Lighting Global Test Methods for Ingress Protection for PV Modules

January 2015

Procedure Summary:

This procedure measures the potential for water and solid objects to enter and damage or degrade solar photovoltaic (PV) module junction boxes. It is designed for reference by the Lighting Global Quality Standards and will be submitted as an amendment to IEC 62257-9-5 when appropriate. This test would be conducted with a sample size of n=1 for all Lighting Global test methods (ISM, QTM, MCM, and renewal testing).

The result of the overall ingress protection (IP) test is a pass/fail assessment on the equivalent of IP3X and a modified IPX4.[1] IP3X is a physical ingress measure that protects against insect intrusion, while the modified IPX4 indicates protection from permanent outdoor exposure to water in the context of rooftop installation. PV modules must be assessed for both measures to meet the Lighting Global Minimum Quality Standards.

There are three main steps:

1) Assess physical ingress protection class.*
2) Inspect the junction box for sensitive electronic components.
3) If sensitive components are present, assess water ingress protection class.*

*this step requires the use of an unmodified PV module (junction box has never been opened)

Note that if a water ingress assessment is required, then this test requires two PV modules that are unmodified – one for inspection and one for IP testing.

[1] The modified IPX4 assessment for water ingress protection follows the same procedure to test for IPX4 as described in IEC 60529 with the exception of the angle of spray. IEC 60529 requires that the DUT be sprayed at angles ±180° from vertical, while the modified method described below requires that the DUT be sprayed at angles ±90° from vertical.

IP Assessment for Solid Foreign Objects:

Note: This test can be destructive. Do not perform any additional tests on the sample's PV module after testing. The sample's PV module, including its enclosure and/or junction box, shall not have been altered in any way prior to testing; however, if the only alteration is that the PV module's connector (e.g. barrel plug) has been removed from the end of the PV cable, it may be used for IP assessment testing.

Assess the PV module for IP3X as described in Appendix U of IEC/TS 62257-9-5:

1. Before the measurement, be sure that the DUT is properly functioning.
2. Explore the DUT's entire surface to test for penetration with a 2.5 mm probe.
3. If the probe can enter a part of the DUT's enclosure that contains electronic components, electrical connections or circuits, the DUT does not pass the IP assessment for ingress of solid foreign objects. If the probe can enter an external jack, this is not considered a failure, unless it can enter the DUT's enclosure through the external jack. Document any failures with photographs and text.
4. If the 2.5 mm probe cannot enter the DUT, the DUT meets the requirements for IP3X.

Note: Since the enclosure is not opened until the enclosure inspection procedure, below, it may not be possible to determine whether the DUT passes or fails this test until after the enclosure inspection procedure is performed.

Enclosure Inspection:

1. Open the junction box or PV enclosure to determine if a circuit board or other sensitive electronics are present. (This can be destructive.) If no circuit boards or sensitive electronics are present or if the junction box is completely potted with silicone or similar sealant, the product passes and the tester does not need to assess the DUT for water ingress.
2. If a circuit board or other sensitive electronic components are present within the junction box or PV enclosure, the water ingress test shall be conducted on a new sample. (Note: a single diode, not soldered to a circuit board, is not considered a "sensitive electronic component." Any printed circuit board is considered "sensitive." See Figures 1-2 for guidance.)

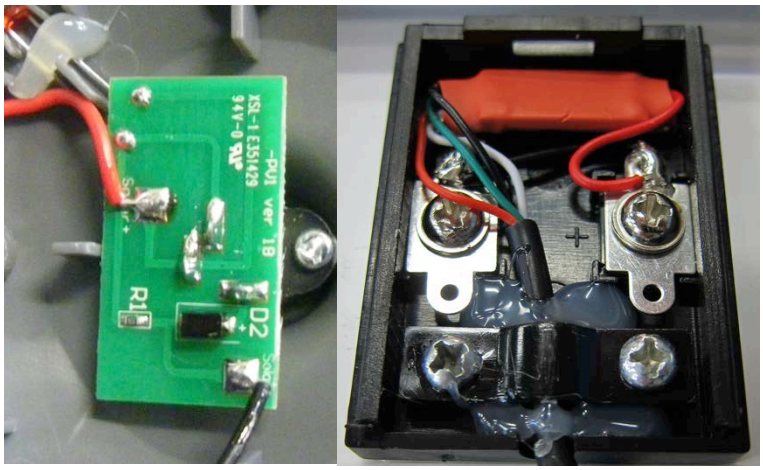

Figure 1. Examples of DUTs containing "a circuit board or other sensitive electronics" and requiring water ingress testing.

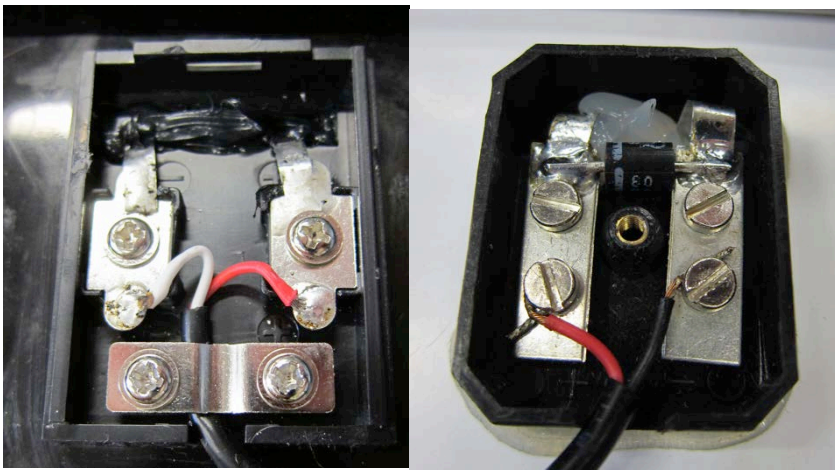

Figure 2. Examples of DUTs *not* containing "a circuit board or other sensitive electronics" and *not* requiring water ingress testing. (The junction box on the right contains a diode.)

IP Assessment for Water:

Note: This test can be destructive. Do not perform any additional tests on the sample after testing. The sample's PV module, including its enclosure and/or junction box shall not have been altered in any way prior to testing; however, if the only alteration is that the PV module's connector (e.g. barrel plug) has been removed from the end of the PV cable, it may be used for IP assessment testing.

1. Place the DUT with the active PV area facing up on a smooth, solid, flat surface that is tilted at a 10° angle from the horizontal (Figure 3). The DUT shall be placed in the least favorable orientation on the surface. The placement is intended to resemble common rooftop installations and allow for the possibility that water would run behind the module. This will typically be accomplished by allowing the PV cord to rest under the frame as could occur when installed.

   Note: The least favorable orientation is typically the one in which the cable exits the junction box on the upslope side.

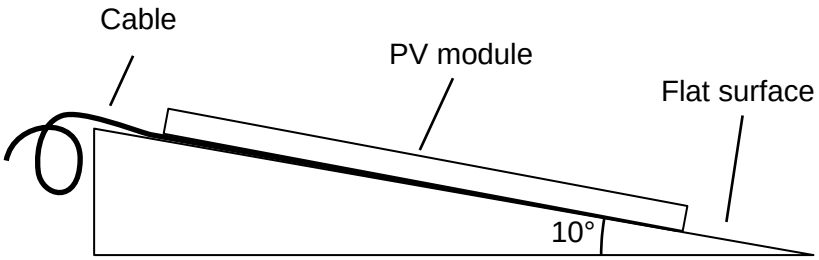

Figure 3. Side view of module prepared for testing.

2. Conduct the modified IPX4 equivalent test as follows:
    a. Spray water from the controlled water source over the DUT in all practical directions (at angles +/- 90° from vertical). The water flow rate shall be close to 10 l/min. Spray the water over the DUT for 1 min per square metre of enclosure surface area for a minimum of 5 minutes. The distance between the water source and the DUT should be between 0,3 m and 0,5 m.
    b. After spraying water over the DUT, dry the DUT's exterior on all sides with a towel without tilting the DUT.
    c. Open the junction box or enclosures protecting electronic components. (This can be destructive.) To the degree practical, avoid tilting the DUT while opening the junction box.
    d. If the module does not have a typical junction box, but rather its connections are within an enclosure around the PV module itself (for example, see Figure 4), open the enclosure with the proper screwdriver(s) or other devices. (This can be destructive.)

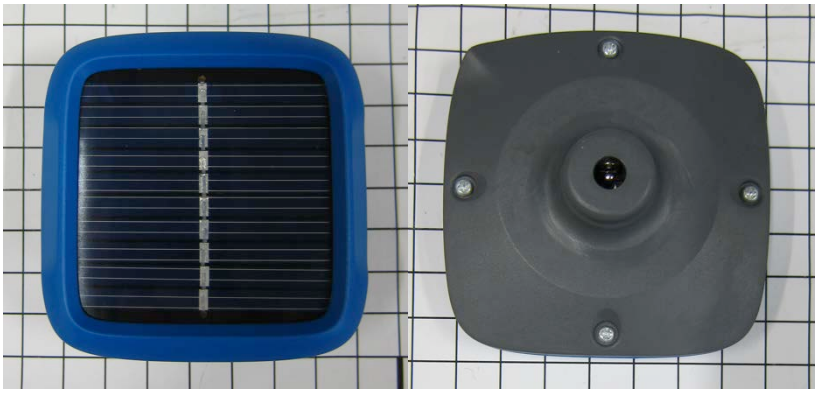

Figure 4. Example of a module without a "typical junction box."

3. After opening the junction box and enclosures, note if there are any unsealed penetrations through which water could reach the active material of the PV module.
4. If no water is found inside the junction box, enclosures or any unsealed penetrations, the product passes.
5. If any water is found on electronic components inside the junction box, enclosures or any unsealed penetrations, document with photographs and text. For the DUT to pass, electronic components and the active material of the PV module must be adequately protected according to the technical aspects outlined in Annex V.

Adequate protection is evaluated by an organization with expertise in product design, failure analysis, energy systems, and general engineering practices. This requirement cannot be met through labeling or consumer-facing documentation.

TESTING FLOW DIAGRAM