

# PV Connector Guidance and Installation Best-Practice

**PV connectors** are commonly used on the DC portion of an installation, making an electrical connection between modules, field-installed wiring (often referred to as home-run conductors), or other equipment such as microinverters or DC-to-DC converters (optimizers).

Connectors are often factory-installed on modules and equipment, and field-installed on home-run wiring. Depending on system size, there can be tens, hundreds, or even thousands of connections at the array. Although

it may not be evident, it is critical that the installation or mating of all connectors be in compliance with manufacturer's installation instructions and product listing. Adhering to manufacturer's warranties and installation

instructions includes the special care prior to installation as well as the type of connector it has been certified to mate with. Additionally, DC electricity also has the ability to hold an arc for long periods of time. DC arcs from poor electrical connections could melt metal wire or burn insulation.

Good connections will degrade, which could create bad connections over time. For this reason, it is very important to start with the very best connection possible.



Figure 1. Many connectors can be used on one site.

# Care and Contamination

Because **PV connectors** are typically part of products that may be stored outdoors prior to installation, such as on modules, additional protection may not be apparent.

Like all electrical terminations, it is important to ensure that PV connector interiors are properly protected prior to installation. Connectors must not be contaminated by standing water, dirt, or with foreign chemicals.

Contaminants will cause deterioration or corrosion of the materials that make up the connectors. Any contaminated connectors should be replaced before installation.

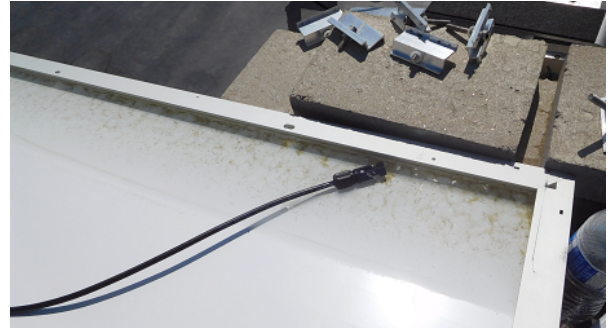


Figure 2. Connector exposed to standing water.

# Cross-Mating Concerns

The terms “cross-mating” or “intermating” refer to two different brands or types of connectors plugged together.

This situation may be a violation of the standards outlined below and increases the risk of premature failure at that point in the system. Although different **PV connectors may look the same**, fit together, and conduct electricity, they are often manufactured differently and is the primary reason for concerns with long-term integrity.

The actual properties of PV connectors from each manufacturer are proprietary and because there is no such industry standard: they may have various dimensions, electrical contact material, and plastic chemical properties. These slight differences can have different rates of expansion and contraction when exposed to normal environmental operating conditions, causing catastrophic failure in the connector.

**Not matching connectors from the same product line can cause one or both connectors to fail.**



Figure 3. Connectors may fit together but might not make a good electrical connection.



Figure 4. Wires can pull out of connector when poorly made field connection is installed

# Regulatory Compliance

Section 110.3(B) of the NEC states, “Listed or labeled equipment shall be installed and used in accordance with any instructions included in the listing and labeling.”

Equipment such as modules, DC-to-DC converters (optimizers), inverters, and microinverters typically contain factory-installed recognized component connectors, certified to UL [Q1JQ2](#). The product’s installation instructions, data sheet, or nameplate should indicate the specific type of connector it has been evaluated to mate with. For connections between two pieces of equipment (such as modules to microinverters), **it is important to verify compatibility** with each set of installation instructions.

Additionally, connectors intended to be installed in the field will also contain similar information

regarding ability to cross-mate in the product’s installation instructions, following UL [Q1JQ](#).

Both standards Q1JQ and Q1JQ2 note that “Unless specifically stated, these devices have only been investigated to mate with the same line of connectors/ devices within their product family. These devices have not been investigated to mate with any other similar devices from other manufacturers.”

UL standard [6703](#) outlines the evaluation criteria for PV connectors, such as: latching

or locking requirements, cable/ wire type requirements, the tool used for installation, and overall construction of the product. Not all connectors are manufactured with exactly the same materials or dimensions and is why this standard notes that “Connectors are identified and tested with compatible mating parts and **are to be of the same brand**, unless multiple product manufacturers are submitting under the same evaluation for the purpose of proving intermatability.” As of the writing of this document, no such evaluation exists between two different products certified to cross-mate under this standard.

Some **testing labs** will perform a preliminary “one-time” test of cross-mating connectors outside of their product families. The



Figure 5. Connectors to be the same brand.

purpose of this pre-test is to evaluate the different product samples provided by the party requesting the test. The lab performs similar electrical and environmental tests to that of the full standard. Unlike a full product certification however, this is a one-time test of the actual product samples provided to the test lab, and there is no control or future follow-up with either of the product manufacturers. Because of the uncertainty of future product changes (materials, dimensions, etc.), these tests are typically only valid for

one year. Many of these test reports are also marked, “for internal use” or “not to be used as certification or confirmation letter.” A full product certification includes random quarterly follow up visits from the National Recognized Testing Laboratory to each manufacturer to confirm the manufacturing process and quality of the product is held intact. It is critical to distinguish the vast differences between these tests and a true certification, as the preliminary test reports are often misused as certifications for cross-mating.

## Field-Installed Connectors

Perhaps one of the greatest concerns with PV connector integrity is with field-installed connectors. These connectors are often installed on field wiring that mates to equipment with a factory-installed connector. The installation of such connectors requires special training, methodology, and the proper tool. Each type of field-installed PV connector requires a specific crimping tool that it has been evaluated with. The product’s installation instructions will identify the appropriate tool(s) and methodology that are required for the connection. Using the proper tool is paramount to the short and long-term integrity of the connector. Poorly-crimped conductors may result in a high-resistance connection which will likely lead to a thermal failure. Very loose crimps can also pull out of the connector and create an electric shock hazard and supplemental damage or failure.



Figure 6. Crimping tool for one brand/type of connector.



Figure 7. Conductors can pull out from poorly crimped parts.

# Conclusion

PV connector best practices for solar installations include: research, verify, and purchase products that have matching connectors; consult the connector's instruction manual and verify the correct tool(s) for field connector installation; never expose connectors to moisture or chemical substances; and test connections to ensure a tight fit by gently pulling on all connected parts.

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