

Solar Home System Kit Quality Standards

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Lighting Global is in the process of expanding the quality test methods to cover larger solar home system kits. This document describes the revised Quality Standards for Solar Home System Kits, which set a baseline level of quality, durability, and truth in advertising to protect consumers. Eligibility criteria for kits to be covered by these Standards are listed below, and the proposed Standards are presented in Table 1 on the next page.

Conformance with the Quality Standards is evaluated based on results from laboratory testing according to the Lighting Global Solar Home System Kit Quality Test Method (QTM). The tests are conducted at a third-party, approved test center using randomly-procured samples. Information contained in Lighting Global Standardized Specification Sheets (SSS) or Spec Books is acceptable for determining conformity with the Quality Standards; any product with an up-to-date SSS is required to have passed the Quality Standards.

On-going developments related to the QA framework for solar home system kits will be posted on the Lighting Global Stakeholder page (<https://www.lightingglobal.org/qa/stakeholder-engagement/>).

Product Eligibility Criteria

1. All components required to provide basic energy services are packaged as a kit:

- PV module(s)
- Charge control unit(s)
- Battery/batteries
- Cables, switches, connectors, and protective devices sufficient to connect the PV module(s), charge control unit(s) and battery/batteries
- Loads (optional)
 - Lighting and requisite cables
 - Load adapter cables (e.g., for mobile phones)
 - Other appliances (TV, fan, radio, etc.) and their requisite cables

Note that the kit may consist of interchangeable components from a product family. The product family may be eligible for testing according to the [Lighting Global Framework for Testing Product Component Families](#).

2. The system voltage must be considered extra-low voltage (below 50 V DC).

3. Only DC systems, outputs and loads are covered. No inverters or AC outputs/outlets, or AC appliances are eligible for support through Lighting Global.

4. The peak power rating of the kit is less than or equal to 100 Watts.

5. Kits must be plug-and-play. Plug-and-play implies that no design expertise is required to choose appropriate system components and no technicians or electricians are necessary to safely and successfully install and operate the system. All electrical connections can be made without the use of tools. Installation and operation instructions should be presented using language and graphics that can be understood by the typical consumer.

Table 1. Solar Home System Kit Quality Standards

Category ^a	Metric	Quality Standard
Truth In Advertising	Manufacturer	Accurately specified
	Product Name & Model #	Accurately specified
	Performance Claims: Light Output, Run Time, Appliance Power Consumption	If reported, accurately specified ^b
	Lamp Type, PV Power, Battery Capacity, Charger Rating, Other Aspects	If reported, accurately specified ^b
	Ports	Port voltage and current specifications, if provided, must be accurate. Included appliances must function. Power output of port must be sufficient to power appliances that are advertised but not included. Specific guidelines for USB and 12-V ports are below. ^c
	Functionality	All advertised features must be functional. Any description of the product that appears on the packaging, inside the package and in any other medium (internet, etc.) should be truthful and accurate. No statements should mislead buyers or end users about the features or utility of the product. Any user interfaces (charge indicators, SOC estimates, etc.) must be accurate.
Lumen Maintenance	Lumen Maintenance at 2,000 Hours	Average relative light output of 4 samples $\geq 90\%$ of initial light output at 2,000 hours, with only one sample allowed to fall below 85% OR All samples maintain $\geq 95\%$ of light output at 1,000 hours.
Health and Safety	Circuit and Overload Protection	The system must pass an overcurrent and an overload protection test. Products must include a current limiting mechanism to prevent irreversible damage to the system. The mechanism must be easily resettable or replaceable by the user, or must automatically reset. If replaceable fuses are used for circuit protection, sizes must be labeled on the device and listed in the user manual, and, if fuses are replaceable by the user, at least one spare fuse must be included with the product.
	AC-DC Charger Safety	Any <i>included</i> AC-DC charger carries approval from a recognized consumer electronics safety certification organization. ^d
	Wiring and Connector Safety	Wires, cables and connectors must be appropriately sized for the expected current and voltage.
	Hazardous Substances Ban	No battery may contain cadmium or mercury at levels greater than trace amounts ($<0.0005\%$ Hg and $<0.002\%$ Cd by weight in accordance with the EU Battery Directive).
Battery	Replaceability	Batteries must be field replaceable. Tamper-evident enclosures are permitted, though tamper-proof enclosures are not. ^e
	Battery Protection	All 4 samples are protected by an appropriate charge controller that prolongs battery life and protects the safety of the user. ^f Lithium batteries must additionally carry UN 38.3 certification and have overcharge protection for individual cells or sets of parallel-connected cells.
	Battery Durability	The average capacity loss of 4 samples must not exceed 25% and only one sample may have a capacity loss greater than 35% following the battery durability storage test. ^g
Quality and Durability	PV Overvoltage Protection	If the battery is disconnected, the system must not be damaged and PV open-circuit voltage must not be present on load terminals.

Category ^a	Metric	Quality Standard		
	Miswiring Protection	The user interface should be designed to minimize the likelihood of making improper connections. If improper or reversed connections can easily be made, they should cause no damage.		
Quality and Durability continued	Physical Ingress Protection (for components containing electronics or electrical connections)	Fixed Outdoor Components	IP5x	
		All PV Modules	IP3x	
		All Other Components	IP2x	
	Water Protection ^h (for components containing electronics or electrical connections)	Fixed Outdoor Components	Permanent outdoor exposure: IPx5 OR IPx3 AND circuit protection	
		All PV Modules	Outdoor rooftop installation: Modified IPx4 OR circuit protection	
		Portable Integrated Components	Frequent rain: IPx3 OR technical equivalent OR IPx1/equivalent + warning label	
		Portable Separate Components	Occasional rain: IPx1 OR technical equivalent OR with warning label	
		Fixed Indoor Components	No requirement	
	Drop Test	Portable components	All 4 samples are functional after drop test (1 m onto concrete); none result in dangerous failures ⁱ	
		Fixed Indoor and Outdoor Components	No requirement	
	Soldering and Electronics Quality	All 4 samples of system and any included appliances must pass a soldering, electronics and assembly inspection.		
	Switch, Gooseneck, Moving Part, and Connector Durability	Mechanisms expected to be used regularly	All 4 samples are functional after 1000 cycles	
		Mechanisms expected to be used primarily during installation	All 4 samples are functional after 100 cycles	
	Strain Relief	All cables on 4 samples must pass a strain relief test.		
Cable Specifications	Cables must be at least 3 m long when connecting a “fixed indoor” or “portable separate” component to the PV module or any other fixed outdoor component.. Otherwise, components will be considered “fixed outdoor” or “portable integrated.” Any outdoor cables must be outdoor-rated and UV resistant. ^j			
Consumer Information	User Manual	User manual must present instructions for installation, use and troubleshooting of the system. Installation instructions must include appropriate placement and installation of the PV module. Basic electrical safety and system maintenance must also be covered. Installation and operation instructions should be presented using language and graphics that can be understood by the typical consumer.		
	Minimum Warranty Terms	Accurately specified and consumer-facing; minimum coverage of at least three years for the system and PV module and at least two years for the battery. Details are noted below.		

Note: Modifications to these Quality Standards may be included in the final framework targeted for release in November 2015. Topics under review are listed below. Note that this is not an exhaustive list, nor is it guaranteed that all topics will be included in the final framework.

- On-the-box performance reporting requirements such as daily energy service in units of watt-hour per solar day (Wh/day)
- Acceptance of LM-80 data for meeting the lumen maintenance Standard
- Modifications of the Standards to accommodate pay-as-you-go (PAYG) systems

Warranty Requirements Details

To meet the Standard, Lighting Global requires that the following guidelines be followed when presenting and offering a warranty:

- The minimum warranty period is three years for the system and PV module and two years for the battery from the time of purchase by the end-user.
- The warranty must cover, at a minimum, manufacturing defects that impede operation under normal use and protection from early component failure.
- The consumer-facing warranty must explain how the consumer can access the warranty (return to point of purchase/distributor/service center, call or SMS a number, etc.), how the warranty will be executed (repair, replacement, etc.) and should advise the customer to inquire about the warranty terms prior to purchase.
- Full terms of the warranty must be available to the consumer in writing in a way that enables the end user to verify and understand the terms of the warranty prior to purchase. The written information should be in a regionally appropriate language. Consumer-facing warranties could be included on the product box or on a warranty card that is easily accessed prior to purchase.

Note that this is a *Minimum* Standard and it is up to the discretion of manufacturers and distribution partners to exceed the basic protection offered in these terms to differentiate the best quality products in the market.

Other Notes

^a If a sample fails on any aspect at any point during testing, even if not during the specific test used to evaluate that aspect, the sample will still fail on the basis of that aspect. For example, if a switch stops functioning on a sample while its luminous flux is being measured, this failure would be included in the count of failures for the switch test.

^b Numeric aspects, such as light output and run time, must deviate no more than 15% from advertised ratings (though it is always acceptable if actual performance is better than advertised).

^c All ports advertised or reasonably expected to provide 12 V must maintain a voltage between 10.5 – 15 V. All ports with a USB form factor, and all 5 V ports advertised or reasonably expected to be used for mobile phone charging (including barrel plugs) must meet the following standards. These standards are based on the USB Battery Charging Specification Revision 1.2 (USB Implementers Forum, 2012).

- Minimum steady-state voltage: 4.75 V at all simulated battery voltages except the deep discharge protection voltage; 4.25 V at the deep discharge protection voltage.
- Maximum steady-state voltage: 5.25 V
- Maximum sustained current with voltage required to be within range: 0.5A. If higher a current is advertised, voltage must remain within range (4.75-5.25 V) at all currents up to advertised limit.
- Minimum undershoot voltage: 4.1 V
- Maximum overshoot voltage: 6.0 V
- Maximum undershoot time: 10 ms

^d Approved marks: UL, CE, TÜV Rheinland, CCC, or similar, with accompanying valid documentation of testing by an accredited test laboratory. Detailed guidelines are described in the AC Charger Safety Approval Policy

^e Tamper-evident enclosures enable a company or technician to know that a product or battery has been tampered with, but do not impede the function of the product. An example is a sticker that covers the opening to a battery case that would be torn if the enclosure were opened. Tamper-proof enclosures are those in which attempts to open or tamper with the product would result in the product either being damaged or no longer functioning. Examples include products with tamper-proof screws, welded plastic enclosures that cannot be opened, or software measures designed to disable a product if the enclosure is opened or battery is removed. Note, exceptions to this requirement are being considered for PAYG products in which the company maintains ownership of the product.

^f Table 2 contains recommended battery deep discharge protection voltages during testing and Table 3 contains recommended battery overcharge protection voltages and maximum cell temperatures specific to the five common types (i.e., chemistries) of batteries. These default values are used when determining appropriate charge controller behavior, unless alternate appropriate design values are provided by the battery manufacturer for the deep discharge protection voltage cutoff, overcharge protection voltage cutoff or maximum cell temperature. Note that the minimum voltage specification for nickel-based batteries only applies in cases where more than one cell is wired in series.

Table 2. Recommended battery deep discharge protection voltage specifications

Battery type	Recommended deep discharge protection voltage (V/cell)	Minimum allowable discharge protection voltage (V/cell)	Maximum allowable discharge protection voltage (V/cell)
Flooded lead-acid	≥ 1.87	1.82	--
Sealed lead-acid	≥ 1.87	1.82	--
Lithium-ion	≥ 3.00	2.95	--
Lithium iron phosphate	≥ 2.50	2.45	--
Nickel-metal hydride	= 1.00	0.95	1.10

Table 3. Recommended battery overcharge protection voltage and temperature specifications

Battery type	Recommended overcharge protection voltage (V/cell)	Minimum allowable overcharge protection voltage	Maximum allowable overcharge protection voltage	Maximum charging temperature (°C)
Flooded lead-acid	≤ 2.40	2.35	2.50	TBD
Sealed lead-acid	= 2.40	2.35	2.45	45
Lithium-ion	≤ 4.20	--	4.25	45
Lithium iron phosphate	≤ 3.65	--	3.70	45
Nickel-metal hydride	≤ 1.45	--	1.50	60

^g The battery durability storage test requirement may be waived for flooded lead acid batteries which are shipped dry. In cases where batteries are shipped dry, manufacturers must provide the test labs with an adequate amount of the appropriate solution or accurately specify the density and composition of the solution to be used.

^h There are two alternative water protection compliance pathways allowed by Lighting Global (i.e., these are alternatives to meeting the IP class requirements). In one alternative (“technical equivalent”), the whole system of protection (ingress protection + electronic circuit protection + manufacturing QC) is

evaluated to determine if the protection level is equivalent to that of a product with the required level of ingress protection. In another alternative (“warning label”) there are clear messages to the consumer about the degree of protection from water. The warning level messages must meet Lighting Global program guidelines. The pathways and associated guidelines are described in greater detail in a document titled “Integrated Water Protection Assessment.”

ⁱ Dangerous failures are defined as those which may expose the user to physical harm, such as harmful chemicals, heat (e.g., from an electrical short or fire), or sharp materials (e.g. broken glass).

^j Requirements for outdoor cables are still under development. Products must comply with the final policy within one year of when the requirement details are announced.