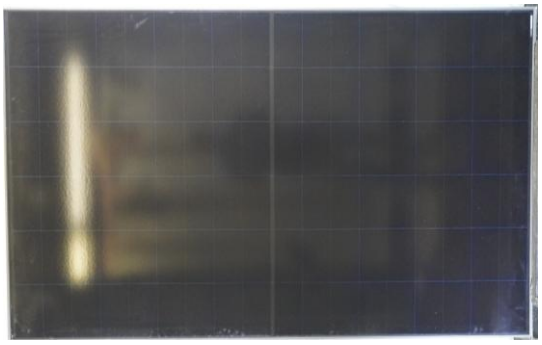
Test Report No.: *Prüfbericht-Nr.:*	**DE25V9PK 001**	**Order No.:** *Auftrags-Nr.:*	300103085	
Client Reference No.: *Kunden-Referenz-Nr.:*	2042170	**Order date:** *Auftragsdatum:*	22/09/2025	
Client: *Auftraggeber:*	LONGi Solar Technology Co., Ltd. Managed by TÜV Rheinland Shanghai Co., Ltd.			
Test item: *Prüfgegenstand:*	Photovoltaic (PV) modules			
Identification/ Type No.: *Bezeichnung / Typ-Nr.*	LR7-54HVBB-465M			
Order content: *Auftrags-Inhalt:*	Measurement of Optical Reflectance of Photovoltaic (PV) Modules			
Test specification: *Prüfgrundlage:*	see page 6			

Date of sample receipt: *Wareneingangsdatum:*	02/09/2025
Test sample No: *Prüfmuster-Nr.:*	HV2025002363 see page 7
Testing period: *Prüfzeitraum:*	29/09/2025
Place of testing: *Ort der Prüfung:*	Am Grauen Stein, 51105 Cologne/Germany
Testing laboratory: *Prüflaboratorium:*	TÜV Rheinland Solar GmbH
Test result*: *Prüfergebnis*:*	No pass/fail criteria applicable



tested by: *geprüft von:*	30.09.2025 X Expert Signiert von: Mehdi Azmani	**authorized by:** *genehmigt von:*	30.09.2025 X Laboratory manager Signiert von: Johannes Stang
Date: *Datum:*		**Issue Date:** *Ausstellungsdatum:*	
Position / Stellung:	Expert	**Position** / Stellung:	Laboratory manager

Others / ./.
Sonstiges:

Condition of the test item at delivery: *Zustand des Prüfgegenstandes bei Anlieferung:* Test item complete and undamaged

* Legend:	P(ass) = passed a.m. test specification(s)	F(ail) = failed a.m. test specification(s)	N/A = not applicable	N/T = not tested
* *Legende:*	*P(ass) = entspricht o.g. Prüfgrundlage(n)*	*F(ail) = entspricht nicht o.g. Prüfgrundlage(n)*	*N/A = nicht anwendbar*	*N/T = nicht getestet*

Remarks
Anmerkungen

A	Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben. Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden. *The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system.* *Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.*
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C	Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben. Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt. *Test clauses with remark of * are subcontracted to qualified subcontractors and descripted under the respective test clause in the report.* *Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.*
D	Die Entscheidungsregel für Konformitätserklärungen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC GC8:2019 und IEC Guide 115:2023, es sei denn, in der auf Seite 1 dieses Berichts genannten angewandten Norm ist etwas anderes festgelegt oder vom Kunden gewünscht. Dies bedeutet, dass die Messunsicherheit nicht berücksichtigt wird und daher auch nicht im Prüfbericht angegeben wird. *The decision rule for statements of conformity in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance to ILAC GC8:2019 and IEC Guide 115:2023, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account and hence also not declared in the test report.*
E	Wenn auf dem Bericht kein Akkreditierungshinweis aufgebracht ist, wurde der Bericht nicht im akkreditierten Bereich erstellt und ist folglich auch nicht vom EA MLA abgedeckt. Unabhängig davon wurde der Bericht auf Basis der allgemeinen Regeln der ISO/IEC 17000er Reihe erstellt. Mit "#" gekennzeichnete Prüfungen sind nicht Bestandteil der Akkreditierung D-PL-22040-01-00. *If there is no accreditation notice on the report, the report has not been produced in the accredited area and is consequently not covered by the EA MLA. Regardless of this, the report has been prepared based on the general rules of the ISO/IEC 17000 series. Tests marked with "#" are not covered by the accreditation D-PL-22040-01-00.*

Table of contents
Inhaltsverzeichnis

General information
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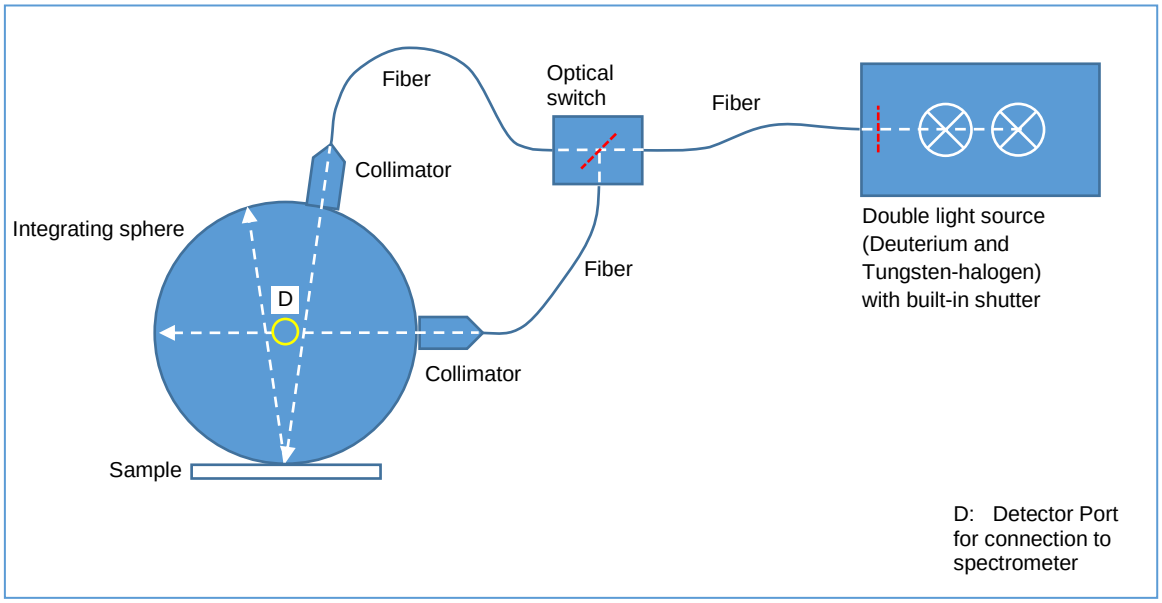
1 General information

1.1 Executive summary

Measurement of spectral optical reflectance

The procedure used here is analogous to the determination of spectral transmittance described in Section 7 and 8 of ISO 13468-2. The test set-up is shown in the figure below. The sample is irradiated by a beam whose axis has an angle of 8° with respect to the vertical on the sample surface. Spectral reflectance is measured in the wavelength range 300 nm to 1600 nm. Measurement is performed using an integrating sphere with 150 mm inner diameter, suitable to collect the entire (hemispherically) reflected light. The measuring spot size is 10 mm in diameter.



Based on the resulting spectral optical reflectance curves, the ISO 9050 external light reflectance is calculated, which involves weighting by:

a) D65 solar spectral irradiance in accordance with ISO/CIE 10526
b) Spectral luminous efficiency for photopic vision (standard observer for photometry) in accordance with ISO/CIE 10527

For the detailed calculation specification, see Appendix A.

General information
Allgemeine Informationen

1.2 Setting of tasks

According to the inquiry of the customer following measurements on the below listed crystalline PV module(s) shall be performed:

- Spectral hemispherical optical reflectance of one PV module shall be measured analogous to ISO 13468-2:1999 but extended to the wavelength range 300 nm to 1600 nm.
- “External light reflectance” shall be calculated according to ISO 9050:2003.

1.3 Summary of test results

- When measuring on a solar cell, the external light reflectance of the PV module surface is on average 2.6%. External light reflectance varies between 2.59% and 2.70%, depending on the solar cell investigated.
- When measuring between the solar cells, external light reflectance of the PV module surface is approx. 2.97%, based on one measurement location.

General information
Allgemeine Informationen

1.4 Test specifications

QMA 2.581.102 (TÜV Rheinland Solar GmbH)	Optische Transmissions- und Reflexionsmessung Optical transmission and reflection measurement
ISO 13468-2:1999	Plastics – Determination of the total luminous transmittance of transparent materials – Part 2: Double-beam instrument
ISO 9050:2003	Glass in building − Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors

2 Product description

2.1 Test sample obtaining

☒ Sending by customer ☐ Sampling by TÜV Rheinland Group
☐ others:

2.2 List of test samples

Sample No.	Sample S/N	Manufacturer	Module type	Module technology
HV2025002363	ONP0100552507003091 38	LONGi Green Energy Technology Co., Ltd	LR7-54HVBB-465M	Half cut c-Si

Supplementary information: Measurement location(s): 4 locations as specified in Section 3.

3 Module examinations

3.1 Measurement of spectral optical reflectance

External light reflectance was computed from spectral optical reflectance in accordance with ISO 9050, Section 3.4.1 (see Appendix A).

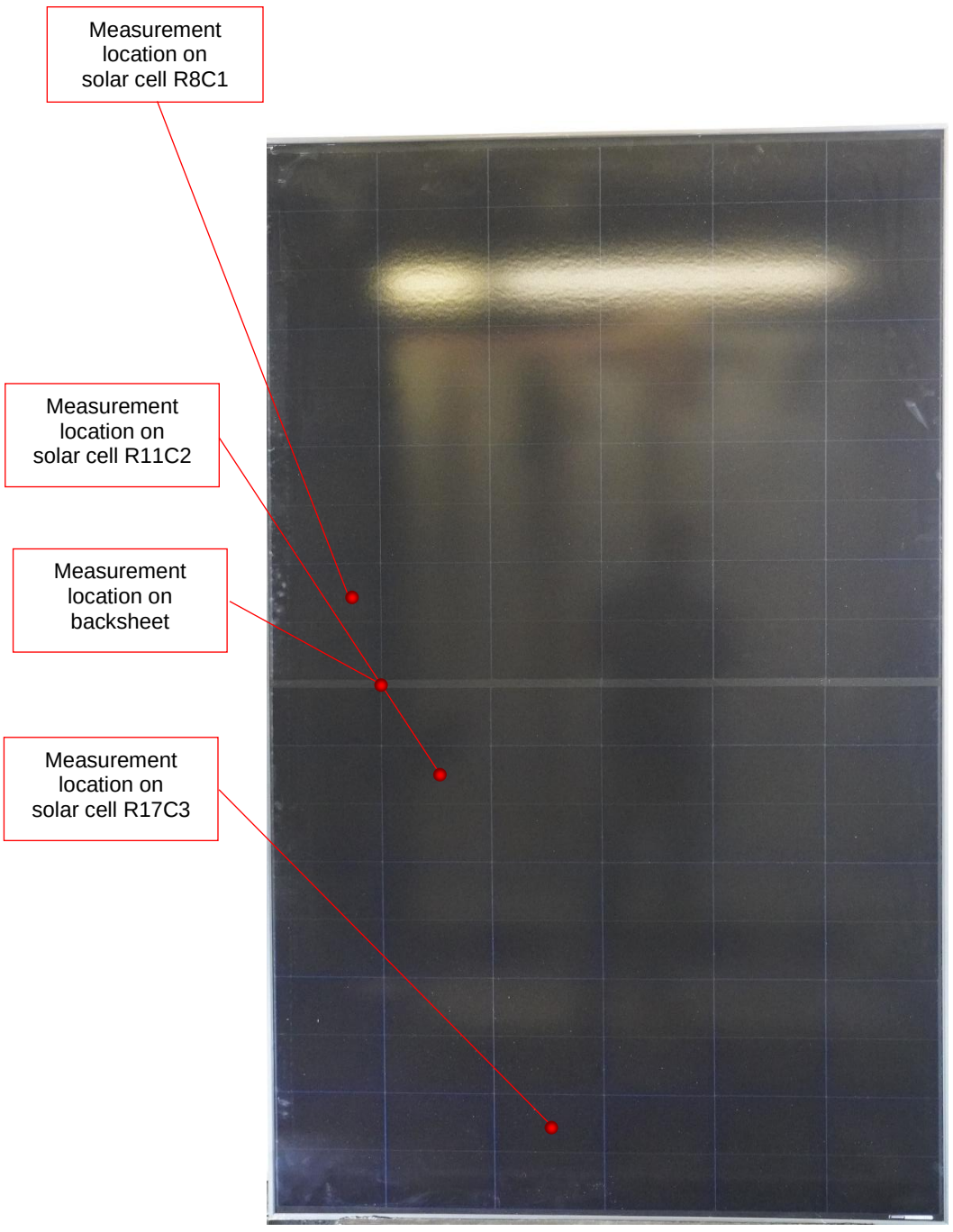
Test date [yyyy-mm-dd]	29/09/2025	
Sample No.	HV2025002363	
No. of measurement locations	4, as specified in the picture below	
Measurement location	**ISO 9050 external light reflectance**	**Average**
Cell R8C1	2.59%	2.6%
Cell R11C2	2.64%	
Cell R17C3	2.70%	
Backsheet	2.97%	—

Summary of results:

- When measuring on a solar cell, the external light reflectance of the PV module surface is on average 2.6%. External light reflectance varies between 2.59% and 2.70%, depending on the solar cells investigated.
- When measuring between the solar cells, external light reflectance of the PV module surface is approx. 2.97%, based on one measurement location.

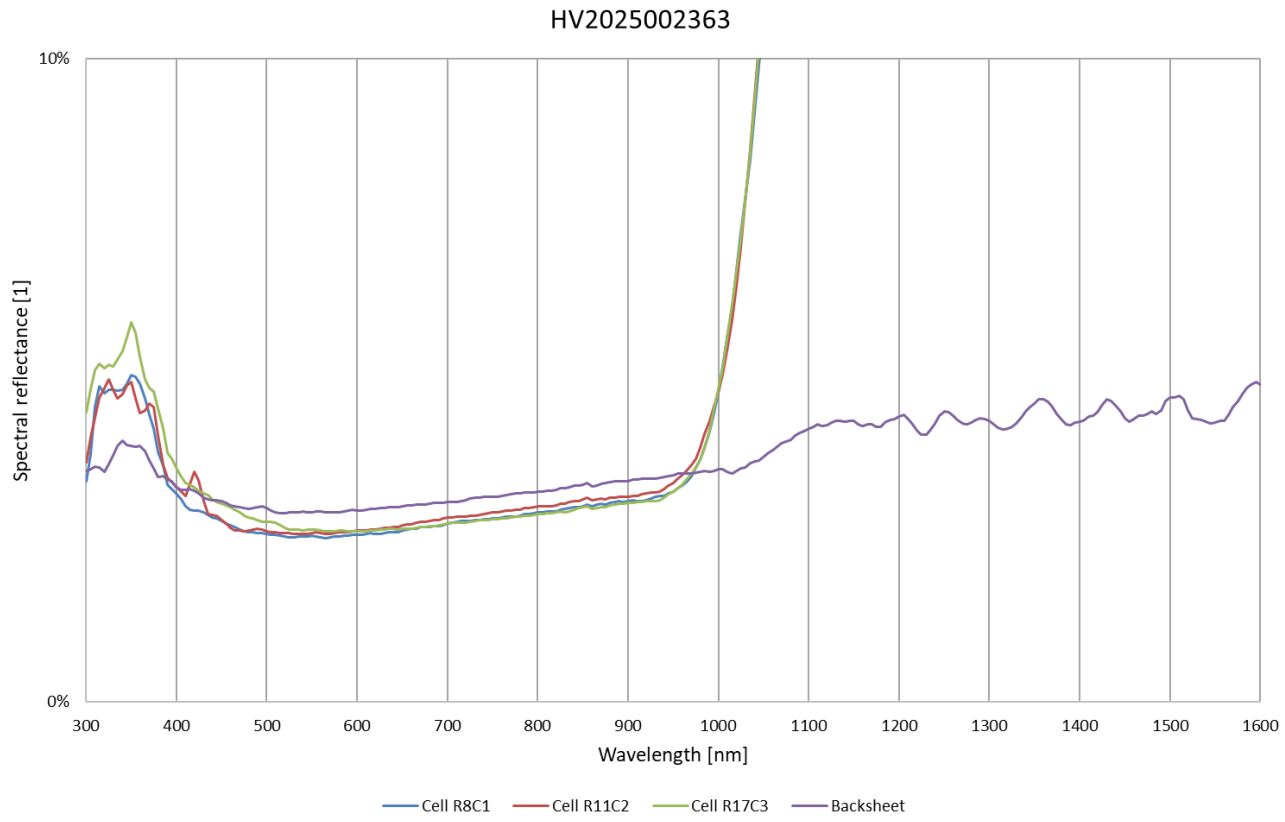
Supplementary information: the measurement of Backsheet (between solar cells) has been performed on the crossing of the large lines spacing between columns 1 and 2 and rows 9 and 10 avoiding the metallic bus bar to the maximum possible (see picture on page 9).

Module examination
Modulprüfungen



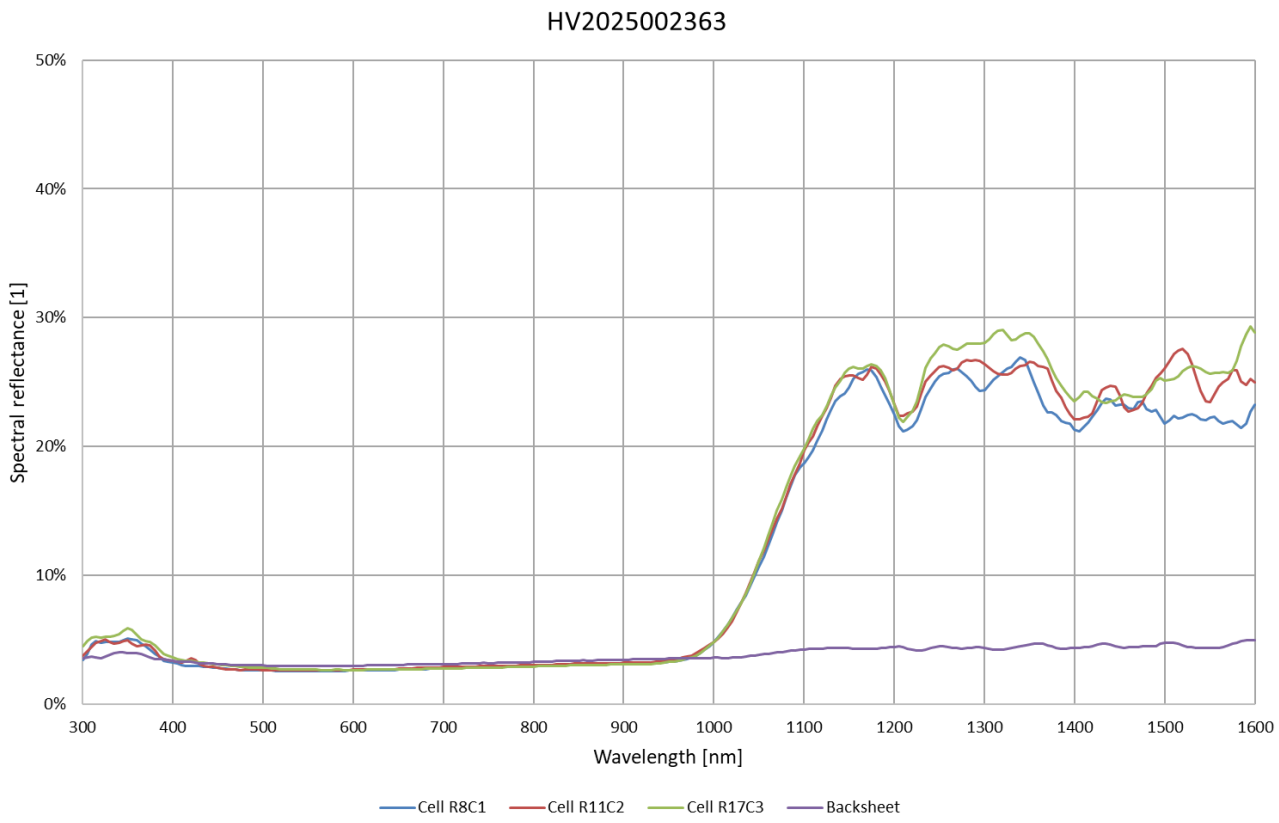
Measurement locations on test sample HV2025002363
Row (R) and column (C) of the tested solar cells are indicated

Module examination
Modulprüfungen



Measured spectral hemispherical reflectance curves

Module examination
Modulprüfungen



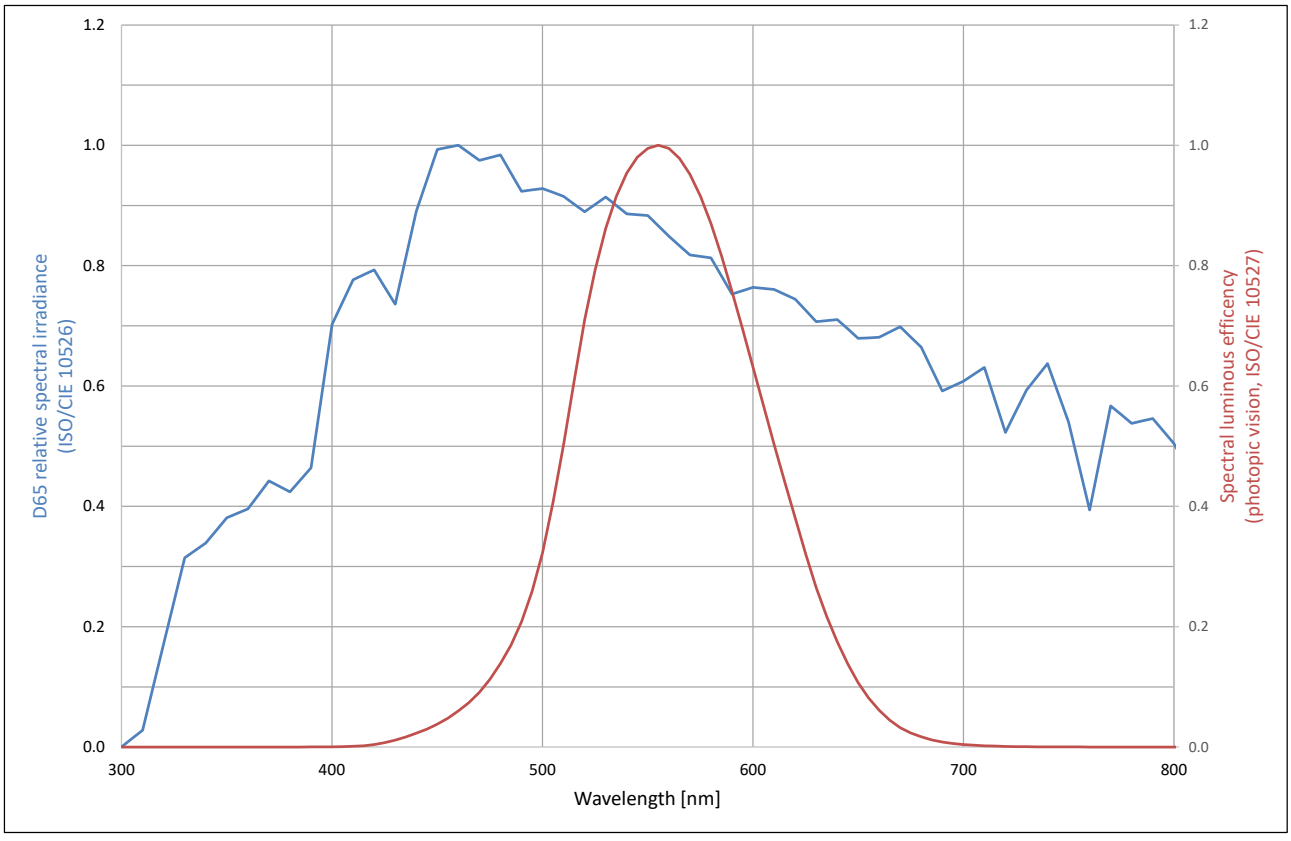
Measured spectral hemispherical reflectance curves (detail)

Additional documentation
Zusatzdokumentation

Appendix A: Calculation of ISO 9050 external light reflectance $\rho_{v,o}$ (ISO 9050, Section 3.4.1)

$$\rho_{v,o} = \frac{\sum_{\lambda = 380\ nm}^{780\ nm} \rho_o(\lambda)\, D_\lambda\, V(\lambda)\, \Delta\lambda}{\sum_{\lambda = 380\ nm}^{780\ nm} D_\lambda\, V(\lambda)\, \Delta\lambda}$$

$\rho_o(\lambda)$	is the spectral external reflectance of the glazing
D_λ	is the relative spectral distribution of illuminant D65 (see ISO/CIE 10526)
$V(\lambda)$	is the spectral luminous efficiency for photopic vision defining the standard observer for photometry (see ISO/CIE 10527)
$\Delta\lambda$	is the wavelength interval



D65 relative spectral irradiance and Spectral luminous efficiency

Additional documentation
Zusatzdokumentation

Appendix B: Abbreviations possible in the report

P_{max}	– *Maximum power*	R_{iso}	– *Insulation resistance*
I_{mpp}	– *Maximum power point current*	A	– *Module surface*
V_{mpp}	– *Maximum power point voltage*	SC	– *Stabilization cycle*
I_{sc}	– *Short circuit current*	n-Stab	– *Non-Stability*
V_{oc}	– *Open circuit voltage*	STC	– *Standard Test Conditions*
FF	– *Fill factor*	MQT	– *Module Quality Test*
a	– *Irradiance correction factor*	MST	– *Module Safety Test*
R_s	– *Series resistance*	PID	– *Potential Induced Degradation*
α	– T*emperature coefficient of I_{sc}*	DHT	– *Damp heat test*
β	– T*emperature coefficient of V_{oc}*	HFT	– *Humidity freeze test*
γ	– *Temperature coefficient of P_{max}*	TCT	– *Thermal cycling test*
κ	– *Temperature coefficient of R_S*	Hrs	– *Hours*
		Deg.	– *Degradation*

--- End of Test Report ---