SEMI M20-0998
SPECIFICATION FOR ESTABLISHING A WAFER COORDINATE SYSTEM

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1 Scope

1.1 This specification defines a wafer coordinate system which can be used to locate uniquely any point on a wafer using the wafer center as the origin and either polar (r-θ-z) or Cartesian (x-y-z) coordinates.

1.2 For unpatterned wafers, this wafer coordinate system can be used directly or in conjunction with a rectangular or polar overlay array.

1.3 This wafer coordinate system can also be used to locate the origins or other reference points of other coordinate systems used to define or report position data of site, die, or map arrays on a patterned or unpatterned wafer. In this way, the array coordinate system may be referenced to the physical geometry of the wafer.

2 Referenced Documents

2.1 *SEMI Standards*

SEMI E5 — Equipment Communications Standard 2, Message Content (SECS II)

SEMI M1 — Specifications for Polished Monocrystalline Silicon Wafers

SEMI M12 — Specifications for Serial Alphanumeric Marking of the Front Surface of Wafers

SEMI M17 — Specification for a Universal Wafer Grid

3 Interferences

3.1 Mask alignment conventions are not necessarily consistent with the wafer coordinate system.

3.2 In SEMI M1, the position of the secondary flat on silicon wafers is defined by the clockwise rotation from the primary flat. This is opposite to the convention used for the polar angle in the wafer coordinate system.

3.3 In SEMI E5, the "normal" position of the wafer is defined similarly to that in the wafer coordinate system; that is, the primary fiducial is downward and its bisector is the negative y-axis. However, the rotational position of the wafer is defined by its clockwise rotation from the "normal" position, again opposite to the convention used for the polar angle in the wafer coordinate system. Further, in SEMI E5, the coordinate system axes do not rotate; the wafer rotates with respect to these axes. In the wafer coordinate system, the coordinate axes are referenced to the wafer itself, independent of the physical position of the wafer in space.

3.4 SEMI M12 and SEMI M13 specify the mark field location for 100 mm, 125 mm, or 150 mm diameter flatted wafers relative to the flat rather than the wafer center. Thus, the mark field location may vary with respect to the wafer center and the coordinates of the corners of the mark field location (in the wafer coordinate system) may vary from wafer to wafer. However, the mark field location for notched wafers 150 and 200 mm in diameter is referenced to the wafer center.

3.5 There are some circumstances in which the front surface of an unpatterned wafer is not readily distinguished from the back surface.

4 Procedure for Establishing the Wafer Coordinate System

4.1 Position the wafer front surface up.

4.2 Find the center of the wafer. For purposes of this document, the periphery of a wafer is assumed to be the smallest circle enclosing the wafer, disregarding fiducials, and all other edge anomalies. The center of this circle is to be used as the center of the wafer.

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4.3 Erect a right-handed Cartesian coordinate system with:

4.3.1 its origin at the geometric center of the wafer,

4.3.2 the *y*-axis on the diameter in the plane of the front surface which bisects the primary fiducial (flat or notch), and

4.3.3 the *x*-axis on the diameter in the plane of the front surface which is perpendicular to the bisector of the primary fiducial.

4.4 Orient the wafer so the primary fiducial is in the negative *y*-direction (see Figure 1).

NOTE 1: The usual convention is that the negative *y*-direction is pointing downward (on a page) or toward the operator (on a table or chuck).

4.5 Reference the polar coordinates, r and θ to the positive *x*-axis.

4.6 Choose Cartesian or polar coordinates according to the application.

5 Applications of the Wafer Coordinate System

5.1 Many, though not all, processing systems now employed in advanced device manufacturing use aligning mechanisms to position the wafer rotationally and in *x*-*y* prior to processing. Many of these scan the wafer periphery and determine the geometric center of the wafer. This is most often seen on stepping aligners, to minimize the effects of wafer-to-wafer diameter variation in mixed aligner type fabs. Similar center-referencing subsystems are found on many characterization systems. The wafer coordinate system provides a method for referencing any other coordinate system, such as a site, pattern, or mapping array, to the physical geometry of the wafer. If the points of the array lie on the front surface of the wafer, only the *x* and *y* (or r and θ) coordinates are relevant. If the point or points lie above or below the front surface, the *z* coordinate must also be used.

5.2 It has become increasingly important in semiconductor material and device manufacturing to describe, in unambiguous terms, the position of a point on a wafer that automatic processing, test, or characterization equipment can recognize and locate. For example, characterization equipment needs to report the precise locations of defects and anomalies discovered in wafers before or after processing in order to relate the presence or absence of such defects and anomalies to device yield variations. The wafer coordinate system can be used to establish the coordinates of each point of interest, and, through transformation to the yield analysis coordinate system, relate them to the die yield map.

5.3 *SEMI E5, in Stream 12* — Wafer Mapping, delineates how a coordinate system for reporting position data may be communicated. The origin of this coordinate system, which is specified by the equipment when generating the wafer map, may be the site at any of the four corners of the array or at the array center. In addition, the stream provides for transmission of an arbitrary number of reference points to relate the map coordinate system to the physical wafer. The wafer coordinate system may be used to establish the locations of these reference points and of the origin of the map coordinate system.

5.4 SEMI M17 defines a polar array of 1000 elements which can be used to identify the locations on a wafer of extended defects such as slip. This array is consistent with the wafer coordinate system.

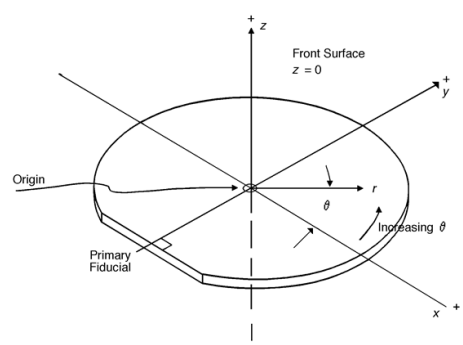

Figure 1
Wafer Coordinate System

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