

Pico-PV Quality Standards

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Lighting Global maintains two sets of Quality Standards, one for pico-products and one for solar home system kits. The Quality Standards are benchmarks that set a baseline level of quality, durability, and truth-in-advertising to protect consumers of off-grid lighting products. The Quality Standards for pico-products (off-grid products with peak power ratings of 10 W or less) are summarized below and listed in more detail on the following pages.

Conformance with the Quality Standards is evaluated based on results from laboratory testing according to the Quality Test Method (QTM) or the Accelerated Verification Method (see [AVM Policy](#)) in the latest edition of the International Electrotechnical Commission (IEC) Technical Specification 62257-9-5. The tests are conducted at a [third-party, approved test center](#) using randomly-procured samples. Products with similar or interchangeable components may not require full re-testing (see [Similar Products Policy](#), [Family of Products Policy](#), [Pay-as-you-go Policy](#) and [Co-branding Policy](#)). Information contained in Lighting Global Standardized Specification Sheets (SSS) or Spec Books is acceptable for determining conformity with the Quality Standards. Products that have met the Quality Standards are also issued a Verification Letter and posted on the Lighting Global website: www.lightingglobal.org/products.

On-going qualification is subject to successful market checks according to the Market Check Method (see [MCM Policy](#)). Renewal testing, equivalent to a primary market check test, is required after two years (see [Renewal Policy](#)).

Summary of Quality Standards



Truth-in-Advertising: Accurate consumer-facing labeling

Lumen Maintenance: L90 time is greater than 2,000 hours.

Battery: Must be durable and adequately protected.

Health and Safety: Batteries may not contain mercury or cadmium, products are safe.

Durability and Quality: Appropriate protection to prevent early failure.

Warranty: Consumer-facing with at least one year of coverage.

Performance Information: Run time and brightness reported along with a note about the impact of auxiliary appliance use, such as mobile phone charging.

Table 1. Lighting Global Quality Standards for Pico-Products

| Category ^a | Metric | Quality Standard |
|---|---|---|
| <i>Truth In Advertising^b</i> | Manufacturer, Product Name and Model No. | Accurately specified |
| | Light Output and Solar Run Time | Accurately reported on packaging for the brightest setting. ^c For other settings, if reported, accurately specified. If there are both pay-as-you-go (PAYG) and non-PAYG versions of a product, each must be truthfully advertised with respect to energy services provided. |
| | Auxiliary Appliance Use | Impact of mobile phone charging or other auxiliary appliance(s) on product performance qualitatively described on packaging. ^c |
| | Fee-for-service or Pay-as-you-go (PAYG) Metering | The PAYG system should be capable of accurately metering service to customers so they reliably get the service that is paid for. |
| | Other Aspects Including: Lamp type, PV Power, Battery Capacity, Charger Rating, Appliance Power Consumption | If reported, accurately specified. If there are both pay-as-you-go (PAYG) and non-PAYG versions of a product, each must be truthfully advertised with respect to energy services provided. |
| | Ports | Port voltage and current specifications, if provided, must be accurate. Included appliances must function when connected to ports. Power output of ports must be sufficient to power appliances that are advertised but not included. Specific guidelines for USB and 12 V ports are below. ^d Ports that are intended for a function other than providing power, such as data ports, are not required to meet this standard. |
| | 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. |
| <i>Lumen Maintenance</i> | Lumen Maintenance at 2,000 hours | Average relative light output of 6 samples $\geq 90\%$ of initial light output at 2,000 hours with only one sample allowed to fall below 85% OR All 6 samples maintain $\geq 95\%$ of initial light output at 1,000 hours. ^e If an included lighting appliance provides ≥ 15 lumens, it is subject to the lumen maintenance standard. |
| <i>Health and Safety</i> | Circuit and Overload Protections | If the product has output ports, 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 product 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. Included appliances are not required to meet this standard unless they have ports that are intended to provide power. |
| | AC-DC Charger Safety | Any <i>included</i> AC-DC charger carries a recognized consumer electronics safety certification. ^f |
| | 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) |

| Category ^a | Metric | Quality Standard | | |
|---|--|--|--|--|
| <i>Battery</i> | Battery Protection | Protected by an appropriate charge controller that prolongs battery life and protects the safety of the user. Five out of 6 samples must meet the requirements outlined below. ^g Lithium batteries must carry IEC 62281, IEC 62133-2, UL 1642 or UN 38.3 certification and have overcharge protection for individual cells or sets of parallel-connected cells. Batteries of included appliances must also meet this standard. For PAYG systems, appropriate battery protection must remain active regardless of whether the system is in an enabled or disabled state. To avoid damage to a battery during long-term periods of non-payment disabled system status, the solar module must be able to charge the battery even if the product is in a disabled state. ^g | | |
| | Battery Durability | The average capacity loss of 6 samples must not exceed 25%, and only one sample may have a capacity loss greater than 35% following the battery durability storage test as defined in IEC 62257-9-5 Annex BB. If an included lighting appliance provides ≥ 15 lumens, it is subject to the battery durability standard. All other appliances are not required to meet this standard. | | |
| <i>Quality and Durability^{h,i}</i> | PV Overvoltage Protection | If the product has output ports and the battery can be disconnected or isolated, the system must not be damaged and the load terminals shall maintain a voltage that is safe for their intended uses. ^j | | |
| | 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 shall cause no damage to the system or harm to the user. | | |
| | Physical Ingress Protection (for components containing electronics or electrical connections) | <i>Fixed Outdoor</i> | IP5x | |
| | | <i>Others</i> | IP2x | |
| | | <i>All PV Modules</i> | IP3x OR IP2x with circuit protection | |
| | Water Protection ^k (for components containing electronics or electrical connections) | <i>Fixed Indoor Components^l</i> | No requirement | |
| | | <i>Portable Separate Components^l</i> | Occasional rain: <i>IPx1 OR technical protection OR warning label</i> | |
| | | <i>Portable Integrated Components</i> | Frequent rain, which requires meeting one of: 1) <i>IPx3</i> 2) <i>IPx1 + technical protection</i> 3) <i>IPx1 + warning label</i> 4) <i>Technical protection + warning label</i> | |
| <i>Fixed Outdoor Components</i> | | Permanent outdoor exposure: <i>IPx5</i> | | |
| <i>All PV Modules</i> | | Outdoor rooftop installation: <i>Modified IPx4 OR circuit protection</i> | | |
| Drop Test | <i>Fixed Indoor and Outdoor Components^l</i> | No requirement | | |

| Category ^a | Metric | Quality Standard | |
|--|---|---|--|
| <i>Quality and Durability Continued</i> ^{h,i} | | <i>Portable Components</i> | Portable lighting components: 5 out of 6 samples are functional after drop test (1 m onto concrete); none result in dangerous failures. ^m |
| | | | Non-lighting portable appliances (such as battery-powered radios, fans, razors and lights with light output below 15 lumens): 5 out of 6 samples are functional following a modified drop test requiring only 2 drops per sample rather than the standard 6 drops; none result in dangerous failures. The sides on which the product is dropped will be alternated between samples to ensure that all six sides are dropped at least once. |
| <i>Quality and Durability Continued</i> ^{h,i} | Soldering and Electronics Quality | The system and any included appliances must be rated “Good” or “Fair” for workmanship quality as defined in Annex F of IEC/TS 62257-9-5. At most, one sample may fail to function when initially evaluated. | |
| | Switch, Gooseneck, Connector, and Moving Parts Durability | Mechanisms expected to be used regularly | All samples and any included appliances are functional after 1000 cycles |
| | | Mechanisms expected to be used primarily during installation ⁿ | All samples and any included appliances are functional after 100 cycles |
| | Strain Relief Durability | All cables on all samples and any included appliances must pass a strain relief test. | |
| <i>Warranty</i> | Minimum Warranty Terms | Accurately specified and consumer-facing; minimum coverage of at least one year on manufacturing defects under normal use, including the battery. Details are noted below. ^e | |

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 at least one year from the time of purchase by the end-user.
- The warranty must cover the entire product, including the battery.
- 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.
- The consumer-facing 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 user agreement or 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 their products in the market.

Electrical Connection Requirements

All electrical connections, other than permanently installed connections made at the time of installation, must be made using plug-and-socket connectors without the use of tools.

Permanently installed connections that are made at the time of installation may be made with screw terminals, spring or lever-actuated terminals, quick disconnect (blade) terminals, or similar methods, provided that the following requirements are met:

- The connection is straightforward to make, provides a good quality electrical connection, and does not require technical expertise to make, such as wrapping wire in a specific direction, soldering, or crimping in the field. For example, the following connections are **not** eligible (note, this is not a comprehensive list):
 - Alligator (crocodile) clips
 - Connections made in the field that require soldering or crimping
 - Screw terminals or binding posts in which the wire is wrapped around the screw and held in place with the screw head or nut, rather than being clamped between two plates or washers. For instance, some binding posts have a hole to insert the wire; in others the wire needs to be wrapped around the post. The latter type requires slightly more care to make a good connection; those that require wrapping the wire are not permitted due to the increased likelihood of the connection being improperly made.
 - Twist-on wire connectors (wire nuts) or wires twisted together
- Adequate instructions are provided for making each type of connection, including:
 - A list of all required tools
 - Sufficient instructions, including illustrations, to make each type of connection so that it will be safe and reliable
- After installation, all terminals, other than connections on the charge controller, must be insulated so that no live electrical parts can be contacted or must be enclosed in a way that the component would meet IP2x (i.e., a 12.5 mm probe cannot enter the enclosure where the terminals are located). In the case of battery terminals, only one terminal must be insulated.

Connectors on charge controllers need not be enclosed or insulated, but shall be designed in a way to minimize the potential for short-circuiting, such as with plastic dividers.

Additionally, the leads from the battery to the charge controller shall have short circuit protection, which will be assessed by inspection. This protection shall be located as close to the battery as practical.

Overcurrent protection for the PV module or array shall meet the requirements of IEC 60364-7-712:712.43 unless all of the following criteria are met:

- The potential maximum current from all sources (the entire array) does not exceed the ampacity of the conductors.
- The inverter or battery is incapable of back-feeding power to the array.
- The array has no more than two identical modules (or series-connected strings of identical modules) wired in parallel.

All terminals for loads are considered ports and are subject to the ports and protection tests, which include the overcurrent protection and PV overvoltage. The entire product is subject to the miswiring test.

- Adequate strain relief shall be provided for all screw terminal connections. The method for providing strain relief shall be clearly described in the installation instructions and, if any equipment or devices are required (other than commonly available tools such as flat or Phillips screwdrivers, pliers, wire cutters, or manual wire strippers), these shall be included with the kit. Easily disconnected terminals, like blade terminals, are only permissible if enclosed in a way that the consumer cannot easily access the terminals during normal use.
- A means is provided and described in the instructions to identify wires or cables in order to avoid incorrect connections (e.g., color coding or labeling of wires).
- Any required tools other than commonly available tools (e.g. flat or Phillips screwdrivers, pliers, wire cutters, manual wire strippers) shall be included with the kit. Alternatively, for kits that are exclusively installed by the company's trained and authorized technicians, tools need not be included in the kit, but documentation shall be submitted confirming that the necessary tools are supplied to the installing technicians.
- All required materials (e.g. wire and terminals) are provided with the kit, supplied to the installing technician, or adequately specified to allow the installer to select the correct materials to make the connection. Note, for most kits, the required wire shall be included with the kit. For systems that are exclusively installed by the company's trained and authorized technicians, wire need not be included and sold with each kit. If wire is not included with the kit, the company shall provide a sufficient sample of the wire they provide to their installers for testing; the length of the sample may be specified by the test lab and must be of sufficient length to perform all of the required tests. The wire shall be accompanied by

a declaration stating that the sample is representative of the wire used in the field and that the wire is appropriately sized for the system. The declaration and user or installation manual shall also specify the wire type and maximum distance for all wires in the system. The testing laboratory shall test the product using the minimum distance of wire for the lumen maintenance test and the maximum distance of wire for all other tests in IEC/TS 62257-9-5.

- All connectors or terminals shall be appropriate for the wire type and size, number of wires, current, voltage, and installation location. If terminals are for indoor use only, this limitation shall be clearly indicated in the installation instructions. Connectors shall be used within their design limits. The company is required to provide specifications for connectors from the connector manufacturer upon request.

NOTE: In most cases, these connections are not considered to be “sensitive electronics,” and therefore the physical and water ingress protection requirements according to IEC/TS 62257-9-5 are as follows:

- For connectors in junction boxes on the back of PV modules: IP3x, or IP2x with technical protection
- For connectors permanently installed outdoors: IP55
- For connectors used indoors: no protection necessary (IP00)

If connections other than plug-and-socket connectors are required, the following notice will be included in the Lighting Global Specification Sheet and Verification Letter/Type Approval and on the Lighting Global website: “Some connections required for installation of this product are not plug-and-play. Lighting Global verification assesses the performance of the system but cannot assess proper installation of the product.”

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 product 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, the product would fail for functionality.

In certain cases, where products are designed for special applications (e.g., productive uses), certain requirements may be waived, altered, or strengthened at the discretion of Lighting Global. Any deviations from the requirements listed in this document will be noted on the Standardized Specification Sheet and Verification Letter for the product.

^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). If a range is provided, the best rating must be within the 15% tolerance. If a run time is advertised, it is assumed to be for solar run time and for the brightest setting, unless otherwise stated. All advertised features shall 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.

Light distribution must only be measured for one sample to determine the full-width-half-max (FWHM) angle.

Included appliances are subject to truth-in-advertising requirements for performance claims. Relevant tests include: light output, battery capacity, power consumption, and the full-battery and solar run time. At the discretion of Lighting Global, existing performance test results for non-lighting appliances (such as TV power consumption from Global LEAP testing) may be referenced in place of additional testing. Only lights with light output greater than or equal to 15 lumens are required to be assessed for light output and light distribution.

Advertising regarding physical and water ingress protection is evaluated at the discretion of Lighting Global. If a product advertises an IP rating of IP54 or higher, the manufacturer must provide documentation of meeting that IP rating based on test results from an accredited laboratory. The following common advertising terms are expected to meet the following IP levels:

- IPX7: Waterproof, or similar
- IPX4: Splashproof, or similar
- IPX3: Rainproof, protected from heavy rain, or similar
- IPX1: Water resistant, splash resistant, rated for outdoor use, or similar
- IP5X: Dustproof, protected from dust, or similar

Note, advertisements cannot supersede the basic IP requirements by component form factor described in the Quality Standards.

^c All manufacturers are required to present performance metrics on product packaging and other relevant consumer-facing materials to enable consumers and distributors to compare products and make educated choices. Detailed guidelines are described in the [Performance Reporting Requirements Policy](#). Four elements are required:

- Brightness / light output in lumens
- Daily solar run time in hours
- Basic warranty terms as described above (note that warranty terms may be included on a user agreement or warranty card that is easily accessed prior to purchase, rather than on-the-box).
- For products that offer mobile phone charging or other auxiliary services, a note that qualitatively describes the impact of mobile phone charging and other auxiliary services on product performance, e.g. reduced solar run time.

The light output and solar run time must be reported for the brightest setting, which is defined as all of the included light points on, including torches or portable lamps, on their brightest settings.

^d *Truth-in-Advertising Requirements for Ports:*

Advertised port voltage ranges are subject to truth-in-advertising requirements.

The measured values shall not fall more than 0.1 V outside of the advertised range for a 12 V port or more than 0.05 V outside of the advertised range for a 5 V port, except that the voltage may fall below the lower limit when the product's battery is at the low-battery voltage.

Any port power and current specifications, if provided, shall be accurate. If a current or power range is advertised in association with a port, the port shall be able to provide within 5% of the advertised rating at the typical battery discharge voltage, as defined in IEC/TS 62257-9-5. The current and power ratings are evaluated using the average measured value across all samples. Power output of ports shall be sufficient to power appliances that are advertised but not included.

Functionality Requirements:

Included appliances shall function when connected to ports and shall not be damaged or present a safety hazard over the entire voltage range of the port as assessed in the appliance operating voltage range test or the assessment of DC ports of IEC/TS 62257-9-5. The appliance need not function when the product's battery is at the low-battery voltage if the feature or behavior is described in the user manual and the description is written in a way that is meaningful to a typical user; for example: "some appliances may not work when the battery is low."

Non-standard connectors

Ports with a connector type that is not commonly used for 12 V or 5 V ports need not meet the functionality requirements below, provided that the consumer-facing advertising or documentation states that generic user-supplied or off-the-shelf appliances cannot be used and no adapter that converts the port to a commonly used connector type is included or described. The following receptacle types are not eligible for this exception unless modified so that standard or conventional plugs cannot be inserted:

- Any receptacle type defined by any version of the USB standard;
- A barrel jack of any dimensions;
- A cigarette lighter receptacle.

12 V ports

All ports advertised or reasonably expected to provide 12 V shall maintain a voltage of at least 10.5 V over the advertised current range, or, if no current range is advertised, over the entire tested range of currents. However, port voltages may fall below 10.5 V when the product's battery is at the low-battery voltage if the feature or behavior is described in the user manual and the description is written in a way that is meaningful to a typical user; for example: "some appliances may not work when the battery is low." At no time shall the port voltage exceed 15 V.

Separate current ratings may be specified for functionality and for overcurrent protection. The current rating for functionality shall not be less than the current required to use the advertised appliances and to allow the operation of user-supplied appliances in a manner consistent with the consumer-facing advertising and documentation. For example, consider a 12 V-rated port that can reliably provide 12 V at 3 A and has overcurrent protection that

activates at 6 A. In this example, the port cannot sustain 12 V at currents above 3 A, and a typical 12 V, 6 A appliance may not work properly at a reduced voltage. A current rating for this situation could state: “the port can supply 6 A, but some appliances might not function properly if the load exceeds 3 A.”

Ports that would be reasonably expected to provide 12 V, but meet all of the following criteria, need not comply with the lower voltage limit of 10.5 V:

- The port is not a cigarette lighter receptacle.
- One of the following is true:
 - The consumer-facing documentation and advertising materials, including but not limited to the packaging, user manual, and manufacturer’s website, do not state that the product can be used with any appliances other than the included lighting appliances or depict such use, or
 - There is a prominent consumer-facing statement on the product box or user agreement clearly stating that the product can be used only with manufacturer-supplied appliances, whether included or sold separately. No other consumer-facing information may contradict this statement.

Ports that meet the requirements above need not comply with the upper voltage limit if there is a consumer-facing warning on the packaging or user manual that clearly states that user-supplied appliances can be damaged if connected to the port.

5 V ports

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 requirements below. These standards are based on the USB Battery Charging Specification Revision 1.2 (USB Implementers Forum, 2012), with some modifications to address common charging requirements in the off-grid product market. Ports must comply with these default limits unless an acceptable reason and clear justification is presented for the port managing current and voltage in a different manner. Acceptance of alternate management schemes is at the sole discretion of Lighting Global.

- USB ports shall be able to provide at least 0.5 A at all simulated battery voltages when tested according to IEC/TS 62257-9-5.
- Voltage requirements when the port is operating at a current less than or equal to 0.5 A or the advertised maximum current, whichever is greater:
 - Minimum steady-state voltage: 4.5 V at all simulated battery voltages except the low-battery voltage; 4.25 V at the low-battery voltage.
 - Maximum steady-state voltage: 5.5 V
- Voltage requirements when the port is operating at a current greater than 0.5 A or the advertised maximum current, whichever is greater:
 - No minimum steady-state voltage requirement
 - Maximum steady-state voltage: 5.5 V

Separate current ratings may be specified for functionality and for overcurrent protection. The upper limit above refers to the advertised maximum current for functionality.

In the special case that a product has at least two USB ports and at least one of these ports meets the voltage requirements for 5 V ports listed above, the other port may be designed to provide a voltage that exceeds 5.5 V. The maximum steady-state voltage of this port must not exceed 6.0 V under any test conditions and must comply with all other 5 V port requirements listed above. The user manual must include a description of the difference between the two ports, indicate which port is higher voltage, provide a way to identify each port, and state that not all devices will be compatible with the higher voltage port.

There are no requirements for dynamic port performance and the dynamic portion of the ports assessment need not be conducted.

^e The lumen maintenance standard can be assessed using a 2000-hour test or an expedited method that requires LM80 data for the LEDs. Each of these procedures are outlined in Annex J of IEC/TS 62257-9-5. If the 2000-hour test is used, and the pass/fail determination is made at 1000 hours, the test will continue to complete the 2000 hours with no further verdict. The expedited method includes a 500-hour lumen maintenance test and single point temperature measurements of the LED array. The temperature measurements are compared to IESNA

LM80-08 data from the LED manufacturer to determine the lumen maintenance at 2000 hours. For the LM80 method, the average lumen maintenance at 500 hours and the average estimated lumen maintenance at 2000 hours must be $\geq 90\%$ of initial light output, with no more than one sample below 85%. The LM80 test is intended as a way to expedite products entering the market and shall not be used for Renewal or Market Check Method tests.

For products that undergo 500-hour tests with a sample size of two ($n=2$) to qualify for or maintain program support (Renewal, Market Check Method or Accelerated Verification Method tests), both samples must maintain $\geq 95\%$ of initial light output at 500 hours. If a product fails the 500-hour test, re-testing with 6 samples for the full 2000 hours will be required.

^f Approved marks: UL, CE, TÜV, 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](#).

^g Table 2 contains default battery deep discharge protection voltages and Table 3 contains default battery overcharge protection voltages and maximum cell temperatures specific to the four 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. Default battery deep discharge protection voltage specifications

| Battery type | Deep discharge protection voltage (V/cell) | | |
|------------------------------------|--|---------|---------|
| | Recommended | Minimum | Maximum |
| Valve-regulated / 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. Default battery overcharge protection voltage and temperature specifications

| Battery type | Overcharge protection voltage (V/cell) | | | Maximum charging temperature (°C) |
|------------------------------------|--|---------|---------|-----------------------------------|
| | Recommended | Minimum | Maximum | |
| Valve-regulated / 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 |

The requirement for PAYG products to be able to charge the battery in a disabled state may be waived for products using lithium-based batteries in cases where the product is designed to protect the battery from damage when not charged for extended durations (e.g. up to one year). The design shall also ensure the product can still charge once payment is made and the charging system is re-connected. The preventive measures shall address both the discharge during use and self-discharge of the battery. Allowable exceptions will be determined by Lighting Global based on evidence provided by the product designers.

^h All applicable quality and durability standards are extended to PAYG components, such as remote-entry keypads, integrated circuits, and any other hardware systems that are included with the product.

ⁱ All applicable quality and durability standards are extended to appliances included with the product. At the discretion of Lighting Global, some quality and durability requirements may be waived for non-lighting appliances that can be proven to meet other relevant standards. For instance, the following tests may be waived if the manufacturer provides evidence (test report, certification, and/or other relevant documentation) showing that the

appliance meets an internationally recognized standard for appliance safety, such as IEC 60065 (for TVs and radios) and IEC 60335 (for fans):

- Physical ingress protection,
- Strain relief,
- Switch, gooseneck, moving part, and connector durability,
- Drop test, and
- Battery protection (charge controller).

^j If the product has output ports, the product shall have sufficient protection from PV overvoltage as determined by the PV overvoltage protection test of IEC/TS 62257-9-5. This test is used to verify that if the battery is disconnected or isolated, the system will not be damaged, the PV open-circuit voltage will not be present on load terminals and the load terminals will maintain a voltage that is safe for their intended uses. For ports with a nominal port voltage of 5 V, the allowable port voltage limit shall be 6.0 V, which deviates from the limit listed in IEC/TS 62257-9-5. All other allowable port voltage limits are as listed in IEC/TS 62257-9-5.

^k 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](#).” Additional guidance on testing IP requirements for PV modules is in a document titled “[Lighting Global Test Methods for Ingress Protection for PV Modules](#).”

^l The cable between the solar module and the battery (or the product housing that contains the battery) must be at least 3 m long to qualify as a “separate” or “fixed indoor” product.

^m 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).

ⁿ Most switches and connectors are considered to be intended for regular use. Mechanisms expected to be used primarily during installation are limited to only a few cases, such as:

- A safety disconnect switch or circuit breaker that is turned on after installation and only turned off for maintenance.
- Connectors dedicated to light points that are specifically designed and explicitly stated to be for permanent installation and are not intended to be relocated after installation.
- Connections between a light point and an extension cable.