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		THIN-FILM PV ENGINEERING DEPARTMENT SOLAR SYSTEMS UNIT ENERGY SYSTEM SOLUTIONS DIVISION

SPECIFICATION FOR

SOLAR MODULE

MODEL No. NS-F128G6

1. The user of this module shall be aware any characteristics described in the specification. Please study carefully the characteristics of the module described on clause 4.5.
2. This specification sheets include the contents under the copyright of Sharp Corporation ("Sharp"). Please keep them with reasonable care as important information. Please don't reproduce or cause anyone reproduce them without Sharp's consent.
3. Please obey the instructions mentioned below for actual use of this module.
   (1) Main applications of the modules as follows.
   (・Grid-connected PV systems
   ・Telemeter system (Terminal) ・Village electrification, etc.)
   (2) Please take proper steps in order to maintain reliability and safety, in case this module is used for the uses mentioned below which require high reliability.
   (・Unit concerning control and safety of a vehicle (air plane, train, automobile, etc.)
   ・Traffic signal ・Road sign ・Security system ・Other safety system, etc.)
   (3) Please don't use for the uses mentioned below which required extremely high reliability.
   (・Space equipment ・Telecommunication system (Trunk) ・Nuclear control system
   ・Medical system (relating to any fatal element), etc.)

PRESENTED

CUSTOMER'S APPROVAL

BY Kengo Maeda

DATE _____

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Department General Manager
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Revision Record

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1. SCOPE

This document describes the specifications of solar module NS-F121G6

2. APPLICATION STANDARD

This module is designed to meet the requirement of the following standards.

- IEC 61646 Ed.2 Thin film PV modules – Design qualification and type approval.
- EN 61730-1 Photovoltaic (PV) module safety qualification Part 1: Requirements for construction
- EN 61730-2 Photovoltaic (PV) module safety qualification Part 2: Requirements for testing

3. REFERENCES

3.1 Normative References

The following normative documents contain the provisions which, through reference in this text, constitute provisions of this specification. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below.

- IEC 60904-1 Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics.
- IEC 60904-3 Photovoltaic devices - Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data.
- IEC 60904-9 Photovoltaic devices - Part 9: Solar simulator performance requirements.
- JIS C8939 Amorphous solar PV modules
- JIS C8991 Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval

3.2 Installation Manual: Document No. KTA10003-A Ver. 3.11

3.3 Instruction for the usage of thin-film PV module regarding “White Spot” : Document No. MTL11037a and MTL11041A

4. SPECIFICATION

4.1 Application class

This module is applied to application class A in accordance with EN 61730.

4.2 Materials

The materials used for the module shall comply with this specification and unless otherwise specified, the ones that fully meet the requirement of this specification shall be used in any case.

4.2.1 Solar cells

Solar cells shall be produced from amorphous silicon (a-Si:H) and micro-crystalline silicon (μ c-Si). The cell has the a-Si / μ c-Si tandem structure.

4.2.2 Interconnectors

Interconnectors shall be solder coated copper.

4.2.3 Filling materials

Filling materials shall be black resin.

4.2.4 Front cover

Front cover shall be low iron non-tempered glass.

4.2.5 Back cover

Back cover shall be tempered glass.

<NOTE>

Tempered glass used as the back cover material might cause a spontaneous breakage because of the impurity in the tempered glass.

4.2.6 Terminal box

The termination shall be lead wire system. The main material of the terminal box shall be PPE/PPO resin.

4.2.7 Bypass diode

One bypass diode shall be installed in the terminal box.

4.3 Mechanical design

4.3.1 General

The design of module is suitable for long-term operation in general open-air climates.

4.3.2 Interconnection of solar cells

In-series connection between the unit solar cells in a-module is formed by the laser patterning process at the time of manufacture.

4.3.3 Termination

The termination shall be lead wire type with 2.5mm^2/14AWG.

Connector is JAE Europe, Ltd. connector. (Model KB1JS01PG2, KB1JS01SG2L).

4.3.4 Mass

The typical mass of modules is shown in the appended data sheet.

4.3.5 Dimension

The typical size of modules: 1402mm × 1001mm × 24mm

The tolerance in dimension of module is shown in Fig.1 and Fig. 2.

4.4 Identification and product marking

The nameplate design as the identification and product marking is shown in Fig. 3.

4.5 Appearance

The followings shall be considered to be major visual defects:

1) Broken, cracked or torn external surface, including front cover, back cover and terminal box;
2) Bent or misaligned external surfaces, including front cover, back cover and terminal box to extent that the installation and/or operation of the module would be impaired.
3) Voids in, or visible corrosion, or visible de-lamination of any of the thin-film layers of the active circuitry of the module, extending over more than 10% of the module.
4) Bubbles or delaminations forming a continuous path between any part of the electrical circuit and the edge of the module.
5) Loss of mechanical integrity, to the extent that the installation and/or operation of the module would be impaired.

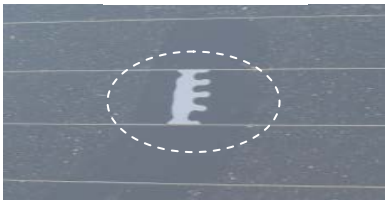
<NOTE> Example of visible discoloration

(1) White, grey or silver colored spots (Figure A)

< Fig. A>

After completion of the module installation white, grey or silver-colored spots may occur during operation of the PV-plant caused by certain shading conditions. These so called "White Spot" are a common feature and a characteristic of thin-film technology. They occur because of certain tolerances in the production process. Document No. MTL11037a and MTL11041 provide instructions how to eliminate the occurrence of White Spots by avoiding certain shading conditions. Please do not shade the PV module surface by specified shadow described in MTL11037a and MTL11041.

< Fig. B >



(2) Discoloration along the internal wiring (Figure B)
This discoloration may occur along the internal wiring in PV module.

4.6 Performance characteristics

4.6.1 Environmental requirement

4.6.1.1 Storage temperature

The storage temperature of the modules should be from -40℃ to +90℃.

NOTE: If any chance the module is to be outdoor, put an appropriate cover so it would not be hit by rain directly. Do not store the module in a storage where condensation many occurs.

4.6.1.2 Operating temperature of solar cells

The operating temperature of solar cells should be from -40℃ to +90℃.

4.6.1.3 Storage humidity

The storage humidity of the modules should be less than 90% of relative humidity.

4.6.2 Electrical performance

4.6.2.1 Electrical output

The electrical characteristics of the module under standard test conditions (irradiance of 1000W/m^2 with IEC60904-3 reference solar spectral irradiance distribution, AM 1.5 spectrum and cell temperature of 25°C) in accordance with IEC60904-1, shall be compliance with the following table. Typical electrical characteristics of this model (open circuit voltage, short circuit current, voltage at point of maximum power, current at point of maximum power, maximum power) are shown in the appended data sheet.

Table1. The electrical characteristics (Nominal value)

Characteristic	Symbol	Nominal Value	Max.	Min.	Unit
Maximum power	Pmax	128	140.8	121.6	W

NOTE1: The maximum power may be initially approx. 18% higher than the quoted nominal

value.

NOTE2: Our warranty applies the maximum output power measured by a solar simulator with Standard Test Condition (STC), (i) after ambient temperature in the sunshine report by the Meteorological Agency have reached 20 degree C for at least 20 consecutive days or (ii) after having the modules annealed with the given conditions (90 degree C, 48 hour) and having the light-soaking tests which are performed in accordance with clauses 10.19.1 – 10.19.3 of IEC61646 Ed.2.

NOTE 3: The maximum output power measurement tolerance by a solar simulator with STC on a system calibrated by Sharp is ±3.5%.

4.6.2.2 Insulation

This module satisfies the requirement of Dielectric withstand test in accordance with IEC61730-2.

4.6.3 Mechanical performance

4.6.3.1 Withstanding mechanical load

This module satisfies the requirement of mechanical load test at 2400Pa in accordance with IEC 61646 Ed.2.

4.6.3.2 Withstanding the impact of hailstone

This module satisfies the requirement of hailstone test in accordance with IEC 61646 Ed.2.

4.6.3.3 Robustness of termination

This module satisfies the requirement of robustness of terminations in accordance with IEC 61646 Ed.2.

5. SHIPPING TEST

Each shipping lot shall successfully pass the shipping tests below.

5.1 Total inspection.

5.1.1 Sampling way

All shipping lot is inspected.

5.1.2 Inspection items

The maximum power (Pmax) is measured in the production line process by flasher data report (power measurement tolerance: ±3.5%).

5.2 Sampling inspection

5.2.1 Sampling way

Sampling shall be done by extracting at production articles.

5.2.2 Inspection items

Test items shall be the dimension, the appearance and the insulation tests.

6. PREPARATION FOR DELIVERY

The shipping carton box specification is shown in Fig. 4 or Fig. 5.

7. WARNING

The items regarding the warning are shown as below and in the installation manual, general installation manual and user manual.

7.1 Use

(1) Main applications of the modules as follows.

・Grid-connected PV systems.

・Telemeter system (Terminal) ・Village electrification etc

(2) Please take proper steps in order to maintain reliability and safety, in case this module is used for the uses or in areas mentioned below which require high reliability.

・Fallen snow area ・Extremely cold area ・Strong wind area

・Over water ・Always poured water area

・Salt water damage area ・Small island ・Desert area

・Unit concerning control and safety of a vehicle (air plane, train, automobile etc.)

・Traffic signal ・Road sign

・Security system ・Other safety system etc.

(3) Please don't use for the uses mentioned below which require extremely high reliability.

・Space equipment ・Telecommunication system (Trunk)

・Nuclear control system ・Medical system (relating to any fatal element) etc.

(4) Please do not connect the modules directly to the loads such as motor since the variation of the output power depending on the solar irradiation causes the damage for the connected motor.

1: In case of brush-less motor, the lock function gets active and the hall IC is most likely to be damaged.

2: In case of the motor with brush, the coil is most likely to be damaged.

7.2 Handling

(1) Never touch the output terminals with bare hands when the module is irradiated. Cover the surface of the module by sufficiently thick cloth or something suitable to prevent incident light, and handle the output terminals with rubber-gloved hands not to receive the electric shock.

(2) Do not drop tools or hard things on the front cover/ back cover of the module, when broken the front cover of the module, never use the module.

(3) Do not wear a metallic jewelry which may become cause of the electric shock during installation.

7.3 Installation

(1) When mounting the module on structure, keep the displacement of the forth corner of the module smaller than 2mm for 1000mm of the diagonal of the module after other 3 corners are placed on structure.

(2) Be careful in handling polarity of insulated output wires.

(3) This module must be grounded by minus pole. Install modules and ground mounting structure in accordance with applicable law of each country.

(4) Do not keep PV modules without grounded condition by minus-pole after series connection, TCO corrosion may be caused.

(5) Consult the government office before the installation of the modules in case that the permission of the installation is required by law.

(6) The modules shall be installed and maintained by qualified personnel.

(7) Follow safety precautions of the battery manufacture if batteries are used with modules.
(8) Consult the manufacturer for proper installation on special vehicles such as boats and campers.
(9) The modules must be mounted using clips on the long sides of the module according to our installation manual.
(10) Remove the cable securing tapes and the cable holders carefully before installation.
(11) The connections must be completely done and locked.
(12) When removing the connection, the lock part should be pressed.
(13) To extend the module connecting leads, the connecting method shall comply with applicable law of each country.
(14) To extend the module connecting leads, only connectors from JAE Europe, Limited. (KB1JS01PG2 / KB1JS01SG2L) can be used in accordance with IEC61646 Ed.2 and IEC617730 Ed.1 as shown Fig. C.

Figure C: Connector type

<Positive electrode>
KB1JS01PG2

<Negative electrode>
KB1JS01SG2L

(15) Please keep the open-circuit condition in the PV modules before completing the electrical wiring of PV system.

7.4 Operation

(1) When a part of the modules is shadowed, the hot spot may be caused. Therefore do not shadow cells.
(2) The modules shall be maintained by qualified personnel.
(3) The electrical characteristics degrade when the front cover of the module becomes dirty.
(4) Do not pour solvent on the modules when cleaning.
(5) Do not produce sparks near flammable vapors.
(6) Do not expose the modules to sunlight concentrated with mirrors, lenses or similar means.
(7) Keep modules away from children.

8. Others

Any doubt as to this specification shall be determined in good faith upon mutual consultation of the both parties.

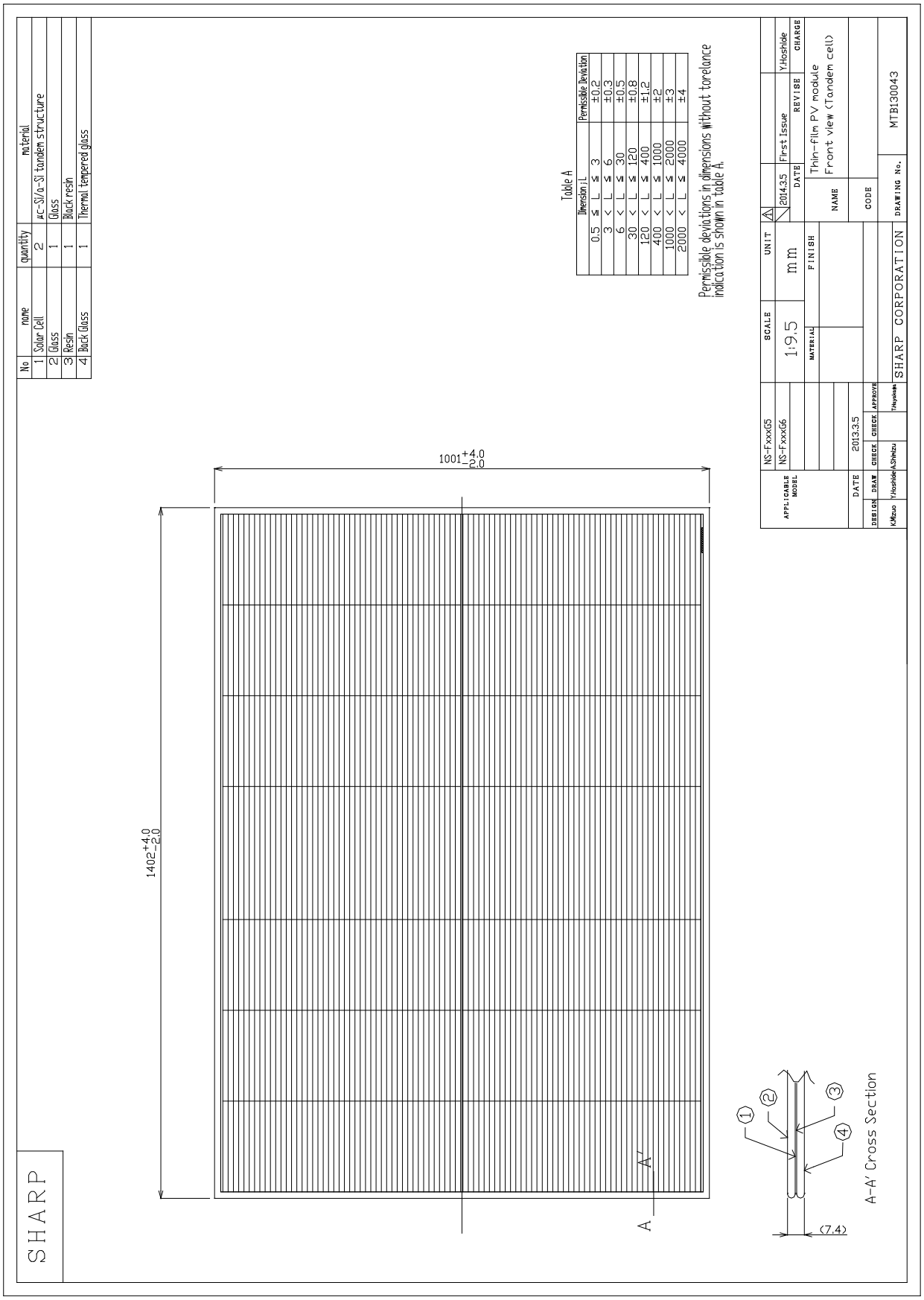


Fig.1 The front view of the module

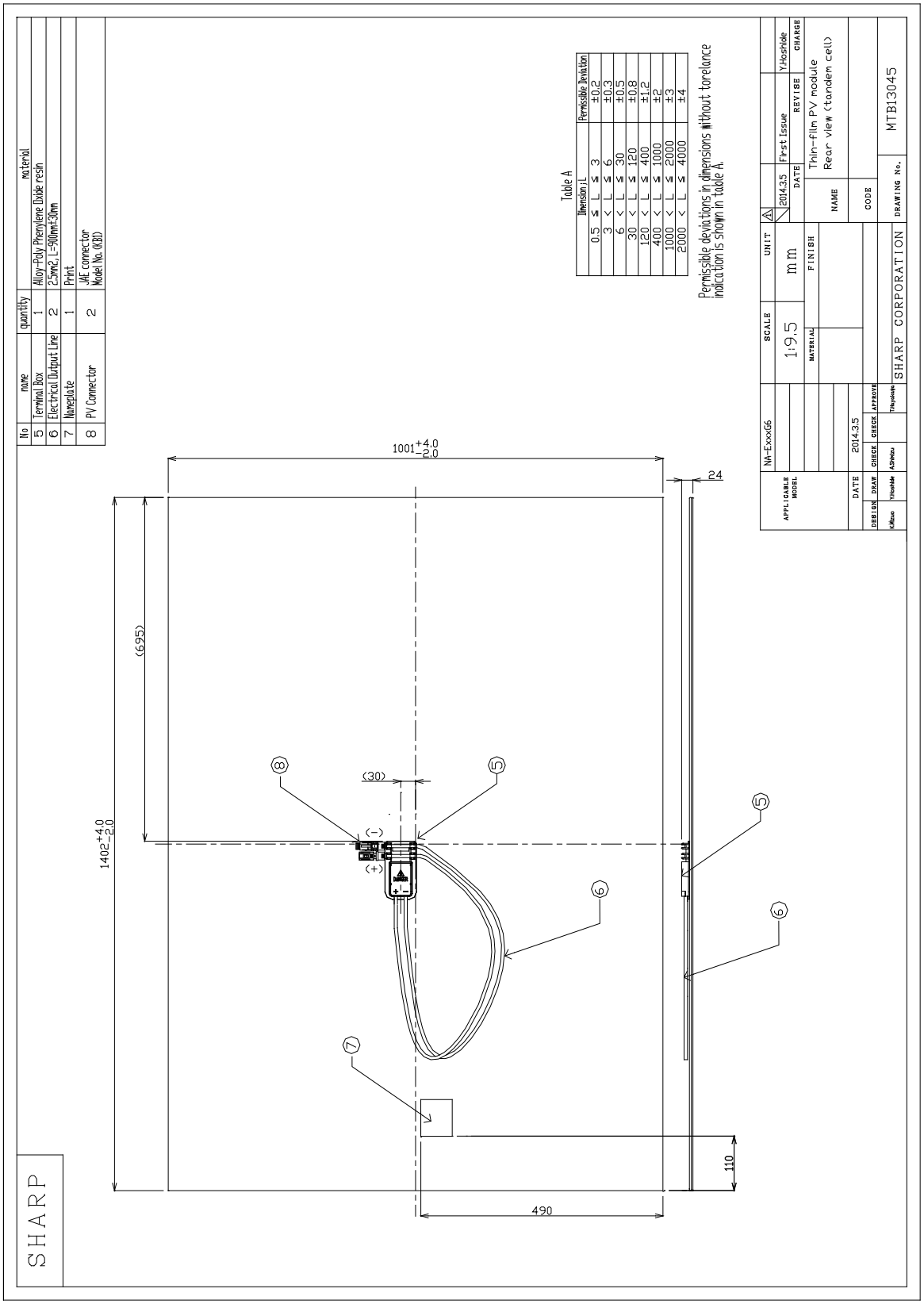


Fig.2 The back view of the module

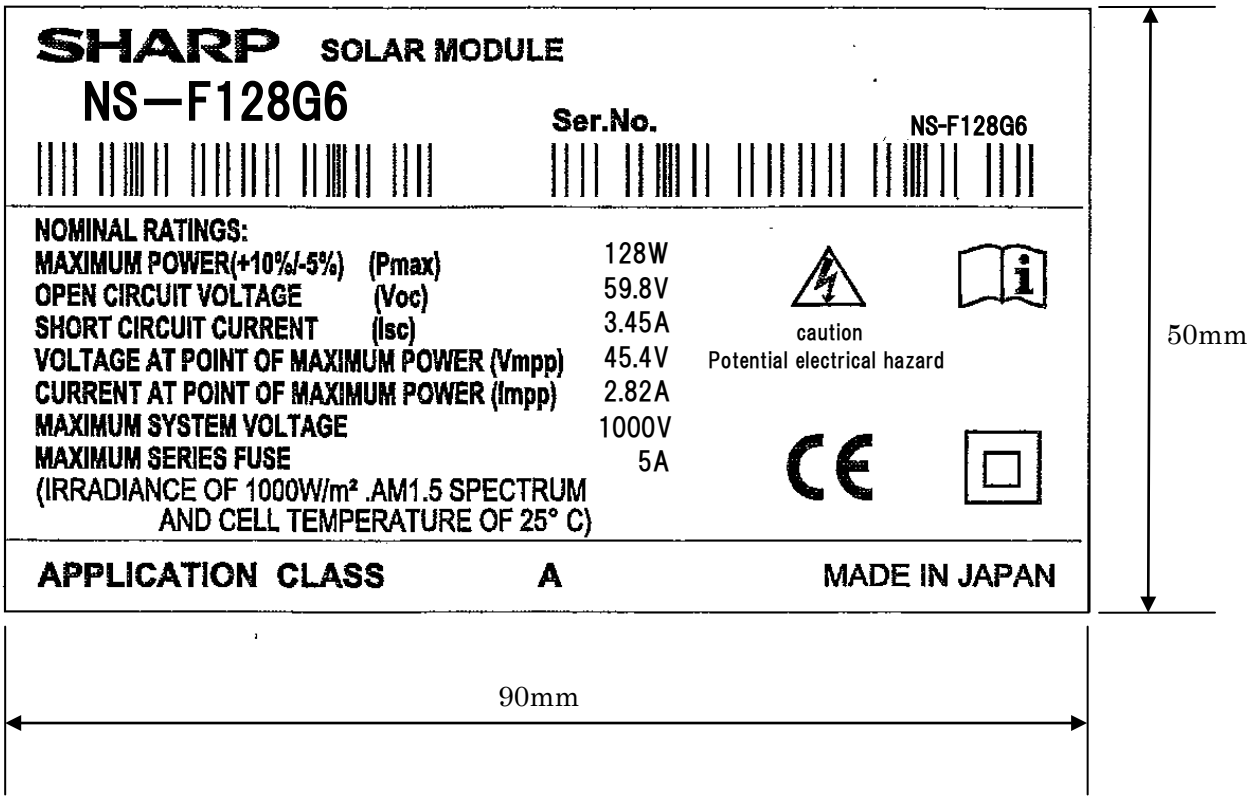


Fig. 3 The nameplate design

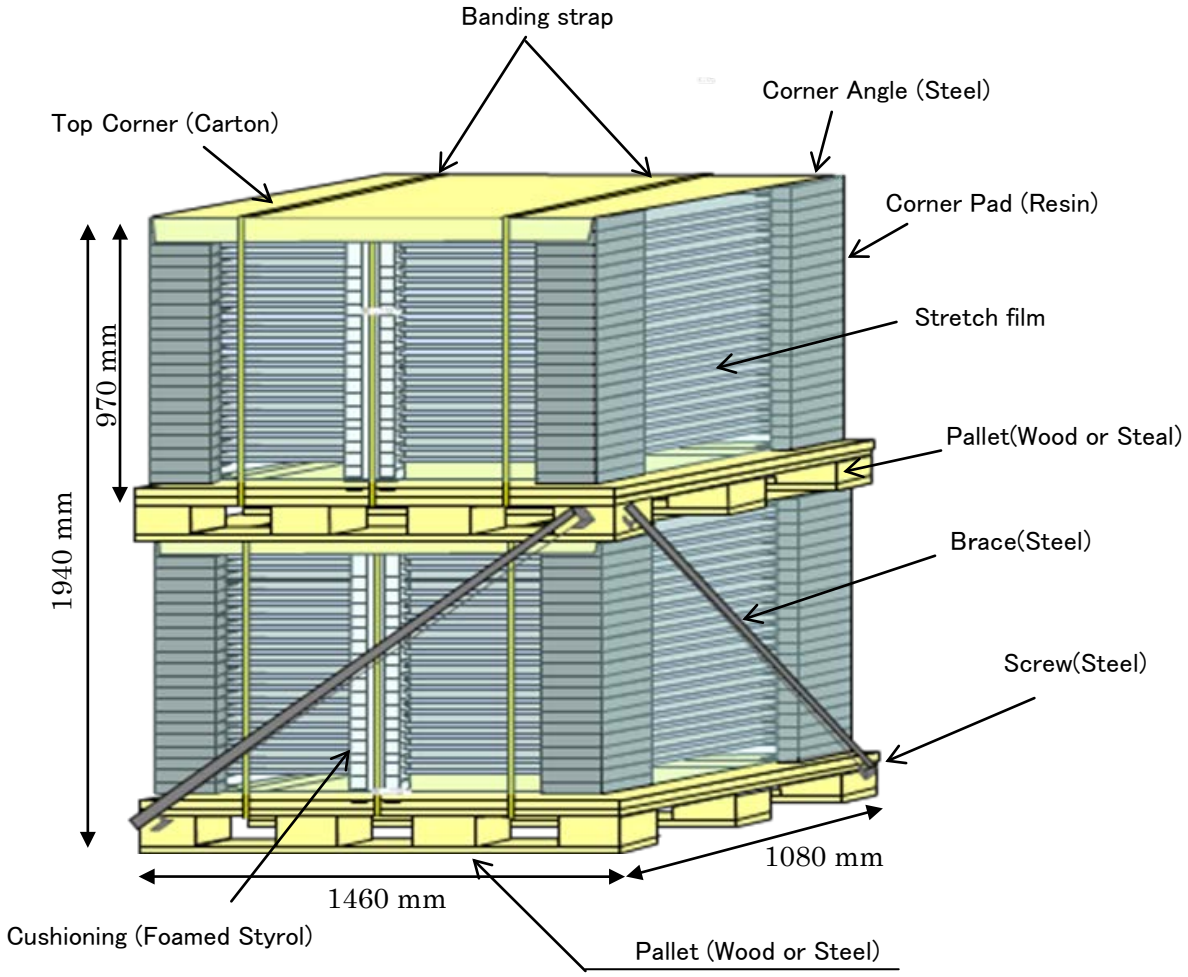
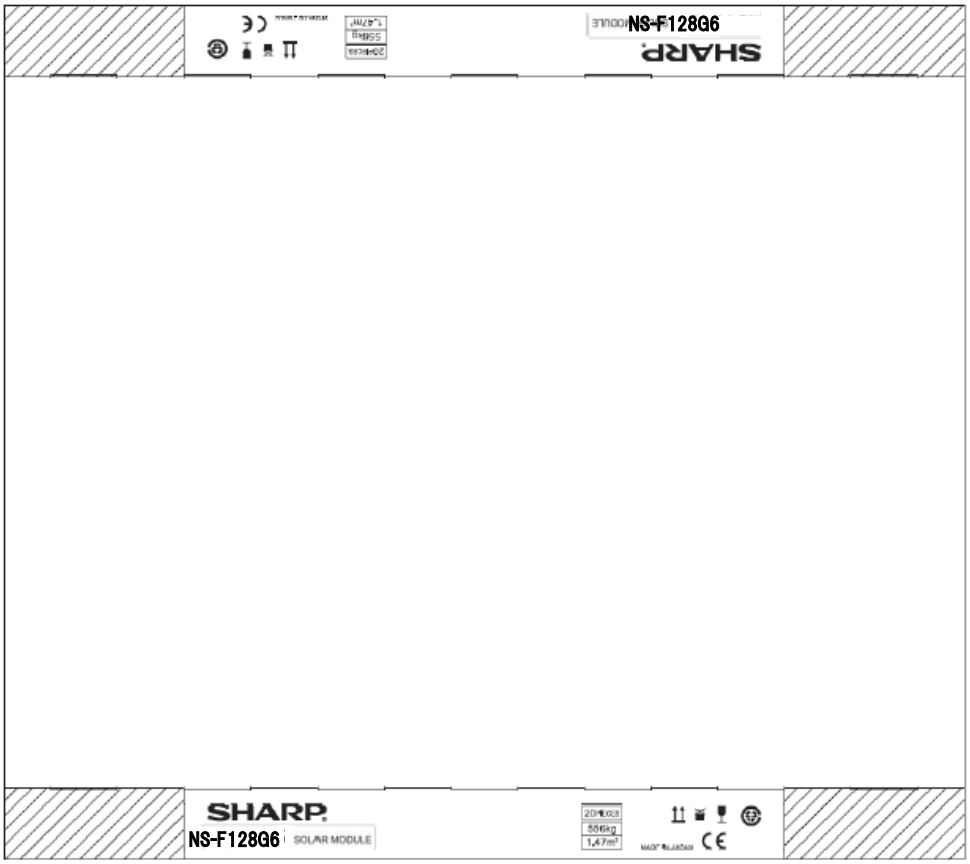


Fig. 4 The shipping carton box specifications (Type A).



The printing design of top cover

Fig. 5 The shipping carton box specifications (Type B).

DATA SHEET of PV module NS-F128G6

Ⅰ－1. SCOPE

This data sheet describes the standard information (not items guaranteed) except specifications for the detail design and work. Users shall consider the other information.

Ⅰ－2. MECHANICAL CHARACTERISTICS

Cell Type	thin-film silicon (amorphous Si / microcrystalline Si tandem structure)
Front cover material	Low iron non-tempered glass
Encapsulation material	Black color resin for Photovoltaic
Back cover material	Tempered glass
Dimension	Length: 1402mm Width: 1001mm Depth: 24mm
Weight (Typical)	26 kg
Terminal box	Material: PPE/PPO resin
Bypass Diode	One bypass diodes shall be installed in the terminal box
Cable	PV1F cable 2.5mm sq. / Length 900mm (Typ.)
Connector	JAE Connector Model No. KB1 IP-rating 67

Ⅰ－3. ELECTRICAL CHARACTERISTICS

The initial electrical characteristics at STC (standard test conditions) (Irradiance: 1000 Wm^{-2} with the AM1.5 spectral irradiance distribution, Cell temperature: 25°C±2°C) is shown in Table I-1 and the nominal electrical characteristics at STC are shown in Table I-2.

Rated electrical characteristics are within ±10% of the indicated value of Isc, Voc and +10%/-5% of Pmax (Power measurement tolerance:±3.5%).

The nominal electrical characteristics (Pmax, Voc, Isc, Vmpp, and Impp) are specified based on the result of the production line test. However, the characteristic of each module measured by the shipping test varies within tolerance. The warranty conditions are specified in this manual.

Table I - 1. Electrical characteristics (Initial value at STC)

Characteristics	Symbol	Value		Unit
Maximum Power Tolerance	Pmax	150.6		
		+10	-5	%
Open-circuit voltage	Voc	60.8		
Short-circuit current	Isc	3.54		
Maximum power voltage	Vmpp	48.6		
Maximum power current	Impp	3.10		

Table I - 2. Electrical characteristics (Nominal value* at STC)

Characteristics	Symbol	Value		Unit
Maximum Power Tolerance	Pmax	128		
		+10	-5	%
Open-circuit voltage	Voc	59.8		
Short-circuit current	Isc	3.45		
Maximum power voltage	Vmpp	45.4		
Maximum power current	Impp	2.82		

*Nominal values are values calculated from the Table I-1 initial values using the results of light-soaking tests. The tests are performed in accordance with Clauses 10.19.1-10.19.3 of the Standard for Thin-Film Terrestrial Photovoltaic (PV) Modules – Design qualification and type approval IEC61646 Ed.2.

These values represent the average value of the seasonal change shown in Fig.I-1. Furthermore, these characteristics of the installed module are changed according to installation environment like the ambient temperature.

After installing these modules outdoors, the maximum power declines 10% or more from an initial value within several days. Then, the maximum output value is changed according to a season focusing on a nominal value. Our warranty applies to the seasonal change and no warranty is given as to the bottom of the seasonal change.

Our warranty applies the maximum output power measured by a solar simulator with Standard Test Condition (STC), (i) after ambient temperature in the sunshine report by the Meteorological Agency have reached 20 degree C for at least 20 consecutive days or (ii) after having the modules annealed with the given conditions (90 degree C, 48 hour) and having the light-soaking tests which are performed in accordance with clauses 10.19.1 – 10.19.3 of IEC61646 Ed.2.

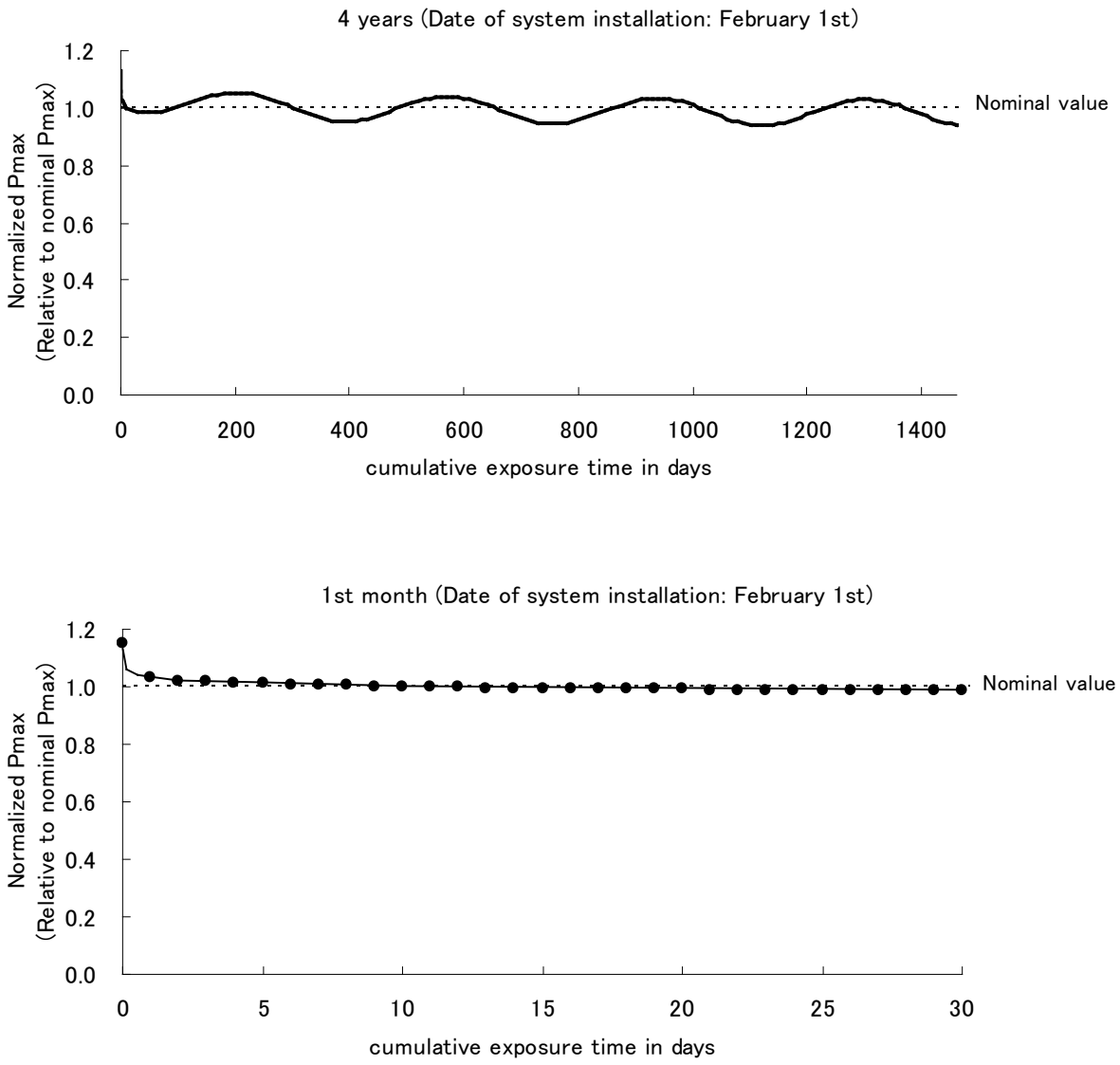


Fig. I -1 Conceptual figure showing nominal and seasonal changes

Table I - 3. Electrical characteristics

Characteristics	Value	Unit
Maximum System Voltage	1000	V
Over-Current Protection	5	A
Application Class	A	

The electric output characteristics of the module under condition other than the standard test condition are shown below. These characteristics are typical characteristics. The characteristic of each module is not necessarily in agreement with the characteristic shown below.

(1) Short-circuit current, Open-circuit voltage, Maximum power vs. Irradiance (Fig. I - 2)

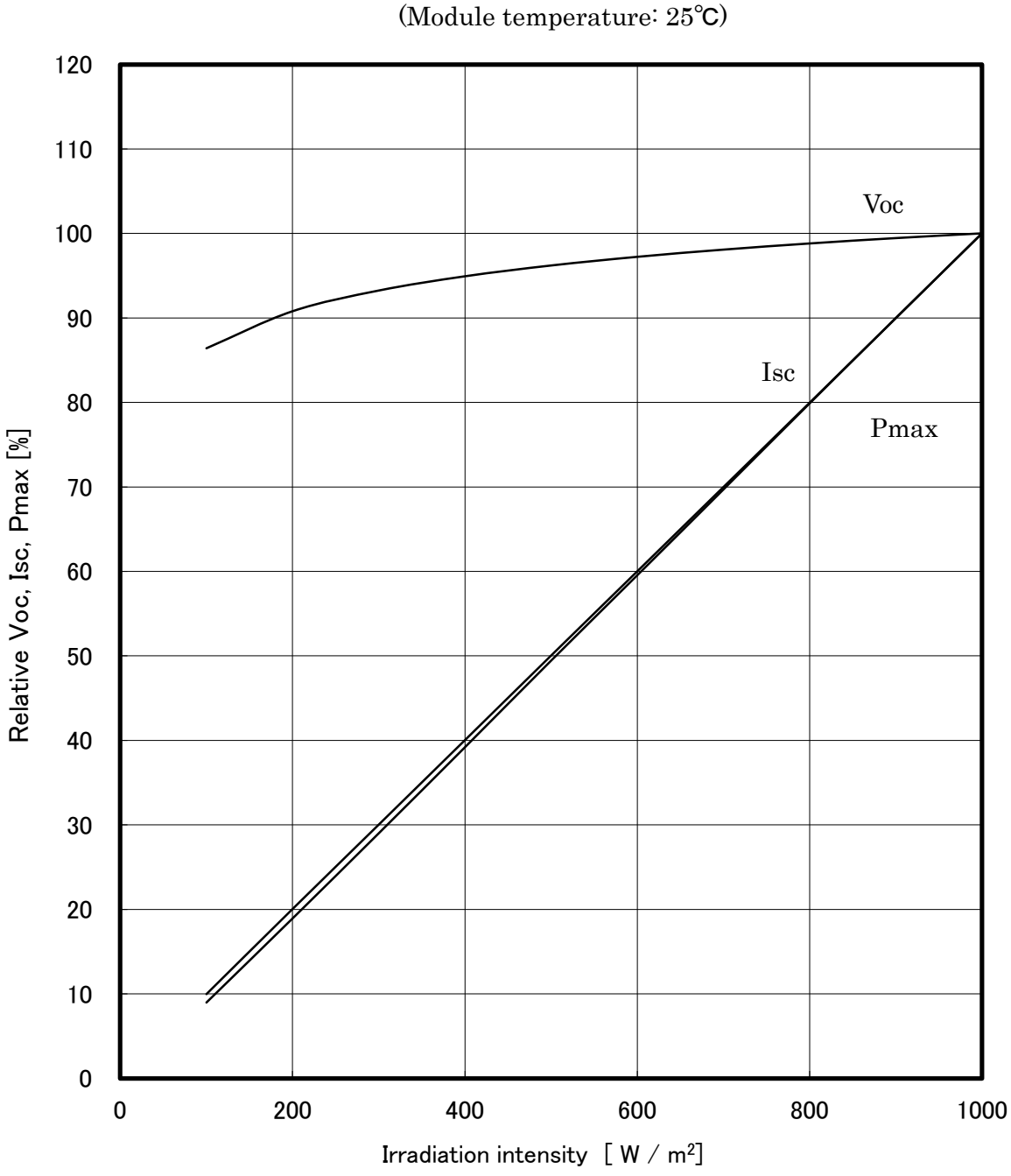


Fig. I -2 Short-circuit Current, Open-circuit Voltage vs. Irradiance Characteristics

(2) Current and Power versus Voltage per irradiance (Fig. I - 3)

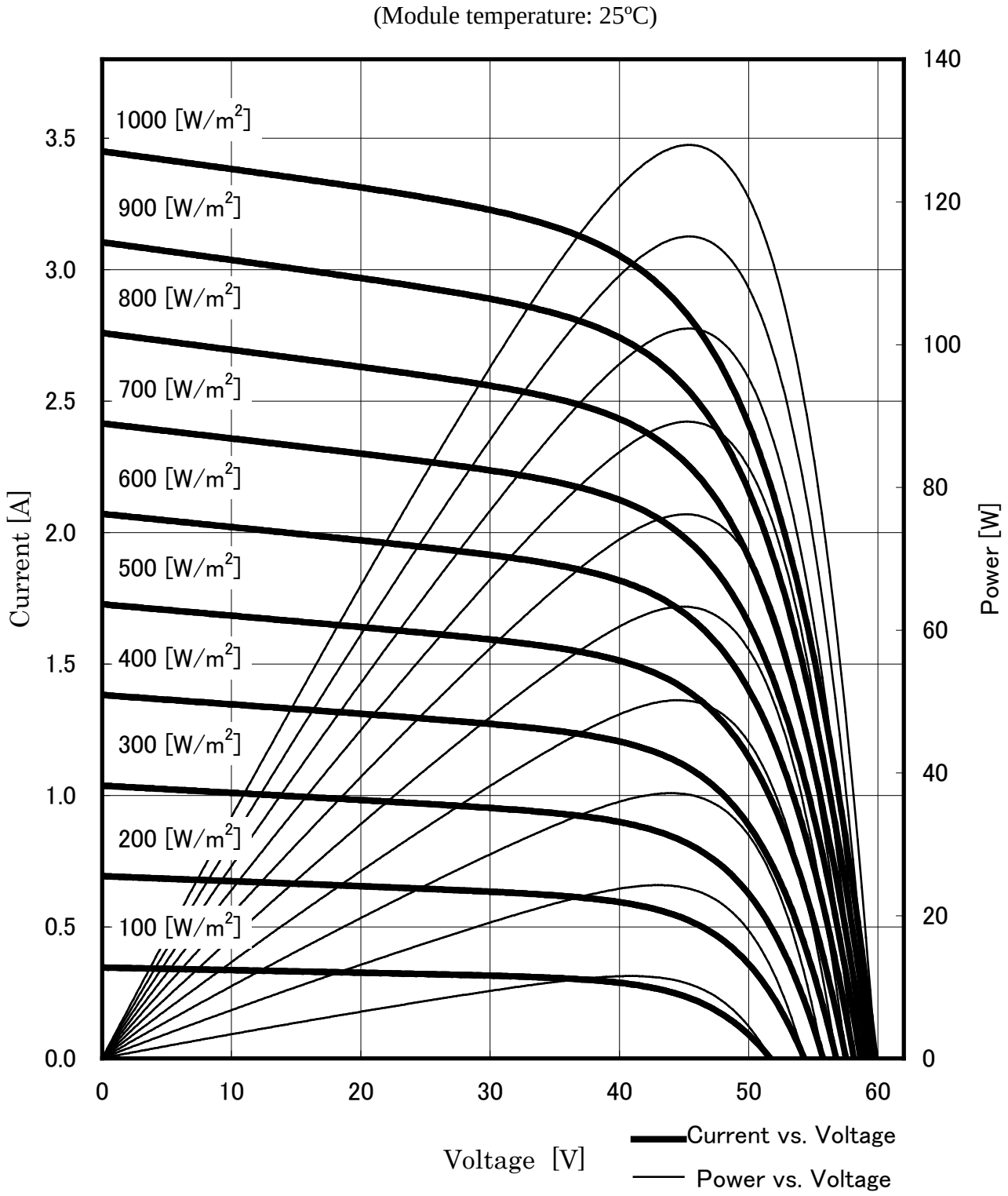


Fig. I -3 Current, Power versus Voltage Characteristics

(3) Normalized characteristics regarding Voc, Isc and Pmax versus Module temperature (Fig. Ⅰ - 4)

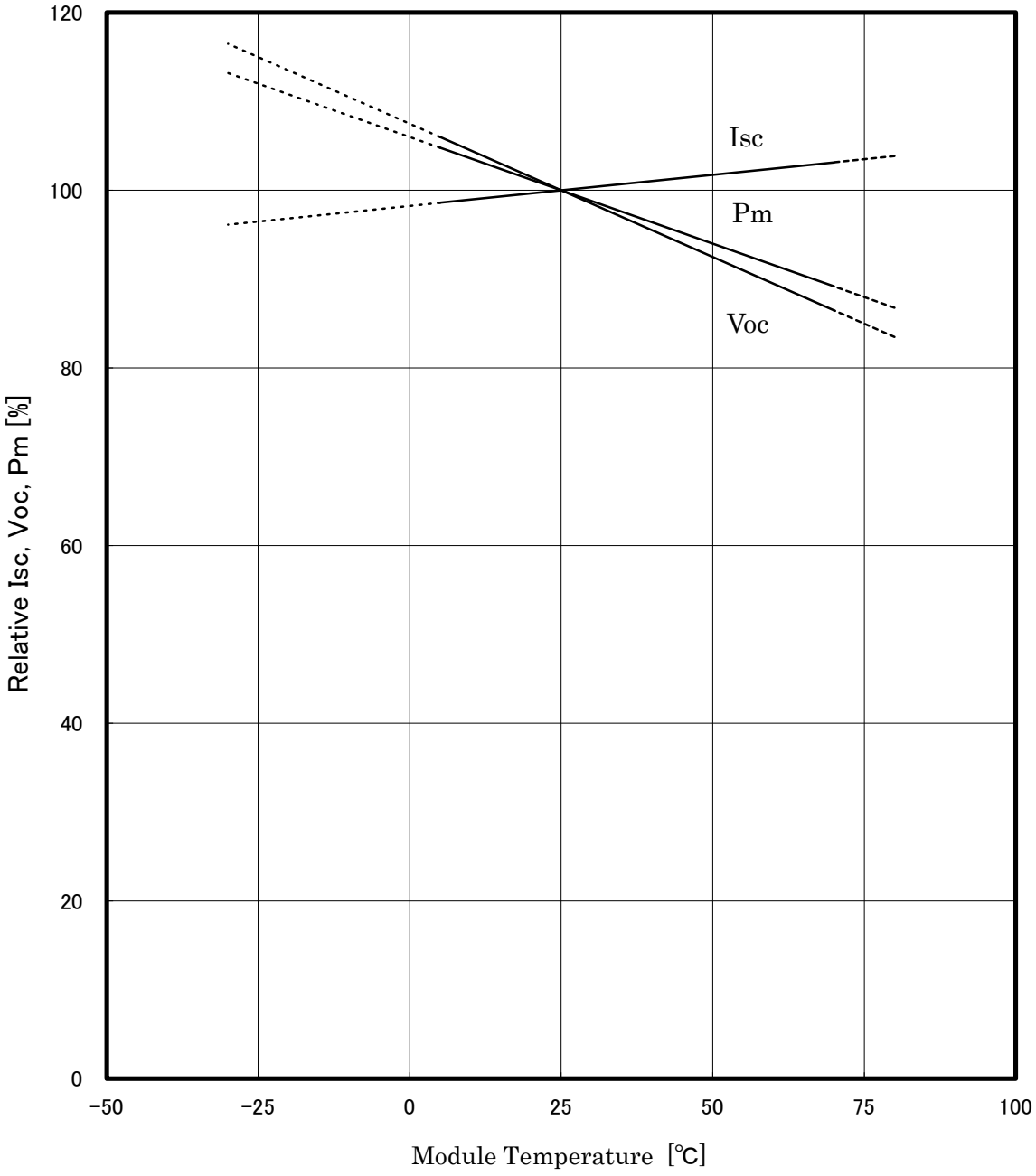


Fig. Ⅰ -4 Short-circuit current, Open-circuit voltage, Maximum power vs. Module temperature Characteristics

(4) Temperature coefficient; the coefficient of Voc, Isc and Pmax is shown in table I-4.

Table Ⅰ-4 Temperature coefficient

Characteristic	Unit	Value
Temperature coefficient of Voc	% / ℃	-0.30
Temperature coefficient of Isc	% / ℃	0.07
Temperature coefficient of Pmax	% / ℃	-0.24

(5) Performance at NOCT

The electrical characteristics of this module at NOCT are shown in Table I-5.

Table Ⅰ - 5. Electrical characteristics (at NOCT)

Characteristics	Symbol	Value	Unit
Maximum Power	Pmax	97.6	W
Open-circuit voltage	Voc	55.7	V
Short-circuit current	Isc	2.79	A
Maximum power voltage	Vmpp	42.8	V
Maximum power current	Impp	2.28	A
Nominal Operating Condition Temperature	NOCT	44	℃

NOCT: Module operation temperature at 800W/m^2 irradiance in the plane of module, air temperature 20°C, wind speed 1m/s and open circuit condition.

(6) Spectrum sensitivity: The performance changes by the spectrum of the light irradiated. The electrical characteristics shown in this specification are measured under the simulated sunlight with AM1.5 spectrum.

(7) Design of system: system design should consider both initial values and nominal values in the Tables.

NOTE: 1

Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at Standard Test Conditions. Accordingly, the values of Isc and Voc marked on this module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor current ratings, fuse sizes, and size of controls connected to the module output.

(8)Fire Class rating: Fire Class C