भारतीय मानक

Indian Standard

IS 16221 (Part 3) : 2023
IEC 62109-3 : 2020

फोटोवोल्टिक पावर सिस्टम में उपयोग के लिए पावर कन्वर्टर्स की सुरक्षा

भाग 3 फोटोवोल्टिक तत्वों के संयोजन में इलेक्ट्रॉनिक उपकरणों के लिए विशेष आवश्यकताएं

Safety of Power Converters for Use in Photovoltaic Power Systems

Part 3 Particular Requirements for Electronic Devices in Combination with Photovoltaic Elements

ICS 27.160

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NATIONAL FOREWORD

This Indian Standard which is identical with IEC 62109-3 : 2020 'Safety of power converters for use in photovoltaic power systems — Part 3: Particular requirements for electronic devices in combination with photovoltaic elements' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on recommendation of the Solar Photovoltaic Energy Systems Sectional Committee and approval of the Electrotechnical Division Council.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminologies and conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
b) Comma (,) has been used as a decimal marker, while in Indian Standards the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places, are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 61215-2 : 2016 Terrestrial photovoltaic (PV) modules — Design qualification and type approval — Part 2: Test procedures	IS 14286 (Part 2): 2019 — Terrestrial photovoltaic (PV) modules — Design qualification and type approval: Part 2 Test procedures (*second revision*)	Identical
IEC 61730-1 : 2016 Photovoltaic module safety qualification — Part 1: Requirements for construction	IS/IEC 61730-1 : 2016 Photovoltaic (PV) module safety qualification: Part 1 Requirements for construction (*first revision*)	Identical
IEC 61730-2 : 2016 Photovoltaic (PV) module safety qualification — Part 2: Requirements for testing	IS/IEC 61730-2 : 2016 Photovoltaic (PV) module safety qualification: Part 2 Requirements for testing (*first revision*)	Identical
IEC 61853-2 : 2016 Photovoltaic (PV) module performance testing and energy rating — Part 2: Spectral responsively, incidence angle and module operating temperature measurements	IS 16170 (Part 2) : 2018 Photovoltaic (PV) module performance testing and energy rating: Part 2 Spectral responsively, incidence angle and module operating temperature measurements	Identical
IEC 62109-1 : 2010 Safety of power converters for use in photovoltaic power systems — Part 1: General requirements	IS 16221 (Part 1) : 2016 Safety of power converters for use in photovoltaic power systems: Part 1 General requirements	Identical
IEC 62109-2 : 2011 Safety of power converters for use in photovoltaic power systems — Part 2: Particular requirements for inverters	IS 16221 (Part 2) : 2015 Safety of power converters for use in photovoltaic power systems: Part 2 Particular requirements for inverters	Identical

(*Continued on third cover*)

CONTENTS

INTRODUCTION

This part 3 of IEC 62109 gives requirements for products which consist of an electronic element and a PV element or PV module. For this type of equipment, specific safety aspects must be considered that arise from the combination of these two product types. This part 3 gives safety requirements by: referring to other parts of IEC 62109 and to PV module standards like IEC 61730, defining tests and requirements that are in addition to these product standards of the sub elements, defining modifications to the test procedures in IEC 62109 and IEC 61730, and providing guidance to apply these tests to the combination of PV module and electronics.

Indian Standard

SAFETY OF POWER CONVERTERS FOR USE IN PHOTOVOLTAIC POWER SYSTEMS

PART 3 PARTICULAR REQUIREMENTS FOR ELECTRONIC DEVICES IN COMBINATION WITH PHOTOVOLTAIC ELEMENTS

1 Scope

This Part 3 of IEC 62109 covers the particular safety requirements for electronic elements that are mechanically and/or electrically incorporated with photovoltaic (PV) modules or systems.

Mechanically and/or electrically incorporated means that the whole combination of electronic device with the photovoltaic element is sold as one product. Nevertheless, tests provided in this document may also be used to evaluate compatibility of PV modules and electronic devices that are sold separately and are intended to be installed close to each other.

Items included in the scope:

Electronic devices combined with PV modules that perform functions such as, but not limited to, DC-DC or DC-AC power conversion, active diodes, protection, control, monitoring, or communication. These requirements specifically address such electronic devices used in combination with flat-plate photovoltaic (PV) modules.

NOTE It is acknowledged that the physical design of products covered by this scope may vary widely, it is anticipated that the requirements of this document may need to evolve to meet the unique safety requirements of such products, particularly if the photovoltaic element of the product is not of a flat-plate configuration. As an example, this document does not fully address the safety requirements of building-integrated photovoltaics (BIPV) and building-attached photovoltaics (BAPV) products, although they would fall under the scope of this document.

The purpose of the requirements of this part of IEC 62109 is to provide additional safety-related testing requirements for the following types of integrated electronics, collectively referred to as module integrated equipment (MIE):

a) Type A MIE where the PV element can be evaluated as a PV module according to IEC 61730-1 and IEC 61730-2 independently from the electronic element;
b) Type B MIE where the PV element cannot be evaluated as a PV module according to IEC 61730-1 and IEC 61730-2 independently from the electronic element.

Items excluded from the scope:

PV modules with only one or more bypass diodes as the combined or integrated element. Such products are covered by IEC 61730-1 and IEC 61730-2.

Aspects included and excluded from scope:

All aspects of IEC 62109-1:2010 apply. Addition to the list “excluded from the scope” is evaluating the MIE to IEC 61215-1.

2 Normative references

Clause 2 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable with the following additions:

IEC 61215-2:2016, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

IEC 61730-1:2016, *Photovoltaic module safety qualification – Part 1: Requirements for construction*

IEC 61730-2:2016, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

IEC 61853-2:2016, *Photovoltaic (PV) module performance testing and energy rating – Part 2: Spectral responsivity, incidence angle and module operating temperature measurements*

IEC 62109-1:2010, *Safety of power converters for use in photovoltaic power systems – Part 1: General requirements*

IEC 62109-2:2011, *Safety of power converters for use in photovoltaic power systems – Part 2: Particular requirements for inverters*

IEC 62790:2014, *Junction boxes for photovoltaic modules – Safety requirements and tests*

3 Terms and definitions

Clause 3of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable with the following modifications:

Modification:

In all cases where the term “PCE” is used in a definition in Clause 3 of IEC 62109-1:2010 or IEC 62109-2:2011, it is replaced in this part with the term “MIE”, except for 3.66.

3.39
Isc PV
Modification:

Replace “array” *with* “PV element”.

3.58
Pluggable equipment type B

Modify Note:

Note 1 to entry: MIE PV AC and DC circuits that use connectors are considered pluggable equipment type B MIE and may also be considered fixed equipment.

3.97
Vmax PV

Modification:

Replace “array” *with* “PV element”.

Additional subclauses:

3.300
module integrated equipment
MIE
minimally, the complete combination of photovoltaic elements, electronic devices, wiring with connector(s), and mechanical mounting means

Note 1 to entry: This document uses two designations for MIE only for the purpose of describing test methods and what tests apply: Type A MIE and Type B MIE. These type designations have no meaning outside of this document.

Note 2 to entry: MIE with inverters as the electronic element are sometimes referred to as AC PV Modules. For the purpose of this document, MIE is used to describe all combinations regardless of the type or function of the electronic element.

3.301
type A MIE
construction where the PV module has been evaluated to IEC 61730-1 and IEC 61730-2 independently from the electronic element but may include any portion of the electronic element that serves as an attachment means

3.302
type B MIE
construction where the PV element cannot be evaluated as a PV module to IEC 61730-1 and IEC 61730-2 independently from the electronic element or portion of the electronic element (such as the electronic attachment means)

3.303
PV element circuit
MIE PV circuit on the input side of the integrated electronics, including cables

3.304
diode
non-controllable valve device that allows the current to flow in one direction and blocking the current in the reverse direction without any control signal being applied

3.305

circuit used to simulate a diode function using a switching element where the current is controlled with a control signal

3.306
photovoltaic element
PV element
single PV cell, sub-assembly of such cells or entire PV module

4 General testing requirements

Clause 4 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable except as follows:

Addition:

NOTE In IEC 62109-1:2010 and therefore in this Part 3, test requirements that relate only to a single type of hazard (shock, fire, etc.) are given in the clause specific to that hazard type. Test requirements that relate to more than one type of hazard (for example testing under fault conditions) or that provide general test conditions, are given in this Clause 4.

4.1 General

The following text replaces the requirements in IEC 62109-1:2010.

Testing required by this document is to demonstrate that electronic devices in combination with photovoltaic elements are fully in accordance with the applicable requirements of this document. This document requires the use of requirements from IEC 61730-2.

Guidance on modifications to the test procedures in IEC 61730-2:2016 is provided in Table 300.

Type A MIE may be tested to the condensed sequence of Figure 300 when the PV module has already been evaluated to IEC 61730-2:2016 or newer. Designs that allow the electronic element to be electrically and mechanically separated from the PV module without affecting the outcome of the test can use samples consisting of just the electronic element for those tests that do not require a full MIE. Tests for type B MIE may also be used for constructions where the PV element can be separated and has not yet been evaluated as a PV module to IEC 61730-2:2016 or newer independently from the electronic element.

Type B MIE will be evaluated to the test sequence of IEC 61730-2:2016, Figure 1 using Table 300 as a guide for testing with the electronic element. Some modification to the test procedure may be required along with special preparation of samples to gain access to PV element output circuits and the electronics input and output circuits.

The evaluation of the electronic element shall also comply with all applicable clauses of this document and any other IEC standards specific to the type of electronic device.

Some electronic devices and associated hardware require the use of other standards (such as protection, monitoring, communication systems, cabling and connectors) for requirements specific to the function of the device that are not included in:

a) this Part 3, or

b) IEC 62109-1:2010 and IEC 62109-2:2011.

This document does not supersede any requirements for PV modules in IEC 61730 (all parts) and IEC 61215 (all parts).

Junction box designs that contain electronic elements can be evaluated as a component to IEC 62790. However, the completed MIE assembly shall be evaluated to this document considering tests and evaluations already performed to IEC 62790 that relate to requirements in IEC 61730-1 and IEC 61730-2.

NOTE Table 300 and Figure 300 use abbreviations for module safety test (MST) and module quality test (MQT) taken from IEC 61730-2:2016 and IEC 61215-2:2016.

Table 300 – IEC 61730-2:2016 test reference for Type A and Type B MIE

Tests IEC 61730-2:2016 (IEC 61215-2:2016)	**Type A MIE** Considerations when applying Figure 300 test sequence. NOTE	**Type B MIE** Considerations when applying IEC 61730-2:2016, Figure 1 test sequence NOTE
Environmental stress tests		
MST 51 (MQT 11) Thermal cycling	Test using procedure MST 51 (MQT 11), except: a) The electronic element may be tested without a PV element if the electronic element is not secured by adhesive to the PV element and does not rely on any part of the PV element for environmental protection. b) If the PV element has already been evaluated, a constant current source does not have to be connected to the PV element. c) Thermocouple(s) may be located on the electronic element if the PV element is not needed for the testing. d) For MIE that is required to be earthed and that provides earth continuity between accessible metal parts and the earthing terminal, the earthing continuity shall be monitored during the test. Connect a continuous current source through the earthing path using the same procedure and current as described for the PV module circuit testing in MQT 11. e) The number of cycles shall be 50 unless adhesive is used for securing the electronic element to the PV element, then the number of cycles shall be 200. f) The electronic element is not powered during this test	In addition to the PV module test procedure in MST 51 (MQT 11), for MIE that is required to be earthed and that provides earth continuity between accessible metal parts and the earthing terminal, the earthing continuity shall be monitored during the test. Connect a continuous current source through the earthing path using the same procedure and current as described for the PV module circuit testing in MQT 11. The electronic element is not powered during this test. Post test(s) described in IEC 61730-2:2016, based on Figure 1 test sequence, shall be applied to the MIE using the considerations as described in Table 300 of this document.
MST 52 (MQT 12) Humidity freeze)	Test using procedure MST 52 (MQT 12), except: The electronic element may be tested without a PV element if the electronic element is not secured by adhesive and does not rely on any part of the PV element for environmental protection. a) If the PV element has already been evaluated, a constant current source does not have to be connected to the PV element. b) Thermocouple(s) may be located on the electronic element if the PV element is not needed for the testing. c) For MIE that is required to be earthed and that provides earth continuity between accessible metal parts and the earthing terminal, the earthing continuity shall be monitored during the test. Connect a continuous current source through the earthing path using the same procedure and current as described for the PV module circuit testing in MQT 12. d) The electronic element is not powered during this test.	In addition to the PV module test procedure in MST 52 (MQT 12), for MIE that is required to be earthed and that provides earth continuity between accessible metal parts and the earthing terminal, the earthing continuity shall be monitored during the test. Connect a continuous current source through the earthing path using the same procedure and current as described for the PV module circuit testing in MQT 12. The electronic element is not powered during this test. Post test(s) described in IEC 61730-2:2016, based on Figure 1 test sequence, shall be applied to the MIE using the considerations as described in Table 300 of this document.

Tests IEC 61730-2:2016 (IEC 61215-2:2016)	**Type A MIE** Considerations when applying Figure 300 test sequence. NOTE	**Type B MIE** Considerations when applying IEC 61730-2:2016, Figure 1 test sequence NOTE
MST 53 (MQT 13) Damp heat	Test using procedure MST 53 (MQT 13), except: a) The electronic element may be tested without a PV element if the electronic element is not secured by adhesive and does not rely on any part of the PV element for environmental protection. b) Duration of the test is 200 h. c) The electronic element is not powered during this test.	MIE shall be tested as described in MST 53 (MQT 13). The electronic element is not powered during this test. Post test(s) described in IEC 61730-2:2016, based on Figure 1 test sequence, shall be applied to the MIE using the considerations as described in Table 300 of this document.
MST 54 (MQT 10) UV test	Test using the procedure MST 54 (MQT 10), except: a) The electronic element may be tested without a PV element if the electronic element is not secured by adhesive. b) The UV dose only needs to be applied to the electronic element and its adhesive bond. c) For Figure 300 Sequence A, the UV dose shall be 15 kWh/m^2 and is not required unless the electronic element is secured to the PV element by adhesive. d) For Figure 300 Sequence B, the UV dose shall be 60 kWh/m^2 and is not required when: i) The electronic element is enclosed in metal or consisting of polymeric materials already evaluated as a component (i.e. connectors, cables, plastic enclosures or parts that provide mechanical attachment) with a suitable UV rating, and ii) Mechanically attached without adhesive. The electronic element is not powered during this test.	MIE shall be tested as described in MST 54 (MQT 10). The electronic element is not powered during this test. Post test(s) described in IEC 61730-2:2016, based on Figure 1 test sequence, shall be applied to the MIE using the considerations as described in Table 300 of this document.
MST 55 Cold conditioning	MST 55 does not apply. For electronic elements, testing to reduce from a pollution degree 3 to pollution degree 2 or 1 shall use the procedure described in IEC 62109-1:2010, 6.2 and 7.3.7.8.4.2, instead of MST55.	This test shall be applied to the PV element only. For electronic elements, testing to reduce from a pollution degree 3 to pollution degree 2 or 1 shall use the procedure described in IEC 62109-1:2010, 6.2 and 7.3.7.8.4.2, instead of MST 55.
MST 56 Dry hot conditioning	MST 56 does not apply. For electronic elements, testing to reduce from a pollution degree 3 to pollution degree 2 or 1 shall use the procedure described in IEC 62109-1:2010, 6.2 and 7.3.7.8.4.2, instead of MST56.	This test shall be applied to the PV element only. For electronic elements, testing to reduce from a pollution degree 3 to pollution degree 2 or 1 shall use the procedure described in IEC 62109-1:2010, 6.2 and 7.3.7.8.4.2, instead of MST 56.
General inspection tests		
MST 01 (MQT 01) Visual Inspection	The electronic element may be subjected to additional visual inspection requirements from IEC 62109 series or other relevant standards.	The MIE shall be evaluated to MST 01 (MQT 01). The electronic element may be subjected to additional visual inspection requirements from IEC 62109 series or other relevant standards.

Tests IEC 61730-2:2016 (IEC 61215-2:2016)	Type A MIE Considerations when applying Figure 300 test sequence. NOTE	Type B MIE Considerations when applying IEC 61730-2:2016, Figure 1 test sequence NOTE
MST 02 Performance at STC (Part of the functional test in Figure 300)	MST 02 does not apply to the electronic element.	The MST 02 test procedure is only performed on the PV element.
MST 03 Maximum power determination	MST 03 does not apply.	The MST 03 test procedure is only performed on the PV element.
MST 04 Insulation thickness	MST 04 does not apply. Insulation thickness requirements for the electronic element is evaluated to requirements in this document or other applicable IEC standards that apply to the specific electronics.	The MST 04 test procedure is only performed on the PV element. Insulation thickness requirements for the electronic element is evaluated to requirements in this document or other applicable IEC standards that apply to the specific electronics.
MST 05 Durability of markings	MST 05 does not apply. Markings on the electronic element shall comply with the requirements in this document.	Markings on the PV module shall comply with MST 05. Markings on the electronic element and MIE shall comply with the requirements in this document. Markings on junction box type designs shall comply with IEC 62790 junction boxes.
MST 06 Sharp edge test	MST 06 does not apply to the electronic element since this test is already covered in IEC 62109-1:2010,8.1.	MST 06 shall be performed on the MIE (PV element and electronic element). NOTE MST 06 satisfies the intent of IEC 62109-1:2010,8.1.
MST 07 Bypass diode functionality test	MST 07 applies if the electronic element is equipped with bypass diode(s) for PV elements substring protection.	MST 07 applies if the MIE is equipped with bypass diode(s) for PV elements substring protection.
Electrical shock hazard tests		
MST 11 Accessibility test	MST 11 shall be applied to the MIE. For the electronic element, the enclosure requirements shall apply in this document or other applicable standards.	MST 11 shall be performed on the MIE (PV element and electronic element). Additional enclosure requirements shall apply to the electronic element in this document or other applicable standards.
MST 12 Cut susceptibility test	MST 12 does not apply.	The MST 12 test procedure is only performed on the PV element.
MST 13 Continuity test for equipotential bonding	MST 13 shall be performed on the MIE, which includes the PV module element and any electronic element with DC output(s). For MIE with an AC output, the requirements in IEC 62109-1:2010, 7.3.6.3.3.1, shall apply.	MST 13 shall be performed on the MIE, which includes the PV module element and any electronic element with DC output(s). For MIE with an AC output, the requirements in IEC 62109-1:2010,7.3.6.3.3.1, shall apply.
MST 14 Impulse voltage test	MST 14 does not apply. The electronic element input and output circuits shall be tested to IEC 62109-1:2010,7.3.7.1.2.	MST 14 shall be applied to the PV element DC output. The electronic element input and output circuits shall be tested to IEC 62109-1:2010, 7.3.7.1.2.
MST 16 (MQT 03) Insulation test (Figure 300 Dielectric strength)	For the electronic element, the test procedure of MST 16 (MQT 03) shall be replaced with the test sequence defined in IEC 62109-1:2010, 7.5.2 for the electronic element input(s) and output(s).	The test procedure of MST 16 (MQT 03) shall be applied to the PV module element. For the electronic element, the test procedure of MST 16 (MQT 03) shall be replaced with the test sequence defined in IEC 62109-1:2010, 7.5.2 for the electronic element input(s) and output(s).

Tests IEC 61730-2:2016 (IEC 61215-2:2016)	Type A MIE Considerations when applying Figure 300 test sequence. NOTE	Type B MIE Considerations when applying IEC 61730-2:2016, Figure 1 test sequence NOTE
MST 17 (MQT 15) Wet leakage current test	The test procedure of MST 17 (MQT 15) shall be applied to the MIE. The depth of the solution shall be sufficient to cover all surfaces. Where the electronic element is not designed for immersion the surfaces shall be sprayed with the solution. The insulation resistance test shall be applied to the PV element output, the electronic element input and output port(s). The requirements for the electronic element should be based on the MIE PV element size. Exception: This test does not apply to electronic elements enclosed in a Class I (earthed) metal enclosure. NOTE Earthed metal enclosures may provide a false indication of wet leakage path between the internal circuit and the solution.	The test procedure of MST 17 (MQT 15) shall be applied to the MIE. The depth of the solution shall be sufficient to cover all surfaces. Where the electronic element is not designed for immersion the surfaces shall be sprayed with the solution. The insulation resistance test shall be applied to the PV element output, the electronic element input and output port(s). The requirements for the electronic element should be based on the MIE PV element size. Exception: This test does not apply to electronic elements enclosed in a Class I (earthed) metal enclosure. NOTE Earthed metal enclosures may provide a false indication of wet leakage path between the internal circuit and the solution.
MST 42 (MQT 14) Robustness of terminations test	MST 42 (MQT 14) shall be applied to the electronic element as follows: a) Cord anchorage evaluations may use MQT 14.2 or requirements in IEC 62790 Junction Boxes b) For electronic elements that are attached to the PV element using adhesive, MQT 14.1 shall apply.	MST 42 (MQT 14) shall be applied to the MIE. Post test(s) described in IEC 61730-2:2016, based on Figure 1 test sequence, shall be applied to the MIE using the considerations as described in Table 300 of this document.
Fire hazard tests		
MST 21 Temperature test	The test procedure of MST 21 does not apply to the electronic element. Subclause 4.3 of this document shall be used for testing the electronic element. Testing may be performed on the full MIE sample or a separate sample of the electronic element using 4.3.2.1.301, Method 2 assembly.	The test procedure of MST 21 shall be performed on the PV element. Subclause 4.3 of this document shall be used for testing the electronic element. Post test(s) described in IEC 61730-2:2016, based on Figure 1 test sequence, shall be applied to the MIE using the considerations as described in Table 300 of this document.
MST 22 (MQT 09) Hot-spot endurance test	The test procedure of MST 22 (MQT 09) shall be performed on the MIE, including the PV element cell located over the electronic element.	The test procedure of MST 22 (MQT 09) shall be performed on the MIE, including the PV element cell located over the electronic element. Post test(s) described in IEC 61730-2:2016, based on Figure 1 test sequence, shall be applied to the MIE using the considerations as described in Table 300 of this document.
MST 23 Fire test	MST 23 does not apply. The electronic element shall comply with the enclosure requirements of this document.	MST 23 shall apply to the MIE.
MST 24 Ignitability test	MST 24 does not apply. The electronic element shall comply with the enclosure and material requirements of this document or IEC 62790 junction boxes	MST 24 shall be applied to the PV element. The electronic element shall comply with the enclosure and material requirements of this standard or IEC 62790 junction boxes.
MST 25 (MQT 18) Bypass diode thermal test	The test procedure of MST 25 (MQT 18) shall be applied to the electronic element if equipped with bypass diodes for PV elements substring protection.	The test procedure of MST 25 (MQT 18) shall be applied to the MIE if equipped with bypass diodes for PV elements substring protection. Post test(s) described in IEC 61730-2:2016, based on Figure 1 test sequence, shall be applied to the MIE using the considerations as described in Table 300 of this document.

Tests IEC 61730-2:2016 (IEC 61215-2:2016)	**Type A MIE** Considerations when applying Figure 300 test sequence. NOTE	**Type B MIE** Considerations when applying IEC 61730-2:2016, Figure 1 test sequence NOTE
MST 26 Reverse current overload test	MST 26 does not apply. Electronic elements shall comply with this document, 7.5.5 Equipment with multiple sources and 9.3.4 Inverter backfeed current onto the array. The backfeed current from the electronic element shall not exceed the reverse current capability as determined by the PV element testing to MST 26. For electronic elements that do not provide backfeed current protection meeting the MST 26 PV element rating, the manufacturer shall provide instructions with the MIE specifying the maximum over-current protection required.	The test procedure of MST 26 shall be applied to the PV element. For this test, the electronic part of the MIE shall be disconnected. Electronic elements shall comply with this document, 7.5.5 Equipment with multiple sources and 9.3.4 Inverter backfeed current onto the array. The backfeed current from the electronic element shall not exceed the reverse current capability as determined by the PV element testing to MST 26. For electronic elements that do not provide backfeed current protection meeting the MST 26 PV element rating, the manufacturer shall provide instructions with the MIE specifying the maximum over-current protection required.
Mechanical stress tests		
MST 32 Module breakage test	MST 32 does not apply.	The test procedure of MST 32 shall be applied to the PV element.
MST 33 Screw connection test	The test procedure of MST 33 shall be applied to the field wiring connections of the electronic element.	The test procedure of MST 33 shall be applied to the MIE.
MST 34 (MQT 16) Static mechanical load test	The test procedure of MST 34 (MQT 16) shall be applied to the MIE to ensure that: a) mechanical attachment and location of the electronic element does not damage the backsheet or electronic element during deflection of the laminate, or b) If the electronic element is secured by adhesive, the deflection does not affect the adhesion, which shall be verified by MST 42.	The test procedure of MST 34 (MQT 16) shall be applied to the MIE. Post test(s) described in IEC 61730-2:2016, based on Figure 1 test sequence, shall be applied to the MIE using the considerations as described in Table 300 of this document. If the electronic element is attached to the PV element by adhesive, then after the test of MST 34 (MQT 16) in Test sequence D of IEC 61730-2:2016 Figure 1, perform MST 42 (MQT 14.1 only) on the electronic element.
MST 35 Peel test	MST 35 does not apply.	MST 35 applies to the PV element.
MST 36 Lap shear strength test	MST 36 does not apply.	MST 36 applies to the PV element.
MST 37 Materials creep test	MST 37 does not apply unless the electronic element is secured to the PV element by adhesive.	The test procedure of MST 37 shall be applied to the MIE. If the electronic element is secured to the PV element by adhesive, after the test of MST 37 in Test sequence A, perform MST 42 (MQT 14.1 only) on the electronics element. Post test(s) described in IEC 61730-2:2016, based on Figure 1 test sequence, shall be applied to the MIE using the considerations as described in Table 300 of this document.
NOTE The DC connection between the PV element and the electronic element may need to be separated so that testing can be performed on just the PV element or the electronic element by attaching test leads as necessary to: a) the PV element (+) and (–); b) the electronic element (+) and (–) input; c) the electronic element output.		

4.2 General conditions for testing

4.2.1 Sequence of tests

The following text replaces the requirements in IEC 62109-1:2010:

The sequence of tests required by this document for the electronic element is optional, unless otherwise specified in the particular test clause.

The sequence of testing for the PV element (including tests requiring samples of type B MIE assemblies) is specified in IEC 61730-2:2016, Figure 1. In Figure 300 of this document the test sequence for type A MIE is specified.

Post tests MST 01, MST 16 and MST 17 are required after each sequence as defined in Figure 300. Within each test sequence, these informative tests are optional as indicated.

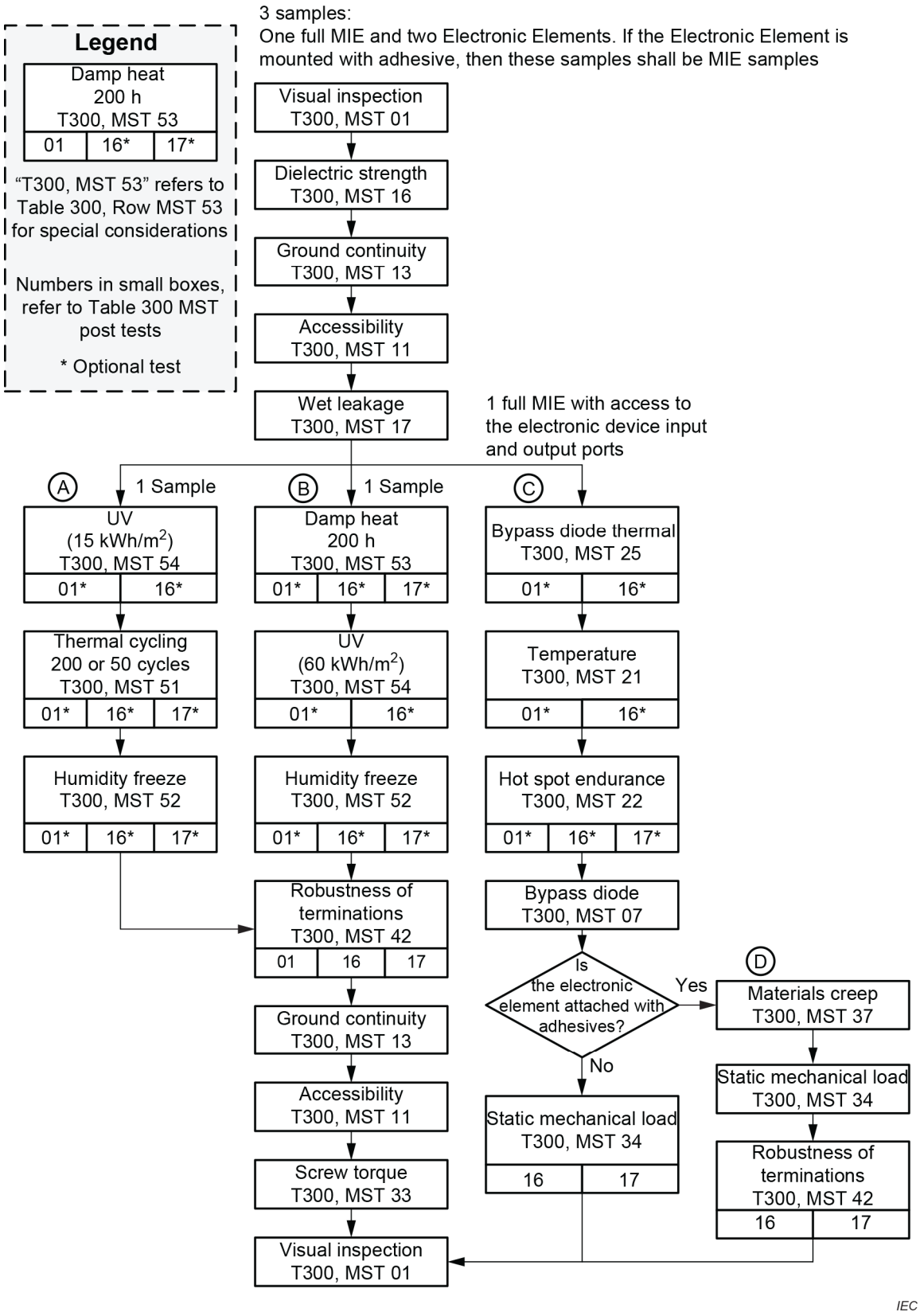

Figure 300 – Test sequence

4.2.2 Reference test conditions

4.2.2.1 Environmental conditions

Addition:

The test location conditions are specified in IEC 61730-2 for the PV module element and any type A and type B MIE samples that are required for that test sequence. Conditioning tests, such as humidity freeze, thermal cycling, damp heat, dry hot conditioning and cold conditioning use more extreme temperature and humidity conditions due to the application of a PV module in outdoor conditions.

Temperature testing of the MIE according to this document also uses higher temperature conditions.

4.2.2.7 Supply ports other than the mains

4.2.2.7.1 Photovoltaic supply sources

Modification:

Replace PCE with MIE. Replace “PV array” with “PV module or PV element”.

Addition:

For MIE without any possibility to disconnect the electronics, it is allowed to:

– modify the MIE in such way that the supply inputs become available to power the electronics by an external source with the same characteristics as the integrated PV module. In that case the modification shall not affect or change the behaviour of the equipment or the outcome of the test compared with the original equipment, or
– power the PV module by simulating the irradiation if the test setup is not affected. In this case the radiation shall be equivalent to the daylight spectrum and the source shall be capable of generating the required:
  a) module current to cause maximum heating, and
  b) voltage and wattage in the module to power the MIE.

NOTE IEC 61730-2 contains additional requirements for the type of solar simulator to use.

4.3 Thermal testing

4.3.2 Maximum temperatures

4.3.2.1 General

Addition:

MIE shall be subjected to the temperature test using either the complete assembly as described in 4.3.2.1.300 or a partial assembly as described in 4.3.2.1.301.

The temperature test will be based on:

a) Environmental temperature as defined in IEC 61730-1:2016 in degrees Celsius for the geographic installation location. The minimum shall be 40 °C as required by IEC 61730-1:2016 and IEC 61730-2:2016. The environmental temperature T_{amb} is used to calculate the PV module maximum backsheet temperature (T_{maxBs}) using formula (1) in 4.3.2.1.302.

b) PV Module nominal backsheet temperature (T_{NBs}) in degrees Celsius that is used to calculate the PV module maximum backsheet temperature (T_{maxBs}) using formula (1) in 4.3.2.1.302. The value used for T_{NBs} shall be either:

   1) the PV module Nominal Module Operating Temperature (NMOT) rating,

   2) the PV module Nominal Operating Cell Temperature (NOCT) rating,

   3) the value of 50 °C, or

   4) the value according to the method in Annex A on the actual PV element.

   NOTE 1 Some PV modules may have a NOCT rating instead of a NMOT rating. As defined above, either rating can be used to calculate T_{maxBs} since both ratings are evaluated at 800 W/m^2 and an ambient temperature of 20 °C. The method used to determine NOCT is considered to produce a higher value than the NMOT method and represents a more severe test condition.

c) Behind the module air temperature in degrees Celsius will be based on the environmental temperature above and the installation instructions. This temperature shall be the chamber test temperature and is typically greater than the environmental temperature. The following guidance is provided for determining the behind the module air temperature based on the module mounting distance according Figure 302 and Figure 303:

   – MIE installed with the entire backsheet exposed to the environmental air temperature and mounted greater than 1 m above the ground or any other surface: environmental temperature or greater;

   – Multiple MIE installed greater than 100 mm to 1 m above a surface with no baffling that obstructs air flow: environmental temperature plus 10 °C;

   – Multiple MIE installed greater than 50 mm to 100 mm above a surface with no baffling that obstructs air flow: environmental temperature plus 15 °C;

   – Other constructions and installation methods that are mounted 50 mm or less to a surface, provided with baffling and/or enclosures shall have a separate evaluation performed before testing the individual module to determine the behind the module air temperature based on the environmental temperature and heating from the MIE under the most severe installation condition according to the installation instructions.

NOTE 2 Building-integrated or building-attached photovoltaics architectural applications using MIE, have less or no air circulation behind the PV modules for cooling. For such configurations, properties of behind the module air temperature require further study for MIE thermal testing condition.

Additional subclauses:

4.3.2.1.300 Method 1 assembly

The test set-up shall consist of:

a) the actual, full sized, PV module;

b) the electronic device mounted to the PV module as follows:

   1) the input of the electronic device is connected to a separate source of supply instead of to the PV module output, and

   2) the electronic device is located and mechanically attached to the PV module in the intended production manner, and

c) a controllable heat source capable of regulating the Figure 302 and Figure 303 backsheet thermocouple temperature to T_{maxBs} using one of the following methods:

   1) Heating pads added to the glass side of the PV module capable of heating either:

      i) the whole surface that would normally be exposed to the sun, or

      ii) an area not less than twice the projected area of the electronic device onto the surface of the module, located so as to cover the whole projected area of the electronic device and extending beyond all sides without extending past the boundary of the module.

NOTE An example of heating pad arrangement for different electronic device mounting locations is illustrated in Figure 301. If multiple heating pads are used to make up the outlined area, gaps between pads are allowed if the gap is no wider than the distance between PV module cells and backsheet thermocouples are added directly opposite each heater pad for adjustment of temperature in 4.3.2.1.302(e).

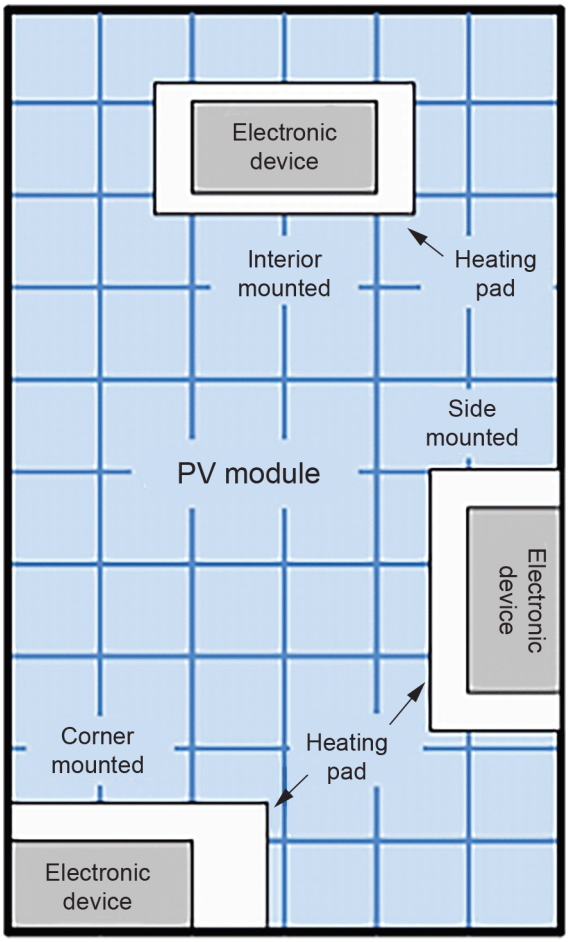

Figure 301 – Location of heating pads

2) For PV elements that can be heated to the required temperature by connecting a controllable power source to the DC output in the forward bias condition (+ to + and – to -), this may be an acceptable alternative to using heater pads.

4.3.2.1.301 Method 2 assembly

The partial test set-up shall consist of the elements in 4.3.2.1.300 except as follows:

a) Instead of using the actual PV module, a smaller size PV module, portion of a module, or simulated PV module may be used. The module or simulated module shall consist of:

   1) a cut-out portion of the actual PV module,

   2) a smaller size PV module using the same laminate, or

   3) a smaller simulated module constructed with materials having equivalent layer construction, emissivity and thermal conduction.

   If the module, portion of a module, or simulated module used is smaller than the module that is used in the production assembly, then it shall have an area not less than twice the projected area of the electronic device onto the surface of the module and allow for placement of heater pads and thermocouples as shown in Figures 301, 302 and 303.

b) The electronic device shall be located and mechanically attached in a manner representative of the intended production.

4.3.2.1.302 Temperature test procedure

The following temperature test procedure shall be used to evaluate the combination of the PV module and electronic element(s) as configured in 4.3.2.1.300 or 4.3.2.1.301:

a) Determine the PV Module nominal backsheet temperature (T_{NBs}) as stated in 4.3.2.1 b).

b) Calculate the PV Module maximum backsheet temperature (T_{maxBs}) using formula (1):

$$T_{maxBs} = T_{amb} + 1\ 200/800 \times (T_{NBs} - 20\ °C) \quad (1)$$

where

T_{amb} is the environmental air ambient temperature determined by 4.3.2.1 a),

T_{NBs} is the PV Module nominal backsheet temperature in 4.3.2.1 b)

NOTE The procedure for determining T_{NBs} in 4.3.2.1 b) uses 800 W/m² at an ambient temperature of 20 °C. The above formula (1) adjusts this for more realistic worst-case irradiance and environmental ambient to ensure maximum temperatures.

c) The test shall be performed in a temperature-controlled chamber. The chamber temperature shall be set to the manufacturer's specified behind the module air temperature as stated in 4.3.2.1 c) before applying power to the electronics and heat source described in 4.3.2.1.300 c).

d) The electronic device under test shall not be subjected to direct air movement from an air circulation chamber. If tested in an air circulation chamber, the electronic device portion of the assembly shall be shielded from direct air movement from the chamber fans. Air shields or chamber design shall not impede the natural convection flow from the electronics.

e) The power output of the heat source in 4.3.2.1.300 c) shall be adjusted for the temperature of the back sheet to stabilize to within -0 °C to 5 °C of the value calculated in b).

f) The electronic device shall be energized from a power source adjusted to provide the output power that would be available from the intended photovoltaic module at an irradiance of 1 200 W/m² and adjusted based on the PV Module temperature coefficient using the temperature T_{maxBs} determined in b). For electronics that limit the PV module power or current, this shall be considered in the calculation.

g) A load (DC or AC), a utility or a simulated utility shall be connected to the output of the electronic device so that the electronic device operates continuously at the desired power level.

h) The chamber temperature shall be regulated to maintain the air temperature behind the module to ±5 °C according to the manufacturer’s specified behind the module air temperature rating. The temperature of the air space behind the module shall be measured at a point defined by the following dimensions and not affected by the heat exhaust of the electronic device:

   1) 25 mm to 35 mm from the perimeter of the electronic device measured parallel to the plane of the module, and

   2) 50 mm to 60 mm from the backsheet measured perpendicular to the plane of the module.

   The difference between the maximum rated and the measured air temperature behind the module is to be subtracted from or added to the measured temperatures used for pass/fail criteria.

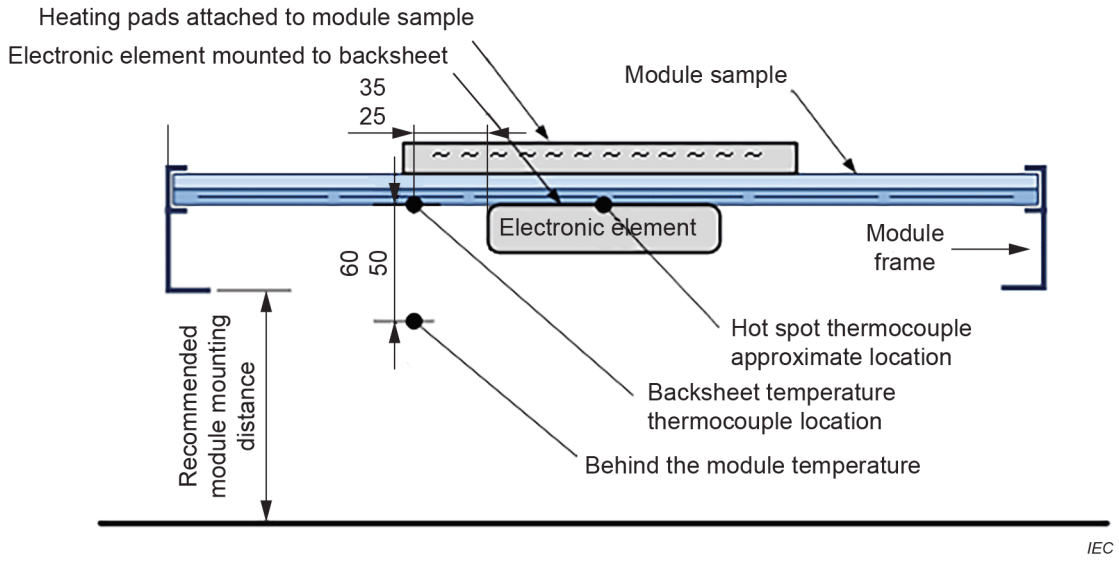

Figure 302 – Test setup for Type B MIE (cross-section view)

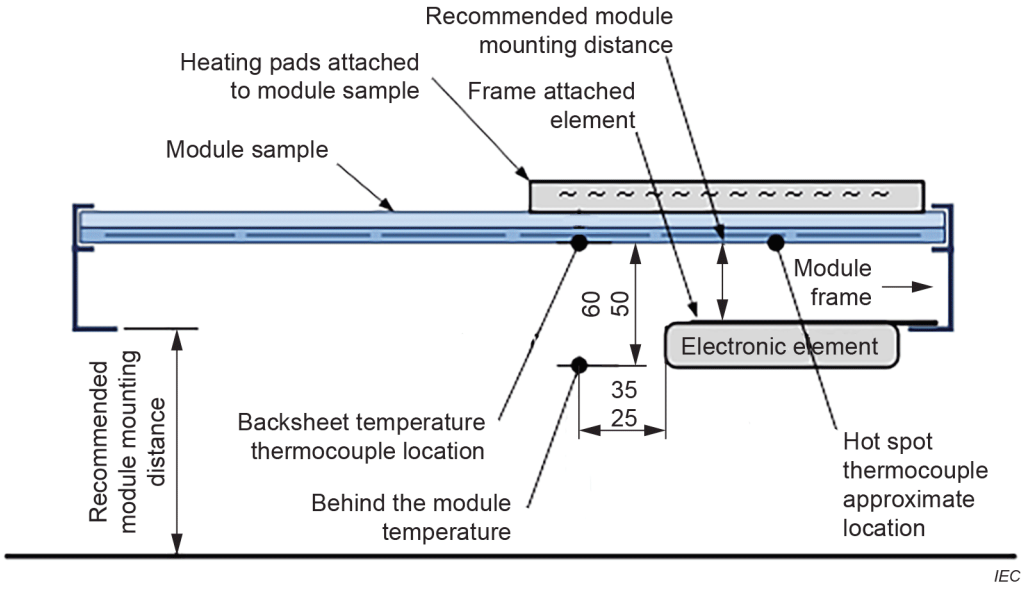

Figure 303 – Test setup for Type A MIE (cross-section view)

i) If the conditions in c) through h) result in less than the electronic device's maximum output, an additional test shall be performed in order to maximize the power by reducing the ambient temperature as follows:

1) Using the PV module temperature coefficients, determine the T_{maxBs} that would provide the current voltage characteristics necessary for the electronic device to deliver its maximum power.

2) Calculate the associated environmental temperature using formula (2) derived from b):

$$T_{amb} = T_{maxBs} - 1\ 200/800 \times (T_{NBs} - 20\ °C) \quad (2)$$

3) Using T_{amb} from step (2), determine the behind the module air temperature as stated in 4.3.2.1 c). If the environmental temperature calculated in (2) is lower than 25 °C, 25 °C shall be used to determine the behind the module air temperature.

4) The test described in c) through h) shall be performed based on the new T_{maxBs} from step (1) and the new behind the module air temperature from step (3).

The temperature measurement points shall include all applicable points listed in MST 21 of IEC 61730-2 and Tables 1, 2 and 3 of IEC 62109-1:2010.

4.3.2.1.303 Pass/Fail criteria

a) None of the measured temperatures shall exceed any of the temperature limits, for materials or components, as described in MST 21 of IEC 61730-2:2016 and Tables 1 to 3 of IEC 62109-1:2010;

b) None of the measured surface temperatures shall exceed limits in IEC 62109-1:2010 unless the instructions contain a warning, and

c) There shall be no creeping, distortion, sagging, charring or similar damage to any part of the module, as indicated in of IEC 61730-2:2016 MST 01.

4.4 Testing in single fault condition

4.4.4 Single fault conditions to be applied

4.4.4.6 Backfeed current test for equipment with more than one source of supply

This clause of IEC 62109-1:2010 is applicable with the following addition:

For MIE intended to be connected simultaneously to more than one source of supply, each input of the MIE shall be tested one at a time, to determine if hazardous conditions can result from current from one source of supply flowing into the wiring for another source under fault conditions.

NOTE In this context, the word “source” is not meant to imply a direction of intended power flow into the MIE. “Source” means any circuit that is capable of delivering energy into the MIE or into another external connected circuit, under normal or single fault conditions, regardless of the intended direction of power flow under normal conditions.

With the MIE operating under normal conditions and intended worst case system installation, a short circuit shall be applied at the input terminals of the circuit under consideration, with all intended other sources connected to the MIE through the overcurrent protective devices (if any) intended to be present in the installation.

In addition to the requirements of 4.4.3 of IEC 62109-1:2010, the short-circuit currents are to be recorded and shall not exceed the maximum reverse current of the PV module or panel. The maximum measured current shall be provided in the installation manual in case the electronics can be separated from the PV module in order to select the correct part combination

The values to be reported are as in a) to c) of 4.4.4.5 of IEC 62109-1:2010.

4.4.4.15 Fault-tolerance of protection for grid-interactive inverters

Addition:

This subclause is applicable to MIE, or systems consisting of MIE and additional equipment, to provide the function of interconnection to the grid.

4.8 Additional tests for grid-interactive inverters

Requirements in 4.8 of IEC 62109-2:2011 shall also be applied to MIE with integrated ground fault protection. Refer to 4.300.

4.300 General requirements regarding protection of the PV element circuit of MIE

MIE may or may not provide galvanic isolation from the PV element circuit to the output of the MIE connected to either an AC mains or a higher voltage DC circuit, and the PV element circuit may or may not have one side of the circuit grounded.

All MIEs shall comply with the requirements in Table 30 and applicable clauses of IEC 62109-2 for the applicable combination of MIE isolation and PV element circuit grounding.

or

The MIE does not include a ground fault protection measure as required by IEC 62109-2 for the PV module circuit. In this case protection of the PV element circuit shall be provided by an external device (e.g. inverter). The MIE shall not interfere with the ability of the external device to detect ground faults internal to the MIE or on the external wiring. Instructions shall state the need to provide external protection according to applicable installation standards, including potential functionality impact of the external protection by the MIE integrated electronics.

NOTE The integrated electronics may impact external protection devices, e.g. blocking external measurements from the PV element circuit. Examples that may impact external detection methods: isolation between the input and output, internal components from DC to chassis such as for EMI that may cause low resistance detection when multiple MIE outputs are connected together.

5 Marking and documentation

Clause 5 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable except as follows:

5.1 Marking

5.1.1 General

Exception to IEC 62109-1:2010, 3rd paragraph:

If the equipment does not need to be removed from its installation to have an element of the product removed, such as for disconnection of one or more sub-assemblies as a feature of the product, then symbols 9 and 15 of Annex C in IEC 62109-1:2010 shall be visible before the disconnection and/or removal of the element, if a safety concern, as described elsewhere in this document, can occur.

Addition:

The markings required by IEC 62109-1:2010 and, if applicable, IEC 62109-2:2011 shall be applied for the MIE.

In addition, all markings according IEC 61730-1 shall be applied that are not already defined by IEC 62109-1:2010 and, if applicable, IEC 62109-2:2011.

For MIE with a PCE element the following markings are optional:

a) “voltage at open-circuit” or “V_{oc}”;

b) “current at short-circuit;” or “I_{sc}”;

c) “PV module maximum power” or “P_{max}”

Optional markings shall not be conflicting with MIE required markings.

5.1.3 Identification

Addition:

All markings required for MIE shall be given on a single name plate. It is allowed to keep the name plates or other markings of the subassemblies like PV element or electronic element in addition to the MIE name plate.

Where the electronic element(s) can be disconnected from the photovoltaic element(s), by design, the following shall apply:

a) Where the elements of the product can be removed or replaced, the MIE nameplate shall be marked with the following or equivalent warning: “This product is a PV-module with integrated electronics. Changes and replacement of any part shall only be performed according manufacturer’s instruction to avoid hazards”.
b) An identification label (with markings according 5.1.3 of IEC 62109-1:2010) shall be provided on the element that does not contain the MIE nameplate.
c) Any safety issues resulting during or after the disconnection procedure, shall have markings placed adjacent to the location of disconnection to:
    1) identify the nature of the safety concern and
    2) the conditions under which the disconnection may be performed to comply with the requirements of this document.

5.1.4 Equipment ratings

Addition:

Exception: If the electronic element is not a PCE the equipment ratings defined in other IEC standards specific to the type of electronic device shall be applied instead.

If electronics and PV elements with different protection classes are combined in an MIE the manufacturer shall define the protection class of the overall MIE and mark the MIE accordingly.

NOTE A typical example is if a class II PV element is combined with a class I inverter. Then the MIE is typically a class I product (after applying required earthing and bonding requirements).

5.3 Documentation

5.3.2 Information related to installation

Additional subclause:

5.3.2.301 Systems of combined MIE and external equipment

MIE that requires external equipment not provided with the product shall be provided with instructions that specify the manufacturer and model number of the equipment with which it is intended to be used.

6 Environmental requirements and conditions

Clause 6 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable.

7 Protection against electric shock and energy hazards

Clause 7 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable.

8 Protection against mechanical hazards

Clause 8 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable.

9 Protection against fire hazards

Clause 9 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable.

10 Protection against sonic pressure hazards

Clause 10 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable.

11 Protection against liquid hazards

Clause 11 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable.

12 Protection against chemical hazards

Clause 12 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable.

13 Physical requirements

Clause 13 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable except as follows:

13.4 Internal wiring and connections

13.4.5 Interconnection between parts of the PCE

This subclause of IEC 62109-1:2010 is applicable for all MIEs and not limited to PCEs.

Modification:

The term “PCE” is replaced with the term “MIE”.

Addition:

Mechanical protection is considered adequate if:

a) Wiring is internal to enclosures, with or without terminating connectors, that have been evaluated to all parts of IEC 62109, or
b) Exposed double-insulated PV style wire between the PV module output port(s) (e.g. junction box) and the electronics element is routed or secured to prevent sagging or displacement beyond the plane of the PV module frame, as verified by the test of 13.4.5.301. Examples of acceptable wire retention methods:
    1) Making the wire as short as possible without causing stress on the connections or wiring insulation due to tension or a sharp bending radius, or
    2) The wiring is mechanically secured.

    The wiring shall not be coiled or tied together in a way that would allow the conductors to experience a short circuit if the insulation was to be removed. It shall be assumed that the insulation on exposed wiring would be damaged due to aging, abrasion, cold flow or from animals.

Additional subclauses:

13.4.5.300 Material temperature rating

All components and materials of the MIE that are relied on for compliance with this clause shall have a temperature rating of not less than the actual temperature that the component or material reaches under normal worst case conditions, taking into account the ambient and surface temperatures expected on the part of the PV module to which the MIE is attached, and shall comply with the temperature test of 4.3. In no case shall the components and materials in contact with the PV module laminate be rated less than 90 °C.

13.4.5.301 Conductor deflection test

When pulled or pushed with a force of 10 N, no wires or cables shall deflect to such an extent that contact can occur with metal parts, or to binding or grounding conductors, including parts of the PV module or parts of the product's assembly system, such as racking, roofing, etc., when installed according to the manufacturer's installation instructions.

13.9 Fault indication

For requirements on fault indication for MIE refer to 13.9.300.

13.9.300 Fault indication for MIE

Where this document requires the MIE to indicate a fault, both of the following shall be provided:

a) Indication located at the site: audible or visual indication detectable from outside the MIE or provided in a separate device associated with the MIE and installed at the site, and

NOTE 1 The reason for the separate indication device above is to ensure that the fault indication is detectable by personnel on site.

b) Remote indication: an electrical or electronic indication that can be remotely accessed and used.

NOTE 2 The intent of item b) is for the fault indication to be received by a person in a different location than the PV system. The means is not defined, but could be implemented as a message sent over a communication system, closure of a pair of contacts, etc.

The installation instructions shall include information regarding how to properly make connections and use the on-site and off-site remote indication means above.

13.300 Requirements for field assembled MIE

The physical assembly of the electronic element to the PV element may be completed in the product manufacturer's factory or in the field. If intended for field assembly, the following additional requirements shall apply:

a) The installation instructions shall include directions on how to assemble the parts.

b) Pluggable connection evaluated for field assembly:

   1) If required, grounding and bonding connections shall be made automatically, and

   2) maintain the environmental protection of the connection, and

   3) be rated for full load interrupting current without hazard to the operator or be a type for no load disconnection or unplugging that requires the use of a tool to open and be marked "Do not disconnect under load".

c) Provision of a mechanical attachment method evaluated for field assembly that does not require any modifications to the MIE, such as drilling, cutting of the frame or modifications to the wiring.

14 Components

Clause 14 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable.

15 Software and firmware performing safety functions

Clause 15 of IEC 62109-1:2010 and IEC 62109-2:2011 is applicable.

Annex A
(normative)

Alternative method for PV module nominal backsheet temperature (T_{NBs})

A.1 General

The following method may be used to determine the nominal backsheet temperature T_{NBs} as required by 4.3.2.1 b).

The backsheet temperature is primarily affected by the ambient temperature, the solar irradiance, and the wind speed.

The following procedure evaluates the nominal backsheet temperature for an open-rack mounted module operating near peak power in the following reference environment:

– Tilt angle: (37 ± 5) °
– Total irradiance: 800 W/m^2
– Ambient temperature: 20 °C
– Wind speed: 1 m/s
– Electrical load: A resistive load sized such that the module will operate near its maximum power point at STC or an electronic maximum power point tracker (MPPT).

NOTE This procedure is only used for establishing the heat source temperature in 4.3 and is based on the former NMOT procedure from IEC 61215-2:2016.

A.2 Principle

This method is based on gathering actual measured module temperature data under a range of environmental conditions including the reference environment conditions specified above. The data are presented in a way that allows accurate and repeatable interpolation of the T_{NBs}.

The nominal backsheet temperature (T_{NBs}) is primarily a function of the environmental temperature (T_{amb}), the average wind speed (v) and the total solar irradiance (G) incident on the active surface of the module.

The nominal module temperature is modelled by:

$$T_{NBs} = (G / (u_0 + u_1 v)) + T_{amb} \quad \text{(A.1)}$$

The coefficient u_0 describes the influence of the irradiance and u_1 the wind impact.

The value for T_{NBs} is then determined from the model formula (A.1) above by using T_{amb} = 20 °C, irradiance G of 800 W/m² and a wind-speed v of 1 m/s.

NOTE Formula (A.1) is derived from IEC 61853-2.

A.3 Test procedure

The data for calculating T_{NBs} shall be acquired using the test method (Methodology for determining module operating temperature) in IEC 61853-2.

(*Continued from second cover*)

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 62790 : 2014 Junction boxes for photovoltaic modules — Safety requirements and test	IS 16911 : 2018 Junction boxes for photovoltaic modules — Safety requirements and tests	Identical

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding of numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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This Indian Standard has been developed from Doc No.: ETD 28 (18551).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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