IEC PV STANDARDIZATION COMMITTEE TC 82

Activities of TC 82

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GOBIERNO DE ESPAÑA
VICEPRESIDENCIA TERCERA DEL GOBIERNO
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO
MINISTERIO DE CIENCIA E INNOVACIÓN
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01

TC 82 STRUCTURE

TC 82: SOLAR PHOTOVOLTAIC ENERGY SYSTEMS

- Technical Commitee TC82 of IEC (International Electrotechnical Commission)

- ❑ Established in 1981

SCOPE

To prepare international **standards for PV systems including** the entire field: **from light input** to a photovoltaic cell **to the interface with the electrical system**.

- ❑ Working Plan
  - 200 publications in force
  - 65 under development (new proposals /new editions)

TC 82

- Working Groups

WG 1	Glossary
WG 2	Modules, non-concentrating
WG 3	Systems
WG 6	Balance-of-system components
WG 7	Concentrator modules
WG 8	Photovoltaic (PV) cells
WG 9	Support Structures

- Project Team

PT 600	Vehicle Integrated Photovoltaic Systems
New ??	**Standards for metastable PV devices**

- Joint Working Groups

JWG 11	Building-Integrated Photovoltaics (BIPV) linked to ISO/TC 160/SC 1
JWG 82	Secondary cells and batteries for Renewable Energy Storage Managed by TC 21
JWG 32	Electrical safety of PV system installations Managed by TC 64

PV DEVICES STANDARDS

TECHNICAL AREAS FOR WG2 PV STANDARDS

- PV devices characterization
- Design and safety qualification
- Components
- Materials
- Specialized Stress and extended reliability tests

02

CHARACTERIZATION STANDARDS

- IEC 60904 Series
- IEC TR 63228

PV DEVICES CHARACTERIZATION STANDARDS

IEC 60891	Photovoltaic devices - Procedures for temperature and irradiance corrections to measured I-V characteristics
IEC 60904-1	**Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics**
IEC 60904-2	Photovoltaic devices - Part 2: Requirements for reference solar devices
IEC 60904-3	Photovoltaic devices - Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data
IEC 60904-4	Photovoltaic devices - Part 4: Reference solar devices - Procedures for establishing calibration traceability
IEC 60904-5	Photovoltaic devices - Part 5: Determination of the equivalent cell temperature (ECT) of photovoltaic (PV) devices by the open-circuit voltage method
IEC 60904-7	Photovoltaic devices - Part 7: Computation of the spectral mismatch correction for measurements of photovoltaic devices
IEC 60904-8	**Photovoltaic devices - Part 8: Measurement of spectral response of a photovoltaic (PV) device**
IEC 60904-9	Photovoltaic devices - Part 9: Solar simulator performance requirements
IEC 60904-10	Photovoltaic devices - Part 10: Methods of linearity measurement

CHARACTERIZATION STANDARDS

IEC 60904-1-1	**Photovoltaic devices - Part 1-1: Measurement of current-voltage characteristics of multi-junction photovoltaic devices**
IEC 60904-8-1	**Photovoltaic devices - Part 8-1: Measurement of spectral responsivity of multi-junction photovoltaic (PV) devices**
IEC/TS 60904-13	Photovoltaic devices - Part 13: Electroluminescence of photovoltaic modules
IEC TR 60904-14	Photovoltaic devices - Part 14: Guidelines for production line measurements of single-junction PV module maximum power output and reporting at standard test conditions
IEC TS 60904-1-2	Photovoltaic devices - Part 1-2: Measurement of current-voltage characteristics of bifacial photovoltaic (PV) devices

CHARACTERIZATION STANDARDS

IEC 60904-1:2020 Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics

Regarding metastable devices their stabilization should be performed prior to any characterization (I-V and spectral responsivity measurements).

The I-V curve measurement should reflect **as closely as possible the performance of the device under steady state conditions**. In case of some thin film devices with complex response **such as perovskite-based ones, see IEC TR 63228.**

PV EMERGING DEVICE MEASUREMENT REPORT

IEC TR 63228:2019 Measurement protocols for photovoltaic devices based on organic, dye-sensitized or perovskite materials

This test report comprises measurement and characterization methods specific to emerging PV technologies employed at research institutes by the time of being issued (2019). The goal of this document is to pave the way to future standardization initiatives that will be carried out for these new PV technologies.

The review comprehends dye-sensitized, organic and **perovskite solar cells**.

PV EMERGING DEVICE MEASUREMENT REPORT

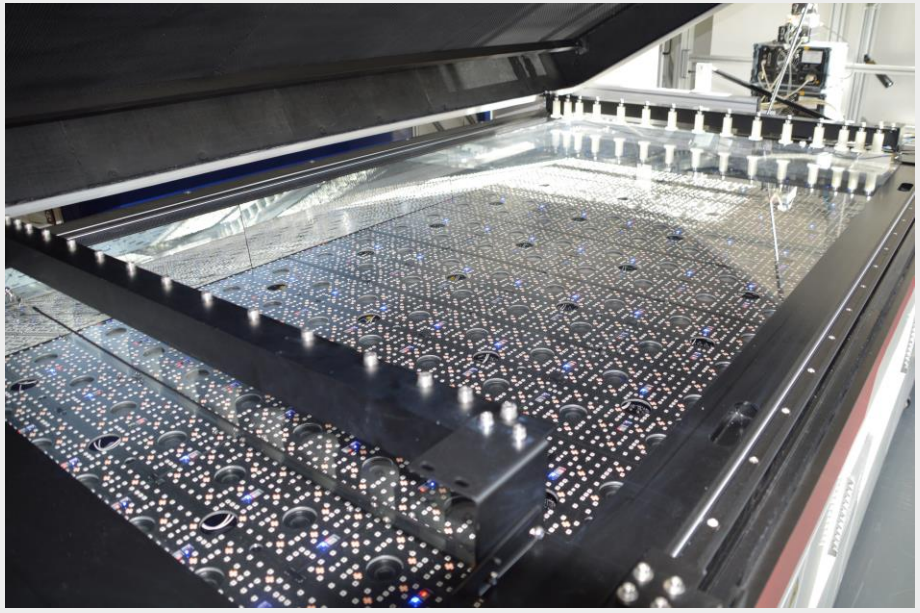
IEC TR 63228:2019 Measurement protocols for photovoltaic devices based on organic, dye-sensitized or perovskite materials

- *Preconditioning*
- *I-V curve procedures*
- *reference cell*
- *spectral responsivity*
- *samples preparation*
- *temperature control*
- *non-standard testing light condition*
- *tandem cells*

PV EMERGING DEVICE MEASUREMENT REPORT

IEC TR 63228:2019 Measurement protocols for photovoltaic devices based on organic, dye-sensitized or perovskite materials

I-V curve measurement. The approach described has been applied effectively for OPV and DSC devices and will likely be applicable to PSC devices



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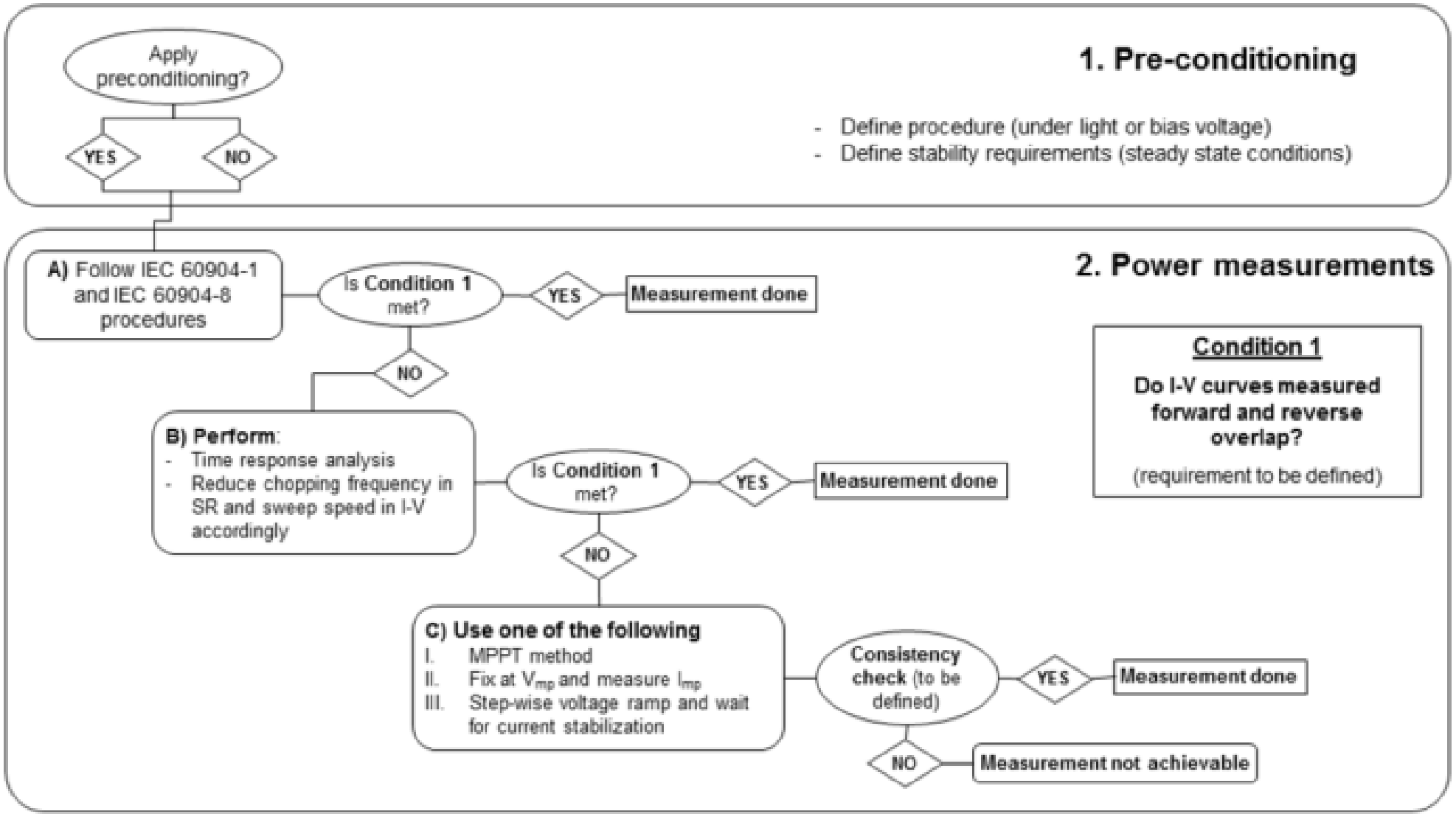
IEC TR 63228:2019



PV EMERGING DEVICE MEASUREMENT REPORT

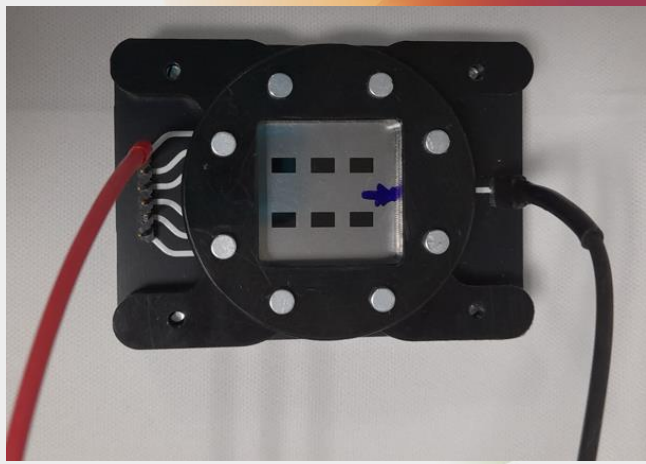
IEC TR 63228:2019 Measurement protocols for photovoltaic devices based on organic, dye-sensitized or perovskite materials

Reference solar cell. A pseudo reference cell with similar spectral responsivity

Preparation of the samples:

Mask application: a minimum sample size should be defined to avoid effects derived from different mask positioning.

The samples should include wirings to minimize differences due to contacting issues.



Temperature control. Mounting the device on a cooled metallic plate equipped with a vacuum sucker is suggested.

Temperature monitoring of the device. Allocation of sensor in rear side support.

PV EMERGING DEVICE MEASUREMENT REPORT

IEC TR 63228:2019 Measurement protocols for photovoltaic devices based on organic, dye-sensitized or perovskite materials

Spectral responsivity measurement

Issues affecting SR measurements for emerging PV devices are: chopping frequency due to transient response, no-linearity (for absolute SR), no-uniformity, stability and potential degradation

Non-standard testing light condition

Market for low-power applications operating indoors will require an extension to the IEC 60904 series for indoor light sources

Tandem solar cells

Optical simulations can be valuable to help select the appropriate bias light spectrum and to decide on the bias light intensity for SR measurements

CHARACTERIZATION STANDARDS

82/2216/NP Guidelines for current-voltage measurements of metastable photovoltaic devices

The proposed document will be part of the IEC 60904 series of standard.
It will focus on metastability-related issues that affect reproducibility of the measured I-V curve

The document will not consider methods designed to produce long-term stabilisation in the device, e.g. technology-specific parameters for the Stabilisation procedure (MQT-19) in IEC 61215.

03

QUALIFICATION STANDARDS

-IEC 61215 Series

-IEC TS 63163

PV MODULE QUALIFICATION STANDARDS

- **IEC 61215 standard series: Design qualification and type approval**
- IEC 61730-1 and -2: Photovoltaic (PV) module safety qualification
- IEC TS 62915: Type approval, design and safety qualification – Retesting
- **IEC TS 63163: Terrestrial photovoltaic (PV) modules for consumer products - Design qualification and type approval**
- IEC TS 63126 : Guidelines for qualifying PV modules, components and materials for operation at high temperatures
- IEC TS 62941:Terrestrial PV modules – Guideline for increased confidence in PV module design qualification and type approval

PV MODULE QUALIFICATION STANDARDS

- **IEC 61215**: Terrestrial photovoltaic (PV) modules – **Design qualification** and type approval
- **Objective**: Determine the electrical characteristics of the module and show that the module is capable of **withstanding prolonged exposure outdoors**.
- It does **not determine** the useful **service life** of the module
- Divided in **several parts:**

IEC 61215-1
Test requirements

IEC 61215-1-1
Requirements for c-Si

IEC 61215-1-2
Requirements for CdTe

IEC 61215-1-3
Requirements for a-Si

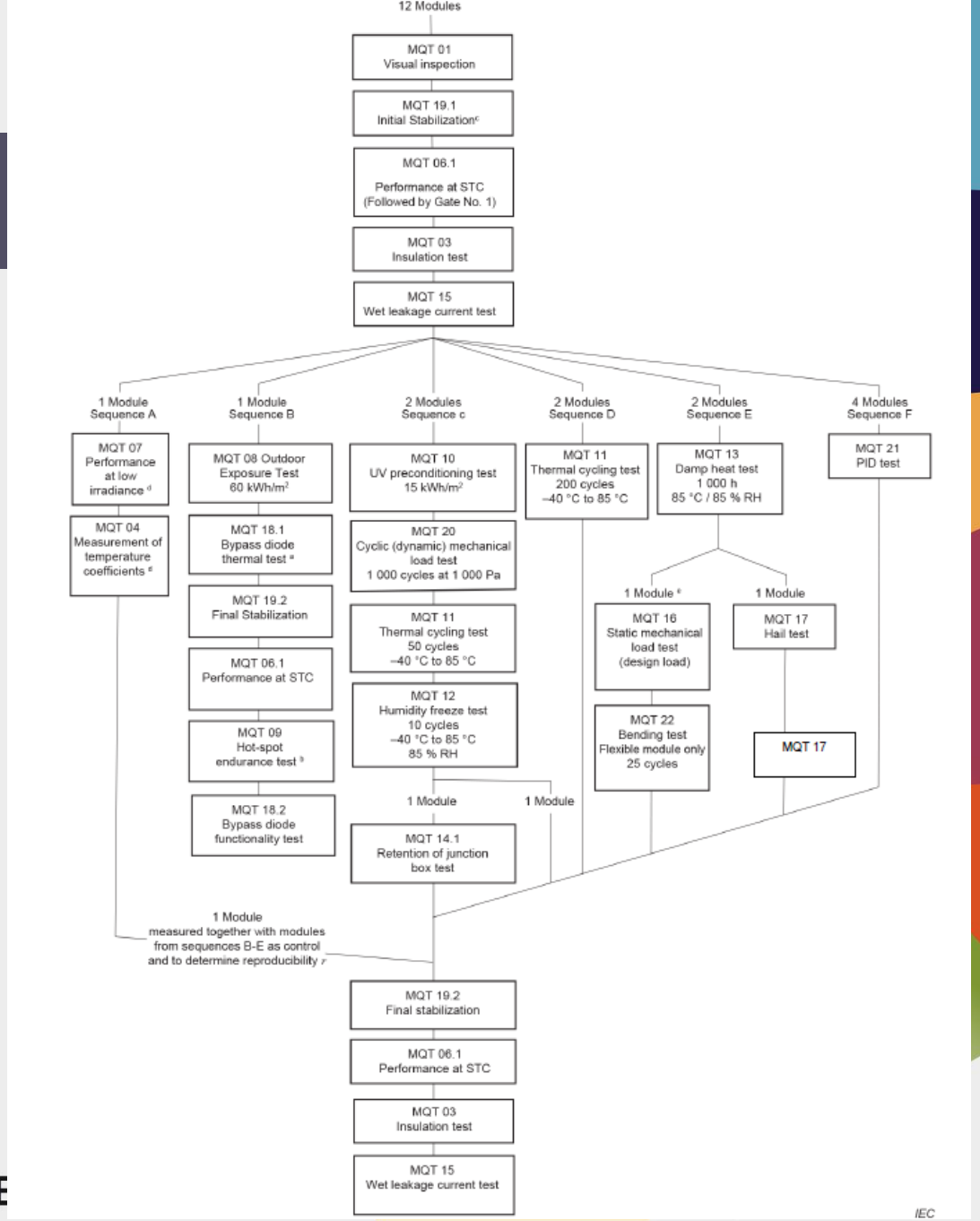
IEC 61215-1-4
Requirements for CIGS

IEC 61215-2
Test procedures

IEC 61215 SERIES

PV MODULE QUALIFICATION STANDARDS

- Samples are subjected to the qualification **test sequence:**
  1. Characterization tests
  2. Degradation tests: (Climatic, electric, mechanical)
  3. Diagnosis tests (used as pass/fail criteria)



PV MODULE QUALIFICATION STANDARDS

Pass Criteria – Final power

- **Gate 2:** Maximum power **degradation** after each test sequence

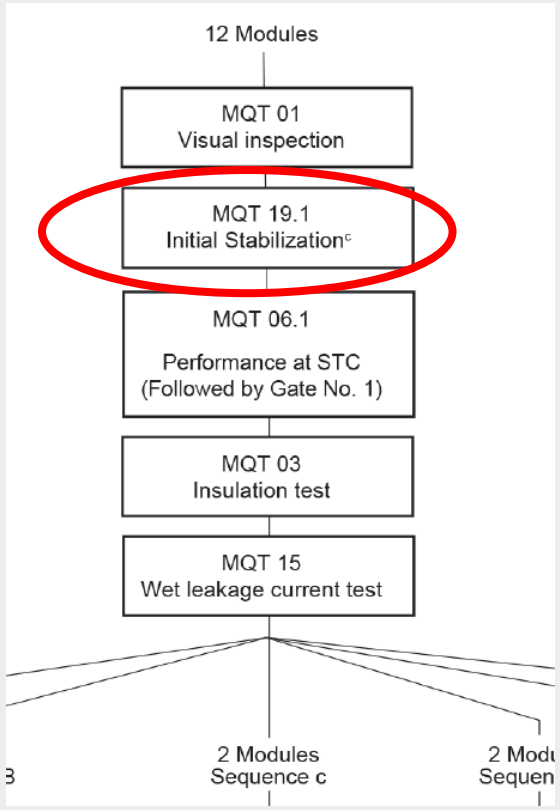
$$P_{max}(\text{Lab\_GateNo. 2}) \geq 0{,}95 \times P_{max}(\text{Lab\_GateNo. 1}) \cdot \left(1 - \frac{r}{100}\right)$$

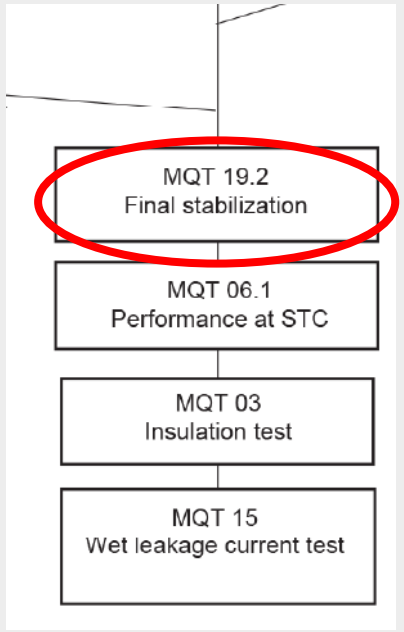
Final measured power — Initial measured power — Reproducibility (%)

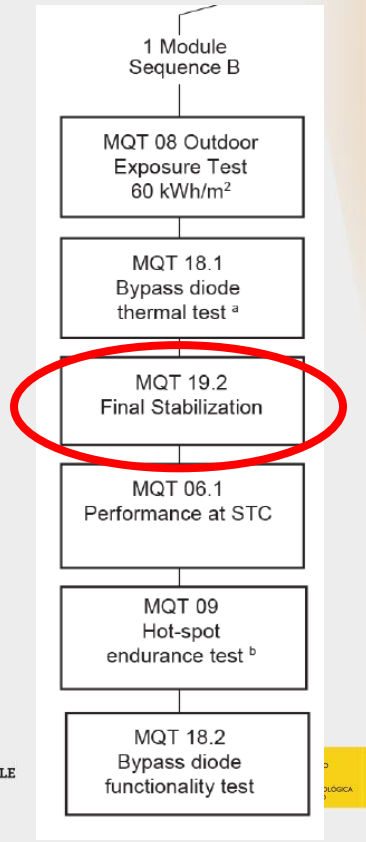
- Power degradation **lower** than **5%**
- **Reproducibility** measured in module from sequence A
- There is a **limit** stated in the standard for **reproducibility**, depending on technology (1% for c-Si, 2% for thin film)

MQT19 – STABILIZATION

- Stabilization at the **beginning** (MQT19.1) and the **end** of the sequence (MQT19.2)
- Initial stabilization (MQT19.1) => For checking the initial **manufacturer label values** (Gate 1)
- Final stabilization (MQT19.2) => For determining **module degradation** (Gate 2)







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MQT19 – STABILIZATION

- **Criterion for stabilization:** From **three** consecutive output power measurement:

$$(P_{max} - P_{min}) / P_{average} < x$$

- c-Si: x = 0,01
- CdTe: x = 0,02
- a-Si: x = 0,02
- CIGS: x = 0,02

- Stabilization **methods**:
  - Light Induced Degradation
  - Other stabilization procedures
  - Stress-specific stabilization (BO-LID)

MQT19 – LIGHT INDUCED DEGRADATION

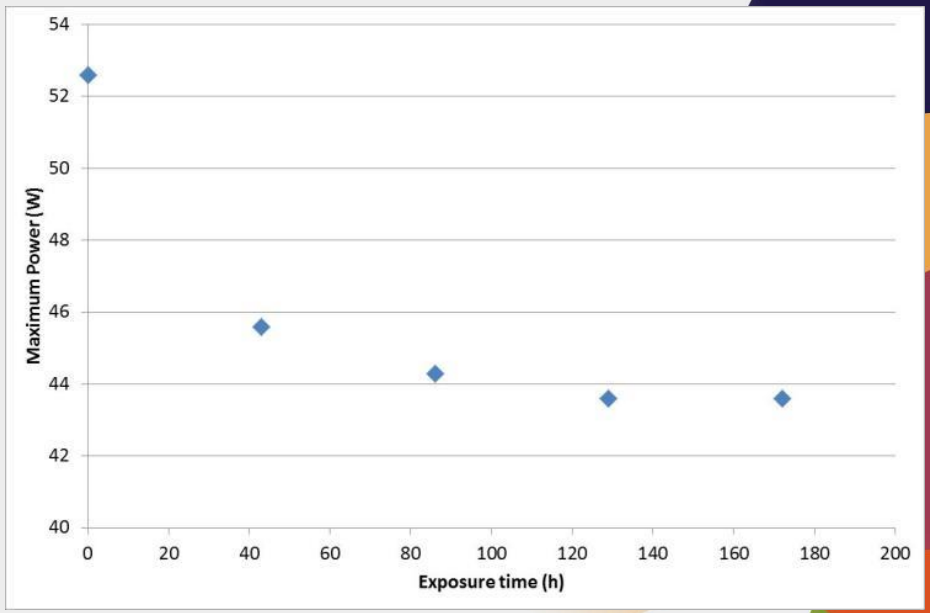
- **Simulated** solar irradiance is **preferred** (higher control and repeatability)

- Measure output power (MQT02)

- Expose modules to light:
  - If simulated light, irradiance between 800 W/m2 and 1 000 W/m2
  - If natural sunlight, integrate irradiance above 500 W/m2

- Irradiation periods:
  - c-Si: 5 kWh/m2
  - CdTe: 20 kWh/m2
  - a-Si: 43 kWh/m2 (usually a total of up to 200 kWh/m2 – 400 kWh/m2 are needed)
  - CIGS: 10 kWh/m2

- Measure power – Irradiate – Measure power. **At least 2 intervals**.



MQT19 – OTHER STABILIZATION PROCEDURES

- Manufacturers can provide **alternative stabilization procedures**
- Application of current or voltage bias, at a determined temperature, during some time…
- Alternative procedures **has to be validated** on three modules
- Validation procedure:
  - Perform alternate procedure
  - Measure output power
  - Perform indoor light induced degradation
  - Difference shall be less than 2% in the three modules

PV MODULE QUALIFICATION STANDARDS

IEC TS 63163: Terrestrial photovoltaic (PV) modules for consumer products – Design qualification and type approval

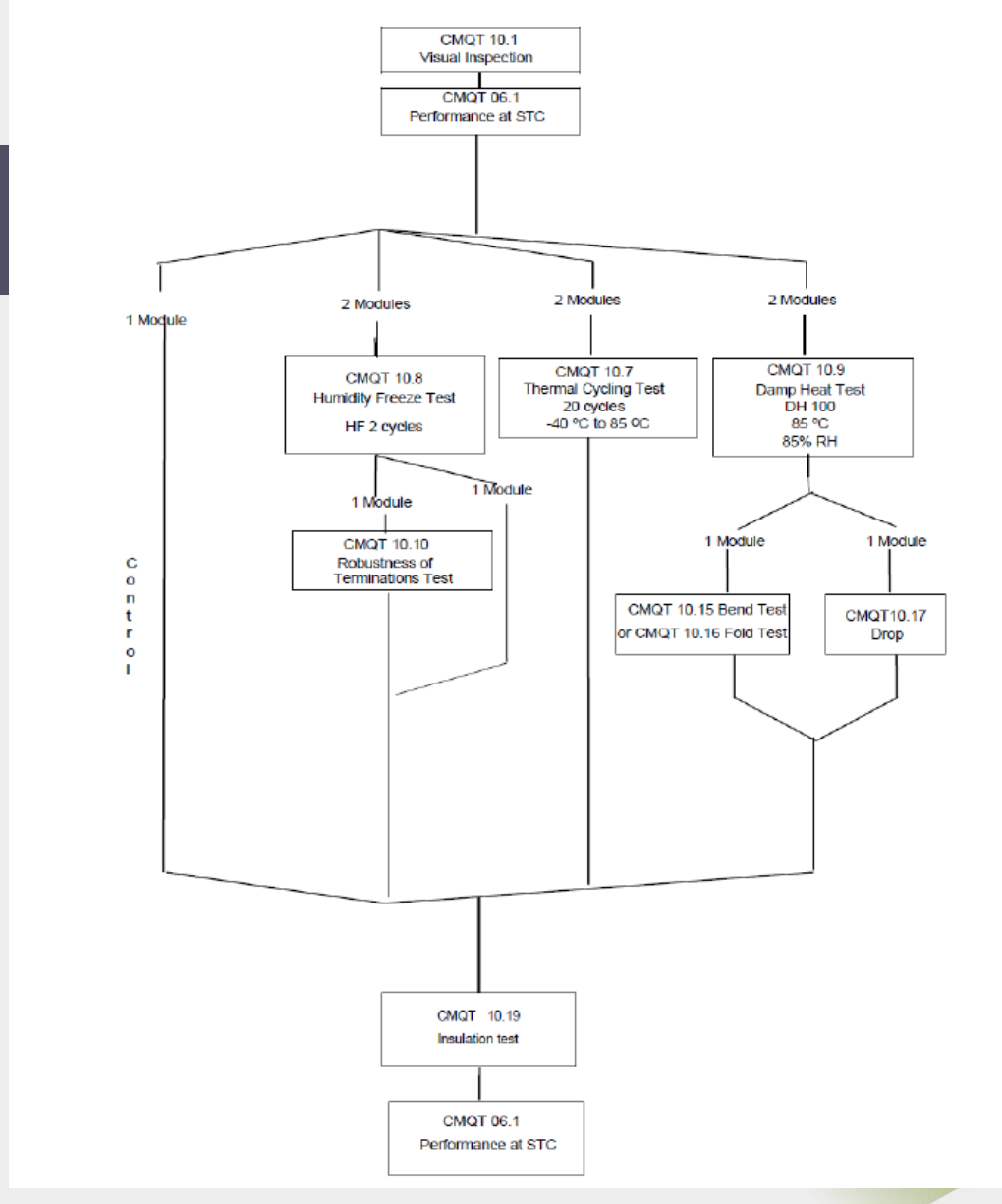
This document is intended to apply to terrestrial modules for consumer applications for outdoor operation shorter than those qualified to IEC 61215

- ❑ Category 1 (Mobile Applications)
- ❑ Category 2 (Portable Applications)
- ❑ Category 3 (Attached Applications)

PV MODULE QUALIFICATION STANDARDS

IEC TS 63163:

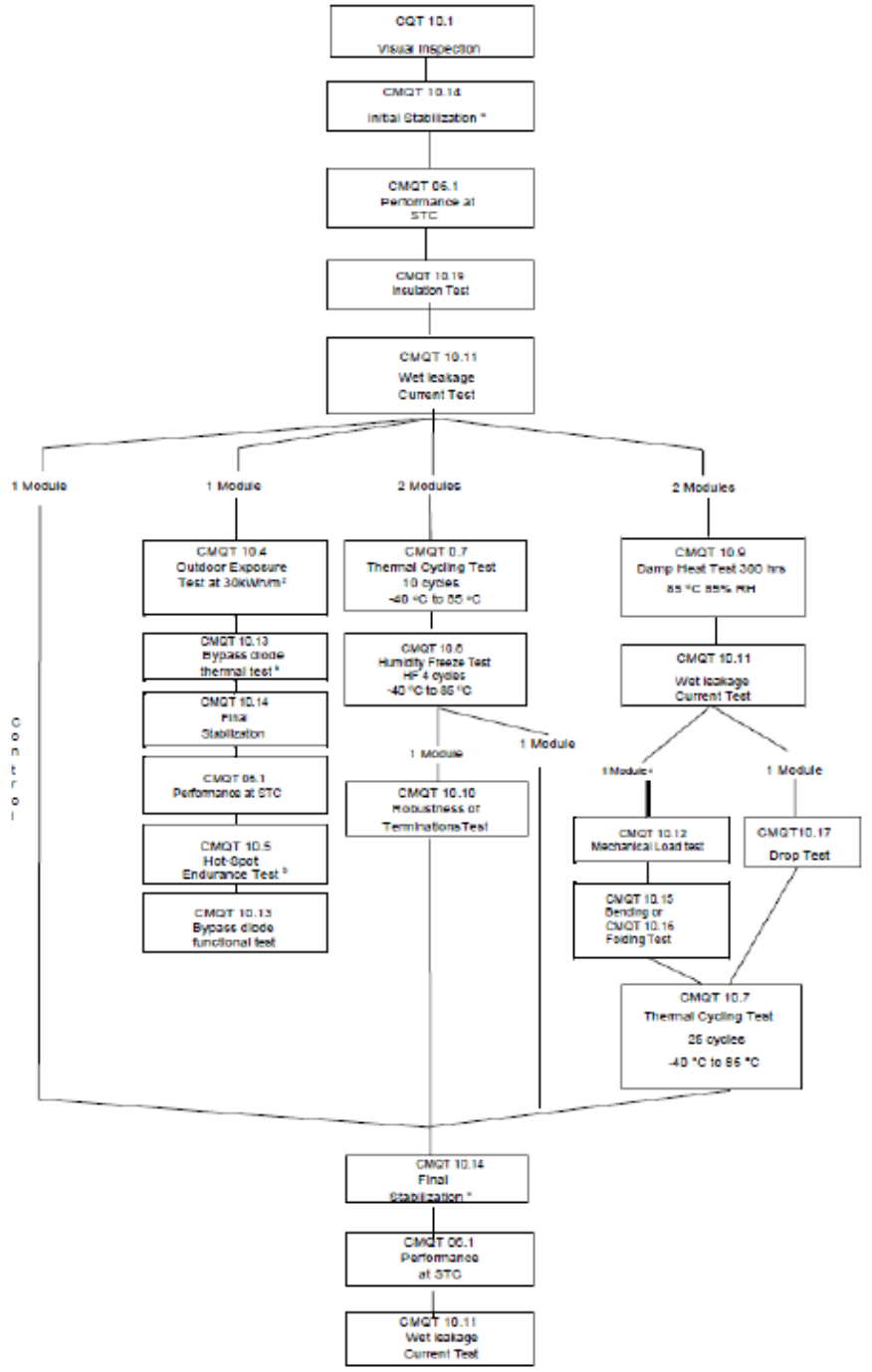
- ❑ Category 1 (Mobile Applications)



PV MODULE QUALIFICATION STANI

IEC TS 63163:

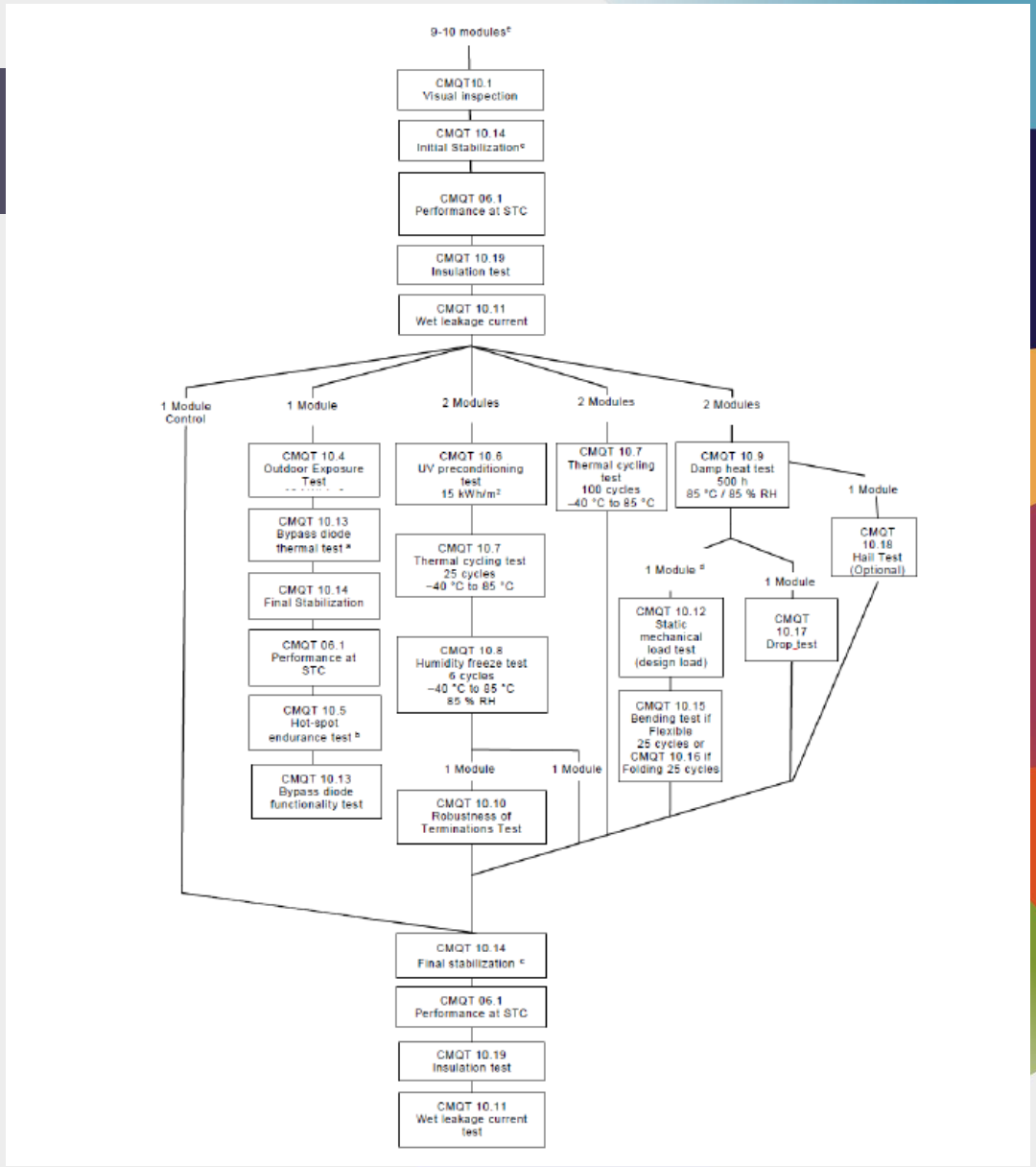
- ❑ Category 2 (Portable Applications)



PV MODULE QUALIFICATION STANDARDS

IEC TS 63163:

- ❑ Category 3 (Attached Applications)



THANKS A LOT.

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