

SEMI PV32-0312 (Reapproved 0219) SPECIFICATION FOR MARKING OF PHOTOVOLTAIC SILICON BRICK FACE AND PV WAFER EDGE

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1 Purpose

- 1.1 The high volumes of silicon (Si) wafers manufactured for photovoltaic (PV) solar cells exert continuous pressure on manufacturing cost and yield. This requires continuous improvement of quality control throughout the entire process chain for producing c-Si based PV solar cell modules. A prerequisite for this is a means for uniquely identifying the individual wafers regarding their origin. This can be achieved by providing PV wafers with a unique, unmistakable mark that relates to both the parent brick and the individual wafer. This will benefit the entire PV industry ranging from suppliers of silicon wafers to module manufacturers.
- 1.2 The mark applied to the wafers must be capable of containing all relevant information, has to be stable and remain readable throughout the manufacturing process steps of solar cells and cell modules and their entire life. It also must not decrease the efficiency of the solar cells nor impact the cell/module manufacturing cost negatively.
- 1.3 This Specification defines a mark that can easily be applied and read, and that is designed for stability throughout all solar cell manufacturing steps. It is described as brick slice code (BSC). The BSC consists of a pattern of grooves applied to the polished side surface of a silicon brick by a fast laser scribe process. This pattern then appears as a mark on the individual wafers outside of the active area of solar cells after the brick is sliced. This mark is readable from both the top and bottom sides of the wafer and is independent of the positional orientation of the wafer.
- 1.4 Marks are widely used for identifying tracking and tracing wafers in the semiconductor industry. Therefore equipment for applying and reading marks is easily available.
- 1.5 An additional advantage of a unique wafer mark is product security for producers and users of wafers and solar cells with respect to fraud, theft and counterfeiting.

2 Scope

- 2.1 This Specification defines the geometric and spatial relationships and content of a one-dimensional, machine-readable code called HSC code consisting of small notches along the face(s) and edge(s) of a c-Si PV brick and wafer.
- 2.2 This Specification covers bricks and square and pseudo-square wafers, with a nominal size of 125 mm or larger and a thickness of 100 μm or larger, used for manufacturing photovoltaic solar cells. It applies to both single-crystalline or multicrystalline silicon bricks and wafers.
- 2.3 The BSC is applied on one more polished surfaces of a brick prepared from a larger silicon ingot or rod.

NOTE 1: The BSC should be applied preferably not on the surface which is glued to a carrier for slicing the brick or on the opposite surface. If more than one surface is marked, then the marks should be on adjacent surfaces.

- 2.4 It is assumed that the mark is generated by laser scribing. Other methods for applying this mark may be used provided they comply with this Specification.

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 The surfaces of the silicon bricks or the edge of the silicon wafers, respectively, to be marked have to be free of chips and V-grooves according to EN 50513.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI MF728 — Practice for Preparing an Optical Microscope for Dimensional Measurements

4.2 EN Standards¹

EN 50513 — Solar Wafers – Data Sheet and Product Information for Crystalline Wafers for Solar Cell Manufacturing

4.3 Other Documents

SEMI AUX001 — List of Wafer Supplier Identification Codes

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

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 *BSC* — brick slice code

5.1.2 *CL* — center line

5.1.3 *CR* — code reference

5.1.4 *CS* — code start

5.1.5 *CU* — code unit

5.1.6 *CV* — character value

5.1.7 *HSC* — Hennecke Systems – Compressed

5.1.8 *ID* — identifier

5.1.9 *PS* — position start

5.1.10 *PV* — position value

5.1.11 *SC* — section, of brick

5.2 Definitions

5.2.1 *base, of brick* — end of brick opposite to the top of brick.

5.2.2 *basic distance (b)* — the distance between a pair of straight parallel grooves, respectively, *CS* and *CR*.

NOTE 2: The term ‘groove’ is used in this section for defining terms that refer to the marking of a brick. It should be replaced by ‘notch’ when the definitions are used with respect to a wafer.

5.2.3 *brick* — a squared, cropped section of an ingot.

5.2.4 *brick ID* — a part of the wafer ID containing information about the brick.

5.2.5 *brick slice code (BSC)* — a pattern of grooves on a sidewall of a brick containing information about the brick and identifying the position of individual wafers within the brick.

5.2.6 *center line (CL)* — a straight line bisecting a brick surface or a square or pseudo-square wafer surface. It is equidistant from opposing sides of the brick or wafer surface.

5.2.7 *character value (CV)* — a groove parallel to the adjacent *CR* in the brick ID encoding a digit.

5.2.8 *code reference (CR)* — a groove parallel to *CS* at a specified distance towards *CL*.

5.2.9 *code start (CS)* — a groove indicating the start of a *CU*.

5.2.10 *code unit [of code] (CU)* — an area on a brick surface containing code for one decimal digit. It consists of the three grooves called *CS*, *CR* and *CV* parallel to *CL*.

¹ Available from CENELEC member bodies, see the CENELEC website at <http://www.CENELEC.eu> for information.

5.2.11 *ingot* — a cylindrical or rectangular solid of silicon resulting from a crystallization process, generally of slightly irregular dimensions.

5.2.12 *position start (PS)* — three grooves parallel to CL denoted as PS₁, PS₂ and PS₃ that define the start of the slice ID.

5.2.13 *position value (PV)* — a diagonal groove between PS₃ and CU in the slice ID.

5.2.14 *section, of brick (SC)* — a section of a brick along its height perpendicular to the brick axis.

5.2.15 *slice ID* — a part of the wafer ID containing information about individual wafers.

5.2.16 *sub-pattern* — part of a larger pattern of grooves on a side of a brick that mark a brick or a wafer.

5.2.17 *top, of brick* — the end of the brick that was closer to the top of the parent's ingot (for multicrystalline ingots) or to the seed end (for single crystalline ingots), respectively.

5.2.18 *useable volume, of brick* — that volume of a brick complying with the material specifications and from which wafers are cut.

5.2.19 *wafer ID* — a BSC containing brick ID and slice ID.

6 Ordering Information

6.1 *Checklist* — Purchase orders for silicon bricks or wafers furnished to this Specification shall include the following items:

- Number and relative orientation of brick surfaces where the mark shall be.

7 Requirements

7.1 *Mark Layout* — The BSC mark consists of a pattern of grooves; called wafer ID, applied on one or more sidewalls of a silicon brick along the length of the useable volume of this brick (see Figure 1). After brick slicing, this pattern appears as a pattern of notches along one or more edges of the wafers (see Figure 2). The wafer ID consists of two sub-patterns, one to the left of the center line (CL) of the surface (brick ID) and one to the right of this line (slice ID).

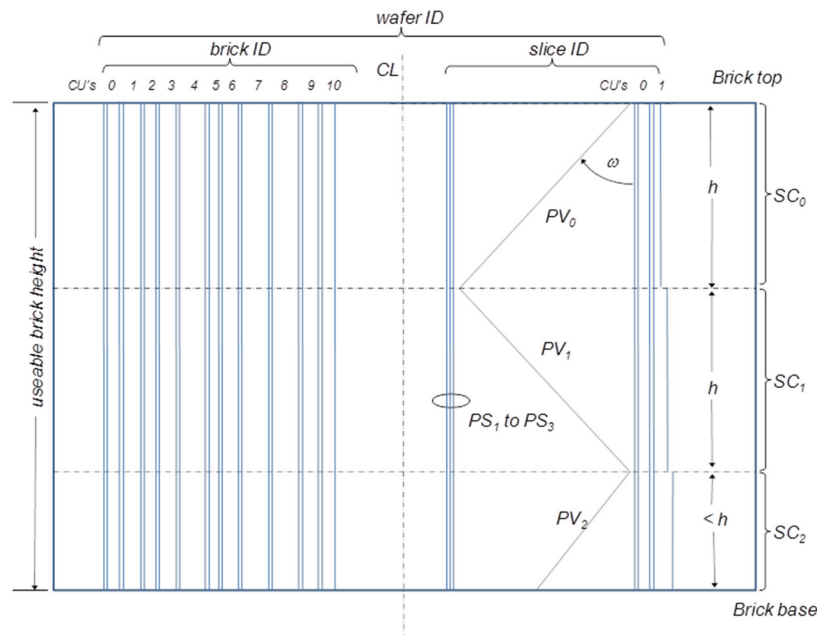
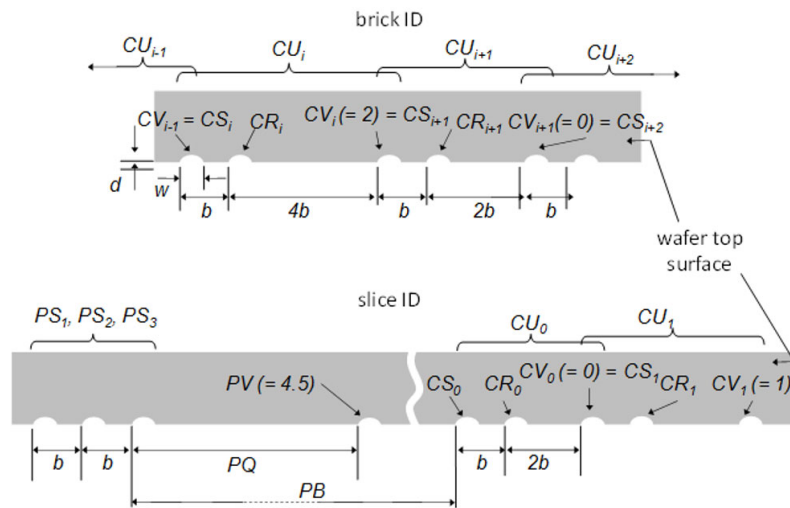


Figure 1
Schematic Drawing of the Marking Pattern on a Sidewall
of the Useable Volume of a Brick (Not to Scale)



#1 The top of the figure displays the sub-pattern of the brick ID, the bottom of the figure displays the sub-pattern of the slice ID.

Figure 2
Schematic Top View of the Edge Region of a Wafer with the Wafer ID Notch Pattern Along a Wafer Edge (Not to Scale)

7.1.1 These specifications assume that the top of the brick is at the top of Figure 1. If a brick is viewed top down then all directional assignments have to be inverted, that means 'right' has to be replaced by 'left' and 'top' by 'bottom' and vice versa.

7.1.2 Wafers are cut from the brick nominally parallel to the top face or base face, respectively.

7.1.3 The brick ID contains the information about the manufacturer, the year of manufacturing and the unique brick number (lot number). The slice ID identifies the position of a wafer within the brick.

7.1.4 The brick shall be thought to be segmented into sections (SC's) of 70 mm nominal height (h). The last section of a brick may be of less height. The counting of the brick sections shall start at the top of the brick.

7.1.5 The slice ID contains information about the position of the slice in the brick.