STANDARDS UPDATE NOTICE (SUN)
ISSUED: June 15, 2023

STANDARD INFORMATION

Standard: UL 61215-2
Standard ID: Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval - Part 2: Test Procedures [UL 61215-2:2021 Ed.2]
Previous Standard ID: Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval - Part 2: Test Procedures [UL 61215-2:2017 Ed.1]

EFFECTIVE DATE OF NEW/REVISED REQUIREMENTS

Effective Date: **August 5, 2024**

IMPACT, OVERVIEW, AND ACTION REQUIRED

Impact Statement: Per our accreditation, Intertek is required to review reports against the standard revisions to confirm compliance. Once compliance is confirmed, the standard reference in the report is updated to show continued compliance to the technical requirements of the standard. Reports not updated to this version by the effective date above will be withdrawn.

Overview of Changes:

- Addition of cyclic (dynamic) mechanical load testing (MQT 20)
- Addition of a test for detection of potential-induced degradation (MQT 21)
- Addition of test methods required for bifacial PV modules
- Addition of test methods required for flexible modules

Specific details of new/revised requirements are found in table below

Current Listings Not Active? – Please immediately identify any current Listing Reports or products that are no longer active and should be removed from our records. We will do this at no charge as long as Intertek is notified in writing prior to the review of your reports.

STANDARD INFORMATION

CLAUSE	VERDICT	COMMENT
		Additions to existing requirements are underlined and deletions are shown ~~lined out~~ below.
1		**Scope** ~~This International Standard series lays down IEC requirements for the design qualification and type approval of terrestrial photovoltaic modules suitable for long-term operation in general open-air climates, as defined in IEC 60721-2-1. This part of IEC 61215 is intended to apply to all terrestrial flat plate module materials such as crystalline silicon module types as well as thin-film modules.~~ This document lays down requirements for the design qualification of terrestrial photovoltaic modules suitable for long-term operation in open-air climates. The useful service life of modules so qualified will depend on their design, their environment and the conditions under which they are operated. Test results are not construed as a quantitative prediction of module lifetime. In climates where 98th percentile operating temperatures exceed 70 °C, users are recommended to consider testing to higher temperature test conditions as described in IEC TS 631261. Users desiring qualification of PV products with lesser lifetime expectations are recommended to consider testing designed for PV in consumer electronics, as described in IEC TS 63163 (under development). Users wishing to gain confidence that the characteristics tested in IEC 61215 appear consistently in a manufactured product may wish to utilize IEC 62941 regarding quality systems in PV manufacturing. This document is intended to apply to all terrestrial flat plate module materials such as crystalline silicon module types as well as thin-film modules. This document does not apply to modules used with concentrated sunlight although it may be utilized for low concentrator modules (1 to 3 suns). For low concentration modules, all tests are performed using the irradiance, current, voltage and power levels expected at the design concentration. ~~The objective of this test sequence is to determine the electrical and thermal characteristics of the module and to show, as far as possible within reasonable constraints of cost and time, that the module is capable of withstanding prolonged exposure in general open-air climates. The actual lifetime expectancy of modules so qualified will depend on their design, their environment and the conditions under which they are operated.~~

CLAUSE	VERDICT	COMMENT
		The objective of this test sequence is to determine the electrical characteristics of the module and to show, as far as possible within reasonable constraints of cost and time, that the module is capable of withstanding prolonged exposure outdoors. Accelerated test conditions are empirically based on those necessary to reproduce selected observed field failures and are applied equally across module types. Acceleration factors may vary with product design and thus not all degradation mechanisms may manifest. Further general information on accelerated test methods including definitions of terms may be found in IEC 62506. Some long-term degradation mechanisms can only reasonably be detected via component testing, due to long times required to produce the failure and necessity of stress conditions that are expensive to produce over large areas. Component tests that have reached a sufficient level of maturity to set pass/fail criteria with high confidence are incorporated into the IEC 61215 series via addition to Table 1 in IEC 61215-1:2021. In contrast, the tests procedures described in this series, in IEC 61215-2, are performed on modules.
		Test procedures The subclauses below provide detailed instructions for performing each module quality test (MQT). Reporting and test sequence requirements for qualification are described in IEC 61215-1.
4		
4.1	Info	**Visual inspection (MQT 01)**
4.1.2		**Procedure** Carefully inspect each module under an illumination of not less than 1 000 lux for conditions and observations as defined in IEC 61215-1:2021. Make note of and/or photograph any defects that may be major visual defects as defined in IEC 61215-1. Also make note of and/or photograph the nature and position of any cracks, bubbles or delaminations, etc., which may worsen and adversely affect the module performance in subsequent tests. Record any other relevant information regarding origin of failure and associated test or lab conditions.
4.2	Info	**Maximum power determination (MQT 02)**
4.2.2		***New clause added;*** **Apparatus** a) Apparatus for measuring I-V characteristics in accordance with IEC 60904-1. b) A PV reference device in accordance with IEC 60904-2. c) At least one of the following two options to reduce the spectral mismatch component of uncertainty shall be utilized: • Perform a spectral mismatch correction. The spectral responsivity of the module shall be measured according to IEC 60904-8. The spectral response

CLAUSE	VERDICT	COMMENT
		data may originate from the same lab that is performing IEC 61215-2:2021, or from a different lab. The sample used to obtain the spectral response data may be the test module or may be a reference cell made with the same bill of materials as the test module. The spectral distribution of the solar simulator shall then be utilized to correct for spectral mismatch according to IEC 60904-7. • Use a matched reference cell or module. The reference device shall be of the same cell technology as the test module, to match spectral responsivity. There is no requirement on the cell or module size. d) A radiant source: natural sunlight or a solar simulator of class CAA or better in accordance with IEC 60904-9. For very large modules, as defined in IEC 61215-1:2021, a class CBA simulator may be used. To achieve a high accuracy of power measurement, the spectral irradiance distribution of the solar simulator should cover the whole wavelength range that is spanned by the spectral responsivity of the PV device under test. See IEC TR 60904-14 and IEC 60904-9:2020. e) A suitable mount for supporting the test specimen and the reference device in a plane normal to the radiant beam.
4.5		***New clause added;*** **Placeholder section, formerly NMOT** The nominal module operating temperature (NMOT) test, formerly MQT 05, is no longer a part of this document. This subclause is preserved so that, in the following subclauses of the document, the MQT numbers match the subclause numbers.
4.6	Info	**Performance at STC (MQT 06.1)**
4.6.1		**Purpose** To determine how the electrical performance of the module varies with load at STC (1 000 W/m2, 25 °C cell temperature, with the IEC 60904-3 reference solar spectral irradiance distribution) ~~and at NMOT (an irradiance of 800 W/m2 and an ambient temperature of 20 °C with the IEC 60904-3 reference solar spectral irradiance distribution). The measurement at STC is used to verify the name plate information of the module).~~ MQT 06.1 is a case of maximum power determination (MQT 02) performed at STC. MQT 06.1 is used to verify the name plate information of the module, and for determining power loss from the stress tests. Uncertainty, m1, shall include a component from spectral mismatch, based either on measured spectral response or the worst-case possibility for a given technology type, and the method used to set the simulator intensity. For nameplate verification, the uncertainty m1 is subject to the limits specified in the technology-specific parts. For determining the power loss from the stress tests, reproducibility of the test, r, is subject to the limits specified in the technology-specific parts.

CLAUSE	VERDICT	COMMENT
4.6.2		***New clause added;*** **Apparatus** a) The apparatus shall be as described in 4.2.2 (MQT 02). b) It shall also be equipped with a means for monitoring the temperature of the test specimen and the reference device to an accuracy of ±1 °C and repeatability of ±0,5 °C. c) For measurement of bifacial modules the following capability is also necessary: The radiant source utilized as specified in 4.6.2a shall be operable with adjustable irradiance levels and/or rear-side irradiance such that BNPI (as defined in IEC 61215-1:2021) can be applied by at least one method allowed by IEC TS 60904-1-2. d) For measurement of multi-junction modules, the simulator and reference device shall meet the additional requirements imposed by IEC 60904-1-1.
4.6.2		***New clause added;*** **Procedure for measuring at STC (MQT 06.1)** Maintain the module at (25 ± 2) °C and trace its current-voltage characteristic at an irradiance of (1 000 ± 100) W/m2 (as measured by a suitable reference device), in accordance with IEC 60904-1, using the apparatus described in 4.6.2. Module temperature shall be corrected to 25 °C using temperature coefficients and IEC 60904 series and IEC 60891. For bifacial modules, measurements shall proceed as specified in IEC TS 60904-1-2. MQT 06 shall be performed at STC and at elevated irradiance BNPI for Gate No 1. Each time MQT 06 is performed at STC, the STC bifaciality coefficients of short-circuit current (ϕIsc = Iscr / Iscf), of open circuit voltage (ϕVoc = Vocr / Vocf), and of power (ϕPmax = Pmaxr / Pmaxf) shall be measured according to IEC TS 60904-1-2. Full definition of these quantities, the method to measure them, and the symbols used to describe them are specified in IEC TS 60904-1-2. When evaluating Gate No 2 (i.e. post-stress), MQT 06 shall only be performed at BNPI. Post-stress, bifaciality coefficients need not be remeasured. unless specifically noted in the MQT stress test procedure. The bifaciality coefficients measured pre-stress may be utilized to calculate the appropriate equivalent intensity in a single-sided illumination measurement. When performing MQT 06 at BNPI, any method described in IEC 60891 may be used to correct the applied irradiance to desired equivalent front-side irradiance, as long requirements on maximum uncertainty m1 are met. For flexible modules, the maximum power determination shall be measured with the flexible module in the flat (i.e. completely unfolded) position. For very large modules (as defined in IEC 61215-1:2021), testing by the testing entity may be performed at the manufacturer's facility, but shall still meet the requirements stated in 4.6.2.

CLAUSE	VERDICT	COMMENT
		For multi-junction modules, measurements shall proceed as specified in IEC TS 60904-1-1.
4.7	Info	**Performance at low irradiance (MQT 07)**
4.7.1		***New clause added;*** **Purpose** To determine how the electrical performance of the module varies with load at 25 °C and an irradiance of 200 W/m2.
4.7.2		***New clause added;*** **Apparatus** a) The apparatus shall be as described in 4.2.2 (MQT 02). The apparatus shall also have the following capabilities: b) Equipment necessary to change the irradiance to 200 W/m2 without affecting the relative spectral irradiance distribution and the spatial uniformity in accordance with IEC 60904-10. c) A means for monitoring the temperature of the test specimen and the reference device to an accuracy of ±1 °C and repeatability of ±0,5 °C. d) For measurement of bifacial modules the following equipment is also necessary: Baffles that can be arranged around the modules edges, as well as a non-reflective cover allowing for temporarily blocking the irradiance to the opposite module side, to evaluate the front- and back-side performance of bifacial modules individually. e) For measurement of multi-junction modules, the simulator and reference device shall meet the additional requirements imposed by IEC 60904-1-1.
4.7.3		**Procedure** Determine the current-voltage characteristic of the module at (25 ± 2) °C and an irradiance of (200 ± 20) W/m2 controlled by an appropriate reference device, in accordance with IEC 60904-1 using the apparatus specified in section 4.7.2. The irradiance shall be reduced to the specified level by using neutral density filters or some other technique which does not affect the spectral irradiance distribution. (See IEC 60904-10 for guidance on reducing the irradiance without changing the spectral irradiance distribution.) Module temperature shall be corrected to 25 °C using temperature coefficients and IEC 60904 series and IEC 60891. <u>For flexible modules, the maximum power determination shall be measured with the flexible module in the flat (i.e. completely unfolded) position. For very large modules (as defined in IEC 61215-1:2021), testing by the testing entity may be</u>

CLAUSE	VERDICT	COMMENT
		performed at the manufacturer's facility, but shall still meet the requirements stated in 4.7.2. For bifacial modules make two single-sided measurements at 200 W/m2, one on the front-side and one on the rear-side using baffles and back-cover screen. Calculate the bifaciality coefficients at low irradiance according to the procedure specified in IEC TS 60904-1-2, except utilizing an irradiance of 200 W/m2 instead of 1000 W/m2. For multi-junction modules, measurements shall proceed as specified in IEC TS 60904-1-1.
4.9	Info	**Hot-spot endurance test (MQT 09)**
4.9.4		**Apparatus** a) Radiant source: Natural sunlight, or a class BBB (or better) steady-state solar simulator conforming to IEC 60904-9 with an irradiance of 800 W/m² to 1 100 W/m². Either type of radiant source shall have an irradiance of (1 000 ± 100) W/m2. This radiant source will be used for applying long-duration stress when worst case shadowing has been applied to the module. This radiant source may be used in the selection of cells for shadowing, or the optional pulsed simulator (described in 4.9.4g) may be used for cell selection. For bifacial modules, the radiant source used for prolonged exposure shall be operable with adjustable irradiance levels and/or rear-side irradiance such that BSI (as defined in IEC 61215-1:2021) can be applied by at least one method allowed by IEC TS 60904-1-2. Tolerance in the total irradiance, whether applied in a single-sided or double-sided configuration, shall be no larger than ±50 W/m2.
4.9.5	Info	**Procedure**
4.9.5.1		Depending on the solar cell technology and the manufacturing process two different procedures exist. MQT 09.1 is typically applicable to wafer-based technologies like standard crystalline silicon. For most common, monolithically integrated, thin film technologies (CdTe, CIGS, a-Si) the procedure MQT 09.2 is applicable. Bifacial modules are also to be tested using MQT 09.1. If MQT 09.1 is performed using a representative sample, the representative sample shall have the same number of cells per bypass diode as the full-size product. Depending on the resulting sample size, this requirement can affect the choice of radiant source needed to perform the test. For all technologies, selection of the shadowing dimensions and location is performed in the irradiance range of 800 W/m2 to 1 100 W/m2. Application of the extended stress is performed with the tighter irradiance specifications described in 4.9.4 a).

CLAUSE	VERDICT	COMMENT
4.9.5.2		***New clause added;*** **Procedure for wafer-based technologies (WBT) MQT 09.1** The first step of the procedure is to select cells with the lowest and highest shunt resistances, (as detailed further in steps c), d) and e) below). See standard for details.
4.9.5.3	Info	**Case S**
4.9.5.3.2		***New clause added;*** Figure 6 illustrates the hot-spot effect in a MLI thin-film module consisting of a serial connection of cells, when a different number of cells are totally shadowed. See standard for details.
4.9.5.3.3		***New clause added;*** **Case SP** Figure 3 illustrates a series-parallel connection, i.e. a parallel connection of P strings each with S cells in series. See standard for details.
4.9.5.3.4		If a module of the parallel-series type (case PS) has an inaccessible internal cell circuit but contains no internal bypass diodes nor equivalent means of reverse bias protection, the following method shall be used to select the cell(s) to be shadowed and to determine the worst case shadowing condition.
4.10	Info	**UV preconditioning test (MQT 10)**
4.10.2		**Apparatus** e) The module shall either be short-circuited or open-circuited during exposure, as per manufacturer recommendations. The circuitry condition used during this test shall be noted in the test report.
4.10.3		***New clause added;*** a) Measure the irradiance at the proposed module test plane and ensure that at wavelengths between 280 nm and 400 nm it does not exceed 250 W/m2 (i.e. about five times the natural sunlight level) and that it has a uniformity of ±15 % over the test plane. b) According to the recommendations of 4.10.2e), short-circuit or open-circuit the module. Mount it in the test plane at the location selected in a), normal to the UV irradiance beam. Make sure that the module temperature sensors read (60 ± 5) °C. For flexible modules, the modules shall be mounted per the manufacturer's documentation with prescribed substrate and adhesive or attachment/mounting means during the test. c) Subject the module(s) front side to a total UV irradiation of at least 15 kWh/m2 in the wavelength range between 280 nm and 400 nm with at least 3 %, but not

CLAUSE	VERDICT	COMMENT
		more than 10 % in the wavelength band between 280 nm and 320 nm, while maintaining the module temperature within the prescribed range. For bifacial modules repeat the procedure of UV irradiation on the rear-side of the modules.
4.11	Info	**Thermal cycling test (MQT 11)**
4.11.2		**Apparatus** f) A 5 N weight capable of being attached to the electrical termination leads of the module.
4.11.3		**Procedure** b) Install the module(s) at room temperature in the chamber. Attach a single 5 N weight to the junction box using one of two options. The weight may be attached utilizing the electrical termination leads of each module so that it hangs down vertically from the junction box, as shown in Figure 8a). The weight may also be attached to the junction box using a wire introduced by the tester, as shown in Figure 8b). A wire introduced by the tester shall not be attached to the junction box lid. In either case, the weight shall not impact or damage the module back surface and shall be at least 5 cm above the floor or module frame at the start of the test, as indicated in Figure 8b). If there are more than one similar junction boxes per module, only one junction box need be weighted, as shown in Figure 8b) or Figure 8c). However, if the junction boxes differ in design, each should carry weights independently. For flexible modules, the modules shall be mounted per the manufacturer's documentation with prescribed substrate and adhesive or attachment/mounting means during the test. e) Throughout the test, record the module temperature and monitor the current flow through the module(s). Document in test report the actual dwell duration at high and low temperatures.
4.12	Info	**Humidity-freeze test (MQT 12)**
4.12.3		b) Install the module(s) at room temperature in the climatic chamber. For flexible modules, the modules shall be mounted per the manufacturer's documentation with prescribed substrate and adhesive or attachment/mounting means during the test.
4.13	Info	**Damp heat test (MQT 13)**
4.13.2		***New clause added;*** **Apparatus** Requirements for the test chamber are listed in IEC 60068-2-78:2012, 4.1.

CLAUSE	VERDICT	COMMENT
4.13.3		The procedure for introducing the sample into the chamber and starting the test is described in IEC 60068-2-78:2012, 4.4. The test shall be carried out with the following provisions. No preconditioning shall be performed. Module connectors shall be short-circuited, unless current is being applied according to options provided in some of the technology-specific parts. For flexible modules, the modules shall be mounted per the manufacturer's documentation with prescribed substrate and adhesive or attachment/mounting means during the test.
4.14	Info	**Robustness of terminations (MQT 14)**
4.14.3		***New clause added;*** The junction box, separate from the module, shall be tested to IEC 62790 "Test of cord anchorage" and shall meet the requirements therein. If the junction box has been pre-qualified prior to IEC 61215-2:2021 testing, the test report shall note the test lab name and date when the requirement was met. The cord anchorage test cannot be applied to junction boxes with integrated connectors, and thus junction boxes with integrated connectors are exempt from this requirement. Exemption shall be noted in the test report.
4.16	Info	**Static mechanical load test (MQT 16)**
4.16.1		The purpose of this test is to determine the ability of the module to withstand a minimum static load. The minimum required design load for a particular site will depend on construction, applicable standards, building codes, probability of event occurrence, design assumptions and location/climate and might require higher sampling rates and other safety factors γm. To determine the maximum possible test load, e.g. by test-to-fail of a construction is not part of this document. MQT 16 verifies minimum test loads. The manufacturer's minimum design load is back calculated from the above minimum test load. The test load is defined as: Test load = γm × design load
4.16.2		**Apparatus** a) A rigid test base which enables the modules to be mounted front side up or front side down. The test base shall enable the module to deflect freely during the load application within the constraints of the manufacturers prescribed method of mounting.

CLAUSE	VERDICT	COMMENT
		b) Instrumentation to monitor the electrical continuity of the module during the test. c) Suitable weights or pressure means that enable the load to be applied in a gradual, uniform manner. The test load may be applied pneumatically or by means of weights. All force shall be applied normal to the module surface. The apparatus shall not contribute to the rigidity of the module (e.g. force applied via a large, flat, plate). d) The entire payload should be applied to the module surface uniformly and gradually without causing impact spikes. The weight shall only be applied on the frontsheet (e.g. the glass) and not on the module frame or cross support rails in the module. If weights are used to load the module, Annex A provides additional recommendations to ensure quality control and consistency of test results. NOTE 1 With incremental loading where weights are loaded by hand, impact shocks not representative of field stress have been observed and are undesirable. e) If an automated system using pistons (or other discrete-point application) is used to load the module, document the coverage ratio in the test report. Coverage ratio is the area under the suction cups (connected to pistons or other contacting points to module) to the surface area of the module. A minimum coverage ratio of 10 % is recommended to assure uniformity of loading on the module. f) The environmental conditions for performing the tests are (25 ± 5) °C in a relative humidity not exceeding 75 %.
4.16.3		**Procedure** b) Mount the module on a rigid structure using the method prescribed by the manufacturer including the mounting means (clips/clamps and any kind of fastener) and underlying support rails. If there are different possibilities each mounting method needs to be evaluated separately. For all mounting methods, mount the module in a manner where the loading is worst case. If there are different possibilities, each mounting configuration needs to be evaluated separately. Worst case loading is typically associated with largest cantilever (overhang span) or largest deflection. For all mounting configurations, mount the module in a manner where the distance between the fixing points is worst case, which typically results in the worst deflection of the module, while following manufacturer recommendations for the specified mounting means. Allow the modules to equilibrate for a minimum of 2 h after MQT 13 before applying the load. For flexible modules, the modules shall be mounted per the manufacturer's documentation with prescribed substrate and adhesive or attachment means during the test.
4.17	Info	**Hail test (MQT 17)**
4.17.3		**Procedure** f) ~~Install the module at room temperature in the prescribed mount, with the impact surface normal to the path of the ice ball~~. Mount the module according to

CLAUSE	VERDICT	COMMENT
		manufacturer specifications. The module shall be at room temperature, with the impact surface normal to the path of the ice ball. For flexible modules, the modules shall be mounted per the manufacturer's documentation with prescribed substrate and adhesive or attachment/mounting means during the test. If the manufacturer's specified application allows mounting in a rigid or flexible mounting condition, testing shall be done on the worst-case condition. The test configuration(s) shall be documented in the test report.
4.18	Info	**Bypass diode testing (MQT 18)**
4.18.1	Info	**Bypass diode thermal test (MQT 18.1)**
4.18.1.2		***New clause added;*** **Test sample** If the module contains three or fewer bypass diodes, then all diodes shall be tested for forward voltage as per 4.18.1.4 and for functionality as per 4.18.2. If the module contains more than three diodes, then three bypass diodes are to be selected for testing. These bypass diodes are to be selected by the test laboratory and should be representative bypass diodes which are subject to the most stress in the design. The test lab shall indicate in the test report which three bypass diodes were selected and why they were selected. a) For more than three diodes embedded in a laminate, select the diodes in these locations: 1) Closest to the centre of the junction box (may be underneath the junction box). 2) Closest to the module frame (or module edge, in case of frameless module). 3) Closest to module centre. b) For more than three diodes in a junction box, select diodes in these locations: 1) Closest to the centre of the junction box. 2) Next closest to the centre of the junction box. 3) Closest to the edge of the junction box.
4.18.1.3		**Apparatus**
		d) Means for applying a current equal to 1,25 times the STC short-circuit current of the module under test with a pulse width not exceeding 1 ms and means for monitoring the flow of current through the module, throughout the test. For bifacial modules, the applicable current is 1,25 times short-circuit current at elevated irradiance BSI, as defined in IEC 61215-1:2021. The short-circuit current at irradiance BSI may be determined either by a measurement (MQT 06.1) at irradiance BSI, or by assuming linearity of short-circuit current with irradiance (as defined in IEC 60904-10). Assuming linearity allows one to calculate the short-circuit current at BSI, Isc-BSI, using Isc values measured for Gate No. 1 (Isc-STC and Isc-BNPI), and the relevant equivalent irradiances: 1 000 Wm-2, GBNPI, and GBSI.

CLAUSE	VERDICT	COMMENT
		To extrapolate Isc-BSI, these quantities are combined as follows: $$I_{sc-BSI} = I_{sc-BNPI} + \frac{(I_{sc-BNPI} - I_{sc-STC})}{G_{BNPI} - 1\,000\ Wm^{-2}} \cdot (G_{BSI} - G_{BNPI})$$ In the above formula, equivalent irradiance are calculated as in IEC TS 60904-1-2, specifically: $$G_{BNPI} = 1\,000\ Wm^{-2} + \varphi \cdot 135\ Wm^{-2}$$ $$G_{BSI} = 1\,000\ Wm^{-2} + \varphi \cdot 300\ Wm^{-2}$$ $$\varphi = Min(\varphi_{Isc}, \varphi_{Pmax})$$
4.18.1.4		**Procedure** a) Electrically short any blocking diodes incorporated in the module. b) Determine the rated STC short-circuit current of the module from its label or instruction sheet. For bifacial modules, use the value of the short-circuit current at elevated irradiance BSI, as defined in IEC 61215-1:2021. c) Connect the lead wire for VD and ID on both diode terminals as shown in Figure 12. If the diodes are potted the connections shall be made by the module manufacturer before delivery of the module. Care shall be taken that the lead wires do not cause heat dissipation from the terminal box leading to misinterpretation of the test results. Thus, current connections should be made as far as possible away from the terminal box, and voltage probes made as small and thin as possible. e) Apply the pulsed current (pulse width 1 ms) equal to the STC short-circuit current of the module, measure the forward voltage VD1 of diode. For bifacial modules, use the value of the short-circuit current at elevated irradiance BSI.
4.18.2	Info	**Bypass diode functionality test (MQT 18.2)**
4.18.2.4	Info	**Requirements**
4.18.2.4.1		***New clause added;*** **Method A** In the current sweep of 4.18.2.3.2 d), identify the largest current at which the forward voltage is specified on the data sheet. The diode(s) forward voltage

CLAUSE	VERDICT	COMMENT
		measured at the identified current is defined as VFM and shall meet the following requirement: VFM = (N × VFMrated) ± 10 %
4.19	Info	**Stabilization (MQT 19)**
4.19.7		***New section added;*** **Stress-specific stabilization – BO LID (MQT 19.3)** Some stress conditions may change the state of semiconductor defects in a way that is not representative of field behavior and is not related to the degradation mechanisms that are targeted by the stress tests. See standard for details.
4.20		***New section added;*** **Cyclic (dynamic) mechanical load test (MQT 20)** The purpose of this test is to evaluate if components within the module are extremely susceptible to low levels of mechanical stress. See standard for details.
4.21		***New section added;*** **Potential induced degradation test (MQT 21)** The purpose of this test is to measure the module design's ability to withstand degradation from applied system voltage, also known as Potential Induced Degradation (PID). See standard for details.
4.22		***New section added;*** **Bending test (MQT 22)** The purpose of this test is to verify that a flexible module can be rolled up (without damage) to form a radius of curvature defined by the module manufacturer in at least one direction per the manufacturer's specification. See standard for details.