

SEMI PV65-0715 (Reapproved 0121) TEST METHOD BASED ON RGB FOR CRYSTALLINE SILICON (C-Si) SOLAR CELL COLOR

This Standard was technically approved by the Photovoltaic Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on December 10, 2020. Available at www.semiviews.org and www.semi.org in January 2021; originally published July 2015.

1 Purpose

1.1 The purpose of this Standard is to standardize the color-testing method for crystalline silicon (C-Si) solar cell to improve the efficiency and accuracy of the test.

2 Scope

2.1 This Standard defines the test method for C-Si solar cell color.

2.2 This Standard is applicable to test the C-Si solar cell color by the cell color detector.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 This Standard is only applicable to the color-testing of the C-Si solar cell that the printing and firing processes have been finished.

4 Referenced Standards and Documents

4.1 ISO Standards¹

ISO 105/A02:1993 — Textiles – Tests for Colour Fastness – Part A02: Grey Scale for Assessing Change in Colour

ISO 14644-1:1999 — Clean Room and Associated Controlled Environments – Part 1: Classification of Air Cleanliness

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 *B* — blue

5.1.2 *CM* — camera module

5.1.3 *C-Si* — crystalline silicon

5.1.4 *G* — green

5.1.5 *H* — hue

5.1.6 *IPC* — Industry PC

5.1.7 *PR* — power rack

5.1.8 *R* — red

5.1.9 *S* — saturation

5.1.10 *V* — value

¹ International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland; Telephone: +41.22.749.01.11, <http://www.iso.org>

5.2 Symbols

5.2.1 °C — degree Celsius

5.2.2 μm — micrometer

6 Summary of Test Method

6.1 It is necessary to process the surface of cell sample, and ensure that the surface is clean and no contamination.

6.2 Cell sample should be placed below a high resolution digital camera, and exposed under the light irradiation, so it acquires digital photos and basal R, G, B color information.

6.3 Using computer software for the analysis of digital photos, and through transformation of the color model, so it acquires hue, brightness and saturation of the color parameters.

7 Apparatus

7.1 Apparatus includes camera module (CM), power rack (PR), Industry PC (IPC). (See Figure 1.)

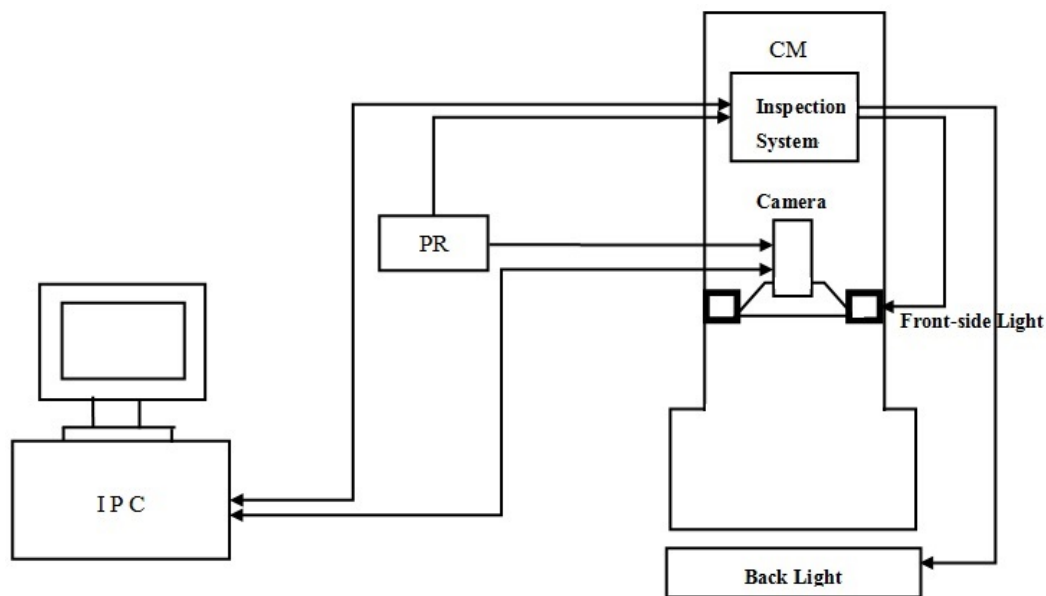


Figure 1
Testing Setup Equipment Diagrammatic Sketch

7.2 Camera Module (CM)

7.2.1 Main test unit is response for LED light controlling; acquisition; image collecting and transmission.

7.2.2 Camera is used to take photos for the cell, and its pixel size should be less than 80 μm .

7.2.3 LED light is divided into front and back light source. The front light is used to supply stable and correct illumination for the camera during acquisition, which have red, green, and blue or other wave length light, and the light source can guarantee the mean gray deviation is less than $\pm 5\%$ when use the white or grey board for white balance testing.

7.2.4 The back light is used to supply stable light environment for the cell edge (Geometry).

7.3 Power Rack (PR)

7.3.1 Response for supply stable power to LED and camera.

7.4 Industry PC (IPC)

7.4.1 The IPC is working for the signal transmission; image collecting; image analysis; result output.

8 Safety Precautions

8.1 *Physical Safety* — Due to the high intensity of the light source, do not look at the light source directly or wear goggles to avoid of the damage of the eyes when exposing to the light source.

9 Test Specimens

9.1 The test specimens is the C-Si solar cell that the printing and firing processes have been finished, and it must be integrated, clean and no contamination on the surface.

10 Preparation of Apparatus

10.1 Because the temperature and humidness influence the test result, the test environment should meet the following conditions:

10.1.1 The test environment temperature should be $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$, the environment humidness should be from 40% to 70%.

10.1.2 Environmental cleanliness should be better than grade 6 clean room requirements as defined in ISO 14644-1:1999, Clean Room and Associated Controlled Environments – Part 1: Classification of Air Cleanliness.

10.1.3 The platform for the cell color detector should be horizontal and kept stable.

11 Calibration and Standardization

11.1 The camera focus calibration, vision field calibration, white balance calibration, front light source calibration and back light plate calibration are required with the special tools when first installed the cell color detector (refer to ISO 105/A02:1993).

11.2 These calibrations should be done periodically when the cell color detector is used in the process.

12 Procedure

12.1 A reliable evaluation result requires the measurement should be conducted under appropriate conditions, with the measurement process should be clearly described in the report. (See Figure 2.)

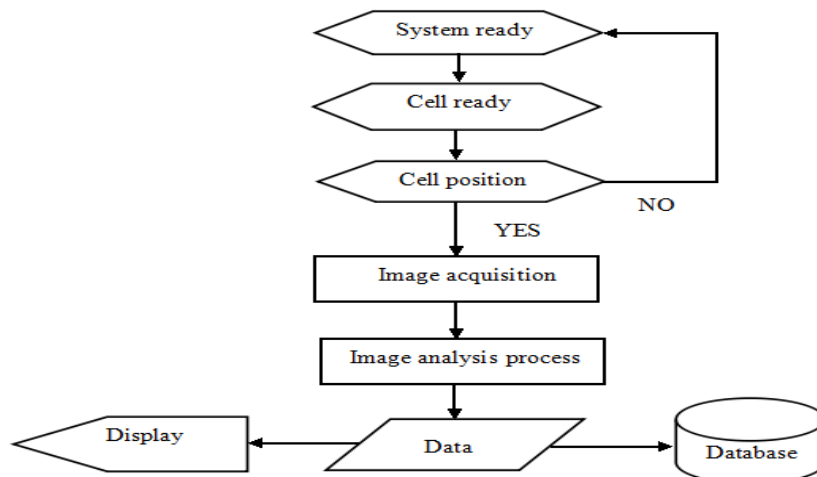


Figure 2
Test procedure