



# **Solar Module Quality Standard (SMQS)**

**Part 1: General Requirements for PV  
Module Manufacturing, Documentation  
and further Requirements**

VDE SPEC 90038-1 V1.1 (en)

## Foreword

Publication date of this VDE SPEC: 06.12.2024.

No draft has been published for the present VDE SPEC prior to publication.

This VDE SPEC resulted from the work of a project group between the authors as stated below.

This VDE SPEC was developed according to the VDE SPEC procedure. VDE SPEC 90038-1 (en) has been developed in a project group aiming for a Solar Module Quality Standard (SMQS) and it cannot be granted that all possibly interested parties could have been involved. However, a proposal for interaction for public interaction was made by means of and according to the VDE procedure and all parties – possibly not involved at this point – were asked to participate in the process.

This VDE SPEC is not part of the VDE set of regulations or the German set of standards.

In particular, this VDE SPEC is not a technical rule within the meaning of Section 49 EnWG.

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## Executive Summary

Photovoltaics is a rapidly growing source for renewable electricity production worldwide. Solar modules are the central component for the direct generation of electrical energy from natural sunlight through the photovoltaic (PV) effect and a central component of solar PV systems.

Solar modules are manufactured as a mass product and are typically purchased in large quantities. In module supply contracts, requirements for the solar modules' quality are usually agreed, which are summarized in this specification.

As a generic text, this SMQS (Solar Module Quality Standard) series of specifications represents a way of simplifying the purchasing process: Requirements are described in general terms and a selection option for specifying the technical conditions to be agreed upon in the purchasing contract is defined. During contract negotiations the customer and seller/manufacturer can easily define the intended level.

Although the authors have made every effort to ensure that this specification is free of errors and inconsistencies, no guarantee can be given that this guide is absolutely free of errors. The same applies to the completeness of the topics listed.

Part 1 of this series of specifications provides definitions and technical requirements for the documentation and the production site and certain further requirements.

Part 2 of this series provides details for measurement and testing procedures.

Part 3 of this series provides a framework for production monitoring requirements.

The three parts contain checklists that can be agreed upon during module supply / purchasing negotiations.

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## Introduction

Photovoltaic solar energy is a rapidly growing segment in electrical power supply worldwide. There are great opportunities for a further renewable expansion of this infrastructure in grid feed-in: In the segment of utility scale PV power plants addressed within this specification ground mounted PV systems have a major and rapid impact on further development.

Today, solar modules are sourced through a global supply chain. Therefore, this specification is published exclusively in English language.

The aim of this series of specifications is to standardize communication between manufacturers and customers to guarantee an elevated level of quality and at the same time speeding up the purchasing process.

After all, PV Modules are the long-lasting key components of a PV system.

## 1 Scope

This specification aims to describe the quality level and framework conditions for solar modules made of crystalline silicon using today's technology (i.e. in the year of publication of the specification). The focus is on solar modules that are usually used in so-called ground mount PV systems.

Other technologies, such as thin-film modules or modules based on tandem solar cells, are not within the scope of this document. For products based on these technologies, the text can nevertheless be used as a guide. However, the applicability and completeness must then be checked with particular care by the user.

Not in the scope of this text are evaluation catalogs regarding electroluminescence (EL) or visual criteria (VI). Such catalogs are typically either agreed upon based on manufacturer's documentation or may be documented separately. Furthermore, this VDE SPEC does not specify any safety requirements. The corresponding safety standards for PV applications apply.

Although it is quite possible that different scenarios are conceivable, this specification uses the terminology "manufacturer" and "customer". No distinction is made between "manufacturer" and "seller" and "supplier". Moreover, the terms "customers" and "buyer" could also be used equivalent within this specification. Users of this specification are requested to adapt the terms to their corresponding actual situation if necessary.

Part 1 of this series of specifications provides definitions and generic quality requirements for solar modules and production facilities.

Different quality levels ("basic", "standard" and "advanced") are defined, which can be selected by the manufacturer and the purchaser of solar modules. In some cases, such differentiation is not provided as suggested, and then the definitions shall be binding. Eventually, a checklist is provided to simplify the documentation of technical conditions during contract negotiations for the purchase of modules.

## 2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes the requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2 PFG 2944 07.23 (Prüfgrundlage TÜV Rheinland), *Ultraviolet-Induced Degradation (UVID) testing for PV Modules*

EN 50380:2017, *Marking and documentation requirements for Photovoltaic Modules*

IEC TS 60904-1-2, *Photovoltaic devices – Part 1-2: Measurement of current-voltage characteristics of bifacial photovoltaic (PV) devices*

IEC 61215 Series, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61730 Series, *Photovoltaic (PV) module safety qualification*

IEC 62788-1-6 Ed.1.0, *Measurement procedures for materials used in photovoltaic modules – Part 1-6: Encapsulants – Test methods for determining the degree of cure in Ethylene-Vinyl Acetate*

IEC 62790 Ed.2.0, *Junction boxes for photovoltaic modules – Safety requirements and tests*

IEC TS 62804-1 Ed.1.0, *Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation – Part 1: Crystalline silicon*

IEC 62852 Ed.1.0 + Amd. 1, *Connectors for DC-application in photovoltaic systems – Safety requirements and tests*

IEC TS 62915:2018 Ed.1.0, *Photovoltaic (PV) modules – Type approval, design and safety qualification – Retesting*

IEC TS 62915:2023 Ed.2.0, *Photovoltaic (PV) modules – Type approval, design and safety qualification – Retesting*

IEC 62930 Ed.1.0, *Electric cables for photovoltaic systems with a voltage rating of 1,5 kV DC*

IEC 62938 Ed.1.0, *Photovoltaic (PV) modules – non-uniform snow load testing*

IEC 62941 Ed.1.0, *Terrestrial photovoltaic (PV) modules – Quality system for PV module manufacturing*

IEC TS 63209-1 Ed 1.0, *Photovoltaic modules – Extended-stress testing – Part 1: Modules*  
IEC TS 63342:2022 Ed.1.0, *C-Si photovoltaic (PV) modules – Light and elevated temperature induced degradation (LETID) test - Detection*  
ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*  
ISO/IEC 17065, *Conformity assessment – Requirements for bodies certifying products, processes and services*  
ISO 2858-1:1999, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*  
ISO 9001:2015, *Quality management systems – Requirements*  
ISO 14001:2015, *Environmental management systems – Requirements with guidance for use*  
ISO 14067:2018, *Greenhouse gases Carbon footprint of products – Requirements and guidelines for quantification*  
ISO 22095:2020, *Chain of custody – General terminology and models*  
ISO 45001:2018, *Occupational health and safety management systems – Requirements with guidance for use*  
ISO 50001:2018, *Energy management systems – Requirements with guidance for use*  
SA 8000, *Social Accountability 8000 International Standard (2014/2023)*  
UL 4703, *Photovoltaic Wire*  
UL 1703, *Flat-Plate Photovoltaic Modules and Panels*

### 3 Terms and Definition

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

#### 3.1

##### Standard Test Conditions (STC)

environmental standard test conditions for Solar PV Modules as defined in IEC 61215 and IEC 60904

#### 3.2

##### Bill of Material (BOM)

list of all primary products and auxiliary materials used in production

#### 3.3

##### Reference BOM

a choice of BOM options, out of which one or more combinations are selected to define the BOM

#### 3.4

##### Manufacturer

any legal entity that manufactures a product or has developed or manufactured a product and places this product on the market under its name or trademark; a manufacturer may entertain several production sites

#### 3.5

##### Production site

actual factory / workshop used for the production of PV modules under the module supply contract

#### 3.6

##### Degree of Cross linking

value obtained by the “primary method” as described in IEC 62788-1-6 for EVA; in the sense of this document also applicable for POE or a mix of EVA and POE

### **3.7**

#### **Anti PID function**

property of encapsulation material, glass, and/or solar cells, that makes sure that no significant loss is observed (max. 5 % loss or less when specified in this specification) according to endurance testing of per IEC TS 62804-1

### **3.8**

#### **Minor Defect**

a defect that is not likely to materially reduce the usability of the unit of product for its intended purpose or is a departure from established standards having little bearing on the effective use or operation of the unit

### **3.9**

#### **Major Defect**

a defect, other than critical, that is likely to result in failure, or to reduce materially the usability of the unit of product for its intended purpose

### **3.10**

#### **Critical Defect**

a defect that judgement and experience indicate is likely to result in hazardous or unsafe conditions for individuals using, maintaining or depending upon the product; or a defect that judgment and experience indicate is likely to prevent performance of the function of a major end item



## 4 Symbols and abbreviations

The following abbreviations are used in this text

AI	Artificial Intelligence
B/S	back sheet (rear side plastic foil of GBM, not applicable for GGM)
CB	Certifying Body, issuing the product certificate and accredited by a member body of IAF
CDF	Constructional Data Form for Photovoltaic Modules
Ce	Cerium (chemical element)
CID	Current Induced Degradation
CO <sub>2</sub>	Carbon dioxide
ESG	Environmental Social Governance (requirements)
EVA	Ethylene-vinyl acetate
GBM	Glass-backsheet module: PV module with glass at the front side and B/S at the rear side
GGM	Glass-glass Module: PV module with glass at the front side and rear side
GHG	Greenhouse gas
HJT	Heterojunction Technology (general term for certain solar cell technologies)
IAF	International Accreditation Forum ( <a href="http://www.iaf.nu">www.iaf.nu</a> )
IEC	International Electrotechnical Commission ( <a href="http://www.iec.ch">www.iec.ch</a> )
IQC	Incoming quality control
ISO	International Standardization Organization ( <a href="http://www.iso.org">www.iso.org</a> )
LeTID	Light and elevated temperature induced degradation
MPP	Maximum Power Point: operation condition providing peak output for a PV module
PA	Polyamide
PAN file	(from French. „panneau“): full dataset defining a specific PV module for PV Syst
PET	Polyethylene terephthalate
PID	Potential Induced Degradation
POE	Polyolefin Elastomer
PV	Photovoltaic
PVDF	Polyvinylidene fluoride
PVF	Polyvinyl fluoride
PV Syst	software made by PVSYST SA (Satigny, Switzerland) for yield calculation
QA	Quality assurance
Sb	Antimony (chemical element)
SI	International System of Units
SoP	Start of Production
SOP	Standard Operation Procedures (e.g. work instructions)
TOPCon	Tunnel Oxide Passivated Contact (solar cell technology)
TPT	B/S consisting with a three-layer construction: PVF-PET-PVF
TS	Technical specification
UVID	<u>U</u> ltraviolet (light) <u>i</u> nduced <u>d</u> egradation: possible degradation mechanism for solar cells
UL	Underwriter Laboratories

**Table 1 – Symbols used**

<b>Symbol</b>	<b>Quantity referenced</b>	<b>SI Unit (if applicable)</b>
Voc	Open Circuit Voltage (of a PV Module)	[V]
Isc	Short Circuit Current (of a PV Module)	[A]
Pmax	Power at MPP	[W] (often noted as [Wp])
r.H.	Relative humidity	[%] (not a SI Unit)

## 5 Specifications and Requirements

Some requirements are provided with selection options that allow the quality level to be defined quickly during the purchasing process. Here the differentiation is a), b), c), whereas:

- a) indicates the option with the lowest quality level: **Basic**
- b) indicates the option with the medium quality level: **Standard**
- c) indicates the option with the highest quality level: **Advanced**

If a higher quality level is agreed, the requirements of the lower quality level are automatically deemed to be included and are deemed agreed: For example, option c) includes options a) and b) - similarly, if b) is agreed, option a) is also deemed to have been agreed.

For some requirements no selection option is specified. Such requirements are compulsory, and a choice is not offered in the checkbox of Annex A.

### 5.1 Product name and data sheet

The product name, i.e. the exact type of designation of the solar module, must be clearly defined by the manufacturer and shall not include any variant that could lead to confusion.

This means that the following information shall be specified:

- weight
- geometric dimensions
- STC performance of the module
- The product name and type
- the manufacturer
- the production site as described in the CDF
- data sheet as specification and drawings of the module

The data sheet must meet the requirements of the latest version of EN 50380 and the requirements of the latest version of the IEC 61215 series.

The data sheet shall be clearly attributable to the modules sold. The data sheet information shall match the label information on the product itself.

The data sheet shall bear a revision number.

Regarding the permissible tolerances for electrical parameters, further requirements can be set in accordance with of this part of this standard that goes beyond the requirements specified in EN 50380. The following parameters must be specified:

- a) **Basic:**  
P<sub>max</sub>: Positive sorting;  
V<sub>oc</sub>: +/- 5%  
I<sub>sc</sub>: +/- 5%
- b) **Standard:**  
P<sub>max</sub>: Positive sorting;  
V<sub>oc</sub>: +/- 3%  
I<sub>sc</sub>: +/- 3%
- c) **Advanced:**  
P<sub>max</sub>: Positive sorting;  
V<sub>oc</sub>: +/- 1%  
I<sub>sc</sub>: +/- 1%

Note: the core text of this section is a mandatory requirement. A choice is offered only for the parameters as listed above in the checklist of Annex A

## 5.2 Product certificates and documents

All certificates for the products shall be issued by a certification body accredited by a national accreditation institute in accordance with ISO 17065. The certificates shall include the specified product type.

### a) Basic

The solar modules shall be certified according to the following standards and have the following documentation

- IEC 61215 series (2016 or later)
- IEC 61730 series (2016 or later)
- the manufacturer of the solar modules must provide a CE declaration for the products.
- A testable CDF must be provided which demonstrates that a re-testing in accordance with IEC TS 62915 Ed.2.0 has been carried out for the BOMs used.
- The manufacturer must provide a PAN file for the PV SYST simulation software that is to be regarded as binding for the module type.

### b) Standard

Solar modules with the exact BOM as in the purchase contract (refer to section 5.4 and 5.5 of this text) are certified according to the following standards or there is documented information:

- IEC 61215 series (2021 or later)
- IEC 61730 series (2021 or later)
- PID (IEC TS 62804-1): severity: 196 h, 85°C, 85% r.H. ; Power loss < 3%
- LeTID (IEC TS 63342:2022 Ed.1.0); Power loss < 3%
- Salt Mist
- Non uniform snow load testing (IEC 62938 Ed.1.0)
- Bifaciality factor to be verified by test report, determined according to IEC 60904-1-2
- The Manufacturer must provide a PAN file for the PV SYST simulation software, which is to be regarded as binding for the module type and verified by a 3rd party, for which the BOM used to create the PAN file has been shared.
- CO<sub>2</sub> footprint, determined according to ISO 14067:2018
- Declaration of take-back for recycling by the manufacturer (country-specific)

### c) Advanced

Solar modules with the exact BOM as defined in the purchase contract are certified according to the following standards and requirements or documented information is available.

- LeTID (IEC TS 63342:2022 Ed.1.0): Power loss < 1%
- IEC TS 63209-1 Ed 1.0: Test report with power loss < 2% for all tested modules

## 5.3 Installation instructions

Installation instructions (sometimes referred to as “installation manual”) must be available which, depending on the different fastening options, take into account at least the following cases, among others: the specified design and partial loads for installation with clamps and for installation with slide-in systems (linear mounting on the short or long side of the module).

The prescribed torque for the nuts fastening the clamps must be defined (with tolerance range). The permissible clamping range must be specified (if necessary, differentiated according to load case). If other methods of fastening are proposed (e.g. rivets), precise information on processing and requirements for the components must be included in the installation instructions (differentiated according to load case if necessary).

The distinction between design and test load in accordance with the procedure described in the latest IEC 61215 series must be applied and documented. The design load must always be specified in the installation instructions. It must also be specified in the data sheet.

The installation instructions must be available at least in English and additionally in the language of the country where the modules are installed, and in any case also in German.

Note: this section is a mandatory requirement. No choice is offered in the checklist of Annex A.

## 5.4 BOM

The BOM shall always be defined as a Reference BOM when the contract is concluded. The Reference BOM can contain several components per BOM element.

The final BOM must be communicated 14 days before the start of production (SoP). It may not exceed

- a) **Basic:** three
- b) **Standard:** two
- c) **Advanced:** one

separate combinations.

One combination is a fixed and defined choice of all components as described in the sections 5.5.1, 5.5.2, 5.5.3 (if applicable), 5.5.4, and 5.5.5.

The BOM components are defined and used exclusively for production under the sales and purchasing agreement.

Only one single type of connector is specified for the complete delivery.

Note: A delivery batch must not have more than one BOM combination.

## 5.5 Components

### 5.5.1 Solar Cells

#### a) Basic:

The origin of solar cells must be verifiable and the type of solar cell used must be included in the CDF. When using cells with newer technologies (e.g. TOPCon or HJT), proof must be provided with regard to UVID in accordance with the TÜV Rheinland test specification 2 PfG 2944/07.23 (Ultraviolet-Induced Degradation (UVID) testing for PV Modules), combined with the requirement that the power loss before and after the test must not exceed 3%.

#### b) Standard:

Only solar cells from the manufacturer's own solar cell production line shall be used to manufacture the solar modules specified in this text.

The technical data sheet, processing instructions and safety instructions must be provided in English.

#### c) Advanced:

Traceability of the silicon used in the wafer of the solar cells (see section 5.8 of this text).

### 5.5.2 Glass

#### a) Basic:

- If the glass contains lead, this must be indicated and quantified.
- For glass/foil modules, a minimum thickness of 3.2 mm and a toughening that leads to a surface tension of at least 80 MPa.
- For glass/glass modules, a minimum thickness of 1.9 mm and a hardening that leads to a surface tension of at least 80 MPa (to be verified for both glass panes (front and back) e.g. via 3-point bending test).

**b) Standard:**

- The anti-reflective coating must be resistant and should be produced by sputtering or by established chemical processes.
- In the case of glass/glass modules, the two panes for the front and rear side should demonstrably come from the same finishing line (tempering), even if the rear side is not made of low-iron glass.
- The technical data sheet for the glass and the anti-reflective coating, the processing instructions and safety instructions must be provided in English.

**c) Advanced:**

- Traceability of the glass and restriction to a maximum of 2 original suppliers for the solar glass.

### 5.5.3 Backsheet type (if applicable)

**a) Basic:**

- No use of PA-based B/S constructions
- No use of pure PET films

**b) Standard:**

- B/S is based on PVDF (Kynar layer, not just F coating) and does not contain a PP layer.
- The technical data sheet, processing instructions and safety instructions must be provided in English.

**c) Advanced:**

- TPT (PVF-PET-PVF) or TPE (PVF – PET - EVA layer)

### 5.5.4 Encapsulation material

**a) Basic:**

- GGM: EVA / POE with a volume resistance of at least 1E10 Ohm  
Degree of cross-linking test: > 65 %
- GBM: EVA with anti PID function  
result of cross-linking test: > 75 %
- Material thickness > 0.4 mm

**b) Standard:**

- Glass-glass modules: EVA / POE with a volume resistance of at least 1E10 Ohm  
result of cross-linking test: > 75 %
- Glass-glass modules: POE / POE with a volume resistance of at least 1E10 Ohm  
result of cross-linking test: > 65 %
- Glass-foil modules: EVA with anti PID function  
result of cross-linking test: > 80 %
- The technical data sheet, processing instructions and safety instructions must be provided in English.

**c) Advanced:**

- Glass-glass modules: EVA / POE with a volume resistance of at least 1E11 Ohm  
Degree of cross-linking test: > 85 %
- Glass-glass modules: POE / POE with a volume resistance of at least 1E11 Ohm  
Degree of cross-linking test: > 75 %
- Glass-foil modules: EVA with anti PID function  
Degree of cross-linking test: > 80 %

### 5.5.5 Cables, junction boxes and connectors

#### a) Basic:

- IEC 62930 Ed.1.0 for cables
- IEC 62790 Ed.2.0 for junction boxes
- IEC 62852 Ed.1.0 + Amd. 1 for connectors
- Only one type of connector is used for the entire delivery

#### b) Standard:

- Connectors according to customer requirements (e.g. from Staeubli, e.g. MC4 Evo 2)

#### c) Advanced:

- Cable also suitable for the US market and approved according to UL 4703 Photovoltaic Wire

## 5.6 Definition of a batch and sampling of test specimens to detect serial defects

### 5.6.1 Batch in the entire delivery

For delivery volumes of more than 20 MWp, contiguous delivery and production of batches of typically 5 – 20 MWp are agreed. All modules in a single batch of continuous production must have the same BOM and must come from a single manufacturing site.

Customer and manufacturer agree on and define the applicable size of batches for the entire delivery. Another option is the selection of batch sizes on the base of thresholds per piece according to ISO 2859-1.

The customer is free to use batches as a basis for tests.

The customer is free to demand a minimum quantity of continuous production per day or per week.

Note: this section is a mandatory requirement. No choice is offered in the checklist of Annex A.

### 5.6.2 Random sample for the detection of serial errors

Serial defects are defects that can be detected at a rate of 5% in a random sample of modules taken from a lot.

The lot is selected by the customer at his own discretion from the following options:

- All modules under the purchase contract
- All modules from a specific factory
- All modules in one solar plant
- All modules in a solar plant from one production site
- All modules that contain a specific BOM element (e.g.: solar cell, J-box, connector, encapsulant, B/S) or a specific combination of BOM elements
- All modules in a solar plant that contain a specific BoM element or a specific combination of BOM elements

The sample size for sampling from the lot is based on the general level II according to ISO 2859-1.

- Faults are characterized by the fact that they result in current or future non-performance of the modules, including but not limited to:
- Performance losses that exceed the manufacturer's standard warranty
- PID (power loss, as observed in the field)
- LID (power loss detected in the field)
- LeTID (power drop observed in the field)
- Delamination
- Yellowing and discoloration to the extent that a loss of performance beyond the performance guarantee is detected.
- Corrosion of the cell connectors or busbars of more than 10% of the area of a busbar or cell connector or to the extent that this can clearly be attributed to insulation faults during operation.

- Mechanical or electrical instability of the module as a whole, the junction box, the electrical connections.
- Non-compliance with the requirements for wet leakage of the module in accordance with IEC 61215 series (> 40 MΩm<sup>2</sup>) with submerged cable and connectors
- Safety problems

Note: this section is a mandatory requirement. No choice is offered in the checklist of Annex A.

## 5.7 Approved production sites

Production sites designated for manufacturing PV modules in the module purchasing contract must be listed in the CDF and defined in the module purchasing contract.

The manufacturer declares that full control over all quality related aspects and other requirements of this specification is fully ensured.

If there are product-related restrictions with regard to the manufacturing site in the CDF, the manufacturer must prove that the selected manufacturing sites are approved for the production of the solar modules specified in the purchase contract.

For deliveries of quantities of up to 100,000 solar modules, a maximum of 1 production site shall be used. For deliveries of quantities of more than 100,000 solar modules, up to 2 manufacturing sites may be accepted.

It is a prerequisite that solar modules are manufactured exclusively in production facilities that are 100% owned by the manufacturer. Contract manufacturing by third parties is excluded.

The production facilities must have traceable monitoring by the CB issuing certificates for the product (Certifying Body according to IECCE). In particular, this also means retesting based on IEC TS 62912.

The manufacturer must submit the CDF and verifiable documentation.

Note: this section is a mandatory requirement. No choice is offered in the checklist of Annex A.

Note: further requirements as per VDE SPEC 90038-2 of this specifications apply.

## 5.8 Documentation requirements in relation to the production site

The following certificates issued by a certifier accredited with the corresponding scope by a IAF member must be presented for the production facility specified in the supply contract. Such production site related certificates must be subject to regular monitoring.

Other regulations may apply to requirements for certifiers according to b) or c).

### a) Basic:

- ISO 9001:2015
- ISO 14001:2015

### b) Standard:

- ISO 45001:2018
- ISO 50001:2018
- The production site as well as the product within the delivery is applicable to the product related certificate (as per 5.2) according to ISO 14067:2018
- Supply chain verification according to ISO 22095:2020 or comparable up to prime poly silicon

### c) Advanced:

- Supply chain verification according to ISO 22095:2020 or comparable up to mining of the raw silicon



## 5.9 Disclosure of manufacturer's quality documents

### a) Basic:

- The manufacturer shall have all the documents described in the sections of this text ready upon conclusion of the contract.
- The manufacturer must disclose the serial number key.
- All documentation defined in this section shall be updated by the manufacturer and provided to the customer regularly.

### b) Standard:

The manufacturer provides work and process instructions for production such as (but not limited to):

- Work instructions for repair processes
- Quality Control Plan
- Process instructions for lamination (temperatures / times / pressure)
- Process / work instructions for the cell connection (soldering) and for the corresponding QA
- Process instruction for checking the sun simulator stability
- Work instructions for feeding in preliminary products such as silicone, films, junction box
- Process instructions for storage after production and before shipping (curing)
- Internal VI and EL criteria of the manufacturer. These documents shall be applicable to the product under this contract. This applies in particular to EL images.

The relevant documents can be selected during an audit at the production site.

### c) Advanced:

- The manufacturer shall provide all the quality documents and records listed under b) in English language as a document by e-mail.
- In addition, the manufacturer provides production-related quality records such as pull-off tests or tests of the degree of cross-linking as well as quality records of the incoming goods inspection tests (IQC) or as per customer's request.

## 5.10 Requirements for the transmission of technical data per delivery

The manufacturer must provide the following data per delivery or batch.

### a) Basic:

- Flash test reports (electrical characteristic data acquired at the end of production) in electronic form (e.g. as an Excel list) including assignment of the serial numbers to the pallet and container number and to the BOM.

### b) Standard:

- Back-end EL images, whereby requirements for the resolution of the EL images are documented elsewhere (see part 2 of this series of specifications).
- 10 sample images must be provided for each error type so that they can be used to train AI software.
- The manufacturer must specify the rejection rate in relation to EL. This is applicable for both human and AI based assessment of the EL data.
- If the manufacturer is already evaluating the EL images using AI, access to the system can also be provided as an alternative.

### c) Advanced:

- Results of cross link tests
- Results of IQC for cells, films (encapsulation material and / or B/S) and glass
- Data set of Re-testing of the production flasher with a so-called "silver module"
- EL data from all modules rejected by the manufacturer internally during production

## 5.11 Requirement according to ESG

### a) Basic:

- Manufacturer's intention to fulfil ESG requirements (comparable to b) and c)) are documented

### b) Standard:

- Member of Solar Stewardship Initiative (SSI) and certificate available
- SA 8000 membership and certificate available

### c) Advanced:

- Member of Solar Stewardship Initiative (SSI) and certificate available for production site
- SA 8000 membership and certificate available for production site

## Annex A Checklist

If no choice for selection is given, a mandatory requirement is described in the respective section

When the contract is concluded, options are selected by ticking the checkboxes (  ).

If no marking is made in a line, the strictest selection (i.e.: "advanced" c)) is always deemed to have been agreed between the parties.

Checklist referencing VDE SPEC 90038-1		Quality Requirement		
Clause	Keyword	Basic	Standard	Advanced
5.1	Product name and tolerances	NO options for core (always valid). Choices can be applied to tolerances		
		a) <input type="checkbox"/>	b) <input type="checkbox"/>	c) <input type="checkbox"/>
5.2	Product certificates and documents	a) <input type="checkbox"/>	b) <input type="checkbox"/>	c) <input type="checkbox"/>
5.3	Installation instructions	NO options (always valid)		
5.4	BOM	a) <input type="checkbox"/>	b) <input type="checkbox"/>	c) <input type="checkbox"/>
5.5.1	Solar cells	a) <input type="checkbox"/>	b) <input type="checkbox"/>	c) <input type="checkbox"/>
5.5.2	Glass	a) <input type="checkbox"/>	b) <input type="checkbox"/>	c) <input type="checkbox"/>
5.5.3	Backsheet type (if applicable)	a) <input type="checkbox"/>	b) <input type="checkbox"/>	c) <input type="checkbox"/>
5.5.4	Encapsulation material	a) <input type="checkbox"/>	b) <input type="checkbox"/>	c) <input type="checkbox"/>
5.5.5	Cables, junction boxes, connectors	a) <input type="checkbox"/>	b) <input type="checkbox"/>	c) <input type="checkbox"/>
5.6.1	Batch in the entire delivery	NO options (always valid)		
5.6.2	Random sample for the detection of serial errors	NO options (always valid)		
5.7	Approved production sites	NO options (always valid)		
5.8	Documentation relating to the production site	a) <input type="checkbox"/>	b) <input type="checkbox"/>	c) <input type="checkbox"/>
5.9	Disclosure of manufacturer's quality documents	a) <input type="checkbox"/>	b) <input type="checkbox"/>	c) <input type="checkbox"/>
5.10	Transmission of technical data per delivery	a) <input type="checkbox"/>	b) <input type="checkbox"/>	c) <input type="checkbox"/>
5.11	Requirement according to ESG	a) <input type="checkbox"/>	b) <input type="checkbox"/>	c) <input type="checkbox"/>

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