Jackery
Solar Generator

Jackery Solar Generator Standard

Bring Green Energy to All

Q/JAK

Jackery Solar Generator

(Carbon-reducing Product) Standard

Q/JAK 001-2024

Solar Generator (Carbon-reducing Product) Requirement

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Jackery. Inc

Contents

Introduction

Please note that certain contents of this document may be subject to patents. The public agency of this document assumes no responsibility for identifying patents.

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Requirements for Solar Generator (Carbon-reducing Products)

1 Purpose

This document specifies the supply chain, product performance, safety regulations, and reliability requirements and testing methods for Jackery's carbon-reducing product - the Solar Generator ("SG"), to support the supplying of reliable Solar Generator products to global consumers.

This document applies to the combination of solar generators with lithium-ion batteries, portable power stations and portable solar panels, which are used in outdoor conditions. The solar generator gets the electricity input through portable solar panels, with one or more AC/DC voltage input ports, and one or more AC/DC voltage output ports.

2 References

The contents of the following documents are essential clauses of this document through normative references in the text. For referenced documents with annotated dates, only the version corresponding to that date is applicable to this document; For referenced documents without annotated dates, the latest version (including all amendments) is applicable to this document.

IPC-A-610 IPC Acceptability of Electronic Assemblies
J-STD-001 IPC Requirements for Soldered Electrical and Electronic Assemblies
J-STD-033 IPC Handling, Packing, Shipping and Use of Moisture, Reflow, and Process Sensitive Devices

ANSI-ESD/20.20 American National Standards Institute (ANSI) / Electrostatic Discharge (ESD) Association Standard

Project Management Professional (PMP) Certification (developed by PMI)

Failure Modes and Effects Analysis (FMEA) AIAG-VDA 5th Edition

SPC/MSA/PPAP/APQP/FMEA, Five Tools of IATF16949

VDA6.3 German Automotive Industry Quality Standard - Process Audit Standard

ISTA-2A/3A International Safe Transit Association Standards

CQI AIAG Continuous Quality Improvement Series

GB/T 2423.5-2019 Environmental Testing Part 2: Test Methods Test Ea and Guidelines: Shock

GB/T 2423.10-2019 Environmental testing Part 2: Test methods Test Fc: Vibration (sine)

GB 4943.1-2022 Safety of Information Technology Equipment Part 1: General Requirements

GB 31241-2022 Safety Requirements for Lithium-ion Batteries and Battery Packs for Portable Electronic Products

IEC 60068-2-78: 2012 (Environmental testing- Part 2-78: Tests - Test Cab: Damp heat, steady state)

IEC 60904-1 (Photovoltaic devices- Part 1: Measurement of photovoltaic current-voltage characteristics)

IEC 60904-2 (Photovoltaic devices-Part 2: Requirements for photovoltaic reference devices)
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: Classification of solar simulator characteristics)
IEC 61215-2: 2021 (Terrestrial photovoltaic (PV) modules- Design qualification and type approval- Part 2: Test procedures)
IEC TS 61836 (Solar photovoltaic energy systems - Terms, definitions and symbols)
IEC TS 63163 (Terrestrial photovoltaic (PV) modules for consumer products - Design qualification and type approval)

3 Terms and Definitions

GB 4943.1-2022, GB 31241-2022, and IEC TS 61836 definitions and the following terms and definitions apply to this document.

3.1 Solar Generator (SG)

The system consists of power converters (inverters), energy storage devices (e.g., lithium-ion batteries and battery packs), circuits, housing, portable solar panels and other components.
It provides stable AC/DC voltage output and is carried by users.
Note 1: "AC/DC" in this document refers to "alternating current and/or direct current".
Note 2: The input voltage may be either DC or AC.
Note 3: Typically, the weight of the portable power station does not exceed 18 kg, or it may be equipped with wheels or other devices that facilitate mobility to perform its intended purpose.
Note 4: portable solar panels with structure, dimensions, weight and other features that are suitable for carrying and repeated installation and deployment can be equipped with brackets for outdoor, emergency or courtyard power generation applications.

3.2 Rated Input Voltage

The input voltage value or voltage range specified by the manufacturer.
Note: Indicated by U_{in} in volts (V).

3.3 Rated Input Current

The input current value or current range specified by the manufacturer.
Note 1: Indicated by I_{in} in amperes (A) or milliampere (mA).
Note 2: The input current is the maximum continuous consumption current under the rated input voltage conditions.

3.4 Rated Output Voltage

The output voltage value or output voltage range specified by the manufacturer.
Note: Indicated by U_{out} in volts (V).

3.5 Rated Output Current

The output current at the rated output voltage of a single port specified by the manufacturer, or the maximum total output current at the same output voltage for multiple ports.

Note 1: Indicated by I_{out} in amperes (A) or milliamperes (mA).

Note 2: Rated output currents at different output voltages are specified separately by the manufacturer.

3.6 Output Energy

The product of output voltage, current, and time.

Note: The unit is watt-hour (Wh) or kilowatt-hour (kWh).

3.7 Typical Output Energy

Typical Output Energy refers to the discharge energy actually output to an external load when a fully charged solar generator is discharged under the nominal AC output voltage and current conditions until the undervoltage.

Note 1: The typical output energy is the discharge energy at AC output.

Note 2: The output voltage and output current are the labeled output values of the Solar Generator, as shown in 4.2.2 f).

Note 3: The unit is watt-hour (Wh) or kilowatt-hour (kWh).

3.8 Standard Test Conditions (STC)

The irradiance on the irradiation plane is 1000 W/m2, the p-n junction temperature is 25 ℃, and the spectrum conforms to the irradiance distribution of the reference solar spectrum in IEC 60904-3.

3.9 Portable solar panels

Solar panels with structure, size, weight and other elements that are suitable for carrying and repeated installation and deployment.

Note: The portable solar panels referred to in this document is used for outdoor, emergency or courtyard power generation, and can be equipped with brackets according to the application.

4 Advanced Quality Requirements

4.1 Responsibilities of Jackery and Supply Chain

1) Jackery and its supply chain actively respond to the integrity and anti-corruption policy, and all employees work together to build a clean and transparent supply-demand relationship.
2) Jackery provides qualified products to customers on time and in the specified quantity, and provides all necessary supporting data.
3) Jackery communicates openly with customers about any quality, delivery, and cost issues, and responds in a timely manner.
4) Reliable quality is the image identity of Jackery, and it aims to achieve the vision of "becoming the most trusted green energy brand for global consumers".

4.2 Quality Management System (QMS)

1) Jackery has a clear quality management system and has documented requirements to describe all quality related activities.

Jackery is certified to ISO 9001 Quality Management System, ISO 14001 Environmental Management System, ISO 50001 Energy Management System and other ISO system certifications.

2) Jackery establish, document and maintain a Quality Management System as a means of ensuring that products meet specified requirements.
3) Jackery maintain quality records to demonstrate compliance with specified requirements and effective operation of the quality system.
4) The quality system should ensure that all quality activities are implemented during manufacturing and monitored after implementation.

4.3 Quality Management Activities

Jackery implements the following activities to ensure that the product meets customer requirements.

4.3.1 Project Plan

All new products of Jackery require project management plan, and project manager need to obtain the Project Management Professional (PMP) certification initiated by the Project Management Institute (PMI).

The project plan should include sub-project plans for core suppliers, such as pilot production verification on the supplier side, etc.

4.3.2 Pilot Production

All new products of Jackery need to follow a strict pilot production process, which includes four stages: EVT (Engineering Verification Test), DVT (Design Verification Test), PVT (Process Verification Test), and MP (Mass Production).

4.3.3 Risk Identification

Jackery's project team needs to have the ability to identify design risks of the product in the early stage of the project, recommend the use of DFMEA tools, optimize design defects with higher risk levels, and simultaneously pass on the risk items to the manufacturing process verification before PVT. The manufacturing risks should be identified and controlled through the use of PFMEA tools.

4.3.4 Control Plan (CP)

Jackery's quality team needs to develop a quality control plan based on the output of FMEA, and relevant control items need to have documented implementation records. The implementation methods can be achieved through overall inspect, fault-tolerant, and SPC.

4.3.5 Final Inspection and Testing

All products must be passed final inspection and testing before shipment, and the results must be retained.

5 Manufacturing Quality Requirements

5.1 Storage Conditions

5.1.1 Storage Conditions for Raw Materials

It is necessary to monitor environmental temperature, humidity, and electrostatic protection, and to identify battery materials, ESD-sensitive electronic components, and humidity-sensitive components (MSD) for special control, with reference to local fire regulations, ANSI/ESD S20.20, and IPC-J-STD-033.

5.1.2 Storage Conditions for Finished Product

Special attention should be paid to the stacking height to prevent damage to the bottom products. The stacking height should be evaluated through ISTA-2A/3A compression testing and comply with local fire regulations.

5.2 Manufacturing Equipment Requirements

For all manufacturing equipment, stability assessment must be conducted to demonstrate their ability to control critical process parameters stably (CMK>1.67). For all inspection fixtures, repeatability and detection capability evaluation must also be conducted. Test capability, repeatability and measurement system analysis (MSA) must be conducted for all test equipment. The testing equipment should be capable of recording detailed test data and results, and retaining relevant data for at least 5 years.

5.3 Foolproof Validation

All foolproof designs must be validated and assess their ability to detect and intercept defects beyond specifications. The data and results of these evaluations must be formally documented.

5.4 Consumables Validation

Consumables (solder, glue, cleaning paper, cleaning fluids, gloves, coveralls, etc.) must be evaluated to demonstrate their compliance with process requirements and ensure they do not affect product quality.
The data and results of these evaluations must be formally documented.

5.5 Validation of Raw Materials

All raw material suppliers must undergo evaluation by the quality department using the assessment tool of VDA6.3. The requirement for admission to the qualified supplier list is an evaluation score of over 80, and the evaluators need to be qualified for VDA6.3 audits. For the performance verification (including reliability) of raw materials, please refer to Jackery components approval standards.

5.6 Manufacturing Process Requirements

5.6.1 Manufacturing Process Validation

Validation of all manufacturing processes is necessary to demonstrate their stability with respect to identified critical process parameters or product parameters. The acceptance criterion is Cpk > 1.67.

5.6.2 Manufacturing Process Criteria

For the acceptance criteria of printed circuit board assembly (PCBA), refer to IPC-A-610 Class 3 standard. For the process requirements, refer to J-STD-001 Class 3 standard. The PCBA manufacturing workshop must pass the IPC QML Class 3 certification for the above two standards of IPC.

For the assembly process, relevant process standards shall follow the AIAG CQI (Continuous Quality Improvement) series, e.g., CQI-17 Soldering System Assessment Standard, CQI-12 Coating System Assessment Standard, etc.

5.7 Product Traceability

The product serial number must be single and unique, and can be used to query the information such as batch of raw materials, production date, key equipment, testing record, logistics and etc.

6 Transportation Quality Requirements

Product packaging should use environmental-friendly materials and provide a hazardous substance testing report that complies with the environmental requirements of relevant countries/regions. The outer packaging box should meet the requirements of UN38.3 and pass the verification test, complying with the standard requirements for the transportation of hazardous materials. The DGM transportation qualification certificate must be provided and updated at least annually.

After undergoing product transportation packaging testing, which should follow the requirements of ISTA 2A/3A and pass the test and visual inspection, and a laboratory test report should be provided. The packaging shall be secured using pallet stacking method (with a height not exceeding 250 cm).

7 Peripheral Quality Requirements

7.1 Appearance and Marking

7.1.1 Appearance

The appearance of the Solar Generator should meet the following requirements:

a) The product surface should be free of obvious dents, deformations, or other damages, and the surface coating should not have bubbles, cracks, peeling, or abrasion.
b) Metal parts should be free of rust or other damage;
c) Product surface markings should be clear and firmly attached;
d) Product parts should be securely fastened without loosening, and the pluggable parts should be firmly connected.

The appearance of the portable solar panels should meet the design identification and standardization, and the following serious appearance defects are not allowed:

a) Surface damage, cracks, tears;
b) Bending or misalignment of the front panel, back panel, frame, and damage to the junction box;
c) Performance loss caused by bubbles or delamination;
d) Melting or burning of front panel, back panel, adhesive film, or PV device;
e) Damage or loss of mechanical integrity of handles, fasteners, and mounting components;
f) Damage to connections, welding, wiring, and ports;

g) Short circuits or exposed live parts;

h) Failure of label adhesion or unreadable surface printing information;

i) Surface oxidation and rust.

7.1.2 Marking

The main body of the energy storage power product should be marked with the following identification in a clear and legible manner using a common language:

a) Device name and model number;

b) Nominal output energy (the corresponding output voltage, output current and power supply should be indicated)

c) Rated battery energy;

d) Indicate input or output terminal near the interface;

e) Indicate the following parameters near the input connector:

1) Input voltage;

2) Input current;

3) The nature of power supply, DC or AC.

f) Parameters to be indicated near the output interface: The nature of power supply, output voltage or output power.

g) Manufacturer or trademark;

h) Necessary warnings and precautions;

j) Necessary compliance certification marks, e.g. Safety Certification Mark, EMC, energy efficiency, etc;

Portable photovoltaic products should have the following markings:

a) Manufacturer's name or trademark;

b) Product name or model number;

c) Tolerance of open circuit voltage, short circuit current, nominal power value, and related parameters under standard test conditions (STC);

d) Maximum system voltage;

e) The manufacturing date and location should be indicated on the component or can be traced by the product serial number.

f) Electrical shock protection level and necessary safety certification marks.

7.1.3 User Document

Necessary product user information should be provided, including but not limited to:

a) User Manual including usage safety, component maintenance, etc.

b) Important Safety Instructions

c) Assembly or Installation Instructions, including but not limited to safety warnings, electrical connection methods, mechanical installation methods, etc.;

In addition, the corresponding accessories, connection methods, operation methods of the Solar Generator should be defined, as well as preventive measures in case of emergencies during use. The maximum recommended number of components for portable photovoltaic products in series/parallel should also be provided.

7.1.4 Packaging

a. Indicate the dimensions (Height x Length x Width) and weight (Weight) of the product packaging.

b. The shipping mark should include the following:

1) Purchase Order

2) SKU number

3) Product Description

4) Up arrow to indicate stacking direction

5) Case pack count

6) Case weight

7) Country origin

c. Battery mark must indicate the UN number, and the mark format follow UN38.3 document.

d. The package meet ISTA 2A or 3A test requirement and can provide test report from CNAS lab.

7.2 Interfaces

The input and output interfaces should be clearly specified in the provided product manual. The appearance should be neat, regular, without damage or deformation, and have reverse polarity protection design. After plugging in, it should be able to input and output with normal function and safety.

8 Function and Environmental Adaptability

8.1 Portable Power Station

8.1.1 Charging Method

Charge in compliance with the method specified in the instruction manual.

Note: Before charging, the product should be discharged in compliance with the method specified in the instruction manual.

8.1.2 Discharging Method

Discharge in compliance with the rated output voltage and rated output current specified in the instruction manual until the output is turned off.

8.1.3 Function Test

Verify the functions of the power supply in compliance with the product specification and key technical parameters, and generate a test report. The product should not catch fire, explode, leak liquid, or leak gas, and the product should not have any internal components exposed. After testing, the function should be normal. For test items, please refer to Table 1.

Table 1 Product Function Test Items

No.	Test items	Test conditions	Judgment criteria
1	Output energy	Set aside the fully charged product for 4 hours at an ambient temperature of 23℃±2℃, and discharge it under the output working conditions declared by the manufacturer.	The output energy should not be less than nominal output energy
2	Low temperature output energy	Set aside the fully charged product for 6 hours at an ambient temperature of -10℃±2℃ or lower, and discharge it under the output working conditions (output voltage and output current) declared by the manufacturer.	1. The output energy should not be less than 70% of the typical output energy; 2. For the lithium iron phosphate battery, the output energy should not be less than 60% of the typical output energy
3	High temperature output energy	Set aside the fully charged product for 4 hours in a high-temperature chamber at 40℃±2℃, and discharge it under the output working conditions (typical output voltage and output current) declared by the manufacturer.	The output energy should not be less than 80% of the typical output energy;
4	Energy retention capability	Set aside the fully charged product in the off state for 28 days at an ambient temperature of 23℃±2℃.	The output energy should not be less than 95% of the typical output energy;
5	Battery cycle life	Conduct the test at an ambient temperature of 20℃±5℃, and perform a capacity check every 50 cycles during the test, for a total of 1000 cycles or more, based on the manufacturer's declared working conditions and cycle times.	The capacity should not be less than 80% of initial capacity
6	AC Output Voltage	Adjust the load on the output port in compliance with the rated voltage and current defined by the manufacturer, and measure it after loading for 10 minutes.	U_{out}+7%, U_{out}-10%
7	DC Output Voltage		u_{out}±5%
8	Noise	Measure the product noise in compliance with section 7 of the GB/T 18313-2001 standard, using A-weighted acoustic power level.	The noise should not exceed 50 dB.

8.1.4 Environmental Adaptability

Verify the structural reliability of the Jackery product in compliance with the product specification and structural strength requirements, and generate a test report. The product should not catch fire, explode, leak liquid, or leak gas during the testing process, and the product should not have any internal components exposed. After testing, the function should be normal. If there is no special requirement, generally refer to the following test items as Table 2.

Table 2 Mechanical Strength Test Items

No.	Test items	Test conditions	Judgment criteria
1	Vibration	Conduct a sine vibration test on the X, Y, and Z directions in compliance with the test method specified in GB/T 2423.10, with the vibration waveform parameters referring to Table 3.	The product function is normal and no loose parts or exposed components.
2	Shock	Conduct the test in compliance with the test method specified in GB/T 2423.5 for shock testing.	The product function is normal and no loose parts or exposed components.
3	Free fall	1) For product with a weight of <=18kg, drop the product from a height of 75cm in free fall onto a concrete floor. Total 3 orientations including X, Y, and Z, each for one time. 2) For product with a weight of >18kg, drop the product from a height of 20cm in free fall onto a concrete floor. Total 3 orientations including X, Y, and Z, each for one time.	The product function is normal and no loose parts or exposed components.

Table 3 Vibration Waveform Parameters (sine Curve)

Frequency (Hz)	Amplitude (mm)	Acceleration m/s^2	Logarithmic sweep cycle time (min)	Number of tests in each direction
10~35	0.35	/	15	12
35~200	/	30		

8.1.5 Safety

Verify the safety protection function of the Jackery product in compliance with the product specification and safety requirements, and generate a test report. The product should not catch fire, explode, leak liquid, or leak gas during the testing process, and the product should not have any internal components exposed. After testing, the functions should be normal. For test items, please refer to Table 4.

Table 4 Product Safety Test Items

No.	Test items	Test conditions	Judgment criteria
1	Overcharge Protection	Load the input port with a power supply continuously for 8 hours, with the power supply voltage set to 1.1 times the rated input voltage.	The product function is normal.
2	Short-circuit protection	Short-circuit the positive and negative poles with a resistor of (80±20 mΩ) on the output end for 1 hour, and monitor the battery temperature changes during the test.	The product function is normal and the battery temperature should not exceed 150℃.
3	Overload protection	Connect an adjustable load and adjust the load to reach the maximum rated output current value. Continuously adjust the load until the overload protection circuit is activated.	The product function is normal.
4	Misoperation	Connect the rated input voltage to the output port and charge for 1 minute, and connect the rated output voltage to the input port for 1 minute.	The product function is normal.

8.2 Portable Solar Panels

8.2.1 Product Classification

Under the general outdoor weather conditions defined in GB/T 4797.1, the products are classified as 2 categories listed in Table 1 according to different application scenarios and expected outdoor exposure times.

Table 1 Product Classification of portable solar panels

Product type	Category I	Category II
Application scenario	Mobile applications, suitable for charging smart phones, mobile terminals and other electronic devices, with low-frequency outdoor exposure	Portable applications, used in emergency power supply /hiking/camping, with medium-frequency outdoor exposure and mechanical strength, and with repeated installation and storage requirements.
Electric Safety	It meets the requirements of IEC 61730-1 anti-electric shock protection class III with the open voltage not exceeding 35V and the power not exceeding 40W for photovoltaic module. The open voltage of the series system should not exceed 35V,	It meets the requirements of IEC 61730-1 anti-electric shock protection class II for photovoltaic module with the power greater than 40W.

	and the parallel system should provide reverse current and over-voltage protection.	

8.2.2 Test Items

Table 2 lists the test items for portable solar panels.

Table 2 Test Items for portable solar panels

No.	Test description		Product category	
			Category 1	Category 2
1	Visual inspection		√	√
2	Determination of maximum power		√	√
3	Insulation test		√	√
4	Wet leakage test		-	√
5	Outdoor exposure test		√	√
6	Hot spot endurance test		-	√
7	UV pre-treatment test		-	√
8	Thermal cycling test		√	√
9	Damp heat test		√	√
10	Damp freeze test		√	√
11	Salt spray test		√	√
12	Photovoltaic lead terminal strength test	a) Cable swing	√	√
		b) Cable load	√	√
13	Plug and unplug test		√	√
14	Mechanical vibration test		√	√
15	Single-device drop test		√	√
16	Folding and unfolding test		√	√
17	Bracket endurance test		√	√
Note:"√" indicates that the test is required, "-" indicates that the test item is not required.				

8.2.3 Different Arrangements for the Same Test

Different categories of portable solar panelss have different arrangements for differences during the same test, as shown in Table 3.

Table 3 Parameters of Test Items for Different Product Categories

Items	Total Irradiation of Outdoor Exposure (kWh/㎡)	Total UV aging irradiation dose (kWh/㎡)	Thermal cycling test (number of cycles)	Damp heat test (h)	Damp freeze test (number of cycles)	Photovoltaic lead terminal strength test (number of swings)	Plug and unplug test (number of times)	Folding and unfolding test (number of cycles)	Bracket endurance test (number of cycles)

Category 1	30	-	20	100	2	500	500	3000	500
Category 2	60	√	60	300	4	1500	1500	3000	1500
Note: "-" indicates not applicable, " √ " indicates that the test is required.									

8.2.4 Test Sequence

The test sequence should be performed in accordance with the requirements of Jackery's in-house laboratory testing standards.

8.2.5 Determination Rules

When all test items meet the requirements, the type test is determined to be qualified. If one or more samples do not meet the specified requirements in any of the test items, the test should be stopped. The manufacturer should analyze the unqualified items, find out the reasons for the failures, and take corrective measures. After that, the type test can be conducted again. If the retest is qualified, the test is still determined as qualified. If the retest still has test items that do not meet the specified requirements, the type test is determined as unqualified.

8.2.6 Test Procedure

8.2.6.1 Test Method

Carefully inspect each component under illumination not less than 1000 lux. Record or photograph the status and location of any cracks, bubbles, delamination, etc. These defects may worsen in subsequent tests and have adverse effects on the performance of the components.

8.2.6.2 Determination of Maximum Power

The initial electrical performance of the sample should meet the requirements of a), and the electrical performance measured after environmental testing should meet the requirements of b):

a) Initial electrical performance: open-circuit voltage, short-circuit current, and power should be within the nominal range of the nameplate.
b) Maximum power testing should be conducted before and after the test. For product category I, the maximum output power attenuation after each sequence test should not exceed 20% of the nominal value. For product category II, the maximum output power attenuation after each sequence test should not exceed 15% of the nominal value.

Test method: Conduct initial electrical performance and electrical performance test after environmental test according to the following device conditions and procedures:

a) Irradiance (1000±50) W/m^2, ambient temperature (25±2) °C;
b) The radiation source should be natural sunlight or solar simulator illumination that meets the CAA level or higher level of IEC 60904-9;
c) Standard photovoltaic devices that comply with IEC 60904-2;
d) The reference device should use the same cell technology as the test sample to match the spectral

response, and there are no size requirements for the reference device.

e) The reference device should be perpendicular to the incident light, and the test sample should be placed on a bracket to maintain the same plane as the reference device.

f) I-V curve testing equipment that complies with IEC 60904-1.

g) Test the voltage-current characteristics of the component under standard conditions directly based on the above conditions and device.

8.2.6.3 Insulation Test

The measured insulation resistance multiplied by the component area should not be less than 40 MΩ·m^2.

Test Method: Determine if there is adequate insulation between the energized components and accessible components of the device based on the conditions and steps below:

a) Environmental Conditions: The test should be conducted at room temperature with a relative humidity that does not exceed 75% RH.

b) Connect the positive and negative terminals of the component to the positive terminal of the safety tester.

c) Connect the exposed metal components of the device to the negative terminal of the safety tester. If the device does not have a frame or frame insulation, wrap a conductive foil around the edges of the device and cover all polymer surfaces, including the front and back panels and the junction box. Connect all conductive foils to the negative terminal of the safety tester.

d) Apply a pre-treatment voltage and increase the voltage to 2000 V plus 4 times the maximum system voltage at a voltage rise rate that is less than 500 V/s, and maintain the voltage for 1 minute.

e) Reduce the applied voltage to zero and short-circuit the terminals of the testing equipment to discharge the accumulated voltage in the component.

f) Remove the short circuit;

g) Increase the voltage at a rate less than 500 V/s to 500 V or the maximum system voltage, whichever is greater. Maintain the voltage for 2 minutes and measure the insulation resistance.

h) Reduce the applied voltage to zero and short-circuit the terminals of the testing equipment to discharge the accumulated voltage in the component.

i) Remove the short circuit and disconnect the test equipment from the component.

8.2.6.4 Wet Leakage Test

The measured insulation resistance multiplied by the component area should not be less than 40 MΩ·m^2.

Test Method: Determine the insulation performance of the component under humid working conditions based on the following conditions and procedures, and verify the possibility of corrosion, leakage, or safety accidents caused by moisture from rain, fog, dew, or melting snow:

a) Immerse the component in a water solution with a resistivity not greater than 3500 Ω·cm and a temperature of (22±2)℃. The immersion depth should cover all surfaces except for the entrance of the

lead box (not for immersion). If it is not fully immersed, the lead box should be thoroughly sprayed with the solution;

b) Connect the positive and negative terminals of the component to the positive terminal of the safety tester, and connect the test liquid (water solution) to the negative terminal of the testing equipment.

c) Increase the voltage at a rate less than 500 V/s to 500 V or the maximum system voltage, whichever is greater. Maintain the voltage for 2 minutes and test the insulation resistance.

d) Reduce the applied voltage to zero and short-circuit the terminals of the testing equipment to discharge the accumulated voltage in the component.

e) Remove the short circuit and disconnect the test equipment from the component.

8.2.6.5 Outdoor Exposure Test

Preliminarily evaluate the component's ability to withstand outdoor conditions based the following conditions, and reveal any synergistic degradation effects that may not be detected by laboratory testing:

a) The test is conducted under the general outdoor weather conditions specified in GB/T 4797.1;

b) Connect the positive and negative terminals of the photovoltaic cell to the working load near the maximum power point, install it outdoors in the manner recommended by the manufacturer, and keep it in the same plane as the irradiance monitor.

c) Measure the component with a monitor to ensure that it receives the total irradiance dose specified in Table 3.

8.2.6.6 Hot Spot Endurance Test

Conduct the hot spot endurance test in compliance with the testing method specified in section 4.9 of IEC 61215-2:2021, the result should meet the requirements.

8.2.6.7 UV Pretreatment Test

Before conducting the thermal cycling test, perform UV radiation pre-treatment on the component using the following equipment and method to identify materials and adhesives that are susceptible to UV degradation:

a) Measure the irradiance on the component plane using a radiometer, ensuring that the irradiance in the wavelength range of (280-400) nm does not exceed 250 W/m^2 (approximately 5 times the level of natural light) and the irradiance uniformity does not exceed ±15%.

b) Install the component on the testing plane selected in step a) under short-circuit or open-circuit conditions, with the UV irradiation beam perpendicular to the testing plane. Ensure that the temperature sensor reading of the component is (60±5)℃. For flexible components, during testing, use the specified substrate, adhesive, or accessory in compliance with the manufacturer's documentation and install it in the specified manner.

c) The difference in total ultraviolet irradiation on the front of the component in the wavelength range

between 280 nm and 400 nm should be greater than or equal to 3% and should not exceed 10%. For the total irradiance for UV aging for different products, please refer to Table 3.

8.2.6.8 Thermal Cycling Test

Determine the component's ability to withstand thermal mismatch, fatigue, and other stresses caused by repeated temperature changes using the following device and method:

a) Install a suitable temperature sensor near the center of the front or back of the component, and place the component in a temperature-controlled box at room temperature. Unfold the component to its operating state and install the frame or bracket following the supplier's instructions;

b) Connect the tested component to an appropriate current source. During the thermal cycling test, set the continuous current during the heating cycle to the STC peak power current while the temperature changes from (-40±2)℃ to (+85±2)℃. During the cooling process, the continuous current should be reduced to no more than 1.0% of the STC peak power current when the temperature stays at (-40±2)℃ and exceeds (+85±2)℃ to measure continuity. If the temperature rises too quickly (>100 ℃/h) at the lowest temperature, the current can be delayed until the temperature reaches -20 ℃ before starting.

c) Turn off the temperature-controlled box and cycle the component's temperature between (-40±2)℃ and (+85±2)℃ in compliance with the layout in Figure 1. The rate of temperature change between the highest and lowest temperatures should not exceed 100℃/h, and under each extreme temperature, the current should remain stable for at least 10 minutes. Except for cases where the component has a large thermal capacity and requires a longer cycle time, the cycle time should not exceed 6 hours, and the number of cycles for different products should be based on Table 3.

d) Throughout the entire testing process, record the component's temperature and monitor the current passing through the component.

e) Under open-circuit conditions, after a recovery period of 1 hour in an environment with a temperature of (23±5)℃ and a relative humidity not exceeding 75%RH, conduct the test again in compliance with the methods specified in sections 8.2.6.11 and 8.2.6.12.

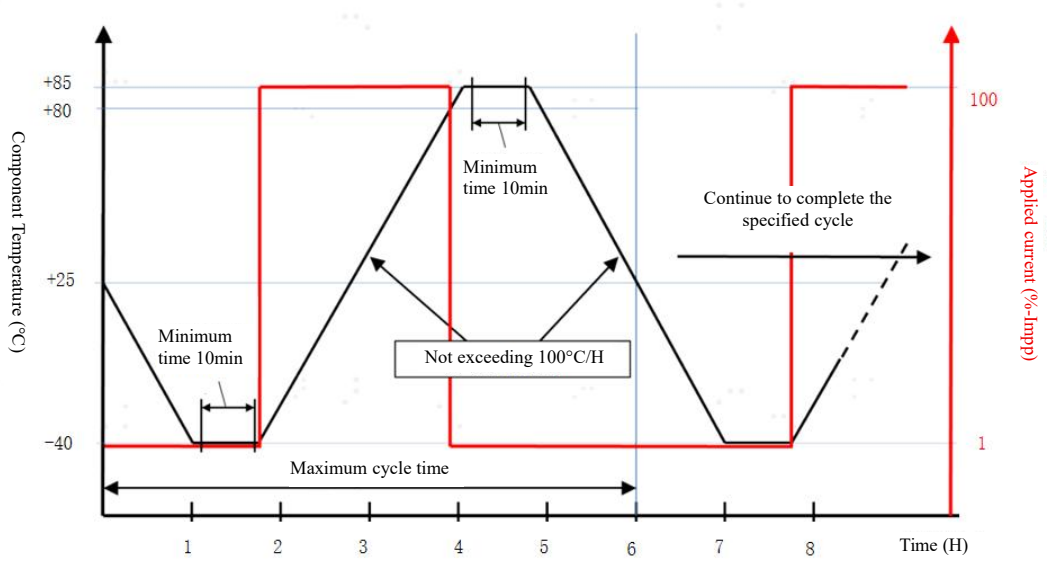

Figure 1 Thermal Cycling Test

8.2.6.9 Damp Heat Test

Determine the component's ability to withstand long-term moisture penetration using the following devices and conditions:

a) Test conditions: Test temperature: (85±2)°C, relative humidity: (85±5)%RH;

b) The test box should comply with section 4.1 of IEC 60068-2-78:2012, and the component should be installed using the specified substrate, adhesive, or accessory and installation method in compliance with the manufacturer's documentation.

c) Short-circuit the component;

d) Apply the test conditions, and the test duration for different products should be based on Table 3.

e) Under open-circuit conditions, after a recovery period of 2-4 hours in an environment with a temperature of (23±5)°C and a relative humidity not exceeding 75%RH, conduct the test again in compliance with the methods specified in sections 8.2.6.1, 8.2.6.2, 8.2.6.3, and 8.2.6.4.

8.2.6.10 Damp Freeze Test

It is required that there should be no current interruption or voltage discontinuity during the test process. After the test is completed, the component should meet the requirements specified in sections 8.2.6.1, 8.2.6.2.b), 8.2.6.3, and 8.2.6.4.

Test methods

Determine the component's ability to withstand high temperature, humidity, and sub-zero temperature using the following device and method:

a) Install a temperature sensor near the center of the back or front of the component. If multiple components

of the same type is tested, it is sufficient to monitor the temperature of only one component.

b) Install the component in a test box with automatic temperature and humidity control in compliance with the manufacturer's specified installation method.

c) Connect the temperature monitoring device to the temperature sensor. Connect the positive terminal of the component to the positive terminal of the power supply, and the negative terminal of the component to the negative terminal of the power supply. Apply a continuous current to the component, with the continuous current set to no more than 0.5% of the measured STC peak power current. If this value is less than 100 mA, then apply 100 mA.

d) Close the chamber and follow the parameter curve shown in Figure 2. The number of test cycles for different product categories should be based on Table 3. The temperature tolerance is ±2℃, and the humidity tolerance is ±5% at a constant temperature of 85℃.

e) During the test, record the component temperature and monitor the current and voltage;

f) Under open-circuit conditions, after a recovery period of 2-4 hours in an environment with a temperature of (23±5)℃ and a relative humidity not exceeding 75% RH, conduct the test again in compliance with the methods specified in sections 8.2.6.1, 8.2.6.2, 8.2.6.3, and 8.2.6.4.

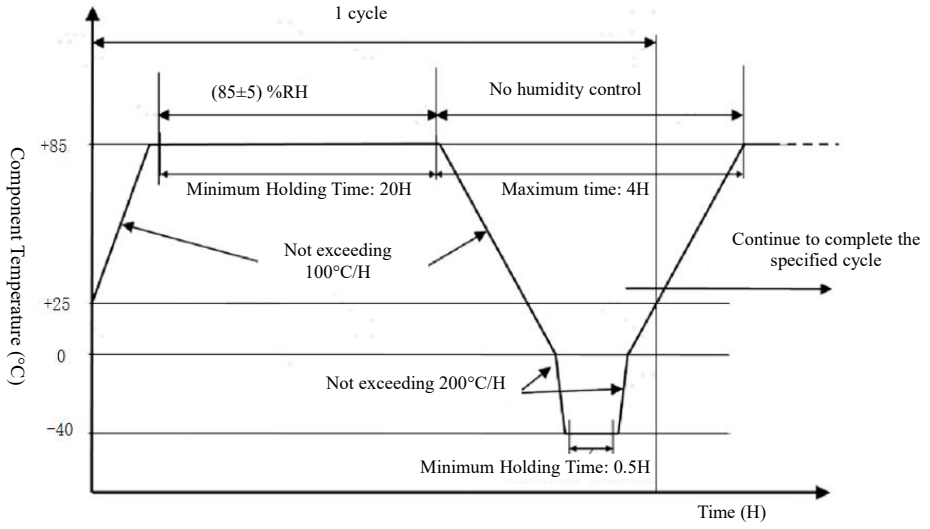

Fig. 2 Cyclic Curve of Damp Freeze Test

8.2.6.10 Salt Spray Test

After the test is completed, the component should meet the requirements specified in section 8.2.6.1.

Use the following conditions and methods to verify the component's corrosion resistance after long-term use, inspect the product's structural design for completeness, and ensure that the minimum level of fastening required for safety requirements is met:

a) Conduct a 24 h test following the test method of GB/T 2423.17;

b) Then, conduct the test in accordance with the method specified in section 8.2.6.1.

8.2.6.11 Photovoltaic Lead Terminal Strength Test

After the test is completed, the component should meet the requirements specified in section 8.2.6.1 and 8.2.6.2.b.

Verify the output wire's ability to withstand swing and mechanical tension using the following test method:

a) Perform a load swing test on the cable in compliance with the method specified in GB/T 2097.1. The load used for the test is 300g, the swing angle is 120 degrees (60 degrees on each side of the vertical line), the speed is 20 times/min, and the number of swings should be based on Table 3.
b) The wire should be at a 90-degree angle with the ground. Suspend the data cable vertically on a tensile testing machine and fix the tail end with a weight of 5 kg for 1 minute.
c) Then, conduct the test in accordance with the method specified in section 8.2.6.1 and 8.2.6.2.

8.2.6.12 Plug and Unplug Test

Verify the reliability of the output or input port after long-term plugging and unplugging using the following method and steps:

a) Test the photovoltaic wiring terminals, adapters, and female sockets by plugging and unplugging them at a rate of 10 times/min. The number of plugging and unplugging for different product categories should be based on Table 3.
b) Then, conduct the test in accordance with the method specified in section 8.2.6.1, 8.2.6.2 and 8.2.6.3.

8.2.6.13 Mechanical Vibration Test

Verify that the component can withstand the vibration conditions during its lifetime and work normally in compliance with the provisions of section 7.3 of GB 31241-2022.

a) At room temperature, fix the product on a sine wave vibration table. Test the foldable product in its closed state, and the product should not deform.
b) Use a sine wave for vibration test and perform a logarithmic sweep with frequency from 7 Hz to 200 Hz within 15 minutes, then return to 7 Hz.
c) Perform vibration in three directions perpendicular to each other (one of the directions must be perpendicular to the plane where the positive and negative terminals of the sample are located). Repeat each direction 12 times using the logarithmic sweep method described above, and vibrate for 3 hours. The logarithmic sweep method is as follows: maintain a peak acceleration of 9.8 m/s^2 from 7 Hz to 18 Hz. Maintain the amplitude at 0.8 mm (displacement of 1.6 mm) until the peak acceleration reaches 78.4 m/s^2 (frequency of about 50 Hz), and then maintain a peak acceleration of 78.4 m/s^2 until the frequency increases to 200 Hz.
d) Then, conduct the test again in compliance with the testing methods specified in sections 8.2.6.1 and

8.2.6.2.

8.2.6.14 Drop Test

Determine the product strength to throwing, compression, and falling during handling, transportation, storage, and use the following conditions and steps. The product should be unpackaged, and the foldable product should be in the folded state. The test method is as follows.

a) Free fall the product onto a concrete floor from the drop height corresponding to Table 4. Drop the product once on each surface, and conduct a total of 6 tests.
b) Then, conduct the test in accordance with the method specified in section 8.2.6.1, 8.2.6.2, 8.2.6.3 and 8.2.6.4.

Table 4 Drop Test Conditions

Component mass*m* kg	Test method	Drop height (cm)
$m<3.5$	Overall	70
$3.5\leq m<8$	Overall	60
$8\leq m<12$	Overall	50
$m\geq 12$	Overall	40
Note: mass indicates the actual measured value of the sample.		

8.2.6.15 Folding and Unfolding Test

Verify the foldable area's ability to resist bending during use using the following method and steps: Consider unfolding and folding of the component once as one cycle, with the test method as follows:

a) The bending frequency should not exceed 20 times/min;
b) The number of folding cycles for different product categories should be based on Table 3;
c) Then, conduct the test in accordance with the method specified in section 8.2.6.1, 8.2.6.2, 8.2.6.3 and 8.2.6.4.

8.2.6.16 Bracket Durability Test

Verify the reliability of the component bracket after long-term use using the following method and steps.

a) Consider unfolding and folding of the brackets once as one cycle;
b) The testing frequency should not exceed 20 times/min;
c) The number of folding and unfolding times for different product categories should be based on Table 3;
d) Then, conduct the test in accordance with the method specified in section 8.2.6.1, 8.2.6.2 and 8.2.6.3.

9 Product Safety and Environmental Protection

The Solar Generator should comply with the safety certification requirements of the corresponding country or region and obtain the product certificate or test report of the corresponding country or region. The product safety standards and requirements of major countries are as follows:

Countries/Regions	Authentication	Categories	Certification standards
All	UN38.3	Transportation safety	UN38.3 Test Report, MSDS, Air/Sea/Land Transportation Certificate, Hazardous Characteristic Identification Report.
United States	UL	Security	The main standard is UL 2743. UL 1741 is added for photovoltaic function, UL 1012 is added for AC output greater than 20A, and UL 1778 is added for UPS function.
	FCC	EMI	47 CFR FCC Part 15 Subpart B:2017 ANSI C63.4:2014, Class B
	FCC ID	Wireless RF	FCC Part 15 Subpart C
	CEC	Energy Efficiency	California Code of Regulations, Title 20: Division 2, Chapter 4, Article 4, Sections 1601-1609. Appliance Efficiency Regulations
	DOE	Energy Efficiency	10 CFR Part 430(the energy conservation standards specified in the Code of Federal Regulations at 10 CFR 430.32(z))
	TSCA	Chemical	40 CFR Parts 700-766
	California Proposition 65	Chemical	US California Proposition 65 - for areas on the outer surface that can be touched
Canada	CUL	Security	The main standard is UL 2743. UL 1741 is added for photovoltaic function, UL 1012 is added for AC output greater than 20A, and UL 1778 is added for UPS function.
	IC	EMI	ICES-003, Class B
	IC ID	Wireless RF	RSS-102, Issue 5 (March 2015) and RSS-Gen, Issue 5 (April 2018).
	NRcan	Energy Efficiency	CSA C381.2-17 or Appendix Y to Subpart B, Part 430 of Title 10
China	Quality Inspection Report	Security	GB4943.1-2022, SJT 11893
	CCC	Security	GB31241-2022, GB4943.1-2022
	SRRC	Wireless RF	Regulations on Radio Management of the People's Republic of China
Japan	Inspection Report	Security	J62368-1(2020), J3000(H25)
		EMC	IEC 61000-3-2:2018, J55032
	Round PSE	Security	J62133
	Diamond PSE	Security	J62368-1(2020). The product should meet the following conditions to apply for the diamond PSE certificate. 1. The product has AC to DC voltage function, which means that when using AC mains voltage, the voltage of the DC output port is converted from the AC mains, not from the battery inside the product. 2. When all DC output ports are loaded with the rated load, the rated power of the input end does not exceed 1 kVA.
		EMC	J55032(H29)
	TELEC	Wireless RF	MIC (Ministry of Internal Affairs and Communications of Japan) Notice No. 88 Regulation
South Korea	KC	Security	KC62368
	KC	Security	KC62133 (≦500Wh)
	KC	Security	KC62619(>500Wh)
	KC	EMC	KSC 9832:2019/KSC9835:2019
	KC	RF	KSX3123:2020, KSX3124:2020/KSX 3126:2020
European Union	CE/LVD	Security	IEC EN62368-1, EN62471, EN62040-1, EN62619, EN62133-2
	CE/EMC	EMC	EN55032, EN55035, EN55015, EN61547, EN50498, Class B

	CE-RED	Comprehensive Requirements	Safety + Health + EMC + Wireless RF
	ROHS	Chemical	Directive EU 2015/863 amending Annex II to Directive 2011/65/EU
	REACH	Chemical	EU Regulation (EC) No 1907/2006 REACH 2011
	WEEE	Chemical	2012/19/EU
	Battery Directive	Chemical	2006/66/EC (for batteries)
	POPs	Chemical	Persistent Organic Pollutants (EU) 2019/1021
	PAHs	Chemical	AfPS GS 2019:01 PAK & REACH Annex 17
Australia	SAA	Security	AS/NZS4763+AS/NZS62368+62040+60335
	C-Tick	EMC	CISPR 14-1
	RCM Registration	Others	Safety + EMC + Wireless RF
All Countries	Quality Inspection Report	Safety & Performance	portable solar panels follow standard IEC TS 63163
United States	FCC	EMC	portable solar panels, FCC Part 15 Subpart B, 10-1-2020 Edition
European Union	CE	EMC	portable solar panels, EN 61000-6-1, EN 61000-6-3

10 Network Security

The security of Solar Generator APP should be comprehensively checked and evaluated to improve the test reports from third-party authoritative organizations, focusing on user data protection, network security, security updates and vulnerability remediation, access control, secure coding practices, etc., in order to meet and comply with local network regulatory requirements, ensure the security of user data, and prevent information theft.

Countries/Regions	Authentication	Categories	Certification standards
United States	IoT Network Security	Security	Conduct an assessment based on NISTIR 8259A
European Union	IoT Network Security	Security	Conduct an assessment based on ETSI EN 303 645

11 Green Supply Chain Requirements

"Bring Green Energy to All" is Jackery's mission, aiming to promote green manufacturing and help the photovoltaic energy storage industry achieve carbon peak and carbon neutrality goals. Jackery continuously seeks to promote the advancement of green supply chains, from obtaining green factory certification for its factories to obtaining carbon footprint certification for its new products. Jackery sets an example and promotes the requirement of zero-carbon emissions throughout the entire supply chain.

Jackery

Solar Generator

Bring Green Energy to All