉



Circuit board

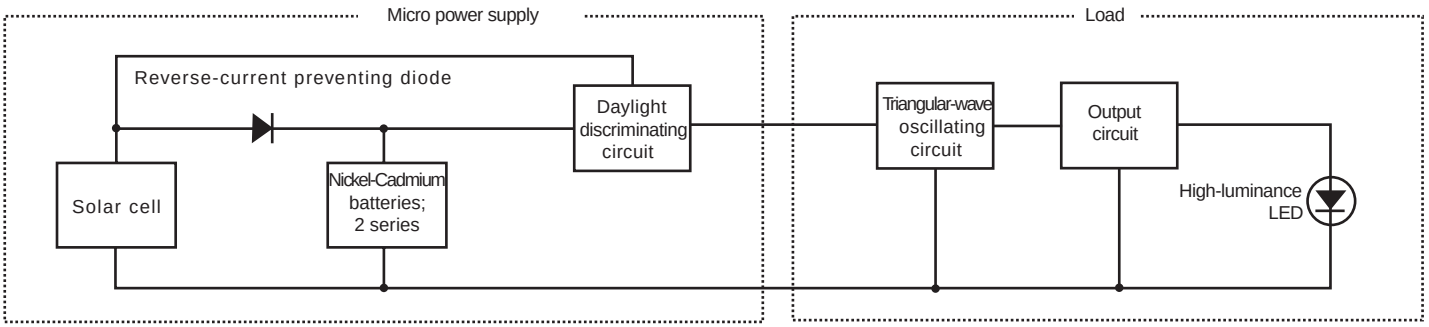


Solar cell

(Note) For detailed dimensions of the solar cell, refer to the Sunceram II Cell for Outdoor Use section.

7.6. BP-6B242UH (Nickel-Cadmium battery type, Fluorescent flashing mode)

- **Circuit structure**



- **Main Specifications**

Unit model number	Rechargeable battery model number	Rechargeable battery nominal voltage	Rechargeable battery capacity	Solar cell model number	* Solar cell output	Lighting mode	Duty ratio	Peak current
BP-6B242UH	P-01H/1P29	2.4V(*2)	110mAh	BP-373334L	3.4V, 14.5mA	Firefly flashing	Equivalent to 5%	15mA (approx.)

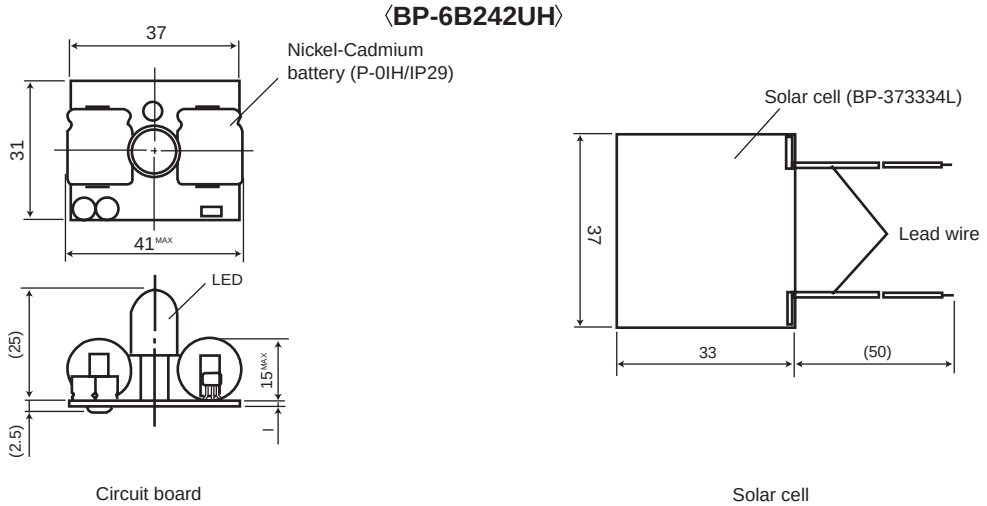
*1 Solar light = AM 1.5, 100mW/cm^2
*2 Two series of nickel-cadmium battery

- **Specifications**

Charging time	approx. 1 hour (clear outdoor;70mW / cm^2 or more)
	approx. 10 hours (cloudy outdoor; 10mW / cm^2 or more)
Illuminance to trigger lighting	30 to 300 ℓ x, outdoor light (standard design)
Lighting duration	approx. 14 hours (standard design)
Flashing cycle	approx. 3.5 second (standard design: battery voltage 1 .25V)
LED	High-luminance 10ϕ, green (standard design)
Service temperature range	-10°C to 50°C
Weight	approx.19g (circuit board)

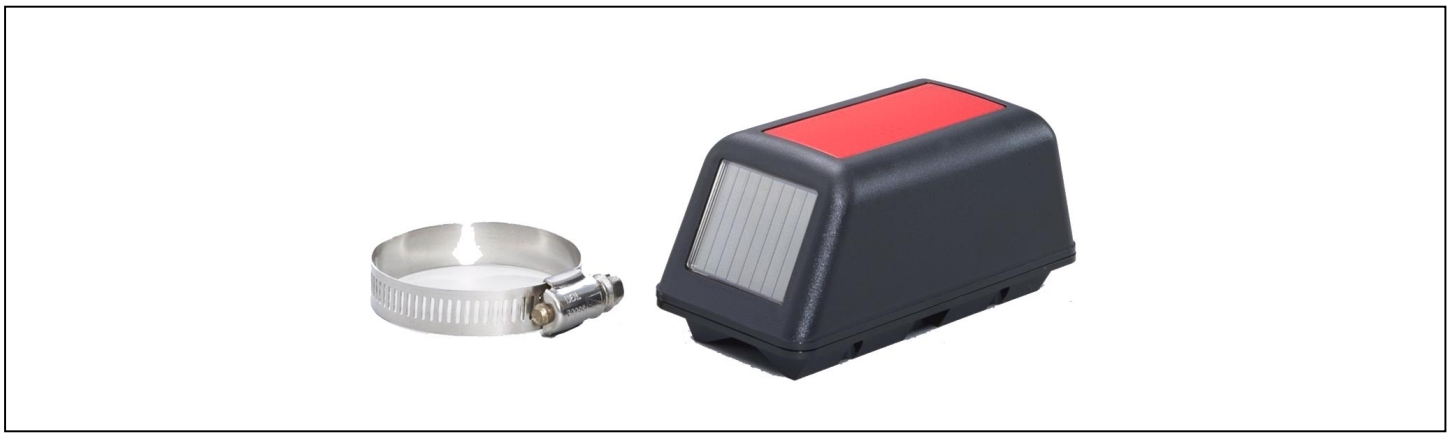
- **Dimensions (unit : mm)**

〈**BP-6B242UH**〉



(Note) For detailed dimensions of the solar cell, refer to the Sunceram II Cell for Outdoor Use section.

8. SOLAR CELL-POWERED WARNING LIGHTS



8.1 General information

This compact, and lightweight warning light consists of an outdoor Sunceram II cell featuring minimal optical deterioration, Ni-Cd cell, LED and flashing control circuit in a single integrated package. The solar cell recharges the Ni-Cd cell, and it also serves to discriminate between daytime or nighttime in order to make the high-brightness LED flash automatically at night. Install and use the warning light in a location which is exposed to sunlight.

The unit can easily be secured to a pole using the stainless steel clamp provided. When it is to be secured, coating the threaded part of the clamp and screw heads with epoxy adhesive ensures that the unit will not be easily dislodged. The light can be designed to flash at the desired interval. Panasonic is also open to consultation about special specifications concerning the unit casing, the color of the LED, the method used to secure the units, etc.

8.2 Features

- High-brightness LED which automatically flashes at night
- Compact size and light weight
- Built-in Ni-Cd batteries and control circuit
- Daytime / nighttime discrimination function using solar cell

8.3 Applications (installation locations)

- Roads: Signs used on the premises of various establishments, construction work signs, pedestrian crossings, entrances to parking lots, "watch your head" signs, "danger"/"caution" signs, corners of residences, "no admittance"/"keep out" signs, bus stops and other stopping places, signposts, telephones, automatic vending machines
- Vehicles: Electrically powered vehicles, yachts, boats

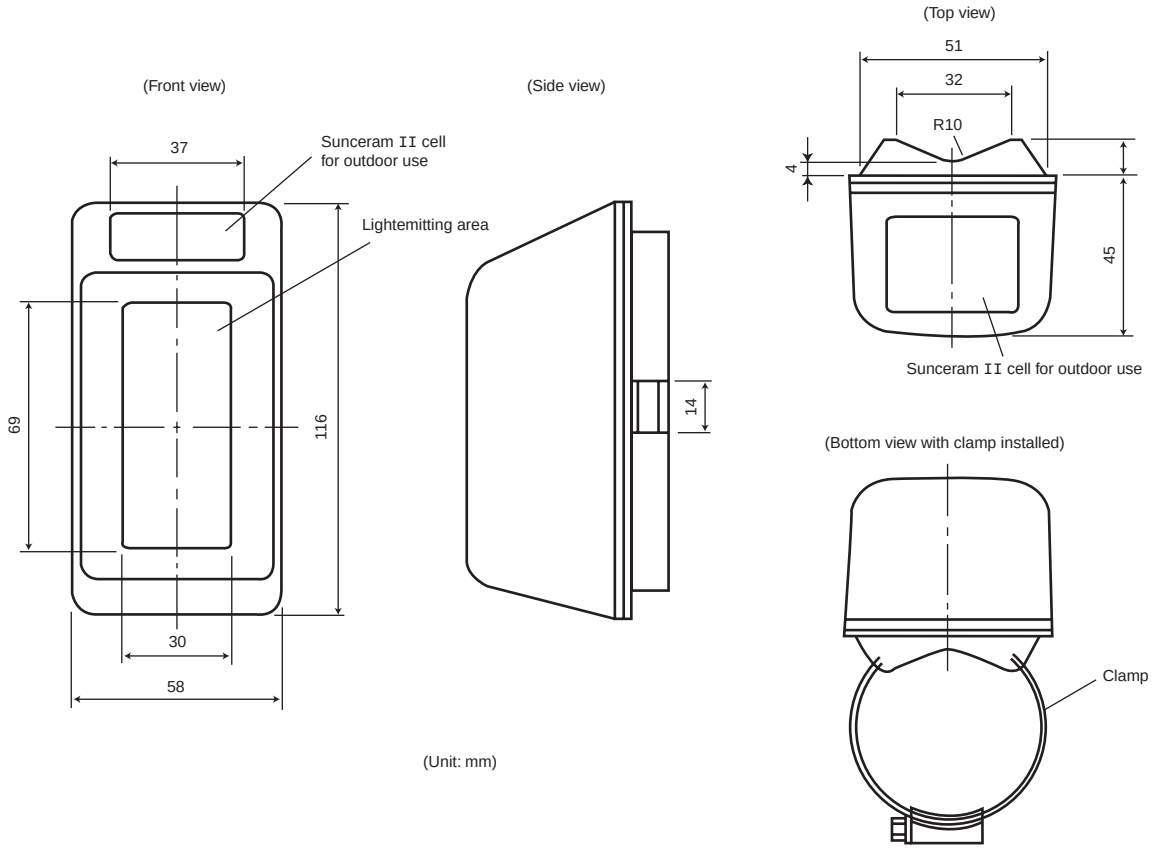
8.4 Standard specifications

Solar cell output	3.4V, 14.5 mA	(average) (incident light AM 1.5,100 mW/cm^2)
Ni-Cd batteries ratings	2.4v, ll0mAh	(5-hour rate)
LED axial light intensity	7,000 mcd	(average) (red, 20 mA)
	6,000 mcd	(average) (yellow, 20 mA)
Flashing cycle	1 sec.	(2.5v battery voltage)
Duty ratio	1.6%	(2.5v battery voltage)
Peak current	37 mA	(2.5v battery voltage)
Operation start illuminance	30 to 300 lux, outdoor light	
Operating temperature range	-l0°C to +50°C	
Unit dimensions	58(W)x116(H)x(55(D) mm	
Weight	l30g (unit), approx. 30g (mounting clamp)	
Compatible pole diameter	34 to 57 mm	(using standard clamp)
	59 to 82 mm	(using large-diameter clamp)
Color of unit casing	Black	(standard; also available in white depending on quantity ordered)

8.5. Installation/operating precautions

- Before securing the warning light, set the switch at the back of the unit to ON, and adhere the accessory seal to the groove provided for the switch.
- Bear in mind that the amount of power generated will be significantly reduced if a tree or structure is situated to the south and in proximity to where the unit is installed.
- If the warning light has been in storage for a prolonged period of time, recharge it adequately by exposing it to direct sunlight before use.
- **Do not use the warning light for applications. where an accident, etc. may be caused by the unit's failure to light.**

8.6. Dimensions (mm)



9. SILICON SOLAR MODULES

High conversion efficiency and long-term reliability

9.1. General Information

Crystal system silicon solar modules are attracting attention through the world today primarily as high-efficiency solar cells. This is because high-efficiency solar modules are capable of converting the radiant energy of sunlight directly into electrical energy which is easy to use. Panasonic began marketing crystal silicon solar modules and solar power supply systems in 1963. We have continued to develop them for use in every field, from the home to industry, improving their performance and reliability while reducing their cost. We have developed a variety of outdoor power supply devices for observation, water discharge warning stations and radio relay stations for dam control. We have also developed solar clocks which have been installed in more than 4,300 locations worldwide. Our latest research and streamlined design systems are highly regarded in many fields all over the world. This is because our work is based on field data from over 10 years in a wide variety of solar battery utilization fields.

9.2. Features

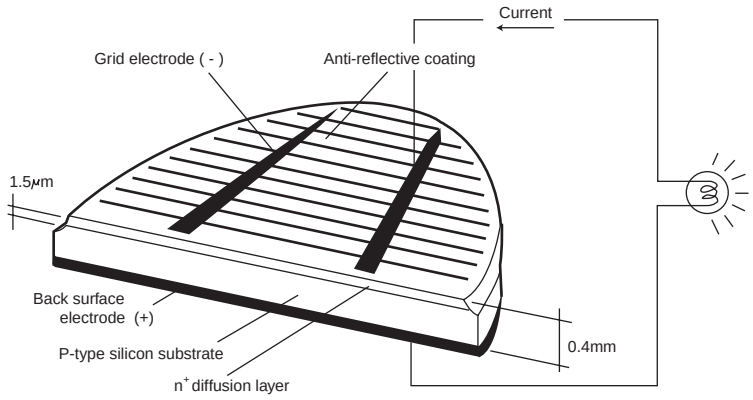
- High in performance with a module using silicon cells.
- Superb reliability and long-lasting durability to meet the operating conditions in various natural environments.

9.3. Applications

- Independent power supply systems for radio relay stations, measuring systems, etc.
- Large-scale solar power generation systems linked with commercial power.

9.4. Structure and Electricity Generation Principle of Silicon Solar Cells

Solar cells use the photovoltaic effect of semiconductors to convert light energy from the sun directly into electrical energy. They do not store electricity. Most silicon solar cells have a structure similar to that shown in the diagram below. They consist of a sheet of silicon called a P-type (approximately 0.4mm thick) with a second, thinner (1-2 μm) layer called a N-type on top of it.



The place where the P-type and N-type meet is called a P-N junction. It constitutes the heart of the solar cell and plays the most important role in the conversion of light to electricity. The solar cell consists of the P-N junction with electrodes on either side of it forming a grid, as well as electrodes on the back surface. To briefly explain the principle whereby electricity is generated, light from the sun shines on the silicon and its energy is absorbed by the crystal.

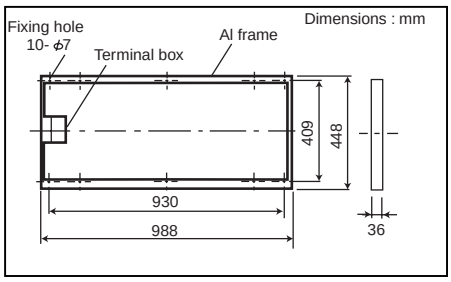
Electrons involved in forming the bonds between atoms fly out from the crystalline framework as free electrons bearing a negative charge. After the electrons have been given off, a positive electron hole is formed. An electrical field builds up inside the silicon present at the P-N junction and the electrons are scattered to the N-type silicon. A voltage is produced at both electrodes and, if a load is connected to them, electrical power is supplied to it.

9.5. Specifications

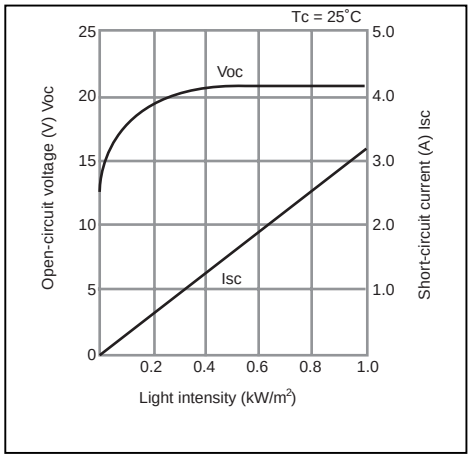
Model No.	Structure						Weight (kg)	Absolute- maximum ratings		Electro-optical characteristics						
	Cell size	Number of cells	Voltage	Dimensions (mm)				Operating temperature Topr	Storage temperature Tstg	Open--Circuit Voltage Voc (V)	Optimum Operating voltage Vpm (V)	Short--circuit current Isc (A)	Optimum-operating current 1pm (A)	Maximum power (W) P max		Conversion efficiency (%)
				W	L	H								min.	typ	
BP-K36KS	100mm	36	DC12V	448	988	36	5.9	-40 ~ +90 °C	-40 ~ +90 °C	21.5	16.9	3.35	3.20	51.4	54.1	15.0
BP-HK36K	100mm/2			445	535	36	3.2			20.7	16.7	1.55	1.44	21.6	24.0	13.0
BP-QK36H	100mm/4			350	340	30	2.0			21.0	16.8	0.78	0.68	11.7	13.0	16.0
BP-EK36	100mm/8			222	278	30	1.2			21.0	16.8	0.39	0.33	5.1	5.6	12.4
BP-STK36	100mm/16			187	201	30	0.7			20.8	16.6	0.19	0.17	2.5	2.8	12.4

Condition : Sunlight intensity at 1.0kW/m^2 Cell temperature at 25°C AM=1.5

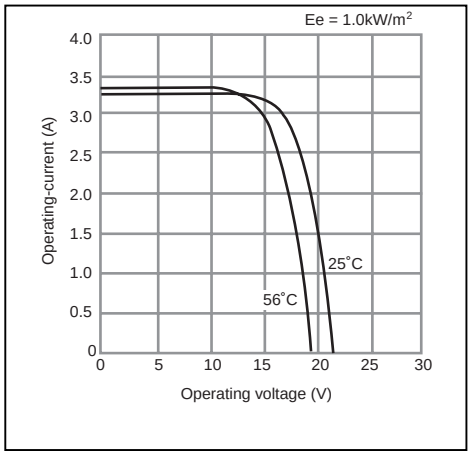
BP-K36KS



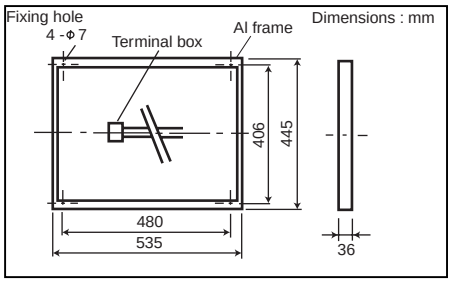
Open-circuit voltage, short-circuit current vs. light intensity



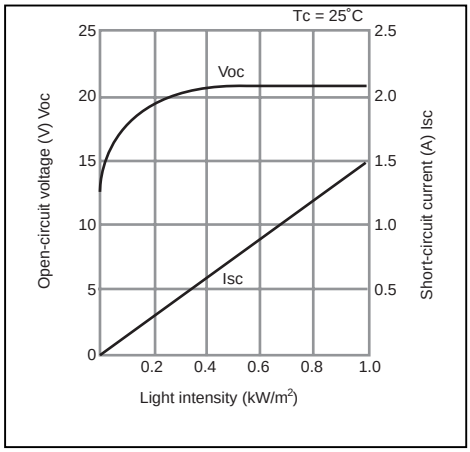
Operating-current vs. operating voltage



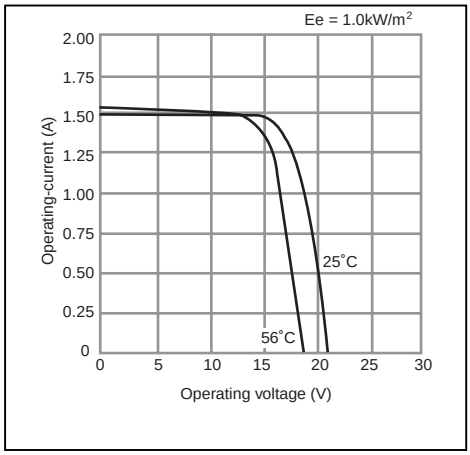
BP-HK36K



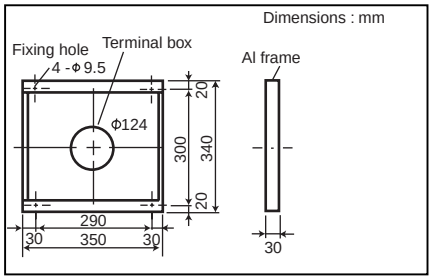
Open-circuit voltage, short-circuit current vs. light intensity



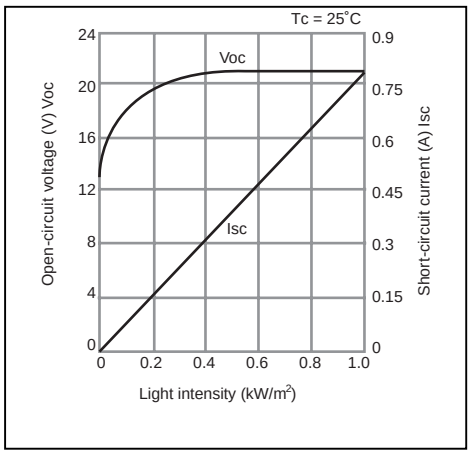
Operating-current vs. operating voltage



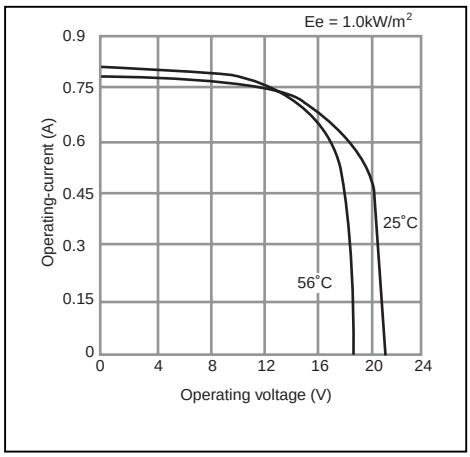
BP-QK36H



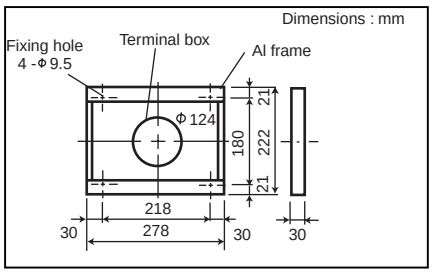
Open-circuit voltage, short-circuit current vs. light intensity



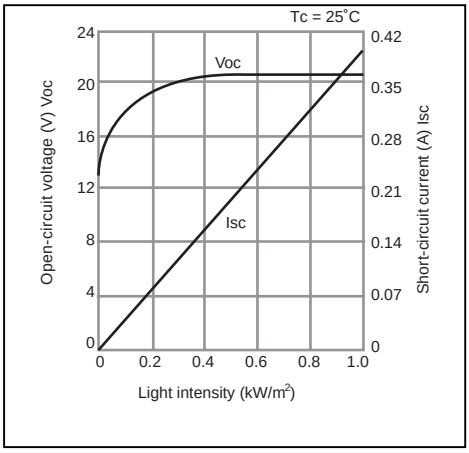
Operating-current vs. operating voltage



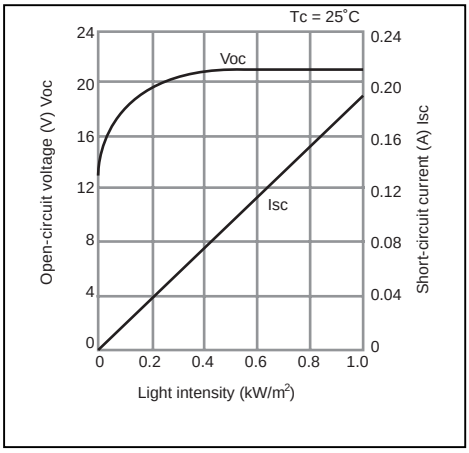
BP-EK36



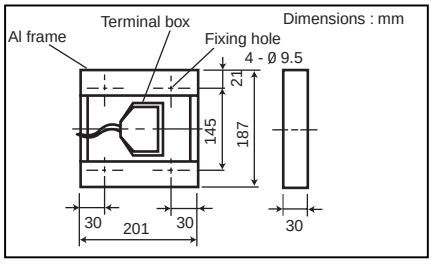
Open-circuit voltage, short-circuit current vs. light intensity



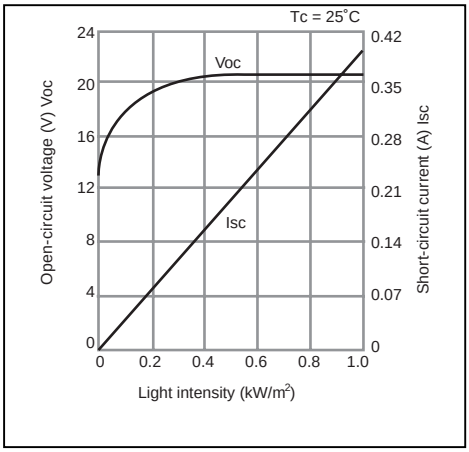
Operating-current vs. operating voltage



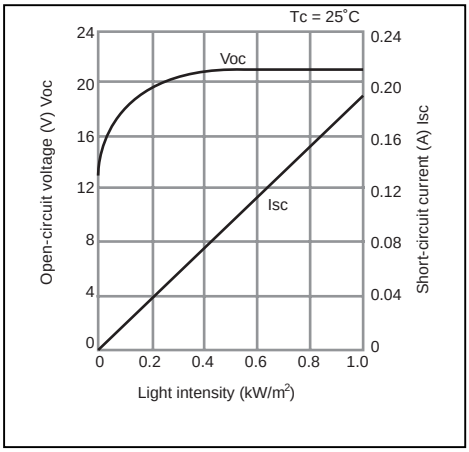
BP-STK36



Open-circuit voltage, short-circuit current vs. light intensity



Operating-current vs. operating voltage



10. SILICON SOLAR MODULES WITH ARRAY SUPPORTS

Suitable for highly reliable power supplies

10.1. General Information

Solar modules with array supports are often combined with storage batteries to create independent power supplies for applications such as telemeter systems in remote or inaccessible areas, lights to guide shipping, firefighter's radio systems and marine monitoring systems.

Solar module array supports consist of solar modules selected to match the required power consumption load and usage conditions, support angle posts, poles to keep away birds, etc. The solar module array supports are installed with the light collecting surface facing due south and at an angle of 30 degrees (standard).

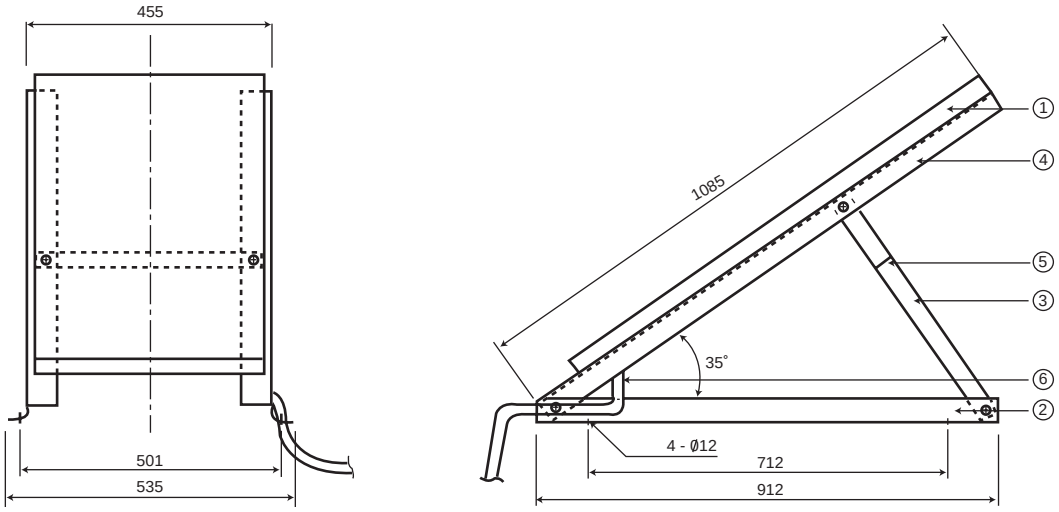
10.2 Features

- Stands up to the elements for superior reliability over the long term.
- Simple set up and maintenance make it easy to provide a stable power supply.

10.3 Specifications

Model No.	Output		Number of modules (series) x (parallel)	Array support installation method	Approximate weight (kg)	External view and parts diagram No.
	Output (W)	Output voltage (V)				
54.0	16.9	1 x 1	Rooftop type	15.9	BP-K36KSU1N	1
108.0	16.9 (33.8)	1 x 2 (2 x 1)	Rooftop type	25.0	BP-K36KSU2N	2
162.0	16.9	1 x 3	Rooftop type	41.8	BP-K36KSU3N	3
24.0	16.7	1 x 1	Rooftop type	8.7	BP-HK36KU1N	4
11.5	16.8	1 x 1	Rooftop type	6.1	BP-QK36HU1N	5
54.0	16.9	1 x 1	Panza type	20.0	BP-K36KSP1N	6
24.0	16.7	1 x 1	Panza type	12.0	BP-HK36KP1N	
11.5	16.8	1 x 1	Panza type	8.8	BP-QK36HP1N	

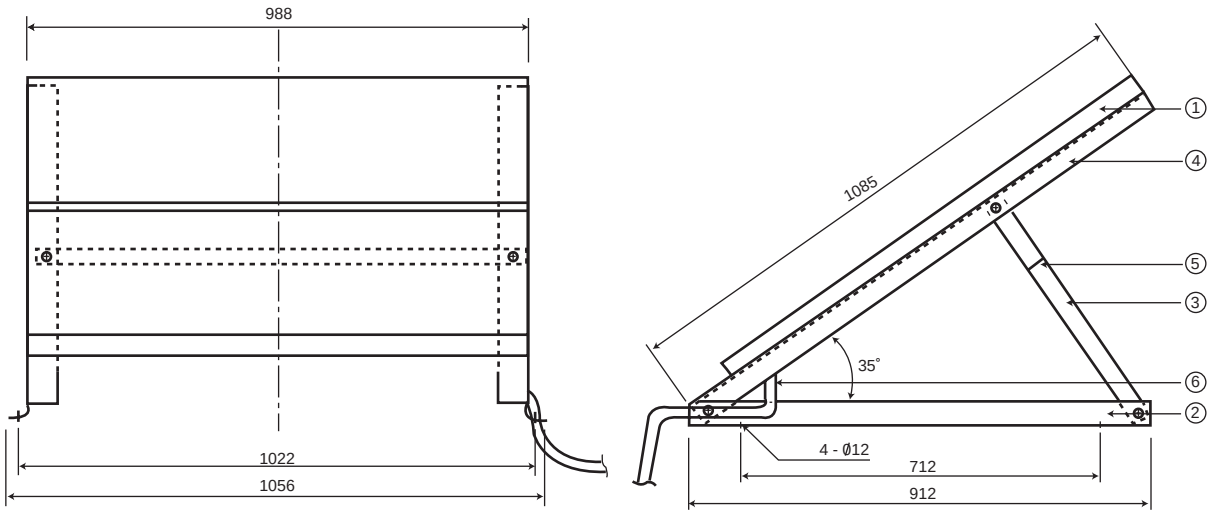
Figure 1. BP-K36KSU1N



- Part tables

Part No.	Product	Matter	Q'ty
1	Solar module	BP-K36KS	1
2	Array support angle	L40 x 40 x 3t	2
3	Array support angle	L40 x 40 x 3t	2
4	Module fixing angle	L40 x 40 x 3t	2
5	Strengthen angle	L30 x 30 x 3t	1
6	The cable (6) in this figure is optional. (However, a cable that outputs 1 m from the terminal block is included).		

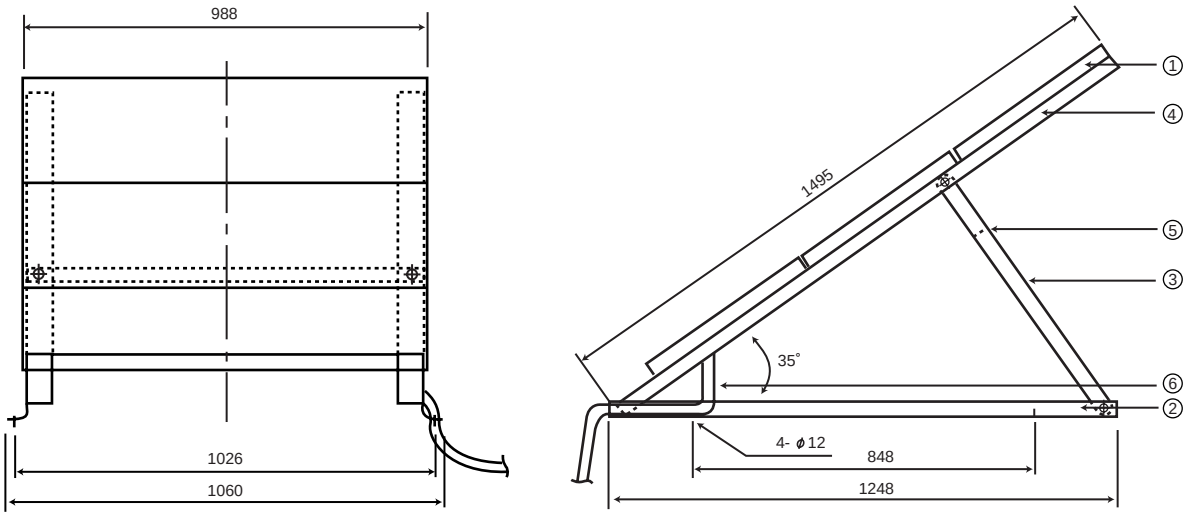
Figure 2. BP-K36KSU2N



- **PART TABLES**

Part No.	Product	Matter	Q'ty
1	Solar module	BP-K36KS	2
2	Array support angle	L40 x 40 x 3t	2
3	Array support angle	L40 x 40 x 3t	2
4	Module fixing angle	L40 x 40 x 3t	2
5	Strengthen angle	L30 x 30 x 3t	1
6	The cable (6) in this figure is optional. (However, a cable that outputs 1 m from the terminal block is included).		

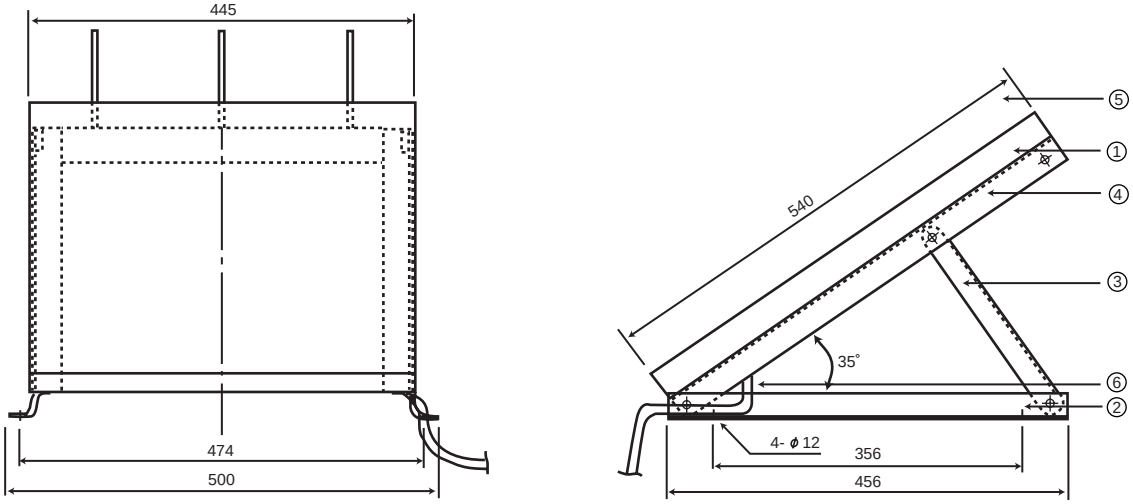
Figure 3. BP-K36KSU3N



- Part tables

Part No.	Product	Matter	Q'ty
1	Solar module	BP-K36KS	3
2	Array support angle	L40 x 40 x 3t	2
3	Array support angle	L40 x 40 x 3t	2
4	Module fixing angle	L50 x 50 x 4t	2
5	Strengthen angle	L40 x 40 x 3t	1
6	The cable (6) in this figure is optional. (However, a cable that outputs 1 m from the terminal block is included).		

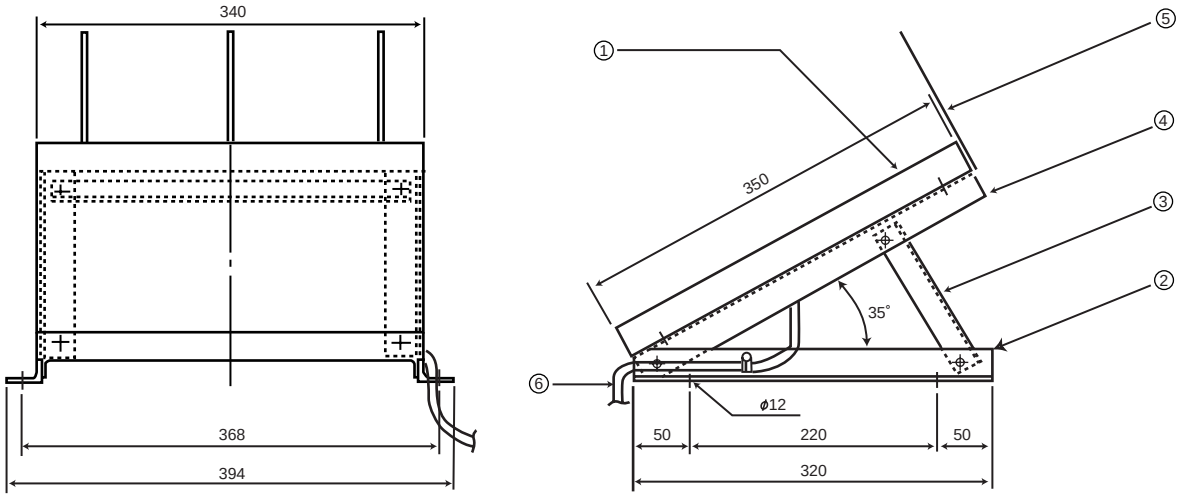
Figure 4. BP-HK36KU1N



- **PART TABLES**

Part No.	Product	Matter	Q'ty
1	Solar module	BP-HK36K	1
2	Array support angle	L30 x 30 x 3t	2
3	Array support angle	L30 x 30 x 3t	2
4	Module fixing angle	L30 x 30 x 3t	2
5	Strengthen angle	SUS304 ∅ 1.5	3
6	The cable (6) in this figure is optional. (However, a cable that outputs 1 m from the terminal block is included).		

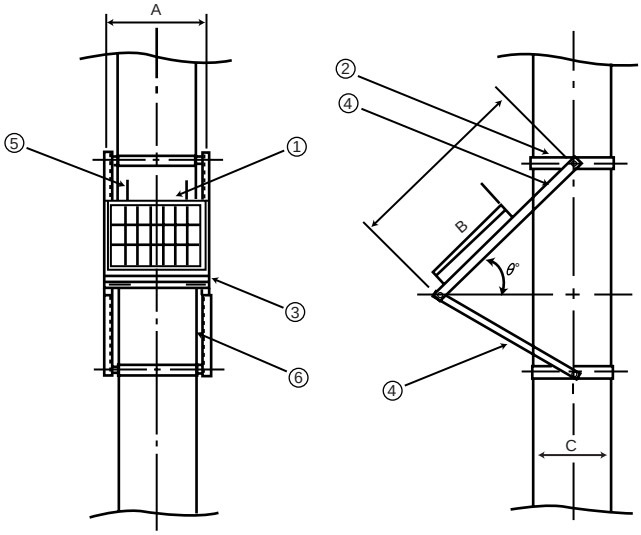
Figure 5. BP-QK36HU1N



- Part tables

Part No.	Product	Matter	Q'ty
1	Solar module	BP-QK36	1
2	Array support angle	L30 x 30 x 3t	2
3	Array support angle	L30 x 30 x 3t	2
4	Module fixing angle	L30 x 30 x 3t	2
5	Strengthen angle	SUS304 ∅ 1.5	3
6	The cable (6) in this figure is optional. (However, a cable that outputs 1 m from the terminal block is included).		

Figure 6. BP-K36KSP1N, BP-HK36KP1N, BP-QK36HP1N



- Dimensions table

Model No.	Output (W)	Dimensions			
		A (mm)	B (mm)	C	θ
BP-HK36KP1N	24.0	445	880	∅120 ~ 265	30° ~ 50°
BP-QK36HP1N	11.5	340	645	∅120 ~ 265	30° ~ 50°
BP-K36KSP1N	54.0	448	1500	∅120 ~ 265	30° ~ 50°

- Part tables

Part No.	Product	Matter	Q'ty
1	Solar module	BP-K36KS, BP-HK36K, BP-QK36H	1
2	Array support angle	L30 x 30 x 3t	2
3	Array support angle	L30 x 30 x 3t	2
4	Module fixing angle	L30 x 30 x 3t	4
5	Strengthen angle	SUS304 ∅ 1.5	2
6			

11. OVERCHARGE PROTECTION CIRCUITS: DISTRIBUTION PANELS

Suitable for highly reliable power supplies

11.1. General Information

The "overcharge protection units" consists only of overcharge protection circuits configured as a unit. Being relatively low-cost, the unit is ideal for systems which do not require testing.
These distribution panels distribute the power generated by solar modules to storage batteries and loads. The measuring circuitry provided makes it possible to test the output current, output voltage, storage battery voltage and load current of the solar modules. The panels are also provided with overcharge prevention circuits to protect the storage batteries from overcharging.

11.2 Features

- Excellent reliability.
- Low current consumption.
- Lightweight
- Easy wiring and operation

11.3 Specifications

Overcharge protection unit

Model No.	Storage battery used	Operating voltage (V)	Return voltage (V)	Maximum allowable input current	External view and parts diagram No.
BP-H3CCUL	Lead storage battery * Alkaline storage battery	14.5 15.5	13.5 14.5	3	7
BP-H10CCUL				10	8

Discharge protection unit

Model No.	Type of Battery Used	Overcharge Protection Circuit Operating Voltage (V)	Overcharge Protection Circuit Restore Voltage (V)	Overdischarge Protection Circuit Operating Voltage (V)	Overdischarge Protection Circuit Restore Voltage (V)	Maximum Allowable Input Current (A)	External View and Parts Diagram No.
BP-CD10A12V	Lead storage battery	14.5	13.5	10.8	12.8	10	9

Measurement Items and meter full-scale levels

Model No.	Measurement items and meter full-scale levels					Maximum allowable input current	External view and parts diagram No.
	Solar modules output current (A)	Solar modules output voltage (V)	Load current (A)	Awaited current (mA)	Storage battery voltage (V)		
BP-H3RCL	3	30	10	60	30	3	10
BP-H10RCL	10	30	30	600	30	10	11

* The suffix “L” is eliminated from model numbers when lead storage batteries aren't used for distribution panels equipped with an overcharge protection circuit or for overcharge protection units.

Figure 7 BP-H3CCUL, H3CCU

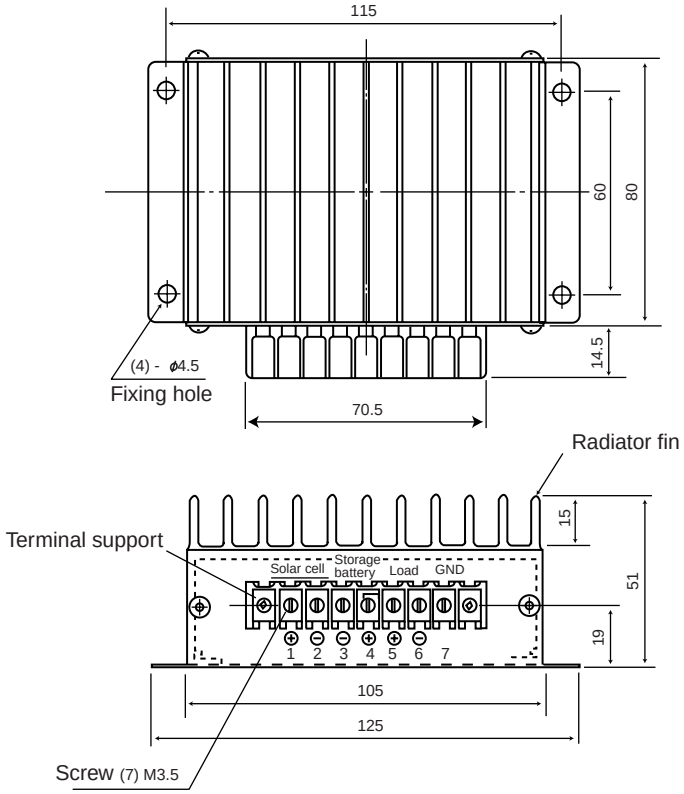


Figure 8 BP-H10CCUL, H10CCU

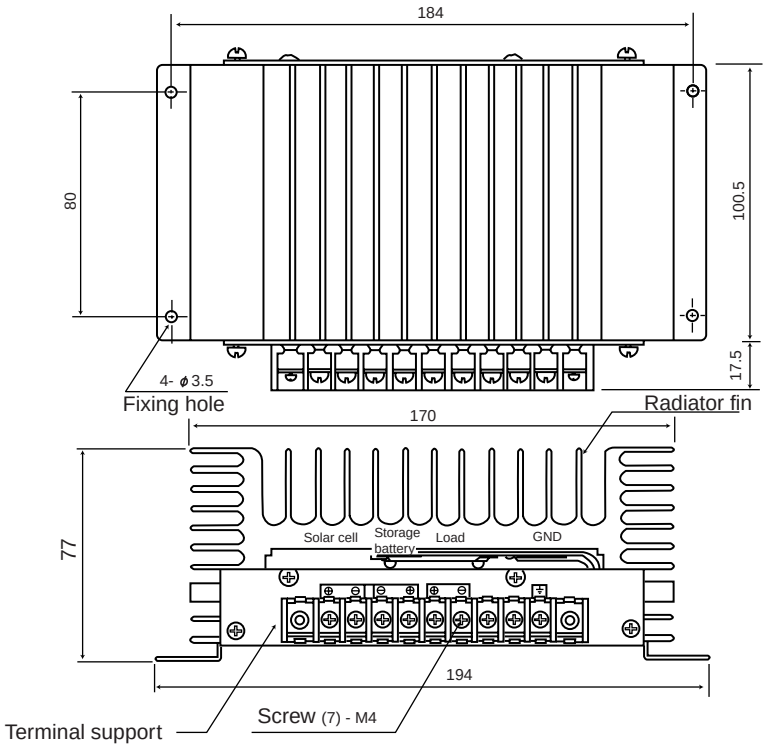


Figure 9. BP-CD10A12V

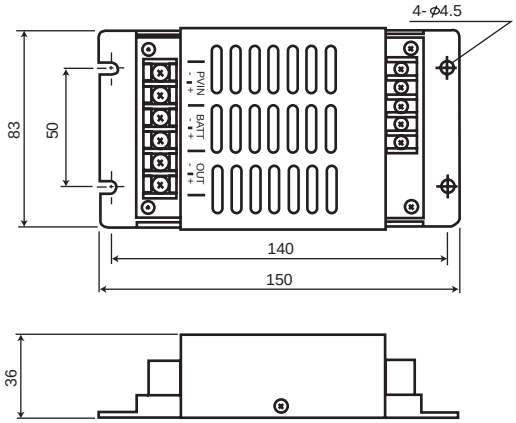
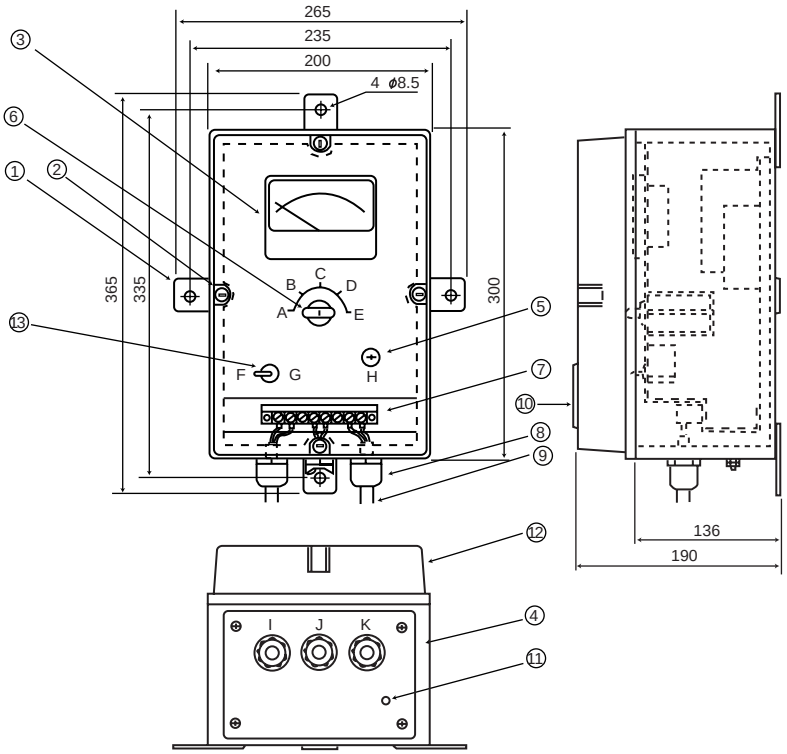


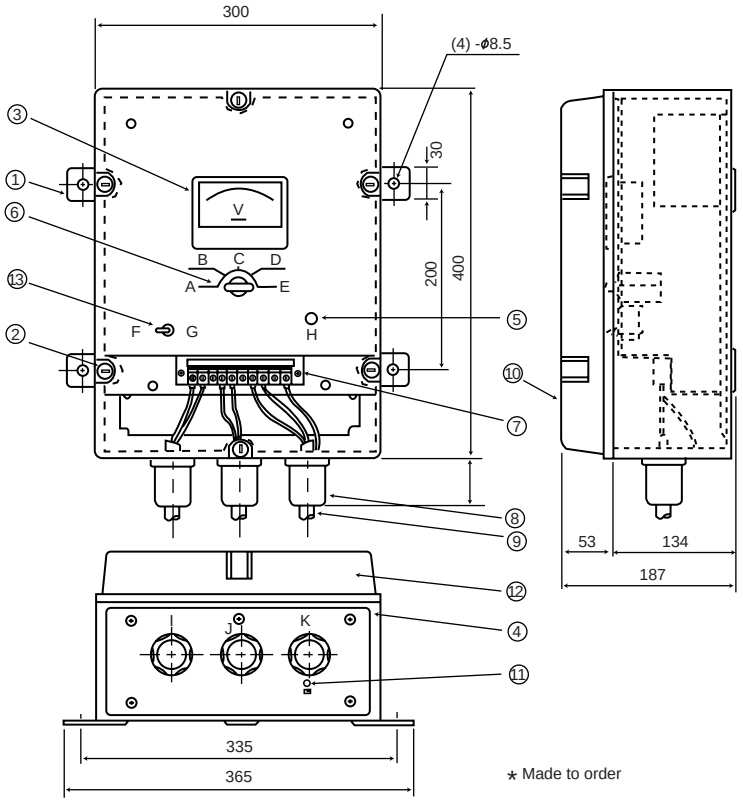
Figure 10. BP-H3RCL



	Indication		Indication
A	Constant position	G	Constant position
B	Output current	H	Waiting current
C	Output voltage	I	Solar cell
D	Load current	J	Storage battery
E	Storage battery voltage	K	Load
F	Measurement		

No.	Product	Qty
1	Metal fittings	4
2	Screw for covering	4
3	Much range V, A meter 2.5 grade	1
4	Substance	1
5	Switch	1
6	Rotary switch for measuring	1
7	Terminal stand	1
8	Water proof cable holder	3
9	Output cable	3
10	Caption	1
11	M4 (BSBM)	1
12	Cover (Polycarbonate)	1
13	Change over switch for measuring	1

Figure 11. BP-H10RC, H10RCL



	Indication		Indication
A	Constant position	G	Constant position
B	Output current	H	Waiting current
C	Output voltage	I	Solar cell
D	Load current	J	Storage battery
E	Storage battery voltage	K	Load
F	Measurement		

No.	Product	Qty
1	Metal fittings	4
2	Screw for covering	4
3	Much range V, A meter 2.5 grade	1
4	Substance	1
5	Switch	1
6	Rotary switch for measuring	1
7	Terminal stand	1
8	Water proof cable holder	3
9	Output cable	3
10	Caption	1
11	M4 (BSBM)	1
12	Cover (Polycarbonate)	1
13	Change over switch for measuring	1

12. SOLAR CELL DESIGN

Solar cells are devices that convert light into electricity, but they do not store electric power. In addition, since the actual amount of power produced varies depending on factors such as the installation conditions and location, as well as the weather, there are a few requirements which must be borne in mind when designing a system. Power supply systems employing solar cells generally fall into one of the following three categories.

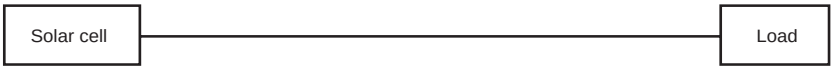
(1) Direct connection to load
(2) Paired with storage battery
(3) Paired with commercial power supply

Presented below are a few simple guidelines and equations to aid in the selection of solar cells and storage batteries, based on the basic system configuration and the load presented by the equipment to be driven. Panasonic has been conducting research on solar cell power supply systems for many years and has collected a voluminous amount of data on the subject. Please consult your Panasonic representative for specific design details.

12.1 Solar Cell Power Supply System Basic Configuration

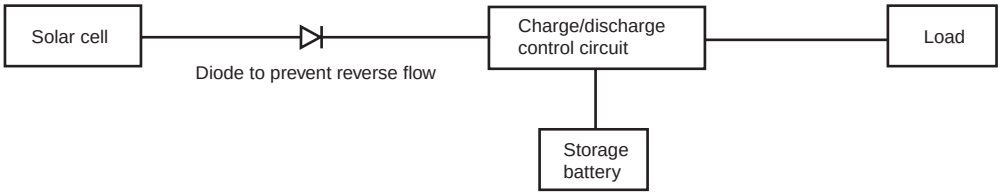
(1) Direct Connection to Load

This type of configuration is suitable for applications such as warehouse ventilation systems, car ventilators or irrigation pumps in which equipment is driven only when there is illumination.



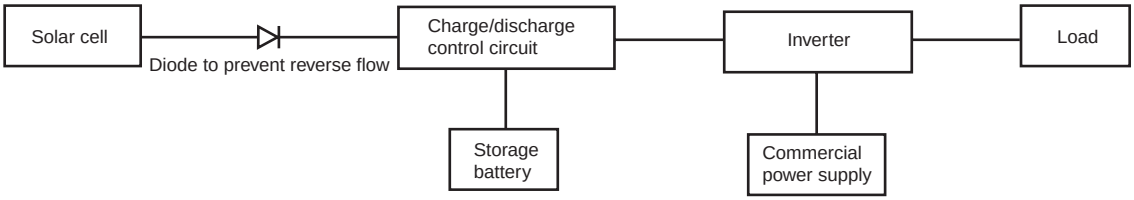
(2) Paired with Storage Battery (Direct load)

In this configuration the solar cell is paired with a storage battery. It is suitable as an independent power supply for applications such as lighting systems, highway displays and communications equipment. Refer to the Design Guide which follows for details on system design.



(3) Paired with Commercial Power Supply (Night load)

This sort of configuration is suitable in cases where a commercial power supply is needed to act as a backup when the solar cell alone is insufficient. As the actual system design is quite complex, please consult Panasonic.



12.2 Solar Cell Power Supply System Design Guide

(1) Direct Connection to Load

This configuration is suitable for applications such as warehouse ventilation systems in which equipment is driven only when the sun is shining. When selecting a solar cell, it is necessary to consider the power consumption of the device to be driven and the weather conditions in the place where the system will be installed. Generally speaking, the power output of the solar cells must be approximately 2 to 3 times as high as the power consumption of the equipment. Consult your Panasonic representative for details.

(2) Paired with Storage Battery

This configuration is mainly used for power supply systems employing solar cells. Refer to the Design Guide below when selecting solar cells and storage batteries to match the load presented by the equipment to be driven.

Design Guide

(1) First, the load conditions of the equipment to be driven must be determined and I_R, the average current consumption per day, calculated

Load Conditions		
Equipment operating voltage	V_L	(V)
Equipment current consumption	I_L	(A)
Equipment operating time	T	h/day

1) Calculation of average current consumption per day

$$1_R(\text{Ah/day}) = I_L(\text{A}) \times T(\text{h/day})$$

(2) Next, the solar cell operating current, I_P is calculated.

2) Calculation of operating current: I_P

$$I_P(\text{A}) = \frac{I_R\ (\text{Ah/day})}{K_1 \times K_2 \times T_S\ (\text{h/day})}$$

- * K_1: The deterioration value based on temperature change, surface area of the solar battery which may become dirty after many years, and which may cause the solar battery output to deteriorate.
- * K_2: The deterioration value of the battery charge and discharge efficiency.
- * T_S: Solar cell average rated output generation time per day.

(3) Next, the storage capacity, C, of the storage battery is calculated

3) Calculation of storage battery capacity: C

$$C(\text{Ah}) = \frac{I_R(\text{Ah/day}) \times D(\text{day})}{K_3}$$

- * D: The number of non-illumination backup days. This is the number of days that in order to run the equipment the storage battery must backup the solar cell because the sun is not shining.
- *K_3: Safety factor for self-discharge by the storage battery, etc. (approx. 0.8)

(4) Last, the operating voltage, VP, of the solar cell is calculated.

V_P = storage battery charging voltage + additional voltage required due to diode for preventing reverse flow + additional voltage required due to output cable + additional voltage required due to temperature

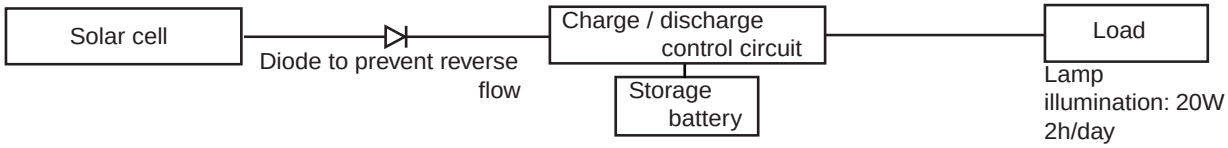
(VL + ∝) (0.3~0.5) (0.1~0.5)

12.3. Calculation Example

- **Lighting System (DC or Direct Current)**

In the following example, a solar cell and a storage battery are selected to power a 12V, 20W lamp which will be illuminated 2 hour per day.

1. Basic System Configuration



2. Selection of Solar cell and Battery

2. Selection of Solar Cell and Battery

Load Conditions		
	Equipment operating voltage	V_L=12V
	Equipment current consumption	I_L=20W/12V=1.67A
	Equipment operating time	T=2h/day

1) Calculation of average current consumption per day

1_R=1.67 x 2
= 3.34 (Ah/day)

2) Calculation of operating current required from solar cell

$$I_P = \frac{3.34}{0.85 \times 0.95 \times 3.21} = 1.29(A)$$

* Solar cell average rated output generation time per day: 3.21 hours

3) Calculation of storage battery capacity

$$C = \frac{3.34 \times 20}{0.8} = 83.5(Ah)$$

* Number of non-illumination backup days: 20 (Set at 7-30 days, taking into account equipment performance)

4) Calculation of solar cell operating voltage

$VP = \underline{14.5}_{t} + 0.4 + 0.5 + 1.3 = 16.7V$

t: Storage battery charging voltage

On the basis of the above, the most appropriate solar cell model is:
the solar module BP-HK36K (Vp=16.7V, Ip=1.44A)
the most appropriate storage battery is: the sealed lead-acid battery LS-90-6E(12V, 90Ah)