

SEMI PV96-1020

GUIDE FOR THE DESIGN OF TESTING AND SORTING EQUIPMENT FOR CRYSTALLINE SILICON SOLAR CELLS

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 March 26, 2020. Available at www.semiviews.org and www.semi.org in October 2020.

1 Purpose

1.1 In order to provide designers with guidelines in the design process of crystalline silicon solar cell testing and sorting equipment, this Standard discusses the design criteria, key design parameters, basic design guide and extensibility design guide for crystalline silicon solar cell testing and sorting equipment.

2 Scope

2.1 This Standard applies to the design of testing and sorting equipment for appearance, electrical properties and EL (electroluminescence) of crystalline silicon solar cells.

2.2 This Standard can also be used as a reference for the design of silicon wafer testing and sorting equipment.

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 Guide analyzes several key design parameters of testing and sorting equipment for the crystalline silicon solar cells' appearance, electrical properties and EL testing. It provides reference and suggestions for equipment designer, but the design of testing and sorting equipment for the crystalline silicon solar cell is not restricted to this guide. Instead, better parameter settings and design methods are recommended.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI E10 — Specification for Definition and Measurement of Equipment Reliability, Availability, and Maintainability (Ram)

4.2 IEC Standards¹

IEC 60904-9:2007 — Photovoltaic Devices – Part 9: Solar Simulator Performance Requirements

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

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 *MTBF* — mean time between failure

5.1.2 *MTTR* — mean time to restoration

5.1.3 *CDA* — compressed dry air

5.1.4 *MES* — manufacturing execution system

¹ International Electrotechnical Commission, 3 rue de Varembe, Case Postale 131, CH-1211 Geneva 20, Switzerland; Telephone: +41.22.919.02.11, Fax: +41.22.919.03.00, <http://www.iec.ch>

5.2 Definitions

5.2.1 *reliability* — the probability that the equipment will perform its intended function, within stated conditions, for a specified period time. [SEMI E10]

5.2.2 *availability* — the probability that the equipment will be in a condition to perform its intended function when required. [SEMI E10]

5.2.3 *maintainability* — the probability that the equipment will be retained in or restored to a condition where it can perform its intended function within a specified period of time. [SEMI E10]

5.2.4 *safety* — the ability of the equipment to protect human health and personal and property from injury or loss during operation.

5.2.5 *economy* — the degree of cost incurred in the design, manufacture, and use of the equipment.

5.2.6 *fragmentation Rate* — the proportion of damaged cells in the total number of cells after tested and sorted by equipment.

6 Design Criteria

6.1 The design of silicon cell testing and sorting equipment should meet the following criteria:

6.1.1 Excellent reliability

6.1.2 Excellent availability

6.1.3 Excellent maintainability

6.1.4 Excellent safety

6.1.5 Excellent economy

7 Key Design Parameters

7.1 Equipment Capacity

7.1.1 As an important practical parameter of equipment, the equipment capacity directly affects the economic benefits of equipment users. Designers need to focus on the single-cell testing time t during the design phase. Calculate the equipment capacity according to Equation 1.

$$W = \frac{3600}{t} \quad (1)$$

where:

W = capacity of crystalline silicon solar cell testing and sorting equipment, the unit is pcs/h, and

t = time from the beginning of this cell testing to the beginning of next cell testing, the unit is s.

7.2 Fragmentation Rate of Equipment

7.2.1 During the design phase, the designer should fully consider the fragile characteristics of the crystalline silicon solar cells, minimize the damage to the cell and reduce the generation of fragment. Fragmentation rate of the equipment can be calculated according to Equation 2.

$$\eta = \frac{N}{10000} \times 100\% \quad (2)$$

where:

η = fragmentation rate of crystalline silicon solar cell testing and sorting equipment and

N = number of damaged cells after the equipment tested 10,000 pieces of cells.