SEMI E142-0921
SPECIFICATION FOR SUBSTRATE MAPPING

This Standard was technically approved by the Information & Control Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on April 30, 2021. Available at www.semiviews.org and www.semi.org in September 2021; originally published March 2005; previously published August 2020.

1 Purpose

1.1 This Specification defines the data items that are required to report, store, and transmit map data for substrates such as wafers, frames, strips, and trays.

2 Scope

2.1 This version of the Specification applies to the substrate types: wafers, frames, strips, and trays.

2.2 This Specification addresses assembly and packaging including the testing of semiconductor devices.

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 Specification does not address the transmission, file naming conventions, storage or archiving of substrate maps. These are addressed in Subordinate Standards of this Specification.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI E5 — Specification for SEMI Equipment Communications Standard 2 Message Content (SECS-II)

SEMI E39 — Specification for Object Services Standard; Concept, Behavior and Services

4.2 *World Wide Web Consortium Document*[1]

RFC2396 — Uniform Resource Identifiers (URI) Update 1738 – W3C August 1998 (ftp://ftp.isi.edu/in-notes/rfc2396.txt)

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

5 Terminology

5.1 *SEMI Standards Compilation of Terms*

5.1.1 Definitions of descriptions of many of the terms used in this Specification can be found in the SEMI Standards Compilation of Terms, available on the SEMI Web site, http://www.semi.org.

5.2 *Definitions*

5.2.1 *bottom side* — the bottom side of the substrate as defined in the corresponding Appendix (Appendix 1, 2, or 3).

5.2.2 *device* — the unit to which the device status code in the map is assigned including, but not limited to die on a wafer, multi-chip modules, and packages.

5.2.3 *frame* — a wafer mounted on a film frame so that it may be diced and the die picked and placed in a package.

5.2.4 *layout* — the logical and physical dimensions of two-dimensional array of devices to which a map may be assigned.

[1] World Wide Web Consortium, 32 Vassar St. Room 32-G515, Cambridge, MA 02139, USA. Telephone: +1.617.253.2613; Fax: +1.617.258.5999, http://www.w3.org

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5.2.5 *map* — a two-dimensional array of data for a specific layout on a substrate.

5.2.6 *panel* — a rectangular or square substrate on which an array of devices are fabricated.

5.2.7 *printed circuit board (PCB)* — printed circuit board with circuitry to interconnect devices mounted on it meet a specific application.

5.2.8 *strip* — a leadframe, board, or other container on which an array of devices are fabricated. [SEMI G84]

5.2.9 *substrate* — as defined in the SEMI Standards Compilation of Terms.

5.2.10 *substrate layouts* — a tree of layouts that share a common 'root' or 'top level' layout.

5.2.11 *tape and reel (TnR)* — a tape wound on a reel that contains one or more rows of pockets where packages may be placed or picked. The reel is marked with an identifier. The pocket column is marked with a sequential number.

5.2.12 *top level layout* — the layout that defines the size of the substrate itself, for example, the wafer diameter or the strip length and width.

5.2.13 *top side* — the top side of the substrate as defined in the corresponding appendix for that substrate (Appendix 1, 2, or 3).

5.2.14 *tray* — an array of devices held in fixed locations by a device carrier such as a waffle pack, gel pack, JEDEC tray, burn-in tray, etc. This array of devices may be considered a substrate for the purposes of substrate mapping.

5.2.15 *wafer* — a round substrate on which an array of devices are fabricated.

6 Requirements

6.1 This Standard defines the data items that are required in a substrate map. This Standard places no special requirements on the file naming conventions, storage, or archiving of substrate maps.

7 Conventions

7.1 *Object Conventions* — This Specification conforms to the conventions for objects established by SEMI E39, including object diagrams, object terminology, and requirements for standardized objects. Accordingly, notation is based on Unified Modeling Language (UML).

7.2 *Object Attribute Representation* — The object information models for standardized objects will be supported by an attribute definition table with the following column headings:

Attribute Name	*Definition*	*Access*	*Requirement*	*Form*
The formal text name of the attribute.	Description of the information contained.	RO or RW	Y or N	(see below)

7.2.1 The Access column uses RO (Read Only) or RW (Read and Write) to indicate the access that service-users have to the attribute.

7.2.2 A 'Y' or 'N' in the requirement (Rqmt) column indicates if this attribute must be supported in order to meet fundamental compliance for the service.

7.2.2.1 The Form column is used to indicate the format of the attribute.

7.2.3 *Formal Name of an Object* — The text capitalizes formal object name references. Similar to the way capitalization is normally used when discussing entities. When describing something in the general (like cities) lower case is used, but when a specific entity is of interest (New York City), then first letters are capitalized.

7.2.4 *Components of Complex Attributes* — The names of object attributes defined in tables are left-justified. The individual elements of complex attributes are right-justified in order of appearance below the complex attribute.

7.3 *Service Message Representation* — Services are functions or methods that may be provided by either the equipment or the host. A service message may be either a request message, which always requires a response, or a notification message, that does not require a response.

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7.3.1 *Service Definition*

7.3.1.1 A service definition table defines the specific set of messages for a given service resource, as shown in the following table:

Message Service Name	*Type*	*Description*

7.3.1.2 Type can be either 'N' = Notification or 'R' = Request & Response.

7.3.1.3 Notification type messages are initiated by the service provider (e.g., the equipment) and the provider does not expect to get a response from the service user. Request messages are initiated by a service user (e.g., the host). Request messages ask for data or an activity from the provider. Request messages expect a specific response message (no presumption on the message content).

7.3.2 *Service Parameter Dictionary*

7.3.2.1 A service parameter dictionary table defines the description, format and its possible value for parameters used by services, as shown in the following table:

Parameter Name	*Description*	*Format: Possible Value*

7.3.2.2 A row is provided in the table for each parameter of a service.

7.3.3 *Service Message Definition*

7.3.3.1 A service message definition table defines the parameters used in a service, as shown in the following table:

Parameter	*Req/Ind*	*Rsp/Cnf*	*Comment*

7.3.3.2 The columns labeled REQ/IND and RSP/CNF link the parameters to the direction of the message. The message sent by the initiator is called the 'Request'. The receiver terms this message the 'Indication' or the request. The receiver may then send a 'Response' which the original sender terms the 'Confirmation'.

7.3.3.3 The following codes appear in the REQ/IND and RSP/CNF columns and are used in the definition of the parameters (e.g., how each parameter is used in each direction):

M	Mandatory Parameter – Must be given a valid value.
C	Conditional Parameter – May be defined in some circumstances and undefined in others. Whether a value is given may be completely optional or may depend on the value of the other parameter.
U	User-Defined Parameter.
-	The parameter is not used.
=	(For response only.) Indicates that the value of this parameter in the response must match that in the primary (if defined).

7.3.3.4 Note that the words 'must', 'will', and 'requires' are used in the conventions section to illustrate the logical results of table organization. Such statements should not be considered requirements.

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8 Overview

8.1 Substrate maps are two dimensional arrays of data that correspond to a physical substrate which may be a wafer, strip or tray as shown in the Appendices. It is expected that other substrate types are added to subsequent releases of this Specification.

8.2 The data items are defined as attributes of the objects shown in Figure 1, Map Data Object Model.

9 MapData

9.1 The MapData object contains a list of zero or more Layout objects, a list of zero or more SubstrateMap objects and a list of zero or more Substrate objects.

Table 1 MapData Attributes

Attribute Name	*Definition*	*Access*	*Reqd*	*Form*

10 Layout

10.1 The full definition of a substrate layout is tree of the layouts that share a common 'root' or 'top level' layout. Each Layout object defines the logical and physical dimensions of two-dimensional array of devices to which a SubstrateMap may be assigned. Any layout object can reference other child layout objects. The top level layout defines the overall size of the substrate that is being mapped (e.g., the wafer diameter or the strip length and width). The "top level" layout can be quickly found amongst the list of layouts by filtering on TopLevel=True. Only one layout in the tree of layouts for a substrate may have TopLevel=True. Any layout object can reference other child layout objects. In this way complex assemblies may be represented. A layout may be flagged as a 'package' (Package=True) layout indicating that devices at that level in the layout hierarchy may be singulated and function independently (e.g. an advanced package assembled on a strip). See the examples in Related Information 1.

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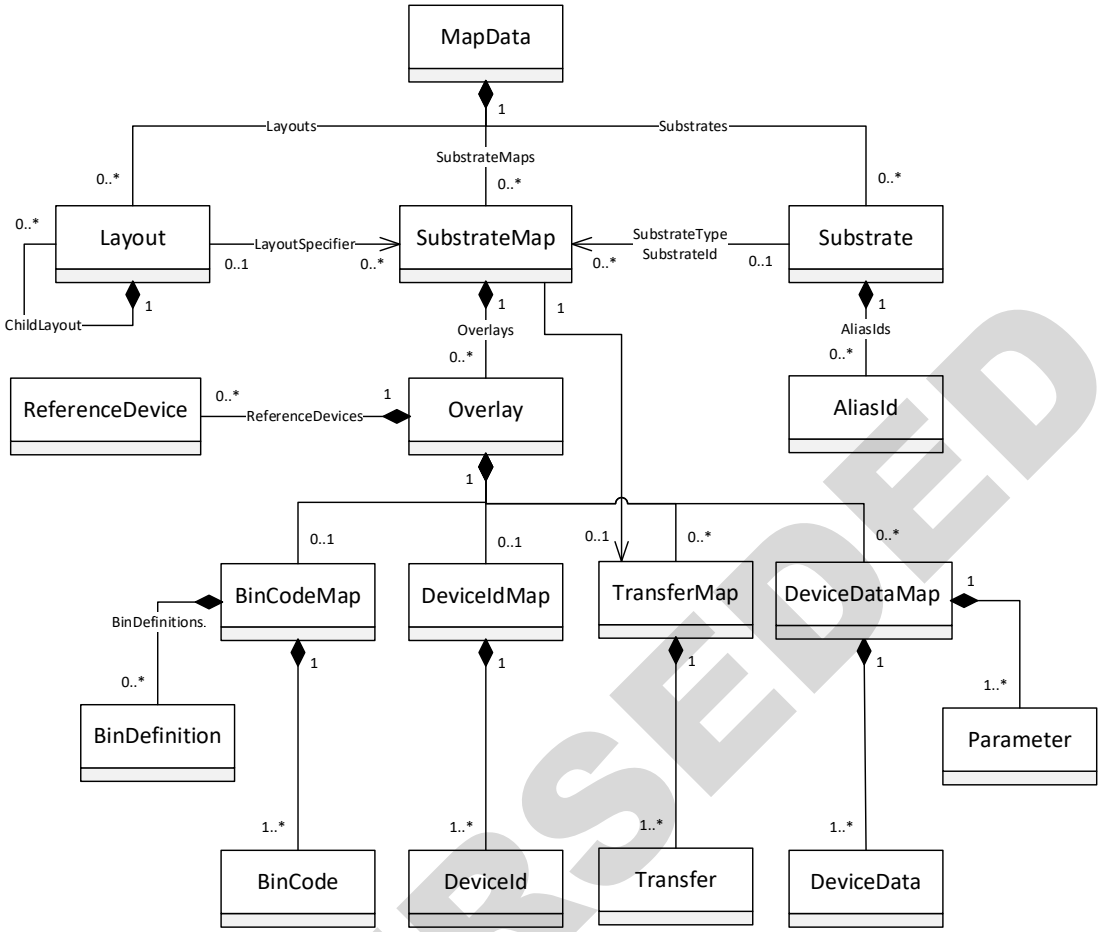

Figure 1
Map Data Object Model

10.2 The LayoutId attribute identifies the Layout and shall be unique within its parent MapData.

Table 2 Layout Attributes

Attribute Name	*Definition*	*Access*	*Reqd*	*Form*
LayoutId	The layout identifier. This shall be unique within the scope of MapData.	RO	Y	Text
DefaultUnits	The units in which physical dimensions and coordinates are represented unless otherwise specified. Restricted to the values; um, mm	RO	Y	Units (as defined in SEMI E5)
Dimension	The number of columns (X-axis) and rows (Y-axis) in the layout. If this is the top level layout then $X = 1$, $Y = 1$.	RO	Y	LogicalCoordinates (see Table 3)
DeviceSize	The X and Y dimensions of the device. If this is the top level layout, then this defines the size of the substrate itself. If not present, then DeviceSize is not defined.	RO	N	XYDimensions (see Table 4)

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Attribute Name	*Definition*	*Access*	*Reqd*	*Form*
StepSize	The distance from a reference point on one device to the same reference point on the adjacent device. StepSize – DeviceSize is equal to the 'street' width between devices. If not present, then StepSize is not defined.	RO	N	XYDimensions (see Table 4)
LowerLeft	The distance of the lower left corner of this layout from the lower left corner of the parent layout. If this is the top level layout, then LowerLeft.X = 0 and LowerLeft.X = 0. If not present, then LowerLeft.X = 0 and LowerLeft.X = 0.	RO	N	XYDimensions (see Table 4)
Z	The logical and physical height of the device above (or below) the parent layout. If this is the top level layout, then Z.Order = 0 and Z.Height = 0. If not present, then Z.Order = 0 and Z.Height = 0.	RO	N	ZDimensions (see Table 5)
TopImage	URI (see W3C RFC2396 in references for a definition of URI) of an image showing the top side of an individual device in the layout.	RO	N	Text
BottomImage	URI of an image showing the bottom side of an individual device in the layout.	RO	N	Text
ProductId	Product identifier for a device in this layout.	RO	N	Text
TopLevel	TopLevel = True indicates that this is a top level layout. TopLevel = False indicates that this layout is the child of another layout. If this is the top level layout, then TopLevel = True. If the TopLevel attribute is not present, this is the same as TopLevel=False. TopLevel may be omitted from child layouts.	RO	N	Boolean
Package	Package = True indicates that parts at this level of the layout hierarchy are a functional unit that will be used directly in the final application or assembled into more complex parts. Package = False indicates that this level of the layout hierarchy represents a carrier of parts, not an independent functional unit. If not present, then Package = False.	RO	N	Boolean

Table 3 LogicalCoordinates Type

Attribute Name	*Definition*	*Access*	*Reqd*	*Form*
X	The column or *X* logical coordinate, according to the values of SubstrateMap coordinate attributes; SubstrateSide, Orientation, OriginLocation, and AxisDirection. (See Appendix 4, Coordinate Systems.)	RO	Y	Integer
Y	The row or *Y* logical coordinate, according to the values of SubstrateMap coordinate attributes; SubstrateSide, Orientation, OriginLocation, and AxisDirection. (See Appendix 4, Coordinate Systems.)	RO	Y	Integer

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Table 4 XYDimensions Type

Attribute Name	*Definition*	*Access*	*Reqd*	*Form*
X	The physical offset from the origin along the *X* axis, according to the values of SubstrateMap coordinate attributes; SubstrateSide, Orientation, OriginLocation, and AxisDirection. (See Appendix 4, Coordinate Systems.)	RO	Y	Floating point value
Y	The physical offset from the origin along the *Y* axis, according to the values of SubstrateMap coordinate attributes; SubstrateSide, Orientation, OriginLocation, and AxisDirection. (See Appendix 4, Coordinate Systems.)	RO	Y	Floating point value
Units	The units in which *X* and *Y* coordinates are represented. If omitted then the Layout, DefaultUnits is used. Restricted to the values; um, mm	RO	N	Units (as defined in SEMI E5)

Table 5 ZDimensions Type

Attribute Name	*Definition*	*Access*	*Reqd*	*Form*
Order	The order of the layouts in the *Z* dimension, according to the values of SubstrateMap coordinate attributes; SubstrateSide, and Orientation. Layouts with higher values for Order are in front of those with smaller values. If this is the top level layout, then Order =0. If not present, then Order =0.	RO	N	Integer
Height	The height of the device above (or below) the parent layout, according to the values of SubstrateMap coordinate attributes; SubstrateSide, and Orientation. If this is the top level layout, then Height =0. If not present, then Height =0.	RO	N	Floating point value
Units	The units in which Height is represented. If omitted, then the Layout.DefaultUnits is used. Restricted to the values; um, mm	RO	N	Text

11 Substrate

11.1 The Substrate object identifies a substrate to which a SubstrateMap may be assigned. A Substrate object may have one or more AliasId objects.

Table 6 Substrate Attributes

Attribute Name	*Definition*	*Access*	*Reqd*	*Form*
SubstrateType	A reference to the type of substrate to which the map data applies. See § 11.3.1.	RO	Y	Text
SubstrateId	The substrate identifier.	RO	Y	Text 1–80 characters
LotId	Production lot identifier for this data.	RO	N	Text 1–80 characters
CarrierType	The type of wafer carrier (e.g., ‘Cassette’, ‘FOUP’, etc.).	RO	N	Text
CarrierId	A character code that may be printed or encoded on the substrate carrier, which uniquely identifies the substrate carrier.	RO	N	Text 1–80 characters

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Attribute Name	*Definition*	*Access*	*Reqd*	*Form*
SlotNumber	This identifies the slot in the carrier in which the substrate is placed.	RO	N	Positive Integer
SubstrateNumber	Identifies the substrate within a lot.	RO	N	Positive Integer
GoodDevices	The total number of 'good' devices on the substrate. The definition of 'good' is beyond the scope of this Specification.	RO	N	Positive Integer
SupplierName	Name of the supplier of the substrate.	RO	N	Text
Status	Status of map data supplying process or preceding process.	RO	N	Text

11.2 *AliasId*

11.2.1 The AliasId object contains other substrate identifiers that may be used to trace the substrate throughout the substrate's life cycle.

Table 7 AliasId Attributes

Attribute Name	*Definition*	*Access*	*Reqd*	*Form*
Type	Type of identifier (e.g., 'FrontsideId', 'BacksideId', 'WaferId', 'FrameId').	RO	Y	Text
Value	Value of the identifier.	RO	Y	Text 1–32 characters

11.3 The combination of SubstrateType and SubstrateId attributes identify the Substrate and shall be unique within its parent MapData.

11.3.1 Valid values of SubstrateType are: wafer, frame, strip, tray, tape and reel (TnR), panel, and printed circuit board (PCB).

12 SubstrateMap

12.1 The SubstrateMap object relates to a single substrate and layout and contains a list of one or more Overlay objects. It may also include a substrate type specific object depending on the value of [SubstrateType].

12.1.1 The combinations of SubstrateType, SubstrateId and LayoutSpecifier attributes identify the SubstrateMap and shall be unique within its parent MapData.

12.1.2 If there are more than one SubstrateMap assigned to a Substrate and Layout combination they should differ in either their Orientation, OriginLocation or both. For example, there may be a map for the top side and one for the bottom side of a Layout.

Table 8 SubstrateMap Attributes

Attribute Name	*Definition*	*Access*	*Reqd*	*Form*
SubstrateType	A reference to the type of substrate to which the map data applies. See § 11.3.1.	RO	Y	Text
SubstrateId	A reference to the substrate identifier to which the map data applies.	RO	Y	Text 1–32 characters
LayoutSpecifier	A reference to the layout to which the map data applies. The LayoutSpecifier defines the full path, using/as a delimiter from the top level layout to the layout to be specified, for example: WaferLayout/L1/DeviceLayout.	RO	Y	Text

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Attribute Name	*Definition*	*Access*	*Reqd*	*Form*
SubstrateSide	Coordinate system attribute that defines the side of the substrate. Restricted to the values; TopSide* Bottom Side *Default value if this item is not present.	RO	N	Text
Orientation	Coordinate system attribute that defines the orientation of the substrate in relation to the map data. This variable increases in the right (clockwise) direction from 0°. It is restricted to values from 0–359°. *Default value if this item is not present is 0°.	RO	N	Integer
OriginLocation	Coordinate system attribute that defines location of the coordinate system origin. Restricted to the values (see Figure A2-1 for an example); LowerLeft* UpperLeft LowerRight UpperRight Center *Default value if this item is not present.	RO	N	Text
AxisDirection	Coordinate system attribute that defines direction in which the *Y* and *X* axis, respectively increase. Restricted to the values (see Figure A2-1 for an example); UpRight* DownRight UpLeft DownLeft *Default value if this item is not present.	RO	N	Text

13 Overlay

13.1 The Overlay object is an array of data that corresponds to the dimensions on the Layout to which the containing SubstrateMap is assigned. An Overlay object may have one or more ReferenceDevice objects and either a BinCodeMap object, a DeviceIdMap object, a list of one or more TransferMaps, or a list of one or more DeviceDataMap objects.

Table 9 Overlay Attributes

Attribute Name	*Definition*	*Access*	*Reqd*	*Form*
MapName	A name that describes the purpose of the bin codes in the map. Possible examples include: ‘CellStatus’, ‘DefectCode’, ‘MarkGrade’, ‘PackageGrade’, ‘SortGrade’, ‘DeviceId’, ‘Transfer’.	RO	Y	Text
MapVersion	The version is used to distinguish between multiple versions of maps for the same substrate with the same MapName.	RO	N	Text

13.2 The combination of MapName and MapVersion attributes identify the Overlay and shall be unique within its parent SubstrateMap.

13.3 *ReferenceDevice*

13.3.1 The ReferenceDevice object defines a reference device on the substrate.

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