

SEMI G81.1-0307 (Reapproved 0315) SPECIFICATION OF GRAND CONCEPT OF MAP DATA FOR CHARACTERISTICS OF DICE ON SUBSTRATE

This Standard was technically approved by the Assembly & Packaging Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on November 11, 2014. Available at www.semiviews.org and www.semi.org in March 2015; originally published March 2007.

NOTICE: This Standard or Safety Guideline has an Inactive Status because the conditions to maintain Current Status have not been met. Inactive Standards or Safety Guidelines are available from SEMI and continue to be valid for use.

1 Purpose

- 1.1 The main purpose of this Standard is to establish a grand concept of map data to classify, specify or characterize semiconductor devices on such substrate as wafers and strips.
- 1.2 The other purpose is to make sure the standard representation of the map data so that the data based on the concept of this Specification can be exchanged between different parties conformably, even if detailed map data representation is dramatically changed in the future.

2 Scope

- 2.1 The most important scope of this Standard is grand concept for eternal principle of die characteristic map on substrate with the following viewpoints. This Standard argues the nature of the map on substrate.
- 2.2 The scope of this Specification is map data on such general equipment as wafer probers and assembly/packaging equipment. Because the data may be transferred, the data communicating between the equipment and such upstream/downstream computers as cell controllers or host.
- 2.3 Map data which contains such very detailed data as analog data or fail bit map data generated on LSI testers or in the communication originated by the testers is out of the scope. As for such detailed map data, refer to SEMI E107 which is standardized as the superset of this Specification for the purpose.
- 2.4 Any communication protocols to transfer or refer map data, including such interface definition languages as WSDL, is not in the scope of this Specification.
- 2.5 While this Standard includes models of nature around map data in Unified Modeling Language (UML), this Standard doesn't intend to make format of map data but to clarify meaning of data items exactly what they are.

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 Because this Standard handles very generic ideas and may be possible to reach many related areas not just test area but also the following manufacturing processes. Terminology in these areas may not be common with the test area. Users related to such area are expected to be aware of it.
- 3.2 Map data is used at many places, for various purposes and applications, on a lot of pieces of equipment and with many different types of computers. Because this Specification provides very common things for the above purpose and scope, some specific things may not appear on this Specification. A part of such things may be expected to be included in other standards.
- 3.3 Also, it represents many different types of substrates. Maps on some specific substrates related to coming technologies or appropriately specifications may not be fully applied with this Specification. Because most substrate specific things are included as subdocuments, such substrate specific issues could be included in a subdocument. Until they are documented in a subdocument, things on it may not be explicitly appeared on this Specification.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI E107 — Specification of Electric Failure Link Data Format for Yield Management System

SEMI E122 — Standard for Tester Equipment Specific Equipment Model (TSEM)

SEMI M21 — Guide for Assigning Addresses to Rectangular Elements in a Cartesian Array

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

5 Terminology

5.1 Definitions

5.1.1 *map* — one- or two-dimensional array or arrays of characteristic data of devices. In case of vertical disposition of the devices on a substrate plane, they may be projected on a virtual plane to avoid three dimension arrays.

5.1.2 *map data* — a set of data which contains one or more maps with their associated data such as substrate information and coordinate system.

5.1.3 *device* — truncated expression of semiconductor device. Minimum devices are fabricated as dice on such substrate as silicon wafer and diced into individual die. It may be mounted on a lead frame and/or packaged. It is still a device. Sometime a device may consist of more than one die packaged together. Or a device may piggy back one or more devices.

6 Overview

6.1 *Sorting* — While most of semiconductor devices grouped in a lot are expected to be good pieces, some of them may become failure during manufacturing process. Because of this fact, they are sorted by electric test at certain milestones. Because the devices are usually lined up on a substrate during fabrication process, the result data of sorting are often handled as map data. Some device types may need more such detailed characteristic information as grade classification or analog data. Such data are also handled as map data.

6.2 *Pick and Place* — During relatively earlier stages of device manufacturing process, semiconductor devices are fabricated on such substrate as silicon wafer. After the final electric test process of the substrates, they are diced into individual devices. Then, the device are picked up and placed on such substrate as lead frame or print circuit board (PCB). The coordinate information array of devices on the source or destination substrate could be represented as map data.

6.3 *Representing Map Data* — Representation of map data may have some variations depending on substrate type and nature of characteristic data in each element of map. However, this fact doesn't bring freedom of representation because it is concerned that following disadvantage on exchanging map data. For example, if a map data is for full functional test for a wafer, it must have a lot of test results of dice and smallest representation is preferred. Also, such conditional information as wafer rotation angle and test program name may be added. If the example is for parametric test on restricted points, total amount of tested dice is small, but measured data amount of each die may be larger. Die coordinate is explicitly given to measuring data of each die. If it transfers information micro-processor devices from a device product tray to PCBs, the number of devices is not so large and each location on the tray is linked to destination board ID and coordinate for the mounted device.

6.4 *Exchanging Map Data* — Map data may be transferred between equipment, to/from manufacturing execution system (MES) host computer or cell/group controller, from electric test service provider (so called test house) to the service client or later process fabrication line (usually device assembly and package process), from semiconductor device manufacturer to users of the device products, and so on. It is prone to have specific representation of the map data depending on the combination of data donor and acceptor. However, having a common representation of the map data brings a great benefit without translating map data representations.

6.5 *Coordinates* — Coordinates to specify locations of dice are defined on substrate. Although such documents as SEMI M21 standardize coordinates, the other coordinating system may be used for some advantage on specific systems. There are many reasons to take such specific coordinating system even if they have disadvantage for exchanging map data widely: architecture of equipment, manufacturing habit, preference of positive numbers, mounting on rear surface of a substrate, handling both sides of a substrate simultaneously, and so on. However, a

coordinating systems could be converted to some other systems, standardize just a certain coordinate system may not be better solution for above reasons. It might be better to standardize a few popular ones for exchanging map data between equipment directly or indirectly, or with such upstream system as host computer or cell controllers.

6.6 Multiple Device Types on a Wafer — Such wider surface wafers as 300 mm diameter wafers allow to make more than one type of products on a wafer easily. Because people nowadays expect so many varieties of products in short period, production of a few types of devices on the wafers for small amount of highly mixed products is one of possible practice. This arrangement of dice may require some extension for map data representation.

6.7 Complicated Die Assembly — Modern electronics sets are so much integrated with high density assembly and packaging technologies. Such technologies as system on chip (SOC) makes semiconductor dice stacked or piggy backed. Map data users may often interested in such data as die identification or grade for more than one horizontal levels of device layout.

6.8 Layout — As long as parent substrates or mounting devices know or show their primary carrying devices on them, configuration of devices on each level can be deduced. Sometimes map data for equivalent devices on equivalent level regardless of substrates may be collected together for bird's-eye view.

6.9 Overlay — Map data may be divided into a few partitioned maps by such categorization as DUT. More than one type of devices may be fabricated or mounted on a substrate simultaneously. Calculation of such figures as yields or ranking summaries together with different types may seldom make much sense. Separating map data for each device type is often practical. However, such divided or separated maps may be overlaid together to look for some correlation.

7 Modeling

7.1 Generalizing Overviews — To establish the universal map concept and model for making the universal standard of map data, it is necessary to generalize real and practical things on the above Overview section.

7.2 Map Data Model — The following diagram shows the Map Data Model. It models general concept of the map data with general nature of most map data sets. As it is described in the Definition section and the Overview section, a set of data map or Map Data in this Standard intends one or more disposition of such characteristic data (e.g., product grade or failure mode) of devices deployed on the surface of one or more substrates. The model diagram depicts architecture and items contained in the Map Data.

7.2.1 Physical Objects — There are a couple of categories in the diagram: physical and logical objects. The physical objects are physically existing things somewhere in the universe, which are instantiated from corresponding physical classes. While often they actually exist, sometimes some of them may be malfunctioned, destroyed, disposed or recycled. For example, Data items in the map data may not exist if once the corresponding devices including those on the way of production have been made. Even if the devices have been scrapped, the data may be kept on such nonvolatile memories as hard disks, DVD disks, data tapes or paper in a binder. Before the start of production of the devices, however, their map may not be considered. Objects instantiated for such classes as substrate, die, device and credential are examples of physical object.

7.2.2 Logical Objects — On the other hand, the logical objects are a kind of imaginable logical things. They may be just imaginable conceptual entities and their values, or attributes, may be recorded on some media. Even if they stay on some magnetic media physically, they are just the incarnation of the logical objects. Objects instantiated for such classes as Coordinate, Coordinating System, Device Information and Substrate Characteristic Map are examples of logical object. A logical object is instantiated from corresponding logical class.

7.2.3 Physical Classes — The following subsections describes physical classes which are the origins to instantiate physical objects.

7.2.3.1 CircuitModule — An abstract class CircuitModule represents the concept of any single modular circuit or an assembly of the circuit: including 2D/3D array of circuit modules, aggregating substrates or possibly container/holder of the circuit. Basically, it must have some disposal on a substrate and it is one of the disposed modules, to make sense in map data specifications; sometimes the disposal may consist of just one device. It may have logical object CircuitInformation. Objects of its subclasses such as substrate, die and ending up device inherit this nature. While this class is one of physical classes, it gives an impression of logical one, since it's abstracted and idealized here in the Standard.

7.2.3.2 Substrate — One of classes inherits CircuitModule directly. This class represents such substrates for Circuit Modules as wafers, flat paned glass plates and print circuit boards. Also, such containers as JEDEC trays and carrier tapes may be a kind of the substrate. Such objects of this class may have characteristic information such as grade of circuit board or summary data yield of a wafer because the class inherits CircuitModule.

7.2.3.3 Die — This is also one of classes inherits CircuitModule directly. This class represents such dice as semiconductor integrated circuits and FPD panels regardless of whether they are on the way of processing in substrate, almost process completed ones before dicing or diced. Each of them has characteristic information of the die.

7.2.3.4 Device — Because this is a classes inherits CircuitModule indirectly, this is a kind of CircuitModule. This class represents such devices as semiconductor integrated circuits and FPD panels regardless. Often this class more intends completed dice, packaged semiconductor devices or assembled FPD devices. Some of them may have the other CircuitModules on them with sockets, bumping, bonding or something like that. Such piggy backed devices shows nature of the Substrate as one of the super classes of this Device class.

7.2.3.5 Credential — This is physical sign to show orientation, plane, reference of the origin of coordinate or index on the substrate and so on. It may be flat or notch of wafer, beveling of corner, absence of pads/pins/leads or some special marking.

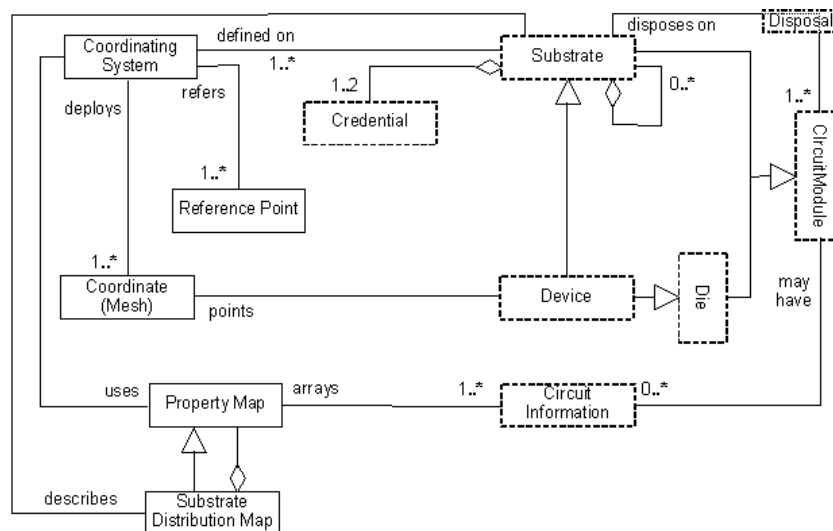


Figure 1
Conceptual Model of Device Characteristic Map Data on Substrate(s)

7.2.4 Logical Classes — The following subsections describe logical classes which are the origins to instantiate logical objects.

7.2.4.1 CircuitInformation — A super class to represent any characteristics such as achievement/grade, failure mode, analog/digital internal data, repair/trimming information, picking/placing information or something like that of the circuit module (e.g., Bin Code, Fuse Data, Fail-bit Map and leak current).

7.2.4.2 PropertyMap — A disposition of CircuitInformation of an area of substrate, on chosen particular CircuitModules or dice mostly, for specific categories or sometimes whole a substrate, ideally in a matrix often in an array practically. This may have criteria information to classify device characteristics in the map intrinsically.

7.2.4.3 SubstrateDeploymentMap (SDMap) — A kind of PropertyMap for certain substrate as an aggregation of one or more PropertyMaps, with such substrate intrinsic information as substrate ID. If it is single substrate with simple disposal and without any subsubstrate (such as piggy back substrates), it is as same as PropertyMap except additional information for the SD Map. This represents a complete set of map for interested property/properties about specific range of devices on substrate. This may be referred to as Substrate Map or Characteristic Map of substrate to shorten or SDMap for abbreviation in the following sections.

7.2.4.4 Coordinate and CoordinatingSystem — Property data of CircuitModules on PropertyMap are arranged with coordinate information to suggest location where they are located on substrate. Each coordinate-combination for a CircuitDiagram is a member of certain coordinating system established on the surface of the substrate, and the combination specifies unique location on the substrate.

7.2.4.5 ReferencePoint — Because the coordinate or general coordinating system can be translatable with bias, a point of reference to fix the coordinating system so that every coordinate-combination represents unique location on surface. This model refers the point as ReferencingPoint which specifies type of the point or entity type on the point, and assuming coordinate-combination of the point. The assuming coordinate-combination is dependent to rotation of substrate and its side or view of physical object.

7.2.5 Attributes and Associations of Classes in the Model — To describe nature of static classes in the model, defining intrinsic information of the classes is one of the most typical ways to specify details of the model. It is referred to as attributes of classes. The following subsections specify them. It is also expected to represent associations how they are to give in mapped data representation. They are also described below.

7.2.5.1 Attributes and Associations of Substrate Class — Attributes of the class are defined in the table below.

Table 1 Attributes of Substrate Class

<i>Attribute Name</i>	<i>Description</i>	<i>Remarks</i>
Substrate Type	Identifies type of substrate	For example, Wafer, Dicing Frame and Strip.
Size	Physical size/dimension of substrate	For example, Both sides for rectangular substrates and diameter for round ones.
Substrate ID	Code to identify substrate uniquely	Physical ID or combination of such information as lot and location in container.
Grid	Square to locate device on substrate and assign location by indices of the square	Often given by least common denominator for non-uniform disposal of device on the substrate.

7.2.5.1.1 Associations with CircuitModule — It is basically given by one or more disposals, actually with their IDs, but often represented as references of disposals or PropertyMap eventually because CircuitModule is assumed as a part of disposal for mapped data.

7.2.5.1.2 Aggregated Substrate — Separated substrates that are child substrates mounted on the aggregating substrate and they are referenced by substrate IDs.

7.2.5.1.3 Aggregated Credential — Credential is physically one of component of the substrate, but it is represented by the orientation, and maybe for each face (top/bottom), of the substrate for the base layer of mapped data.

7.2.5.1.4 Association with Coordinating System — Often just one coordinating system is defined on a substrate especially such ones as wafers. If there is just one substrate in a mapped data, no specific identification of the coordinating system is required and simply lay somewhere in the data. However, it is not the case if the substrate has more than one effective faces, devices on a substrate are laid out so complicated as just one coordinating system is difficult to identify, or more than one substrates with property data of devices on them appears in mapped data.

7.2.5.1.5 Association with Substrate Deployment Map — Because this association for the both ends is one-to-one association, it is enough if one of the side refers the other: one-way reference. Although often Substrate Deployment Map refers Substrate for single substrate in mapped data, Substrate refers the map for the other cases.

7.2.5.1.6 Inheritance from CircuitModule — The nature of CircuitModule is carried in Substrate if it is physically located in a disposal of substrates on a separated substrate.

7.2.5.2 Attributes and Association of Credential Class — Attribute of the class is defined in the table below.