IEC 62109-3

Edition 1.0 2020-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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Safety of power converters for use in photovoltaic power systems –
Part 3: Particular requirements for electronic devices in combination with photovoltaic elements

Sécurité des convertisseurs de puissance utilisés dans les systèmes photovoltaïques –
Partie 3: Exigences particulières pour les dispositifs électroniques combinés aux éléments photovoltaïques

IEC 62109-3:2020-07(en-fr)

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SAFETY OF POWER CONVERTERS
FOR USE IN PHOTOVOLTAIC POWER SYSTEMS –

Part 3: Particular requirements for electronic devices in combination with photovoltaic elements

FOREWORD

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International Standard IEC 62109-3 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
82/1718/FDIS	82/1737/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 62109 series, under the general title, *Safety of power converters for use in photovoltaic power systems*, can be found on the IEC website.

The requirements in this document IEC 62109-3 are to be used with the requirements in IEC 62109-1:2010 and IEC 62109-2:2011. This document IEC 62109-3 supplements or modifies clauses in IEC 62109-1:2010 and IEC 62109-2:2011. When a particular clause or subclause of IEC 62109-1:2010 or IEC 62109-2:2011 is not mentioned in this document IEC 62109-3, that clause of IEC 62109-1:2010 and/or IEC 62109-2:2011 applies. When this document IEC 62109-3 contains clauses that add to, modify, or replace clauses in IEC 62109-1:2010 or IEC 62109-2:2011, the relevant text of IEC 62109-1:2010 and IEC 62109-2:2011 is to be applied with the required changes.

Subclauses, figures and tables additional to those in IEC 62109-1:2010 and IEC 62109-2:2011 are numbered starting from 300 to indicate that they are introduced in this document IEC 62109-3.

NOTE For example, new level 2 subclauses in clause 5 would be numbered 5.300, 5.301, etc. New level 4 subclauses in subclause 7.3.201 would be numbered 7.3.201.300, 7.3.201.301, etc.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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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.

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
active diode
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).