Policy for Non-Plug-and-Play Products

Version 2.0
December 2025

The information in this policy is relevant for products evaluated to IEC 62257-9-5 (Edition 5) and IEC 62257-9-8 (Edition 2). For information relevant to IEC 62257-9-5 (Edition 4) and IEC 62257-9-8 (Edition 1) please refer to the Policy for Non-Plug-and-Play Terminals version 1.0.

This document explains the requirements that must be met for a non-plug-and-play product to be eligible for the VeraSol Quality Assurance (QA) program, and provides examples of acceptable and unacceptable terminals and connectors.

A plug-and-play product, as defined in IEC TS 62257-9-8, meets all of the following conditions:

- All electrical connections are made with plug-and-socket connectors.
- All electrical connections can be made without the use of tools.
- No technicians or electricians are necessary to install and operate the system safely and successfully.

A **plug-and-play connection** is one that meets the conditions above even if other aspects of the product do not. A **non-plug-and-play** product or connection is one that does not meet one or more of the conditions.

For a non-plug-and-play product to be eligible for the VeraSol QA program, all electrical connections **except for permanent connections made at the time of installation** must be able to be made without the use of tools. Non-plug-and-play connectors may be used for permanently installed connections. The requirements differ depending on whether connections are made by the end user or by a trained technician:

- Connections made by the end user must provide a good quality electrical connection and must not require assembly methods that require technical expertise, such as wrapping wire in a specific direction, soldering, or crimping in the field.[1]
- Connections made by a trained technician must provide a good quality electrical connection. Assembly methods requiring technical expertise may be used if the below requirements are met.

If a product has both plug-and-play and non-plug-and-play connections, the requirements of this policy apply only to the non-plug-and-play connections.

[1] For the purpose of this document, the terms *in the field* and *at the factory* are used to differentiate between terminals that must be installed by a technician versus terminals that are preassembled.

This policy does not apply to internal connections made at the factory, which are inspected in the visual screening of IEC TS 62257-9-5.

Requirements

Connections in a VeraSol-certified solar energy kit must meet the following conditions:

1. Connections made by the end user (or any person other than a trained installer or technician) must provide a secure electrical connection and must not require technical expertise to make. Examples of prohibited connections are given below.
2. Connections that are made by installers or technicians must provide a secure electrical connection. All devices (e.g., terminals, connectors, materials, etc.) must be used in accordance with their electrical ratings and the manufacturer's instructions. Evidence showing that the technicians have received adequate training to use the required tools and make the connections correctly must be provided. Evidence can include training manuals, videos, or other training materials. Temporary connections such as alligator clips or unreliable connections such as twisting wires together without a connector must not be used.
3. Adequate instructions are provided for making each type of connection.
4. 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.
5. Connectors on charge controllers must 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 should be located as close to the battery as practical.
6. Overcurrent protection for the PV module or array shall meet the requirements of IEC 60364-7-712:2017, 712.433.1.101.1 unless all of the following criteria are met:
   - The maximum possible current from all sources (the entire array) does not exceed the current-carrying capacity 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.
   - Operation at short-circuit current exceeding the STC value, as described in IEC 60364-7-712:2017, 712.433.1.101.1, should be taken into account by the company when sizing overcurrent protection. However, since the specific location of installation is not known, VeraSol cannot evaluate the appropriateness of the overcurrent protection for a specific site.
7. All terminals for loads will be 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.
8. Adequate strain relief must be provided for all non-plug-and-play terminal connections. The method for providing strain relief shall be clearly described in the installation instructions and, if any equipment or tools are required, 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.

9. A means must be 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).
10. Any required tools other than commonly available tools (e.g. flat or Phillips screwdrivers, pliers, wire cutters, manual wire strippers) must be included with the kit. 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 tools used shall be suitable for the intended purpose. (For example, any crimped terminations shall be made using a crimp tool specified for the terminal or connector included with the kit, not using ordinary pliers.)
11. All required materials (e.g. wire and terminals) must be 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, detailed guidance for providing wire for testing is included in IEC TS 62257-9-8.2
12. All connectors or terminals must 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 must be clearly indicated in the installation instructions. Connectors must be used within their design limits. The company is required to provide specifications for connectors from the connector manufacturer upon request.
13. Connections shall undergo the following tests:
    a. Screw-type terminals tightened by the user or installer shall be tested in accordance with IEC 61730-2 MST 33, UL 61730-2 MST 33, or the screw connections test of IEC TS 62257-9-5;
    b. Reusable screwless-type terminals or connectors (e.g. those with levers or springs) operated by the user or installer shall be tested for 100 cycles in accordance with the switch and connector test of IEC TS 62257-9-5;
    c. There is no testing requirement for single-use connectors such as crimp terminals, locking types of flat quick-connect terminations, insulation piercing connecting devices, or single-use push-in wire connectors;
    d. There is no testing requirement for twist-on connecting devices, whether reusable or non-reusable;
    e. When there are multiple clamping units of the same type (e.g. multiple screw terminals in a terminal block), it is permitted to test only one of each type of clamping unit.

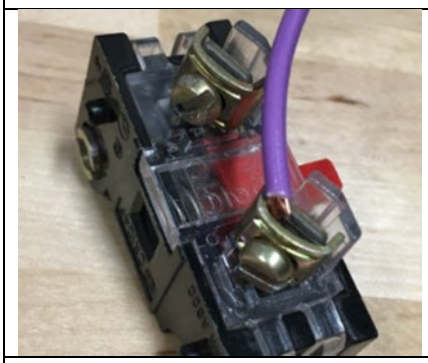
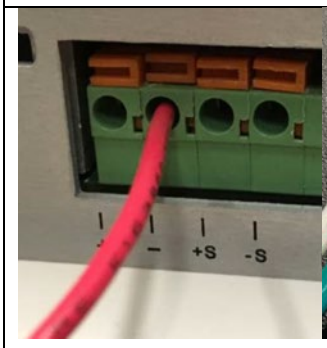
Additional requirements may apply as described in IEC TS 62257-9-8; in case of a discrepancy between this policy document and IEC TS 62257-9-8, the provisions of IEC TS 62257-9-8 will prevail.

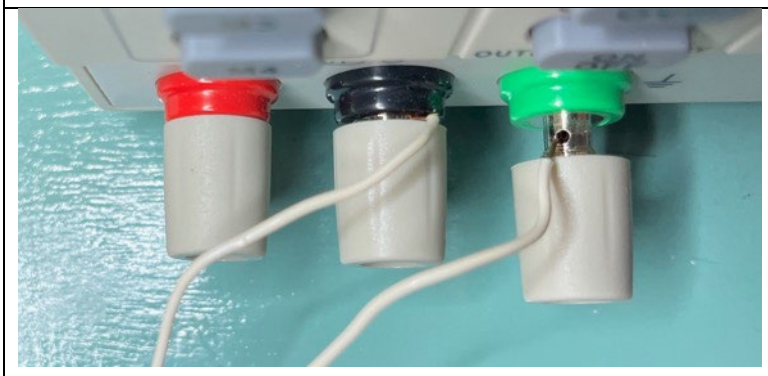
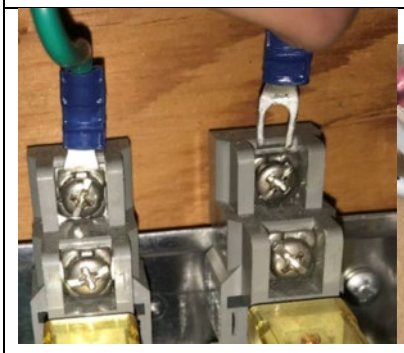
[2] VeraSol began referencing *IEC TS 62257-9-8: Integrated systems – Requirements for stand-alone renewable energy products with power ratings less than or equal to 350 W* in place of the Lighting Global Quality Standards in 2020. See https://verasol.org/updates/transition-to-iec-ts-62257-9-8 for detailed transition information. See the Change Log for Quality Standards for details on new requirements and the differences between the Standards.

Connections that may be made by the end user

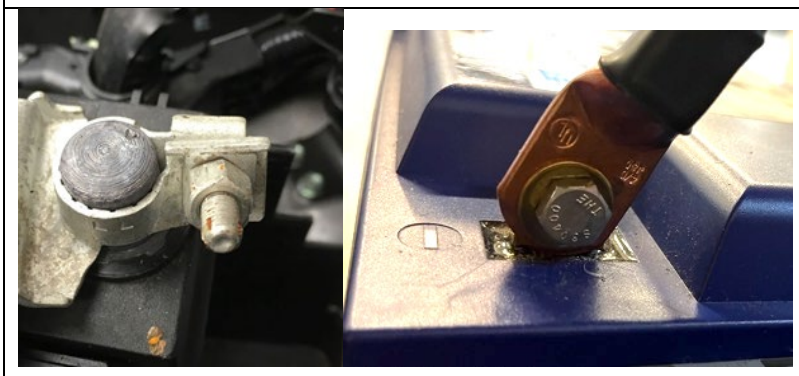
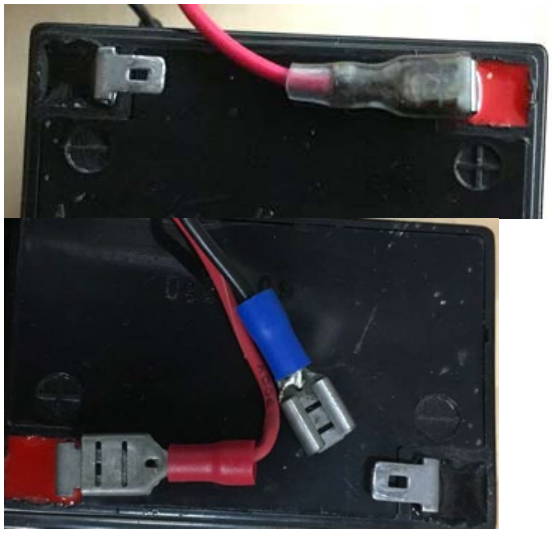
Examples of acceptable terminals are presented below (Table 1). Any type of connection that is permanently made at the factory is also acceptable provided that it complies with the requirements regarding workmanship and current-carrying capacity.

Table 1: Examples of acceptable non-plug-and-play terminals.

Screw terminals in which the wire is inserted into a hole and clamped down	
	These terminals are simple to use and make a reliable connection, when used in accordance with the manufacturer's specifications regarding the size and number of wires inserted.
Screw terminals in which the wire is clamped between two plates or similar	
 	In these types of screw terminals, it is not necessary to wrap the wire around the screw. The wire is inserted between two plates or washers and the screw is tightened to clamp the wire in place.
Lever-actuated terminals or spring terminals (e.g. WAGO®)	
 	In the terminal shown at left, the orange lever is pushed in with a small screwdriver and the wire is inserted. When the lever is released the wire is held in place. In the terminal shown at right, the wire is inserted and the lever is snapped down to lock it in place.

<table>
<tr><td colspan="2">Binding posts with hole to insert wire</td></tr>
<tr><td>  </td><td>Some binding posts have a hole to insert the wire; in others, the wire needs to be wrapped around the post. Only those that have holes to insert the wire are permitted to be assembled by the end user. Those that require wrapping the wire are not permitted due to the increased likelihood of the connection being improperly made. No tools except wire strippers are required.</td></tr>
<tr><td colspan="2">Certain connectors supplied with the product to be attached to wires in the field.</td></tr>
<tr><td>  </td><td>Only connectors with attachment mechanisms similar to those described above (wire is inserted into a hole and clamped down, binding posts, etc.) may be installed by the end user. In the picture to the left, wire is inserted in the hole in the bottom of the plug and a set screw in the back of the plug is tightened to hold the wire in place.</td></tr>
<tr><td colspan="2">Screw terminal connections in which the wire is terminated with a spade or ring lug:</td></tr>
<tr><td> 
  </td><td>These connections are very secure but can negate one of the advantages of using screw terminals, which is that the wire can be cut to size on-site and terminated with basic tools.

Lugs must be crimped to the wire at the factory or by a trained technician or installer using appropriate tools.</td></tr>
</table>

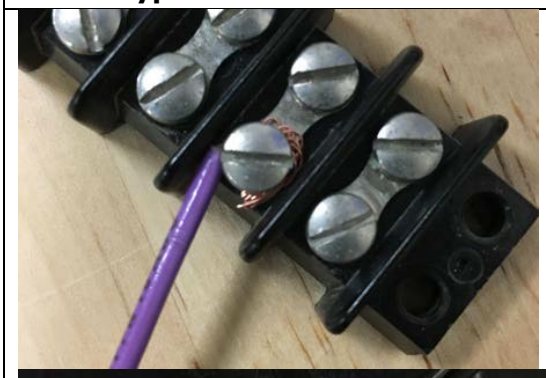
Battery terminals that are secured by a bolt and nut:	
	The wire must be either terminated at the factory or connected using one of the other acceptable methods listed in this document (such as clamped between two plates) if the connection is made by the end user.
Flat quick-connect (FASTON®) terminals	
	Note: these are only permissible if enclosed so the consumer cannot easily access them. Quick-connect terminals must be crimped to the wire at the factory or by a trained technician or installer with appropriate tools.

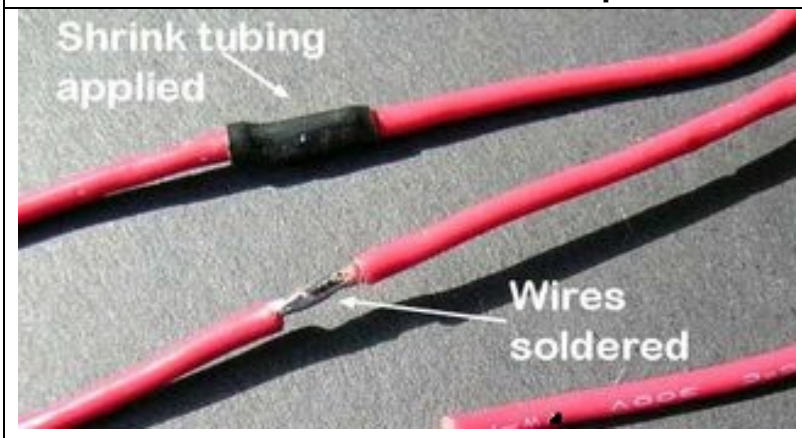
WAGO® is a registered trademark of WAGO GmbH & Co. KG; FASTON® is a registered trademark of TE Connectivity Solutions GmbH. These brand names are provided as examples and do not indicate VeraSol endorsement of a specific company or product.

Connections that must be made by a trained technician or installer

The following connections (Table 2) require technical expertise or specialized tools and are therefore permitted only if made by a trained technician or installer.

Table 2: Examples of non-plug-and-play connections that must be made by a trained technician or installer.

Screw-type terminals in which the wire is clamped by the screw head:	
 	It is easy to fail to secure all the strands in this connection, which can increase the resistance of the connection or short with neighboring terminals.
Binding posts in which the wire is wrapped around the post	
	Similar to a screw terminal, some technical expertise is required to make a secure connection and prevent a short circuit.

Butt splice or splice-cap connections made by the installer to splice two (or more) wires together	
	These connections require skill and the proper tools to install correctly.
Twist-on connecting devices (wire nuts)	
	These are very common in building wiring in some countries (including the US) and uncommon in others (such as the UK). They are not suitable for wires that are subject to flexing or pulling (unless strain relief is provided) and are not suitable for outdoor use.
Soldered connections insulated with tape or heat-shrink tubing	
	These connections require a skilled technician.

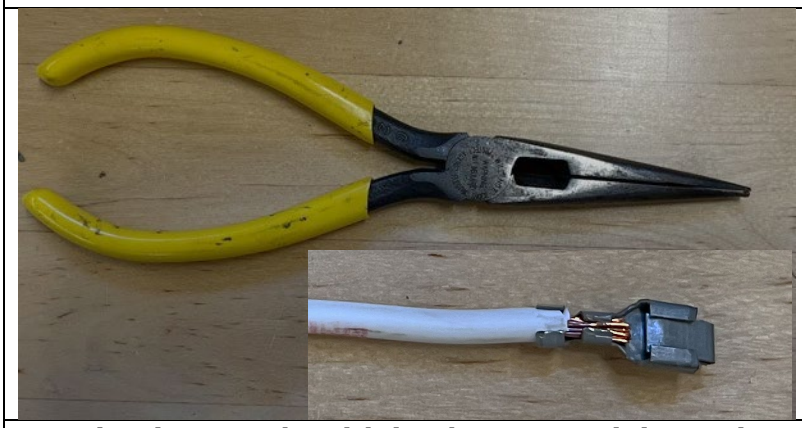
Spade or ring lugs or other terminations crimped on by the installer in the field.	
 	These connections can be more secure than those made with bare wire, but the installer must be trained in proper crimping technique and the tool, terminal, and wire size must all be matched, or a poor connection will result. In addition, training is needed to distinguish a good crimp from a poor crimp.

Unacceptable Terminals or Connections

The following terminals are considered unacceptable and ineligible for the VeraSol QA program because they either provide a poor quality connection or require technical expertise to make, such as wrapping wire in a specific direction, soldering, or crimping in the field (Table 3).

Table 3: Examples of unaccepted non-plug-and-play terminals.

Alligator (crocodile) clips	
 	These are simple to use but can make a poor connection and require exposed conductors to function.

Wires twisted together and taped without soldering	
	This is not an effective method for making reliable wire connections.
Terminations made with improper tools	
	A crimp made with ordinary pliers may initially work, but will be unreliable and could pose a fire hazard.
Terminations made with inadequate training or instructions	
	This crimp was made with the correct tool, but the insulation was not fully inserted into the plastic housing, resulting in inadequate strain relief.

- Companies submitting non-plug-and-play products are required to complete and sign the VeraSol Non-Plug-and-Play Terminals Declaration Form and provide a copy of the installation instructions for the product. Installation instructions are required to include:
    - a list of all required tools
    - sufficient instructions, including illustrations, to make each type of connection so that it will be safe and reliable
    - a means (picture, diagram, etc.) to identify wires or cable
    - clear directions that describe how to install the strain relief
    - a statement that specifies whether the terminals are for indoor use only
    - description of the wire type and maximum length of cable that is used to connect the PV module and light points.

- Companies are encouraged to provide the following documentation in advance of testing to ensure their product will be eligible for the VeraSol program:
    - Photos of permanently installed connections, including connectors.
    - Evidence that all connections, other than those to the charge controller, are insulated or enclosed in a way that the component meets IP2X. Acceptable documentation includes: Photos, technical specification/certification or specific diagrams of enclosure/insulation.
    - Technical specifications/certifications that the leads from the battery and PV module to the charge controller have short circuit protection.
    - Evidence that all terminals have strain relief. Acceptable documentation includes: photographs, technical specification/certifications, or instructions on how to install with effective strain relief.
    - Training manuals, videos, or other training materials, if the system is installed only by trained personnel.

About VeraSol

An evolution of Lighting Global Quality Assurance, the VeraSol program supports high-performing, durable off-grid products that expand access to modern energy services. VeraSol builds upon the strong foundation for quality assurance laid by the World Bank Group and expands its services to encompass off-grid appliances, productive use equipment, and component-based solar home systems. Like Lighting Global Quality Assurance, the VeraSol program is managed by CLASP in collaboration with the Schatz Energy Research Center at California State Polytechnic University, Humboldt. Foundational support is provided by the World Bank Group's Lighting Global program, UKaid, IKEA Foundation, Good Energies Foundation, and others.

Please visit VeraSol.org for more information.