



SEMI E87-0312

SPECIFICATION FOR CARRIER MANAGEMENT (CMS)

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1 Purpose

1.1 This Document provides a standardized behavior for host view communication with production equipment during the coordination, execution, and completion of automated and manual carrier transfers to and from the equipment and, if it exists, its internal buffer space.

2 Scope

2.1 This is a Standard that covers host and equipment communication for SEMI E15.1 300 mm load ports.

2.2 The scope of this Document is to define standards that facilitate the host's knowledge and role in automated and manual carrier transfers, as well as internal buffer equipment carrier transfers. Specifically, this Document provides state models and scenarios that define the host interaction with the equipment for the following:

- Carrier transfer between AMHS vehicles and production equipment load ports.
- Carrier transfers to/from production equipment internal buffer space.
- Equipment and load port access mode switching.
- Carrier to load port association.
- CarrierID verification and Carrier slot map verification.

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 Standard applies to semiconductor equipment with SEMI E15.1 compliant load ports. It may also be applied to other manufacturing equipment that supports automated carrier transfers, and/or contains an internal buffer. This Standard is intended to be used for production equipment. It may or may not be applied to other types of equipment. Also, stocker load ports are not addressed by this Standard.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI E15 — Specification for Tool Load Port

SEMI E15.1 — Specification for 300 mm Tool Load Port

SEMI E30 — Generic Model for Communications and Control of Manufacturing Equipment (GEM)

SEMI E39 — Object Services Standard: Concepts, Behavior, and Services

SEMI E62 — Specification for 300 mm Front-Opening Interface Mechanical Standard (FIMS)

SEMI E84 — Specification for Enhanced Carrier Handoff Parallel I/O Interface

SEMI E90 — Specification for Substrate Tracking

SEMI E99 — The Carrier ID Reader/Writer Functional Standard: Specification of Concepts, Behavior, and Services

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



5 Terminology

5.1 Abbreviations and Acronyms

- 5.1.1 *AGT* — automated guided transport
- 5.1.2 *AGV* — automated guided vehicle
- 5.1.3 *AMHS* — automated material handling system
- 5.1.4 *FIMS* — front-opening interface mechanical standard
- 5.1.5 *FOUP* — front opening unified pod
- 5.1.6 *GEM* — generic equipment model
- 5.1.7 *OHT* — overhead hoist transport
- 5.1.8 *PGV* — person guided vehicle
- 5.1.9 *PIO* — parallel input/output interface
- 5.1.10 *RGT* — rail guided transport
- 5.1.11 *RGV* — rail guided vehicle

5.2 Definitions

- 5.2.1 *automated material handling system (AMHS)* — an automated system to store and transport materials within the factory.
- 5.2.2 *automation* — the degree to which activities of machines or production systems are self-acting. In this standard automation provides methods that will reduce the amount of operator intervention required.
- 5.2.3 *buffer* — a set of one or more locations for holding carriers at/inside the production equipment.
- 5.2.4 *carrier* — a container, such as a FOUP or open cassette, with one or more positions for holding substrates.
- 5.2.5 *CarrierID* — a readable and unique identifier for the carrier.
- 5.2.6 *CarrierID read* — the process of the equipment reading the CarrierID from the carrier.
- 5.2.7 *carrier ID tag (tag, ID tag)* — a physical device for storing Carrier ID and other information. There are two basic types of tags, read-only tags and read/write tags. [SEMI E99]
- 5.2.8 *collection event* — a collection event is an event (or grouping of related events) on the equipment that is considered to be significant to the host.
- 5.2.9 *docked position* — the position where the carrier is ready for substrate extraction or insertion.
- 5.2.10 *front-opening interface mechanical standard (FIMS) port* — the substrate access port where the FOUP is opened and closed.
- 5.2.11 *fixed buffer equipment* — production equipment that has only fixed load ports and no internal buffer for carrier storage. Substrates are loaded and unloaded directly from the carrier at the load port for processing.
- 5.2.12 *host* — the factory computer system or an intermediate system that represents the factory and the user to the equipment.
- 5.2.13 *internal buffer* — a set of locations within the equipment to store carriers. These locations exclude load ports.
- 5.2.14 *internal buffer equipment* — equipment that uses an internal buffer.
- 5.2.15 *load* — the operation of placing a carrier on a load port.
- 5.2.16 *load port* — the interface location on the equipment where carriers are loaded and unloaded.
- 5.2.17 *object instantiation* — the act of storing of information related to a physical or logical entity so that it can be recalled on demand based on its public identifier.
- 5.2.18 *on-line equipment* — equipment that is connected to, and able to communicate fully with, the host.



5.2.19 *process equipment* — equipment used to produce product, such as semiconductor devices. This excludes metrology and material handling equipment.

5.2.20 *production equipment* — equipment used to produce product, such as semiconductor devices, including substrate sorting, process, and metrology equipment and excluding material handling equipment.

5.2.21 *properties* — a set of name value pairs assigned to an object or used in a service message to include additional information about the object (i.e., carrier, port, etc.).

5.2.22 *re-initialization* — a process where production equipment is either powered off then on or when some kind of hardware or software reset is initiated to cause the equipment to reset and possibly reload its software. On production equipment that contains some kind of mass storage device this can also be called a ‘reboot.’

5.2.23 *read position* — any position on a load port or in an internal buffer from which the tag on a carrier can be read.

NOTE 1: This position may vary on any particular equipment depending on the read technology selected by the end user. Some technology/load ports may allow the carrier to be moved during reading. Equipment may have more than one read position.

5.2.24 *single communication connection* — exactly one physical connection using exactly one logical session and a standard set of messages.

5.2.25 *slot map* — the information that relates which slots in a carrier hold substrates, both correctly and incorrectly.

5.2.26 *slot map read* — the process of the equipment reading the slot map for substrate position and placement within the carrier.

5.2.27 *standard message set* — messages conforming to standard message specifications.

5.2.28 *substrate* — material held within a carrier. This can be product, or durables such as reticles.

5.2.29 *substrate port* — the carrier location from which substrates are accessed by the equipment.

5.2.30 *transfer unit* — maximum number of carriers allowed in a specific transfer service:

- AA is the maximum number of carriers allowed for acquisition at the transfer source.
- BB is the maximum number of carriers allowed for deposit at the transfer destination.
- CC is the maximum number of carriers allowed for transfer in one transport vehicle.

The transfer unit is the minimum of AA, BB, and CC.

5.2.31 *undocked* — the status of a carrier on a load port or in an internal buffer that is not at the docked position.

5.2.32 *unload* — the operation of removing a carrier from a load port.

5.2.33 *write position* — any position on a load port or in an internal buffer from which the tag on a carrier can be written to. This position may vary on any particular equipment depending on the write technology selected by the end user. Some technology/load ports may allow the carrier to be moved during writing. The read position and the write position may or may not be the same position.

6 Requirements

6.1 Carrier Management Standard (CMS) compliant equipment is required to provide certain capabilities defined by other standards: accessibility to status information, event reporting, alarm management, and equipment control. These requirements shall be satisfied through compliance to the following sets of Standards:

6.2 Generic Equipment Model Standard (GEM) SEMI E30

- Event Notification
- Status Data Collection
- Equipment Constants
- Alarm Management



- Equipment Control

6.3 Object-Based Standards

- Object Services Standard [SEMI E39]

7 Conventions

7.1 Objects

7.1.1 Whenever the equipment is required to know about specific kinds of entities, and required to manage information concerning these entities, it is useful to treat these entities as objects that comply with the basic requirements of SEMI E39 Object Services Standard (OSS). This is especially true whenever there are a large number of objects of a given type or when the entities are transient rather than permanent. In both cases, it is difficult to describe a general way for the host and equipment to specify which particular entity is referenced and to get information related only to a specific one out of many.

7.1.2 By defining these entities as objects that comply with OSS, it is only necessary for the host to specify the type of object and its specific identifier in order to inquire about one or more properties of the specific entity of interest.

7.1.3 Object Properties

7.1.3.1 A property (attribute) is information about an individual object that is presented as a name/value pair. The name is a formally reserved text string that represents the property, and the value is the current setting for that property.

7.1.3.2 Properties shall be accessible to the host via the service GetAttr for the Carrier object. Using SEMI E39 Object Services Standard, for example, it is possible to:

- get the list of IDs for the current carriers at the equipment, and
- get the specified properties for one or more individual carriers.

7.1.4 Rules for Object Properties

- Attributes with RO access can not be changed using SetAttr service as defined in OSS.
- Attributes with RW access can be changed using SetAttr service as defined in OSS.
- Additional attributes may be specified by the user or the equipment supplier by using an attribute name starting with “UD” (User Defined). Care should be taken to ensure the name of the attribute is unique.

7.1.5 Object Attribute Table

7.1.5.1 The object attribute table is used to list all the attributes related to the defined object as shown below the access is defined as Read only (RO) or Read/Write (RW). The REQD column is used to specify whether the attribute is required for implementation. Finally, the Form column is used to specify the format of that particular attribute.

Table 1 Object Attribute Table

<i>Attribute Name</i>	<i>Definition</i>	<i>Access</i>	<i>Reqd</i>	<i>Form</i>
ObjType	Object type	RO	Y	Text = ‘Carrier’

7.2 State Model Methodology

7.2.1 A state model has three elements: definitions of each state and sub-state, a diagram of the states and the transitions between states, and a state transition table. The diagram of the state model uses the Harel State Chart notation. An overview of this notation is presented in an Appendix of SEMI E30. The definition of this notation is presented in Science of Computer Programming 8, “Statecharts: A Visual Formalism for Complex Systems,” by D. Harel, 1987¹.

¹ Elsevier Science, P. O. Box 945, New York, NY 10159-0945; <http://www.elsevier.nl/homepage/browse.htm>



7.2.2 State Model Requirements

7.2.2.1 The state models included in this Standard are a requirement for CMS compliance. A state model consists of a state model diagram, state definitions, and a state transition table. All state transitions in this Standard, unless otherwise specified, shall correspond to collection events. More explicitly, there must be a unique collection event for each state transition.

7.2.2.2 Equipment must maintain state models for each of the required state models as defined in this Document. Equipment shall maintain individual and unique state models for each logical entity instantiated or physical entity in the equipment that has state models associated with it. The event identifier reported during a particular state transition change for each of these state models shall be shared for all associated state models but unique for each transition. For example, if the equipment has two load ports and the load port state model defines 10 transitions, there must be exactly 10 event identifiers for each load port transfer state model but not 10 for each physical load port. The information identifying the physical entity or logical entity undergoing the transition will be contained within the associated event report.

7.2.2.3 A state model represents the host's view of the equipment, and does not necessarily describe the internal equipment operation. All CMS state model transitions shall be mapped sequentially into the appropriate internal equipment collection events that satisfy the requirements of those transitions. In certain implementations, the equipment may enter a state and have already satisfied all of the conditions required by the CMS state model for transition to another state. In this case, the equipment makes the required transition without any additional actions in this situation.

7.2.2.4 Some equipment may need to include additional sub-states other than those in this Standard. Additional sub-states may be added, but shall not change the CMS defined state transitions. All expected transitions between CMS states shall occur.

7.2.2.5 Transition tables are provided in conjunction with the state diagrams to explicitly describe the nature of each state transition. A transition table contains columns for Transition number, Previous State, Trigger, New State, Actions, and Comments. The 'trigger' (column 3) for the transition occurs while in the 'previous' state. The 'actions' (column 5) includes a combination of:

- Actions taken upon exit of the previous state,
- Actions taken upon entry of the new state, and
- Actions taken which are most closely associated with the transition.

7.2.2.6 When a state model is defined with multiple AND sub-states, the equipment may report all state entry events with only one collection event. When conditional paths are defined in the state model, it is not necessary to report any state transition(s) until a terminal state is reached at which time each transition used to reach that state is reported.

Table 2 State Transition Table

<i>Num</i>	<i>Previous State</i>	<i>Trigger</i>	<i>New State</i>	<i>Actions</i>	<i>Comments</i>

7.3 Services

7.3.1 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.

7.3.2 Service Message Description

7.3.2.1 A service message description table defines the parameters used in a service, as shown in the following table:



Table 3 Service Message Description Table

<i>Service Name</i>	<i>Type</i>	<i>Description</i>

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

7.3.2.2 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).

7.3.3 Service Message Parameter Definition

7.3.3.1 A service parameter dictionary table defines the description, range, and type for parameters used by services, as shown in the following table:

Table 4 Service Message Parameter Definition Table

<i>Parameter Name</i>	<i>Form</i>	<i>Description</i>

#1 A row is provided in the table for each parameter used on a service.

7.3.4 Service Message Definition

7.3.4.1 A service message description table defines the parameters used in a service message. It also describes each message and its cause/effect to the equipment. The columns labeled Req/Ind and Rsp/Conf link the parameters to the direction of the message.

<i>Service Parameter</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>

7.3.4.2 The columns labeled Req/Ind and Rsp/Conf 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'. The receiver may then send a 'Response', which the original sender terms the 'Confirmation'.

7.3.4.3 The following codes appear in the Req/Ind and Rsp/Conf 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 values of other parameters.
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).

7.4 Alarm Requirements Definition

7.4.1 An alarm requirements definition table defines the specific set of alarms required by CMS. The table is divided up by equipment configuration, and then by alarm. The danger and affected columns are marked with 'X' characters to show each alarm and its possible impact to operators, equipment, and material. The table format is shown in the following example:



<i>Equipment</i>		<i>Danger</i>		<i>Affected</i>		
<i>Configuration</i>	<i>Alarm Text</i>	<i>Potential</i>	<i>Imminent</i>	<i>Operator</i>	<i>Equipment</i>	<i>Material</i>
Configuration 1	Alarm 1	X		X	X	X
	Alarm 2		X			X
Configuration 2	Alarm 3	X		X	X	
	Alarm 4	X			X	X

8 Overview

8.1 CMS defines the behavior, data, and services required for equipment supporting automated carrier transfer. This Document provides a standard interface for host/equipment communications regarding the transfer of carriers. The standardized carrier transfer host interface includes not only transfers to and from the external load ports, but also transfers to and from the internal buffer positions on internal buffer type equipment.

8.2 Single Connection Requirement

8.2.1 The expectation of the production equipment supplier is that this Standard be implemented in conjunction with the GEM interface to their production equipment and without the use of a separate communication connection.

9 Load Port

9.1 A load port (port) is used by the factory to load and unload carriers to and from production equipment. A load port may be used as an input load port, an output load port, or as an input/output load port, depending upon equipment type, configuration and/or factory practices. This classification may be fixed or it may be programmable by the user. A load port is generally designed to handle one specific carrier type, such as substrate cassettes, leadframe magazines, SMIF pods, or FOUPs.

9.2 Load Port Numbering

9.2.1 The load port number shall be assigned incrementally from the bottom left to bottom right, then top left to top right when facing the front of the equipment. The load port numbering requirement is to provide a common reference base to external entities, such as humans.

9.3 Carrier Slot Numbering

9.3.1 The slot numbers for a carrier shall be assigned incrementally from the bottom, starting with '1'.

9.4 Load Port Resource Sharing

9.4.1 A model of a load port must account for any mechanical assemblies that are either active during carrier transfer or are capable of interacting with the transfer. The load port is responsible for such mechanisms when the load port is in the TRANSFER READY state. If these mechanisms are shared with other load ports, then the sharing must be coordinated.

9.5 Load Port Transfer State Model

9.5.1 The purpose of the Load Port Transfer State Model is to define the host view of a carrier transfer, which includes the host interactions with the equipment necessary to transfer carriers to and from equipment load ports. Each load port on the equipment shall maintain an independent instance of this state model.

9.5.2 Load Port Transfer State Model Diagram

9.5.2.1 Figure 1 is the diagram for the Load Port Transfer State Model.

9.5.3 Load Port Transfer State Definitions

9.5.3.1 **LOAD PORT TRANSFER** — The super state for the IN SERVICE and OUT OF SERVICE states.

9.5.3.2 **OUT OF SERVICE** — Transfer to/from this load port is disabled. A transition to IN SERVICE is required to continue using this load port for transfers.



9.5.3.3 *IN SERVICE* — Transfer to/from this load port is enabled. A transition to OUT OF SERVICE disables the load port for transfer use.

9.5.3.4 *TRANSFER READY* — A sub-state of IN SERVICE. The load port is available for carrier transfer. The transfer can either be manual or automated, and can be a load or an unload. This state contains two sub-states, which are used depending on whether or not a carrier is present on the load port (*READY TO LOAD* and *READY TO UNLOAD*).

9.5.3.5 *READY TO LOAD* — A sub-state of TRANSFER READY. When transitioning to the TRANSFER READY state, if a carrier is not present on the specified load port, this is the active sub-state. In this state, the load port is available to be loaded with an external carrier, or with a carrier that is currently located inside the equipment (i.e., internal buffer).

9.5.3.6 *READY TO UNLOAD* — A sub-state of TRANSFER READY. When transitioning to the TRANSFER READY state, if a carrier is present on the specified load port, this is the active sub-state. In this state, the load port is available for unloading of a carrier from the loadport to material handling equipment. When the load port is being used by the equipment, the state shall transition to TRANSFER BLOCKED.

9.5.3.7 *TRANSFER BLOCKED* — The carrier transfer state is neither *READY TO LOAD* nor *READY TO UNLOAD*. Because of load port related activity being performed, transfer is not available to/from this load port at this time.

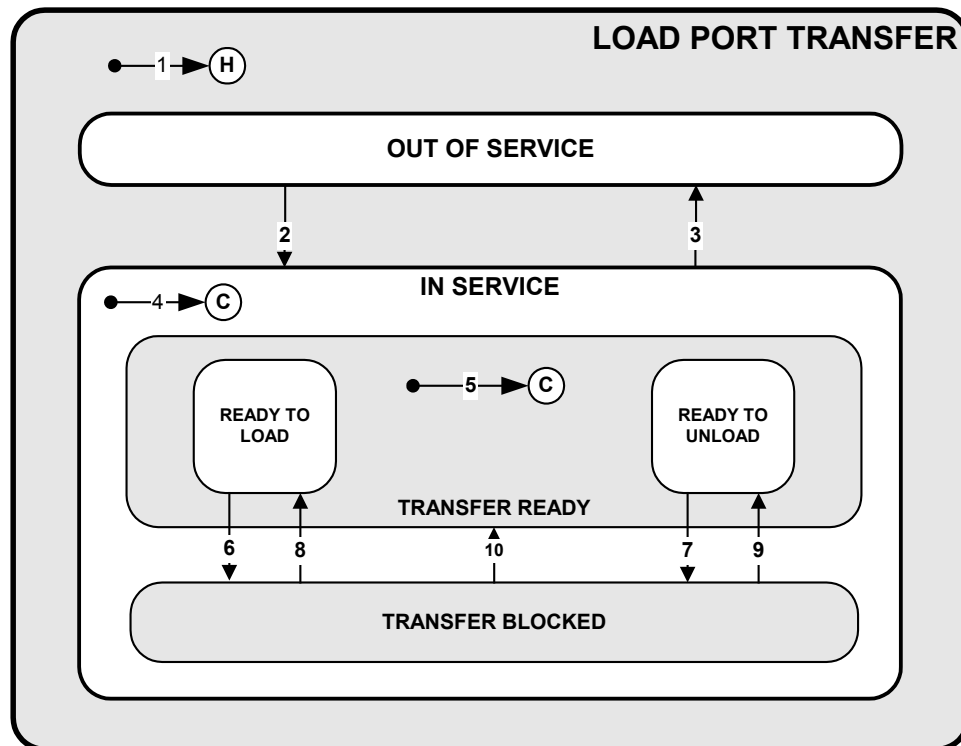


Figure 1
Load Port Transfer State Model Diagram



9.5.4 Load Port Transfer State Transition Table

Table 5 Load Port Transfer State Transition Definition

Num	Previous State	Trigger	New State	Actions	Comments
1	(no state)	System reset.	OUT OF SERVICE or IN SERVICE (History)		This transition is based on what the current transfer status was prior to system reset. Data required to be available for this event report: PortID PortTransferState
2	OUT OF SERVICE	The host or an operator has invoked the ChangeServiceStatus service for this load port with a value of IN SERVICE.	IN SERVICE		Load port is now usable for transfer. Data required to be available for this event report: PortID PortTransferState
3	IN SERVICE	The host or an operator has invoked the ChangeServiceStatus service for this load port with a value of OUT OF SERVICE.	OUT OF SERVICE		Load port is now rendered unusable for transfer. Attempted usage of the load port for carrier transfer after the state transition results in an alarm. Data required to be available for this event report: PortID PortTransferState
4	IN SERVICE	<i>Service:</i> The host or an operator has invoked the ChangeServiceStatus service for this load port with a value of IN SERVICE. <i>System Reset:</i> This transition can be activated by an equipment re-initialization.	TRANSFER READY or TRANSFER BLOCKED		This is the default entry into IN SERVICE. The state is TRANSFER BLOCKED if the carrier, or load port, is not available for carrier transfer. Otherwise, the state is TRANSFER READY. Data required to be available for this event report: PortID PortTransferState
5	TRANSFER READY	<i>Service:</i> The host or an operator has invoked the ChangeServiceStatus service for this load port with a value of IN SERVICE. <i>System Reset:</i> This transition can be activated by an equipment re-initialization. <i>Failed Transfer:</i> If a transfer fails, this transition is activated by transition #10.	READY TO LOAD or READY TO UNLOAD		When entering the TRANSFER READY state, if a carrier is present, the sub-state is READY TO UNLOAD, else the sub-state is READY TO LOAD. If the state is READY TO LOAD, data required to be available for this event report: PortID If the state is READY TO UNLOAD, data required to be available for this event report: PortID CarrierID PortTransferState



Num	Previous State	Trigger	New State	Actions	Comments
6	READY TO LOAD	<p><i>Manual:</i> The equipment recognizes the logical indication of the start of a manual load transfer. This trigger is configurable by the user, examples are included in Table 8.</p> <p><i>Automated:</i> The PIO load transfer is beginning and the PIO “READY” signal is activated (see SEMI E84).</p> <p><i>Internal Buffer:</i> A CarrierOut service has started for this load port.</p>	TRANSFER BLOCKED		<p>When a CarrierOut service is queued and the equipment load port is currently in the TRANSFER BLOCKED state, the equipment shall keep the load port in the TRANSFER BLOCKED state.</p> <p>Data required to be available for this event report: PortID PortTransferState</p>
7	READY TO UNLOAD	<p><i>Manual:</i> The equipment recognizes the logical indication of the start of a manual unload transfer. This trigger is configurable by the user, examples are included in Table 8.</p> <p><i>Automated:</i> The PIO unload transfer is beginning and the PIO “READY” signal is activated (see SEMI E84).</p> <p><i>Internal Buffer:</i> A CarrierIn service has started for this load port.</p> <p><i>By CarrierReCreate Service:</i> A CarrierReCreate service command has been issued by host or operator.</p>	TRANSFER BLOCKED		<p>When a CarrierOut service is queued and the equipment load port is currently in the TRANSFER BLOCKED state, the equipment shall keep the load port in the TRANSFER BLOCKED state.</p> <p>Data required to be available for this event report: PortID PortTransferState</p>
8	TRANSFER BLOCKED	<p><i>Manual:</i> The carrier unload transfer has completed, and the load port is now empty and ready for load transfer. This is indicated when two conditions are met, the presence signal indicates that no carrier is present and the operator has logically indicated that the transfer is complete.</p> <p><i>Automated:</i> The PIO unload transfer ends with the PIO “COMPT” signal (see SEMI E84).</p> <p><i>Internal Buffer:</i> The carrier has finished its move from the load port into the internal buffer, and no CarrierOut services are queued for this load port.</p>	READY TO LOAD		<p>A carrier can now be loaded onto the load port from either an external entity, or by the equipment’s internal material handling resource.</p> <p>Data required to be available for this event report: PortID PortTransferState</p>



Num	Previous State	Trigger	New State	Actions	Comments
9	TRANSFER BLOCKED	<p><i>Manual:</i> Processing for substrates contained within the carrier has completed, or a CancelCarrier/CancelCarrierAtPort service has been issued, and the carrier has returned to the load/unload position on the load port.</p> <p><i>Automated:</i> Processing for the substrates belonging to the carrier has completed, or a CancelCarrier/CancelCarrierAtPort service has been received, and the carrier has returned to the load/unload position.</p> <p><i>Internal Buffer:</i> A carrier has completed its move from the internal buffer to the load port.</p>	READY TO UNLOAD		<p>The carrier on the load port can now be unloaded from the load port to an external entity.</p> <p>Data required to be available for this event report:</p> <p>PortID CarrierID PortTransferState</p>
10	TRANSFER BLOCKED	The transfer was unsuccessful, and the carrier was not loaded or unloaded.	TRANSFER READY		<p>The sub-state of TRANSFER READY which is decided by transition #5.</p> <p>Data required to be available for this event report:</p> <p>PortID PortTransferState</p>

10 Carrier Object

10.1 Information about a carrier is encapsulated as an object. This allows the host to exchange information with the equipment about one or more specific carriers using services defined in SEMI E39, Object Services Standard. A carrier has properties (attributes) that are defined in Table 6, Carrier Attribute Definition.

10.2 Object Instantiation

10.2.1 The carrier object is a software representation of the carrier in the equipment. Under normal circumstances this object is instantiated by the equipment when the host uses the Bind or Carrier Notification service or when the equipment successfully reads the CarrierID from the carrier. A carrier object is instantiated by CarrierID read only if there are no currently existing objects with the CarrierID just read. A carrier object can also be instantiated by either the ProceedWithCarrier or CancelCarrier Services on an NOT ASSOCIATED port. (This implies a failed CarrierID read event.) The ContentMap attribute will be an empty list (a list of zero) when the instantiation is done by CarrierID read. The SlotMap attribute should be a list consisting of all slots enumerated as “UNDEFINED” when the carrier object is instantiated by CarrierID read.

10.2.2 From the host point of view, an object is instantiated if the host is able to query the equipment about that object, its current state, and other attributes. Once instantiated, the object is considered destroyed (no longer instantiated) if the response to such queries is ‘unknown object’.

10.2.3 Summary of carrier object instantiation:

1. Bind or Carrier Notification or CarrierReCreate (with PropertiesList) service;
2. CarrierID read with no currently existing carrier objects having the carrierID just read; and
3. ProceedWithCarrier or CancelCarrier Service on an NOT ASSOCIATED port with a carrier.

10.2.4 Carrier Object Identifier (ObjID)

10.2.4.1 The purpose of an Object Identifier is to allow references to an object within the system. The object identifier is created when an object is instantiated and should be unchanged or persistent until the end of the object lifecycle. The Object Identifier shall be unique at the equipment during lifecycle of the object. The CarrierID is the



Carrier Object Identifier. The equipment is responsible for ensuring uniqueness of the CarrierID prior to instantiation by the bind service.

10.2.5 Carrier Object Destruction

10.2.5.1 Normally, the Carrier Object reaches the end of its lifecycle when the carrier is unloaded from the equipment. Abnormally, the Carrier Object reaches the end of its lifecycle when a CancelBind or CancelCarrierNotification service is executed prior to the carrier being loaded, or when an equipment based carrier verification fails following carrier instantiation by the bind service.

10.2.5.2 Summary of carrier object destruction:

1. A carrier is unloaded from the equipment;
2. A CancelBind or CancelCarrierNotification service is received;
3. An equipment based CarrierID verification fails after a carrier object was previously instantiated with a “Bind” service (Equipment initiated CancelBind); and
4. The host or operator has issued a CarrierReCreate service.

10.3 Carrier Attribute Definitions

10.3.1 The following table contains the attributes that are of importance to the host and/or the equipment in order to manage the history and the reports about the carrier object.

10.3.2 REQD Column

10.3.2.1 All attributes in the following table are required to be associated with the carrier object and are always maintained and updated by the equipment (e.g., if the equipment has a waferID reader, the equipment can determine the ContentMap).

10.3.3 ACCESS Column

10.3.3.1 Even though a value may be marked as RO (read only), the initial value for the attribute may be provided by the host when attached to either the Bind or ProceedWithCarrier services.

10.3.4 Carrier Attribute Definition Table

Table 6 Carrier Attribute Definition

<i>Attribute Name</i>	<i>Definition</i>	<i>Access</i>	<i>Reqd</i>	<i>Form</i>
Capacity	Maximum number of substrates a carrier can hold.	RO	Y	Positive integer.
CarrierIDStatus	Current state of the carrier ID verification.	RO	Y	Enumerated: ID NOT READ, [ID] WAITING FOR HOST, ID VERIFICATION OK, ID VERIFICATION FAILED.
CarrierAccessingStatus	The current accessing state of the carrier by the equipment. The current substate of the CarrierAccessingStatus state model.	RO	Y	Enumerated: NOT ACCESSED, IN ACCESS, CARRIER COMPLETE, CARRIER STOPPED.



<i>Attribute Name</i>	<i>Definition</i>	<i>Access</i>	<i>Reqd</i>	<i>Form</i>
ContentMap	Ordered list of lot and substrate identifiers corresponding to slot 1,2,3,...n.	RO	Y	Ordered list of n structures, where n is equal to the value of “Capacity” above, and each structure consists of a LotID and SubstrateID. List of Structure LotID SubstrateID When no Lot ID is provided by the host, the LotID value should be null. When a slot has no substrate or the host does not know substrate identifier, the LotID and SubstrateID value should be null.
LocationID	Identifier of current location.	RO	Y	Text 1–80 characters.
ObjType	Object type.	RO	Y	Text 1–40 characters equal to “Carrier”.
ObjID	Object identifier.	RO	Y	Text 1–80 characters equal to the CarrierID.
SlotMap	Ordered list of slot status as provided by the host and corresponding to slot 1,2,3...n until a successful slot map read, then as read by the equipment.	RO	Y	Ordered list of n, where n is equal to the value of “Capacity”, each value in the list is from the following enumeration: UNDEFINED, EMPTY, NOT EMPTY, CORRECTLY OCCUPIED, DOUBLESLOTTED, CROSS SLOTTED. (NOT EMPTY provided for equipment that cannot detect incorrectly slotted substrates).
SlotMapStatus	Current state of slot map verification.	RO	Y	Enumerated: SLOT MAP NOT READ, [SLOT] WAITING FOR HOST, SLOT MAP VERIFICATION OK, SLOT MAP VERIFICATION FAILED.
SubstrateCount	The number of substrates currently in the carrier.	RO	Y	Non negative integer less than or equal to the Capacity.
Usage	The type of material contained in the carrier (i.e., TEST, DUMMY, PRODUCT, FILLER, etc.).	RO	Y	Text as defined by the Equipment.

#1 NOT EMPTY is included to indicate presence for equipment that is only able to detect substrate presence but not correct positioning of the substrate slot. For equipment that can detect incorrect positioning such as cross-slotted or double slotted, NOT EMPTY may not be applicable.

10.3.5 Rules for Carrier Attributes

- The equipment shall change object attributes, Capacity, ContentMap, SlotMap, Substrate count and Usage, provided by the host. All other attributes, such as LocationID, shall be set and maintained by the equipment.
- The attributes, Capacity, ContentMap, Substrate count and Usage, shall be provided with Bind, CarrierNotification, or ProceedWithCarrier service before or when SlotMap is provided.
- The SlotMap shall be provided with Bind, CarrierNotification, or ProceedWithCarrier to verify CarrierID, when the SlotMap verification is equipment based. And it shall not be provided when the SlotMap verification is host based.
- Carrier properties may be provided before the carrier arrives as part of the Bind service and should be retained until either a CancelBind service is received or the carrier is removed.
- Carrier properties may also be provided by the ProceedWithCarrier service. The carrier properties that are provided by the ProceedWithCarrier service may differ based whether or not the object is instantiated by the service.
- Carrier properties that are required shall be actively updated by the equipment.



10.3.6 *Carrier Location*

10.3.6.1 A carrier location, signified by LocationID, is used for tracking carriers as they move through the equipment. A carrier location is any physical area that is capable of holding a carrier. It is not intended to represent entire mechanisms, which may have a variety of other properties of interest, but only that portion where a carrier may rest.

10.3.7 *Carrier Location Examples*

10.3.7.1 Carrier locations include load port locations, substrate port locations, internal buffer locations, as well as grippers, conveyors, and elevators that are used internally for moving the carrier from one fixed location to another.

10.4 *Carrier Location Naming*

10.4.1 Carrier locations shall be assigned a unique name. Information about the carrier location can be obtained by querying the CarrierObject for the LocationID or by asking the equipment for the CarrierLocation-Matrix. The text form of the LocationID shall be descriptive of the location. For example, LocationID form for load port load/unload location might be 'LPn', where 'n' equal is equal to the load port number (the load port number is determined through the numbering rule in ¶ 9.1). The LocationID form for the FIMS port location might be 'FIMSn'. The LocationID form for a buffer location might be 'BUFn'.

10.5 *Load Port Carrier Locations*

10.5.1 For fixed buffer equipment configured to handle FOUPs, a Load Port has two different carrier locations. One represents the place where a carrier is delivered and picked up, while the other represents the place where the carrier is docked and can be opened.

10.6 *Carriers Between Locations*

10.6.1 When the carrier is traveling from one location to another, the location attribute remains equal to the source location until the carrier movement is complete and the carrier is resting at the new carrier location (the destination location).

10.6.2 *Usage*

10.6.2.1 The Usage parameter indicates the type of substrate the carrier contains. All Usage values are equipment specific values. Some internal buffer equipment manages carriers by establishing logical partitions. This type of equipment shall use the Usage parameter to determine which logical partition where the carrier is held.

10.6.3 *SubstrateCount*

10.6.3.1 The SubstrateCount parameter can be sent to the equipment by the host in either the Bind service or the ProceedWithCarrier service. However the equipment shall update this parameter based on the results of the read slot map operation. Furthermore, the equipment shall update the parameter based on its own actions of adding and removing a substrate to and from a carrier. If the equipment does not know the value of SubstrateCount prior to instantiation, the equipment shall instantiate the carrier object with the value of null for SubstrateCount.

10.6.4 *Lot information for ContentMap*

10.6.4.1 Lot is defined in SEMI E90 as a group of one or more substrates of the same type. It is organized external to the equipment. The Lot ID is the identifier of this group. If the equipment is informed of the Lot ID to which a substrate belongs, the equipment must maintain this information.

10.6.5 *Carrier Accessing Status*

10.6.5.1 The CarrierAccessingStatus is used by the host to know whether or not the carrier owned by the equipment can be moved out. If the carrier is within the internal buffer equipment, this status may be used by the host to issue CarrierOut service.

10.7 *Carrier State Model*

10.7.1 The purpose of the Carrier State Model is to define the host's view of a carrier. The equipment shall maintain a separate and independent state model for each carrier in/at the equipment.



10.7.2 Carrier State Model Diagram

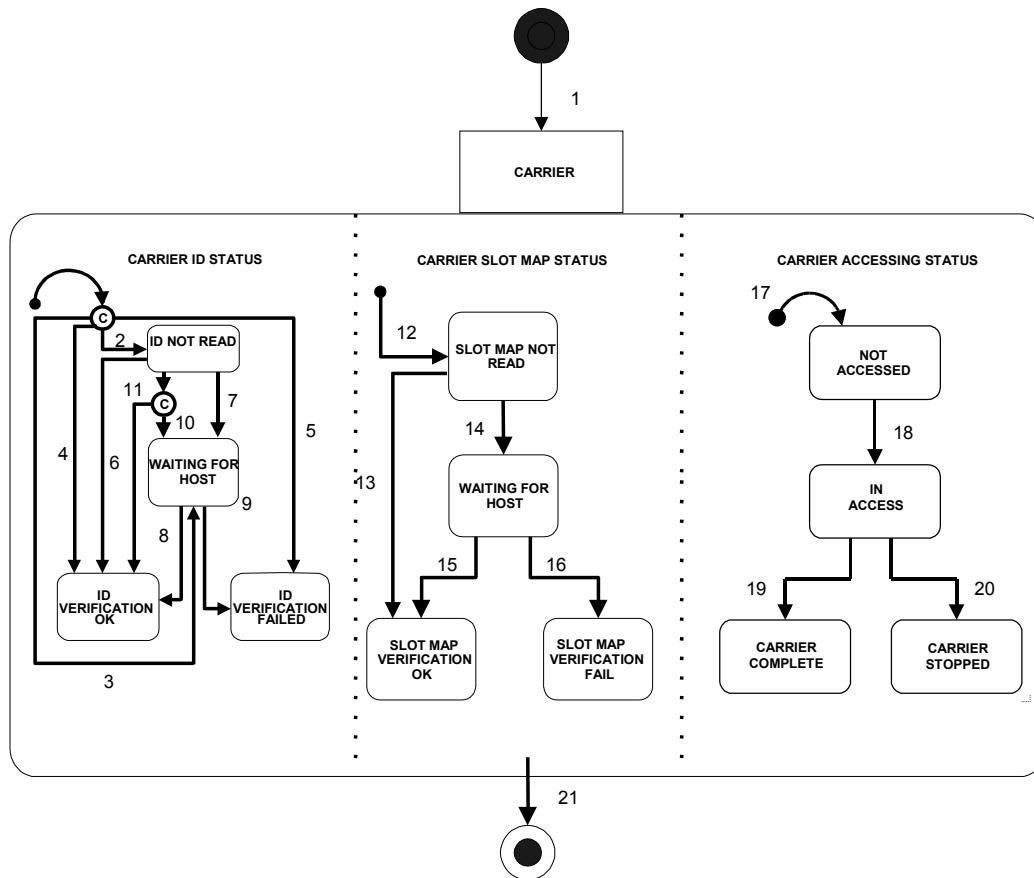


Figure 2
Carrier State Model Diagram

10.7.3 Carrier State Definitions

10.7.3.1 CARRIER — The CARRIER state has three ANDed (orthogonal) states: CARRIER ID STATUS, CARRIER SLOT MAP STATUS and CARRIER ACCESSING STATUS.

10.7.3.2 CARRIER ACCESSING STATUS — This is a substate of CARRIER and indicates the current accessing status of the carrier. It has four substates, NOT ACCESSED, IN ACCESS, CARRIER COMPLETE, and CARRIER STOPPED. The initial default entry substate is NOT ACCESSED.

10.7.3.2.1 NOT ACCESSED — This is a substate of CARRIER ACCESSING STATUS and is active when access by the equipment to the carrier has not been started. The carrier can be moved out.

10.7.3.2.2 IN ACCESS — This is a substate of CARRIER ACCESSING STATUS and is active when access by the equipment to the carrier has been started but has not been finished, and the carrier should not be moved out.

10.7.3.2.3 CARRIER COMPLETE — This is a substate of CARRIER ACCESSING STATUS and is active when the access by the equipment to the carrier has been finished, and the carrier should be moved out. This is a final state.

10.7.3.2.4 CARRIER STOPPED — This is a substate of CARRIER ACCESSING STATUS and is active when the access by the equipment to the carrier has been stopped abnormally, and the carrier should be moved out. This is a final state.

10.7.3.3 CARRIER ID STATUS — This is a substate of CARRIER and indicates the current status of the carrier with respect to its identifier. It has four substates, ID NOT READ, WAITING FOR HOST, ID VERIFICATION



FAILED, ID VERIFICATION OK. The initial substate is conditional based on information the equipment has about the carrier. When the carrierID is provided by the Bind or the Carrier Notification service, the carrier object shall be instantiated in the ID NOT READ substate. When the carrierID is provided by the carrier ID reader, the carrier shall be instantiated in the WAITING FOR HOST substate. When the Carrier is instantiated by the ProceedWithCarrier service, the carrier shall be instantiated in the ID VERIFICATION OK substate. Finally when the carrier is instantiated by the CancelCarrier service, the carrier will be instantiated in the ID VERIFICATION FAILED substate.

10.7.3.3.1 *ID NOT READ* — This is a substate of CARRIER ID STATUS. This state is active whenever the CarrierID has not been read by the equipment.

10.7.3.3.2 *ID VERIFICATION FAILED* — This is a substate of CARRIER ID STATUS and is active when the carrierID has failed verification by the host following the CancelCarrier service. This is a final state.

10.7.3.3.3 *ID VERIFICATION OK* — This is a substate of CARRIER ID STATUS and is active as soon as the CarrierID has been accepted. The ID is determined to be accepted by either successful verification by the equipment or the host, or by bypassing ID read because a carrier ID reader is not available and the BypassReadID variable is set to true. This is a final state.

10.7.3.3.4 *WAITING FOR HOST* — This is a substate of CARRIER ID STATUS and is active during the period of time when the CarrierID has been read by the equipment successfully or unsuccessfully and has not yet been verified by the host.

10.7.3.4 *CARRIER SLOT MAP STATUS* — This is a substate of CARRIER and indicates the current status of the carrier with respect to its slot map. It has four substates, SLOT MAP NOT READ, WAITING FOR HOST, SLOT MAP VERIFICATION FAILED, SLOT MAP VERIFICATION OK. The initial default entry substate is SLOT MAP NOT READ.

10.7.3.4.1 *SLOT MAP NOT READ* — This is a substate of CARRIER SLOT MAP STATUS and is the default entry state. It is active when the Carrier is first loaded at the equipment until the Slot Map has been read successfully by the equipment at the Substrate Port.

10.7.3.4.2 *SLOT MAP VERIFICATION FAIL* — This is a substate of CARRIER SLOT MAP STATUS and is active when the Slot Map has been read by the equipment and has failed verification by the host. This is a final state.

10.7.3.4.3 *SLOT MAP VERIFICATION OK* — This is a substate of CARRIER SLOT MAP STATUS and is active as soon as the slot map has been verified. This is a final state.

10.7.3.4.4 *WAITING FOR HOST* — This is a substate of CARRIER SLOT MAP STATUS and is active when the equipment is waiting for input from the host.

10.7.4 *Carrier State Transition Table*

10.7.4.1 Table 7 indicates the triggers and the expected behavior of the instantiated carrier object.

Table 7 Carrier State Transition Definition

#	Previous State	Trigger	New State	Actions	Comment
1	(no state)	A carrier is instantiated.	CARRIER	None.	No event is required for this transition
2	(no state)	<i>Normal:</i> A Bind or Carrier Notification service is received.	ID NOT READ	None.	Data required to be available for this event report: CarrierID CarrierIDStatus



#	Previous State	Trigger	New State	Actions	Comment
3	(no state)	<i>Normal:</i> A CarrierID not currently existing at the equipment is successfully read. <i>Abnormal:</i> A CarrierID is read successfully but an equipment based verification failed.	WAITING FOR HOST	None.	Data required to be available for this event report: CarrierID PortID CarrierIDStatus Normally, this transition will happen after a successful ID read if a bind service has not been issued (host based verification) or abnormally if a bind service is followed by a successful ID read and an unsuccessful equipment based verification.
4	(no state)	<i>ID Read fail or UnknownCarrierID Events:</i> ProceedWithCarrier service is received.	ID VERIFICATION OK	A carrier is instantiated having the CarrierID provided by the Proceed WithCarrier service.	Data required to be available for this event report: CarrierID CarrierIDStatus This transition can happen only if a bind service has not been received.
5	(no state)	<i>ID Read fail or UnknownCarrierID Events:</i> A CancelCarrier service is received.	ID VERIFICATION FAIL	A carrier is instantiated having the CarrierID provided by the Cancel Carrier service.	Data required to be available for this event report: CarrierID CarrierIDStatus This transition can happen only if a bind service has not been received.
6	ID NOT READ	<i>Normal:</i> CarrierID is read successfully and the equipment has verified the carrierID successfully. <i>Abnormal:</i> The carrier was instantiated via a CarrierNotification service and upon carrier placement the equipment has sent a CarrierID Read Fail Event or UnknownCarrierID Event. Subsequently the host has issued a ProceedWithCarrier service. The ProceedWithCarrier service must provide the PortID parameter as well as the CarrierID parameter in order to unambiguously identify the physical carrier.	ID VERIFICATION OK	None.	Data required to be available for this event report: PortID CarrierID CarrierIDStatus
7	ID NOT READ	CarrierID is read unsuccessfully.	WAITING FOR HOST	None.	Data required to be available for this event report: PortID CarrierID CarrierIDStatus



#	Previous State	Trigger	New State	Actions	Comment
8	WAITING FOR HOST	A ProceedWithCarrier service is received.	ID VERIFICATION OK	None.	Data required to be available for this event report: PortID CarrierID CarrierIDStatus
9	WAITING FOR HOST	A CancelCarrier service is received.	ID VERIFICATION FAIL	None.	Data required to be available for this event report: PortID CarrierID CarrierIDStatus
10	ID NOT READ	BypassReadID variable is set to FALSE, and a carrier is received when the ID reader is not in service or not installed.	WAITING FOR HOST	Wait for ProceedWithCarrier.	Data required to be available for this event report: PortID CarrierID CarrierIDStatus
11	ID NOT READ	BypassReadID variable is set to TRUE, and a carrier is received when the id reader is not in service or not installed.	ID VERIFICATION OK	None.	Data required to be available for this event report: PortID CarrierID CarrierIDStatus
12	(no state)	A carrier is instantiated.	SLOT MAP NOT READ	None.	No event is required for this transition.
13	SLOT MAP NOT READ	Slot Map is read and verified successfully by the equipment.	SLOT MAP VERIFICATION OK	None.	Data required to be available for this event report: PortID (if valid) CarrierID LocationID CarrierAccessingStatus SlotMapStatus
14	SLOT MAP NOT READ	<i>Normal host based verification:</i> Slot Map is read successfully and the equipment is waiting for host verification. <i>Equipment based verification fail:</i> Slot Map is read successfully but equipment based verification has failed. <i>Slot map read fail:</i> Slot Map cannot be read. <i>Abnormal substrate position within the carrier:</i> The Slot Map read has indicated an abnormal substrate position.	WAITING FOR HOST	Save new slot map in the SlotMap attribute.	Data required to be available for this event report: PortID (if valid) CarrierID LocationID SlotMap (if valid) Reason SlotMapStatus
15	WAITING FOR HOST	A ProceedWithCarrier service is received.	SLOT MAP VERIFICATION OK	Proceed with the carrier as instructed.	Data required to be available for this event report: PortID (if valid) CarrierID LocationID SlotMapStatus



#	Previous State	Trigger	New State	Actions	Comment
16	WAITING FOR HOST	A CancelCarrier service is received.	SLOT MAP VERIFICATION FAIL	Prepare the carrier for Unload.	Data required to be available for this event report: PortID (if valid) CarrierID LocationID CarrierAccessingStatus SlotMapStatus
17	(no state)	A carrier object is instantiated.	NOT ACCESSED	None.	No event is required for this transition
18	NOT ACCESSED	The equipment starts accessing the carrier.	IN ACCESS	None.	Data required to be available for this event report: CarrierID CarrierAccessingStatus
19	IN ACCESS	The equipment finishes accessing the carrier normally.	CARRIER COMPLETE	None.	Data required to be available for this event report: CarrierID CarrierAccessingStatus
20	IN ACCESS	The equipment finishes accessing the carrier abnormally.	CARRIER STOPPED	None.	Data required to be available for this event report: CarrierID CarrierAccessingStatus
21	CARRIER	<i>Normal:</i> The carrier is unloaded from the equipment. <i>Abnormal by service:</i> CancelBind or CancelCarrierNotification service is received prior to the carrier load. <i>Abnormal by equipment:</i> An equipment based verification fails and the equipment performs a self-initiated CancelBind service.	(no state)	The equipment destroys the instance of this carrier object.	Data required to be available for this event report: CarrierID

#1 Only one collection event report is required when entering the Carrier State Model (instantiating a carrier object). This event report shall include the entry state of the all the substates of Carrier State Model, (including CARRIER ID STATUS substate and the CARRIER SLOT MAP STATUS substate).

10.7.5 Slot Map Read Details

10.7.5.1 The Slot Map shall be read on all production equipment prior to removal of substrates from the carrier.

10.7.6 *Carrier Read Failure* — A carrier read failure occurs when the carrier ID reader is present, in service, and reports that it is unable to read the ID of a carrier. This represents a transient random failure rather than a steady condition.

10.7.7 *Bypass Read ID* — A carrier ID reader may be unavailable: either out of service, not installed, or otherwise malfunctioning and unable to execute a read operation. This represents a steady condition that often is known in advance. The equipment shall provide a user-configurable variable BypassReadID used to bypass verification of the carrier ID when the carrier ID reader is unavailable or not installed and the loadport is ASSOCIATED. BypassReadID is not used to bypass the carrier ID reader. In this case, the carrier object is instantiated in the ID NOT READ state, and when the carrier is received, the state model transitions to either WAITING FOR HOST or ID VERIFICATION OK, depending upon whether BypassReadID is FALSE (the default value) or TRUE. When TRUE, then the Carrier ID received in the Bind is used automatically. Otherwise, the carrier transitions to



WAITING FOR HOST and waits for the host to send a ProceedWithCarrier. The ID used will be the ID included with the ProceedWithCarrier.

11 Access Mode

11.1 Access Mode State Model

11.1.1 The Access Mode State Model defines the host view of equipment access mode, as well as the host interactions with the equipment necessary to switch the access mode. Each Load Port has its own Access Mode State Model. There are two access mode states: MANUAL and AUTO. These are defined in ¶ 11.3.3.

11.1.2 The access mode for a load port may be switched at anytime by the host or the operator, except when the Load Port Reservation State Model for that Load Port is in the RESERVED state or during carrier transfer. Carrier transfer boundaries, for determining when access mode may be changed, are designated by Table 8, Carrier Transfer Boundaries.

Table 8 Carrier Transfer Boundaries

<i>Transfer Type</i>	<i>Transfer Method</i>	<i>Starting Boundary</i>	<i>Ending Boundary</i>
LOAD	MANUAL	This starting boundary is specified by the user. Known examples of the starting boundary include but are not limited to; the presence sensor detecting a carrier, a load port door opening, input to the equipment by the operator through a switch at the load port or the equipment console.	This ending boundary is specified by the user. Known examples of the ending boundary include but are not limited to; a preset configurable time following presence and placement sensor detecting a carrier, a load port door closing, or input to the equipment by the operator through a switch at the load port or the equipment console or a service message.
	AUTO	The PIO signal 'READY' is active for load (see SEMI E84).	PIO signals a transfer complete signal 'COMPT' (see SEMI E84).
UNLOAD	MANUAL	This starting boundary is specified by the user. Examples of the starting boundary include but are not limited to presence and placement sensor no longer detecting a carrier, a load port door opening, or input to the equipment by the operator through a switch at the load port or the equipment console or a service message.	This ending boundary is specified by the user. Examples of the ending boundary include but are not limited to a preset configurable time following presence and placement sensor no longer detecting a carrier, a load port door closing, or input to the equipment by the operator through a switch at the load port or the equipment console, or a service message.
	AUTO	The PIO signal 'READY' is active for unload (see SEMI E84).	PIO signals a transfer complete signal 'COMPT' (see SEMI E84).

11.2 Manual Carrier Transfer Confirmation Trigger

11.2.1 For a manual transfer completion confirmation, the production equipment supplier must implement a software or hardware mechanism for an operator to inform the equipment that the carrier transfer is complete.

11.3 Access Mode Initial Value

11.3.1 Also, when equipment re-initialization occurs, the access mode(s) must be remembered, and used as the initial value when initializing. Since the access mode is remembered through re-initializations, the initial value that is used the very first time the software is ever loaded is not important. The equipment supplier is free to set this default value.



11.3.2 Access Mode State Model Diagram

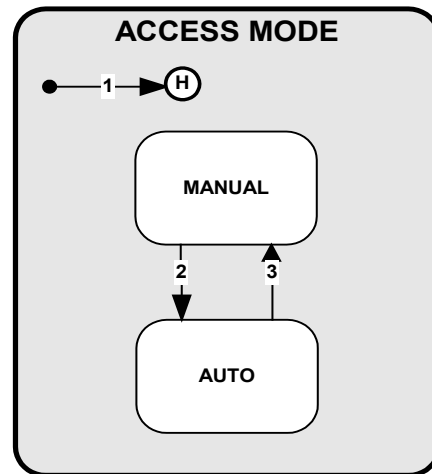


Figure 3
Access Mode State Model Diagram

11.3.3 Access Mode State Definitions

11.3.3.1 *ACCESS MODE* — The parent state for the MANUAL and AUTO substates.

11.3.3.2 *MANUAL* — A sub-state of ACCESS MODE. When the production equipment or specified load ports are in this mode, only manual (nonAMHS) carrier transfers are allowed. The production equipment may generate an alarm if an automated (AMHS) transfer is attempted, but this capability is not required. If a ChangeAccess service with the value of MANUAL is received in this state, the equipment shall accept the service and no event is sent for this action.

11.3.3.3 *AUTO* — A sub-state of ACCESS MODE. When the production equipment or specified load ports are in this mode, only automated (AMHS) carrier transfers are allowed in normal operation. The production equipment shall have the capability of generating an AccessModeViolation alarm if a manual transfer is attempted. If a ChangeAccess service with the value of AUTO is received in this state, the equipment shall accept the service and no event is sent for this action.

11.3.3.3.1 The passive equipment shall behave as follows if a manual transfer occurs in AUTO mode:

11.3.3.3.1.1 If an operator removes a carrier from a load port in access mode AUTO and transfer state READY TO UNLOAD, the equipment shall raise an AccessModeViolation alarm. After the load port transfer state finally transitioned to the READY TO LOAD state the AccessModeViolation alarm shall be cleared automatically. The load port access mode shall remain in AUTO.

11.3.3.3.1.2 If an operator places a carrier on a load port in access mode AUTO and transfer state READY TO LOAD the equipment shall raise an AccessModeViolation alarm. The equipment shall treat the transfer as incomplete but provide means for the operator to continue or cancel the manual carrier delivery (see ¶ 11.3.3.3.1.2.2 for restrictions on continuing).

11.3.3.3.1.2.1 Removing the carrier shall be treated as the cancellation of the manual carrier delivery. The load port shall transition to READY TO LOAD and the AccessModeViolation alarm shall be cleared automatically. The load port access mode shall remain in AUTO.

11.3.3.3.1.2.2 If the operator selects the continue option, the equipment shall treat the transfer as normally completed. The AccessModeViolation alarm shall be cleared automatically. Some IC makers have a policy against accepting a carrier manually placed onto a load port in access mode AUTO. Therefore, in order to prevent the operator who placed the carrier from continuing the manual carrier delivery, the equipment shall provide a configuration to disable the continue option.



11.3.4 Access Mode State Transition Table

11.3.4.1 Table 9 defines the transitions for the Access Mode State Model.

Table 9 Access Mode State Transition Definitions

#	Previous State	Trigger	New state	Actions	Comments
1	(no state)	System restart.	MANUAL or AUTO (History)	The access mode returns to the mode it was previous to the system reset.	Data required to be available for this event report: PortID AccessMode
2	MANUAL	The host or operator has executed a ChangeAccess service with the value of AUTO. This trigger can happen at anytime, except during a carrier transfer or if the load port is RESERVED.	AUTO		The operator may also trigger this transaction from the production equipment console. Data required to be available for this event report: PortID AccessMode
3	AUTO	The host or operator has executed a ChangeAccess service with the value of MANUAL. This trigger can happen at anytime, except during carrier transfer or if the load port is RESERVED.	MANUAL		The operator may also trigger this transaction from the production equipment console or a manual switch at the load port. Data required to be available for this event report: PortID AccessMode

12 Reservation State Model

12.1 The purpose of the Reservation State Model is to define the host view of future activity at a specific load port.

12.1.1 In the Reservation State Model, the ReserveAtPort and CancelReservationAtPort services enable the following items:

1. They enable the host to inform the equipment of a future carrier delivery without specifying the carrier ID and at the same time allow host based verification. (Equipment based verification is enabled via the Load Port/Carrier Association State Model, the Bind service, and the Carrier Notification service detailed in § 13, ¶¶ 15.4.2 and 15.4.11 of SEMI E87.)
2. They enable the equipment to send a state change event to the host if the operator (either local or remote) informs the equipment of a future carrier delivery to a port without specifying the carrier ID. Thus the host knows that the operator expects to use that port for something the host did not request for AMHS based delivery.
3. They enable internal buffer equipment to inform the host that it is physically initiating a carrier out operation (this carrier has a known or specified ID) and that no AMHS delivery should be scheduled.
4. The Bind and CancelBind services also trigger changes in the Load Port Reservation State Model. If the Load Port Reservation state model is in the NOT RESERVED state, the Bind service triggers a transition to the RESERVED state. If the Load Port Reservation is in the RESERVED State, the CancelBind service triggers a transition to NOT RESERVED.

12.1.2 For internal buffer equipment, the Reservation State Model, the ReserveAtPort service, the CancelReservationAtPort service, and all other associated functionality are necessary for fundamental compliance to this Standard.

12.1.3 For fixed buffer equipment, the Reservation State Model, the ReserveAtPort service, the CancelReservationAtPort service, and all other associated functionality is a user option and not necessary for fundamental compliance.



12.1.4 For equipment implementing the reservation state model, the equipment shall provide a load port reservation state model for each load port.

12.2 Reservation Visible Signal

12.2.1 When a port reservation has taken place, the equipment shall display a visible signal indicating that the designated load port is in the Reserved State. Examples of visible signals for the associated load port are: Blinking LEDs, flags, color indicators, or other methods that allow easy recognition that the load port is reserved; proximity to or location on the load port is recommended. The visible signal shall remain present as long as the load port state remains RESERVED. When the state changes to NOT RESERVED the visible indicator shall cease. This capability is not required for fundamental compliance to CMS.

12.3 Reservation State Model Diagram

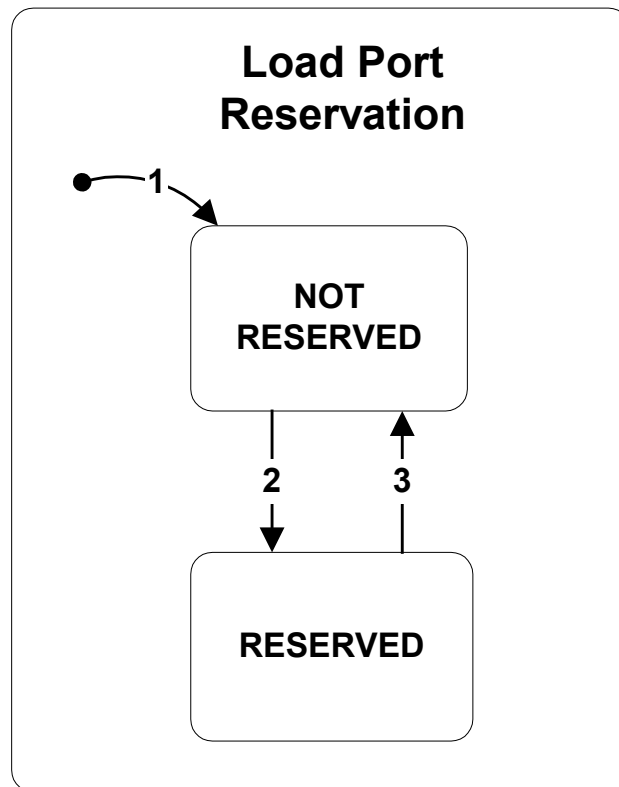


Figure 4
Reservation State Model Diagram

12.4 Load Port Reservation State Definitions

12.4.1 **LOAD PORT RESERVATION** — The super state of the substates NOT RESERVED and RESERVED.

12.4.2 **NOT RESERVED** — A substate of LOAD PORT RESERVATION, this state is active when there is no reservation existing at the load port.

12.4.3 **RESERVED** — A substate of LOADPORT RESERVATION, this state is active when there is a reservation for future activity at the load port. When in this state, the access mode for a load port may not be changed.



12.5 Load Port Reservation State Transition Table

Table 10 Load Port Reservation State Transition Table

#	Previous State	Trigger	New State	Actions	Comments
1	(no state)	System reset.	NOT RESERVED		No event report is required for this transition.
2	NOT RESERVED	<i>Service:</i> If reserved by service, the host or operator sends a ReserveAtPort or a Bind service to the production equipment. <i>CarrierOut:</i> This happens when the equipment physically initiates a CarrierOut operation.	RESERVED	If the user has configured the equipment to use the reservation visible signal indicator, it is activated for this load port.	Data required to be available for this event report: PortID LoadPortReservationState CarrierID may be included when a carrier out or a bind service triggers this transition.
3	RESERVED	<i>Service:</i> If a reservation is cancelled by service, the host or operator sends a CancelBind or a CancelReservationAtPort. <i>Carrier arrival:</i> A carrier arrives at the reserved port.	NOT RESERVED	If the user has configured the equipment to use the reservation visible signal, the indicator is deactivated for this load port.	Data required to be available for this event report: PortID LoadPortReservationState

12.6 Relation of Reservation to Association

12.6.1 The following figure indicates the relationship of Association to Reservation.

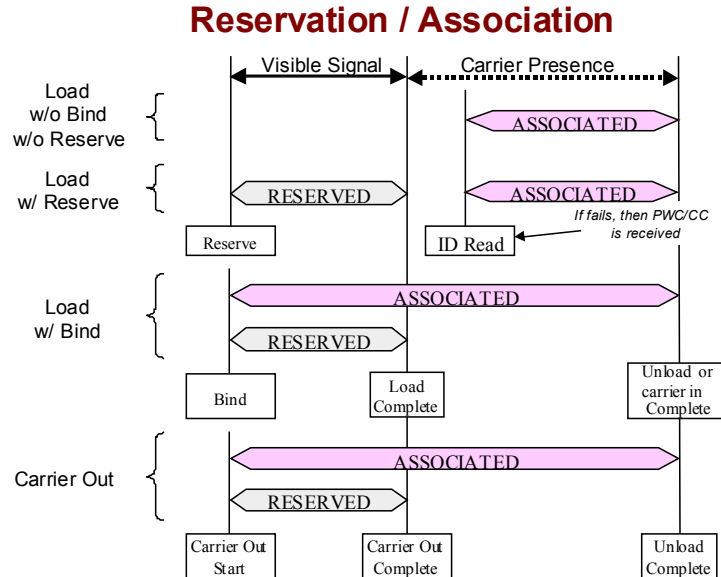


Figure 5
Relation of Reservation to Association

13 Load Port/Carrier Association State Model

13.1 The purpose of the Carrier Association State Model is to define the host view of carrier to load port association of the production equipment, as well as the host interactions with the production equipment necessary to associate a carrier to load port, and to perform equipment based carrier verification. Each load port shall maintain an



independent instance of the Carrier Association State Model. Each instance of this state model must not influence the state of the same state model for a different load port.

13.1.1 This state model provides the ability to perform CarrierID verification with two different methods. If the CarrierID is provided before the equipment reads the CarrierID, the CarrierID that becomes associated with the load port can be used later for equipment based carrier verification. If the association happens by CarrierID read (not by a service execution), then the production equipment shall report the CarrierID information in a data collection event.

13.2 Load Port/Carrier Association State Model Diagram

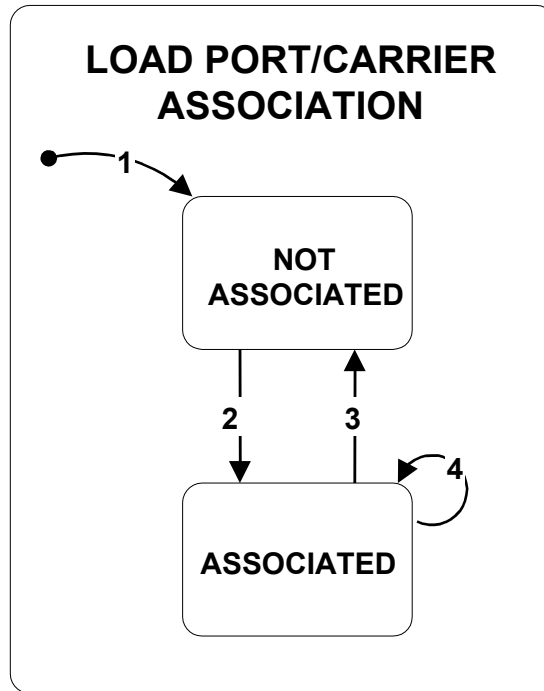


Figure 6
Load Port/Carrier Association State Model Diagram

13.2.1 Load Port/Carrier Association State Definitions

13.2.1.1 **LOAD PORT/CARRIER ASSOCIATION** — The parent state of the NOT ASSOCIATED and ASSOCIATED substates.

13.2.1.2 **NOT ASSOCIATED** — A substate of LOAD PORT/CARRIER ASSOCIATION. There is no carrier association present for this load port.

13.2.1.3 **ASSOCIATED** — A substate of LOAD PORT/CARRIER ASSOCIATION. A CarrierID has been associated with this load port. The load port is not available for a new carrier association.

13.2.2 Load Port/Carrier Association State Transition Table

13.2.2.1 Table 11 defines the transitions of the Load Port/Carrier Association State Model.

Table 11 Load Port/Carrier Association State Transition Definitions

#	Previous State	Trigger	New State	Actions	Comments
1	(no state)	System reset.	NOT ASSOCIATED		No event report is required for this transition



#	Previous State	Trigger	New State	Actions	Comments
2	NOT ASSOCIATED	<p><i>Service Normal:</i> The host sends a Bind service to the equipment when the port is unoccupied.</p> <p><i>Service Abnormal:</i> A carrier is instantiated at the load port because the host sends either a ProceedWithCarrier or CancelCarrier service in response to one of the following events from the equipment: CarrierID Read Fail Event UnknownCarrierID</p> <p><i>CarrierID Read:</i> A CarrierID not currently existing at the equipment is successfully read.</p> <p><i>Known Carrier:</i> A known carrier to the equipment is being moved onto the load port from an internal location. This happens when the CarrierOut service is initiated.</p>	ASSOCIATED		<p>Once the CarrierID to load port association is complete, the load port is not available for association until the state returns to NOT ASSOCIATED again.</p> <p>Data required to be available for this event report: PortID CarrierID PortAssociationState</p>
3	ASSOCIATED	<p><i>Service:</i> If cancellation of a load port association is required; then, this can be accomplished by sending a CancelBind service to the production equipment before the carrier arrives to the loadport or before a transfer sequence has started.</p> <p><i>Carrier Unload:</i> An association cancellation may also be performed by removing the carrier from the load port or by the production equipment moving a carrier to an internal buffer position.</p>	NOT ASSOCIATED		<p>A carrier unload, may happen before or after processing occurs. The load port is available for another association once the carrier is removed.</p> <p>Data required to be available for this event report: PortID PortAssociationState</p>
4	ASSOCIATED	<p>Equipment based carrier verification fails, and the carrier assumes the ID value from the carrier that is on the load port.</p> <p><i>Internal buffer:</i> A carrier is unloaded and a queued CarrierOut service starts.</p>	ASSOCIATED	<p>The existing carrierID that was associated by a Bind service is unassociated by the equipment and the new carrierID is now associated to the Load Port. The equipment shall delay further action until receiving either a CancelCarrier or a ProceedWithCarrier command from the host.</p>	<p>This transition only occurs when the Bind command has been used.</p> <p>Data required to be available for this event report: PortID CarrierID PortAssociationState</p>



14 Verification

14.1 Verification is the operation of comparing an actual value with an expected value. Verification may be performed by either the host or the equipment.

14.1.1 There are two values that are defined by Carrier Management that require verification: CarrierID and Carrier Slot Map.

14.1.2 If the host provides the expected value before the actual value is obtained by the equipment, then the equipment shall perform the verification. The host can provide the expected value(s) for CarrierID and Carrier Slot Map by using the Bind and CarrierNotification services. The host can also provide the expected value for Carrier Slot Map by using the ProceedWithCarrier service.

14.1.3 If the host does not provide the expected value before the actual value is read, then the equipment shall provide to the host the information necessary for host based verification.

14.2 CarrierID Verification

14.2.1 Table 12 defines the methods for verifying the CarrierID.

Table 12 Carrier ID Verification Methods

<i>Verification Method Desired</i>	<i>Host Actions before Load</i>	<i>Equipment Action When Carrier Is Loaded</i>	<i>Host Actions after Load</i>
Production Equipment Based	<i>Bind Service:</i> The host executes the Bind service to associate a load port and a CarrierID.	<i>Bind Service:</i> The production equipment reads the Carrier ID from the carrier, compares it to the CarrierID supplied with the Bind service.	
		<i>Verification Passed:</i> Transition 6 of the Carrier State Model occurs. The production equipment proceeds with processing.	<i>Verification Passed:</i> None.
		<i>Verification Failed:</i> The equipment initiates by itself a CancelBind and destroys the carrier created with the “Bind” service and instantiates a new carrier with the newly read CarrierID. The carrier shall not be opened or moved to an internal buffer in the production equipment until and unless the ProceedWithCarrier service is received from the host.	<i>Verification Failed:</i> The host uses either the CancelCarrier service to force the carrier to the unload position, or indicates to the production equipment that it may proceed with the unexpected carrier, by sending the ProceedWithCarrier service. In both cases the carrierID specified in the service is equal to the one determined by the carrierID read.
	<i>Carrier Notification Service:</i> The host executes the CarrierNotification service to inform the equipment of the future arrival of a carrier to an unspecified port.	<i>Carrier Notification Service:</i> The production equipment reads the Carrier ID from the carrier, compares it to the CarrierID supplied with a CarrierNotification service.	
		<i>Verification Passed:</i> Transition 6 of the Carrier State Model occurs. The production equipment proceeds with processing.	<i>Verification Passed:</i> None.



<i>Verification Method Desired</i>	<i>Host Actions before Load</i>	<i>Equipment Action When Carrier Is Loaded</i>	<i>Host Actions after Load</i>
		<i>Verification Failed:</i> Not Applicable; because there is no association between a load port and a carrier, equipment based verification failure is not possible. If a carrier that has not been instantiated arrives at a load port, the equipment shall consider this as host based verification.	<i>Verification Failed:</i> Not Applicable, because there is no association between a load port and a carrier, equipment based verification failed is not possible. If a carrier that has not been instantiated arrives at a load port, the equipment shall consider this as host based verification. The host will respond with either a ProceedWithCarrier or a CancelCarrier Service (see Host Based verification method).
Host Based	None required, the host may issue a ReserveAtPort service.	The production equipment reads the CarrierID and reports it to the host in an event report. Following CarrierID read the equipment initiates Transition 3 of the Carrier State Model and a carrier object with the CarrierID equal to the one determined by the CarrierID read is instantiated. The carrier shall not be opened or moved to an internal buffer in the production equipment until and unless the ProceedWithCarrier service is received from the host.	<i>Verification Passed:</i> The host sends a ProceedWithCarrier service indicating the verification passed.
			<i>Verification Failed:</i> The host uses the CancelCarrier or CancelCarrierAtPort service to force the carrier to the unload position.

14.3 Slot Map Verification

14.3.1 Table 13 defines the methods for verification of the Carrier Slot Map. Some user's factory operations may not require strict management of the slot map. In this case the user may use the host based verification method.

Table 13 Slot Map Verification Methods

<i>Verification Method Desired</i>	<i>Host Actions Before Verification</i>	<i>Equipment Action When Carrier is Loaded</i>	<i>Host Actions After Load</i>
Production Equipment Based	The host provides a Slot Map with the Bind service or the ProceedWithCarrier service.	The production equipment checks the carrier slot map and compares it to the slot map supplied by the host. Either transition 13 or 14 of the Carrier State Model occurs.	<i>Verification Passed:</i> None, the production equipment proceeds with the carrier. <i>Verification Failed:</i> If the host decides to cancel processing, the host issues the CancelCarrier service. If the host decides to continue processing, the host issues the ProceedWithCarrier service.
Host Based	None.	The production equipment checks the carrier slot map and reports it to the host in an event report. The host has the responsibility for verifying the slot map.	<i>Verification Passed:</i> The host sends a ProceedWithCarrier indicating the verification passed. <i>Verification Failed:</i> If the host decides to cancel processing, the host issues the CancelCarrier service. If the host decides to continue processing, the host issues the ProceedWithCarrier service.

14.4 This table clarifies the relation of the reservation and verification to the related services.



Table 14 Reservation and Verification Relation to Service

	Reser- vation	CarrierID Verification	Carrier SlotMap Verification	Service Used	Information Provided with Service		
					Port ID	Carrier ID	Carrier SlotMap
1	Yes	Equipment based	Equipment based	Bind	Yes	Yes	Yes
2	Yes	Equipment based	Host based	Bind	Yes	Yes	No
3	Yes	Host based	Host based	ReserveAtPort	Yes	No	No
				ProceedWithCarrier (following ID read and host verification).	No	Yes	No
4	Yes	Host based	Equipment based	ReserveAtPort	Yes	No	No
				ProceedWithCarrier to provide slotmap (following ID read and host verification).	No	Yes	Yes
5	No	Equipment based	Equipment based	CarrierNotification	No	Yes	Yes
6	No	Equipment based	Host based	CarrierNotification	No	Yes	No
7	No	Host based	Equipment based	ProceedWithCarrier to provide slotmap (following ID read and host verification).	No	Yes	Yes
8	No	Host based	Host based	ProceedWithCarrier (following ID read and host verification).	No	Yes	No

15 Carrier Release Control

15.1 For both fixed buffer and internal buffer equipment, where Carrier Read/Write technology is used, the carrier must remain at the write position where the tag may be accurately written on until the Host has completed all of its read and write operations. For this purpose, a variable that affects the equipment releasing a carrier is defined.

15.2 *Carrier Hold Trigger* — Both fixed buffer equipment and internal buffer equipment shall allow the user to select a trigger to release the carrier when reading/writing is complete. Carrier release does not mean the equipment must move the carrier from the location it currently occupies, only that it is permissible to do so.

15.2.1 *CarrierHold Trigger Set to Host Release* — If the Carrier Hold trigger is set to Host Release, both fixed buffer and internal buffer equipment shall hold the carrier at the write position until the CarrierRelease service is received.

15.2.2 *CarrierHold Trigger Set to Equipment Release* — If the Carrier Hold trigger is set to Equipment Release, the equipment shall release the carrier based on the Carrier Object state model transition to CARRIER COMPLETE or CARRIER STOPPED.

15.3 For fixed load port equipment in AUTO access mode, it may be desirable to leave a completed carrier clamped, locked, or at the docked position until the AMHS arrives to pick it up. This reduces the chance that an operator may remove it. For this purpose, a variable that affects UnClamp Control is provided to allow the user to select the desired behavior. When the equipment finishes with a carrier, the Carrier State transitions from ACCESSING to CARRIER COMPLETE (normal) or CARRIER STOPPED (abnormal) and the equipment sends either the CarrierComplete event (normal) or the CarrierStopped event (abnormal). If the carrier has a door, the door shall be closed by this point.

15.4 Equipment with load ports that have clamp mechanisms shall allow the user to select a trigger to unclamp the carrier based on AMHS arrival at the equipment. If the access mode is MANUAL, the unclamp control trigger has no effect.

15.4.1 *UnclampControl Trigger Set to CARRIERCOMPLETE/CARRIERSTOPPED Triggered Unclamp* — The equipment automatically unclamps the carrier when the Carrier Status transitions to CARRIERCOMPLETE or CARRIERSTOPPED.



15.4.2 *UnclampControl Trigger Set to AMHS Triggered Unclamp* — The equipment behavior depends upon the Load Port Access State. If the Loadport Access State is AUTO, the carrier remains clamped, locked, or at the docked position (it will remain at the docked position only if that is the only position on which the carrier can be clamped) until AMHS has arrived. The AMHS arrives and begins a PIO unload sequence. The carrier must be at or moved to the pickup position and any additional clamp mechanisms must be released by the appropriate point of the sequence.

NOTE 2: It may be necessary to adjust timeouts for the AMHS to allow a few more seconds to move the carrier into the pickup position.

16 Services

16.1 The purpose of this section is to define the message services required to support CMS functionality.

16.1.1 This message service definition has four parts:

- A service description table.
- A service parameter table.
- A service parameter value table that specifies the type and range of the parameters.
- A service state mapping table that defines the states in which each service is valid.

16.2 Service Message Description

16.2.1 There are two types of services:

- An initial message and response between the service user and the service provider.
- A notification message from the service provider to the service user that does not require a response.

16.2.2 The 'TYPE' column in the following table is used to indicate whether the service consists of a request/response message pair, 'R', or a single notification message, 'N'.

Table 15 Service Message Description

<i>Service Name</i>	<i>Type</i>	<i>Description</i>
Bind	R	This service shall associate a CarrierID to a load port and shall cause the load port to transition to the RESERVED state.
CancelAllCarrierOut	R	This service shall cause all CarrierOut services to be removed from the queue.
CancelBind	R	This service cancels a CarrierID to load port association and shall cause the load port to transition to the NOT RESERVED state.
CancelCarrier	R	This service shall Cancel the current carrier related action, and the production equipment shall return the carrier to the unload position of the load port, or an internal buffer position, depending on the carrier's position in the production equipment.
CancelCarrierAtPort	R	This service shall Cancel the current carrier related action, and the production equipment shall return the carrier to the unload position of the load port.
CancelCarrierNotification	R	This service shall cause the equipment to destroy a carrier object instantiated through a prior CarrierNotification.
CancelCarrierOut	R	This service shall cause a specified CarrierOut service to be removed from the queue by the production equipment.
CancelReservationAtPort	R	This service shall cause the equipment to remove the reservation at the specified Port and to deactivate the visible signal.
CarrierIn	R	This service shall cause a carrier to be moved from a load port to an internal buffer location. Used in anomaly situations.
CarrierNotification	R	This service shall cause the equipment to instantiate a carrier object.
CarrierOut	R	This service shall cause a carrier to be moved from the internal buffer to a load port. This service can be queued by the production equipment.



<i>Service Name</i>	<i>Type</i>	<i>Description</i>
CarrierReCreate	R	This service shall cause the carrier object (and consequently, associated state models of the object) specified by the service to be recreated. This service shall be accepted only if the load port is in the 'Ready to Unload' state.
CarrierRelease	R	Release the carrier from Carrier Hold.
CarrierTagReadData	R	Read data from carrier ID tag.
CarrierTagWriteData	R	Write data to the carrier ID tag.
ChangeAccess	R	This service shall change the access mode of the specified Ports at the production equipment. If the equipment is unable to change one or more of the specified port(s) to the specified Access Mode, then the equipment shall accept the command (with appropriate response acknowledgement), and shall change only the Access Mode of those Port(s) allowed by the equipment, supplying host with an indication that not all ports were successfully changed.
ChangeServiceStatus	R	This service shall change the transfer status of a specified load port at the production equipment.
ProceedWithCarrier	R	This service shall instruct the production equipment to proceed with using the specified carrier.
ReserveAtPort	R	This service shall cause the equipment to reserve the specified Port and activate a visible signal. This service is a Transfer boundary.

16.3 Service Message Parameter Definition

16.3.1 The following is a list of required parameters used in conjunction with service messages.

Table 16 Service Message Parameter Definition

<i>Parameter Name</i>	<i>Form</i>	<i>Description</i>
AccessMode	Enumerated AUTO, MANUAL.	The desired access mode of the ports specified.
AttributeData	Could be several different data types.	The data value associated with AttributeID.
AttributeID	Text 1–40 characters.	Identifier of the object attribute in the PropertiesList.
CarrierID	Text Conforms to ObjID as defined in SEMI E39.	Identifier of a carrier.



<i>Parameter Name</i>	<i>Form</i>	<i>Description</i>
CMAcknowledge	Enumerated: Acknowledge, command has been performed Invalid command Cannot perform now Invalid data or argument Acknowledge, request will be performed with completion signaled later by an event Rejected, invalid state	Acknowledgement of request. Some services are commanding a certain task to be performed. This task is only completed if the expected end-condition is reached or has failed. A number of services only have effect on a 'logical' level (e.g., Bind, CancelReservationAtPort). Those services in general can be acknowledged right away after having performed the task. Other services that include triggering of physical movements (e.g., CarrierOut, CancelCarrier) most likely will be interpreted as 'request action to be initiated' rather than 'do action'. The equipment will reply in those cases the command "is going to be performed". This alleviates transaction timeouts for these services that may take a long time to perform. It is however up to the supplier to decide if this is applicable. The completion of the task initiated by the services commanding some task to be performed (either acknowledged or going to be performed) must result in either a state transition or other action that generates a collection event upon normal/abnormal completion.
CMStatus	A structure consisting of CMAcknowledge and Status.	Return information for a service.
Data	Text.	User data.
DataSeg	Protocol-specific.	Indicates specific section of data to read or write.
DataSize	Unsigned integer.	Indicates the number of bytes of data to read or write.



<i>Parameter Name</i>	<i>Form</i>	<i>Description</i>
ErrorCode	<p>Enumerated:</p> <p><i>Valid for all services listed below</i></p> <p>Unsupported option [service] requested</p> <p>Command not valid for current state</p> <p>Insufficient parameters specified</p> <p>Parameters improperly specified</p> <p><i>Bind</i></p> <p>Load port does not exist</p> <p>Load port already in use</p> <p>Object identifier in use, Duplicate CarrierID</p> <p>Invalid attribute value</p> <p>Unknown attribute name</p> <p><i>CancelAllCarrierOut</i></p> <p>(none)</p> <p><i>CancelBind</i></p> <p>Load port does not exist</p> <p>Unknown object instance – Unknown CarrierID</p> <p><i>CancelCarrier</i></p> <p>Load port does not exist</p> <p>Unknown object instance – Unknown CarrierID</p> <p>Missing Carrier</p> <p><i>CancelCarrierAtPort</i></p> <p>Load port does not exist</p> <p>Missing Carrier</p> <p><i>CancelCarrierNotification</i></p> <p>Unknown object instance – Unknown CarrierID</p> <p><i>CancelCarrierOut</i></p> <p>Unknown object instance – Unknown CarrierID</p> <p><i>CancelReservationAtPort</i></p> <p>Load port does not exist</p> <p><i>CarrierIn</i></p> <p>Unknown object instance – Unknown CarrierID</p> <p><i>CarrierNotification</i></p> <p>Object identifier in use, Duplicate CarrierID</p> <p>Invalid attribute value</p> <p>Unknown attribute name</p> <p><i>CarrierOut</i></p> <p>Load port does not exist</p> <p>Unknown object instance – Unknown CarrierID</p> <p><i>CarrierReCreate</i></p> <p>Unknown object instance – Unknown CarrierID</p> <p>Invalid attribute value</p> <p>Unknown attribute name</p> <p>Command not valid for current state</p> <p><i>ChangeAccess</i></p> <p>Load port does not exist</p> <p><i>ChangeServiceStatus</i></p> <p>Load port does not exist</p> <p><i>ProceedWithCarrier</i></p> <p>Load port does not exist</p> <p>Unknown object instance – Unknown CarrierID</p> <p>Invalid attribute value</p> <p>Unknown attribute name</p> <p><i>ReserveAtPort</i></p> <p>Load port does not exist</p> <p>Load port already in use</p>	Contains the code for the specific error found.



<i>Parameter Name</i>	<i>Form</i>	<i>Description</i>
ErrorText	Text	Text in support of the error code.
PortID	Integer 1 to n.	ID number of a load port. The PortID number should be the same as the load port number.
PortList	List 1 to n items.	List of n items PortID ₁ . . n PortID _n
PropertiesList	List 1 to n name/value pairs.	List of n items 1. AttributeID ₁ AttributeData ₁ . . n. AttributeID _n AttributeData _n
ServiceStatus	Enumerated: IN SERVICE, or OUT OF SERVICE.	The desired transfer service status of the specified list of load ports.
Status	A list of ErrorCode/ErrorText pairs.	Reports any errors found.

16.3.2 The “Acknowledge, request will be performed with completion signaled by a later event” response to a service, may apply to services listed in the table below. If this does apply, the supplier must document the event that signals completion. Any service not included in Table 17 shall respond with “Acknowledge, command has been performed.”

16.3.2.1 Events that may signal completion are listed in Table 17.

Table 17 Deferred Completion Events

<i>Service</i>	<i>Events that May Signal Completion</i>
CarrierOut	CarrierLocation Changed Event Load Port State Change Event (transition 9)
CarrierIn	CarrierLocation Change Event Load Port State Change Event (transition 8)
CancelCarrier	CarrierLocation Changed Event Load Port State Change Event (transition 9)
CancelCarrierAtPort	CarrierLocation Changed Event Load Port State Change Event (transition 9)
ChangeService	LoadPortTransferState Change Event (transition 2 and 3)
ChangeAccess	Load Port Access Mode State Change Event (transition 2 and 3)

16.4 Service Message Definitions

16.4.1 The following tables specify the allowable/required parameters for each service. The column marked ‘REQ/IND’ specifies which parameters are required to be supported for CMS compliance (see ¶ 7.3.4.3).

16.4.2 Bind

16.4.2.1 The Bind service is used to associate a CarrierID with a load port. The Bind can contain a PropertiesList of carrier object attributes that are supplied by the host. A carrier object is instantiated when this service is used successfully. The Bind service will be rejected if the carrier specified has already been instantiated through the Bind



or CarrierNotification service, or a CarrierID read. The Bind service also triggers a transition in the Load Port Reservation state model from NOT RESERVED to RESERVED.

Table 18 Bind Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
PortID	M	-	The PortID where a carrier is expected.
CarrierID	M	-	The expected CarrierID.
PropertiesList	C	-	A list of name value pairs providing attributes for the carrier object being instantiated with the Bind service.
CMStatus	-	M	Information concerning the result of the service.

16.4.3 *CancelAllCarrierOut*

16.4.3.1 The CancelAllCarrierOut service is sent to internal buffer production equipment to cancel all CarrierOut services in queue.

Table 19 CancelAllCarrierOut Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
CMStatus	-	M	Information concerning the result of the service.

16.4.4 *CancelBind*

16.4.4.1 The CancelBind request is used to cancel the association between a port and a CarrierID. The carrier object is destroyed when this service is used successfully. The CancelBind service also triggers a transition in the Load Port Reservation state model from RESERVED to NOT RESERVED.

Table 20 CancelBind Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
PortID	C	-	The PortID for which to cancel the load port to carrier association. Either PortID or CarrierID must be specified.
CarrierID	C	-	The CarrierID for which to cancel the load port to carrier association. Either PortID or CarrierID must be specified.
CMStatus	-	M	Information concerning the result of the service.

16.4.5 *CancelCarrier*

16.4.5.1 The CancelCarrier request is used to stop a carrier. If the carrier is at a load port, then it shall be returned to the load/unload location of the load port and made ready for unload. If the carrier is at an internal location the carrier will return to an internal buffer location. A subsequent CarrierOut request is required for the production equipment to move the carrier to the external load port. The production equipment shall reject this service if issued after substrates have been removed for processing.

Table 21 CancelCarrier Service Parameters

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
CarrierID	M	-	The CarrierID to cancel.
CMStatus	-	M	Information concerning the result of the service.



<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
PortID	C	-	The PortID where the carrier object is located. This parameter is not required if the carrier object has been previously instantiated.

16.4.6 *CancelCarrierAtPort*

16.4.6.1 The CancelCarrierAtPort service is used to prepare a carrier for removal from a specified load port. This service is not required to force any state transition for the carrier object. If any of the following conditions are true, this service request shall not complete successfully:

- The specified load port does not exist
- No carrier is on the specified load port
- Substrates have been removed for processing

If the carrier is not at the load/unload location of the load port then it shall be returned to the load/unload location of the load port and made ready for unload.

Table 22 CancelCarrierAtPort Service Parameters

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
PortID	M	-	Any carrier that exist on the load port specified shall be made ready for unloading.
CMStatus	-	M	Information concerning the result of the service.

16.4.7 *CancelCarrierNotification*

16.4.7.1 The CancelCarrierNotification is used by the host to request the equipment cancel a previous CarrierNotification service. This service shall cause the equipment to destroy the carrier object specified.

Table 23 CancelCarrierNotification Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
CarrierID	M	-	The CarrierID of the carrier object to destroy.
CMStatus	-	M	Information concerning the result of the service.

16.4.8 *CancelCarrierOut*

16.4.8.1 The CancelCarrierOut service is sent to internal buffer production equipment to cancel a queued CarrierOut.

Table 24 CancelCarrierOut Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
CarrierID	M	-	CarrierID for the CarrierOut service that is being cancelled.
CMStatus	-	M	Information concerning the result of the service.



16.4.9 CancelReservationAtPort

16.4.9.1 The CancelReservationAtPort service is sent by the host to cancel a reservation at the load port. The load port will enter the UNRESERVED State after receiving this service. A Port reserved by the physical initiation of a carrier out operation may not be cancelled by this service.

Table 25 CancelReservationAtPort Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
PortID	M	-	The Port ID to reserve.
CMStatus	-	M	Information concerning the result of the service.

16.4.10 CarrierIn

16.4.10.1 The CarrierIn service is only used to request the internal buffer equipment internalize a carrier that has been moved to the load port via a previous CarrierOut service. When using host based verification, the production equipment shall move the carrier in to the internal buffer for the first time after receiving the ProceedWithCarrier request. If the CarrierIn service is received by the production equipment without previously having received a CarrierOut service for the carrier, the service will be refused.

Table 26 CarrierIn Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
CarrierID	M	-	The CarrierID for the carrier to internalize.
CMStatus	-	M	Information concerning the result of the service.

16.4.11 CarrierNotification

16.4.11.1 The Carrier Notification service is used by the host to inform the equipment that a carrier with the ID specified will be arriving at the equipment. The load port is not specified; therefore no carrier to load port association takes place. A carrier object with the ObjID equal to the CarrierID specified in the service is instantiated. The CarrierNotification service will be rejected if the carrier specified has already been instantiated through the Bind or CarrierNotification service, or a CarrierID read.

Table 27 CarrierNotification Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
CarrierID	M	-	The CarrierID of the carrier object to instantiate.
PropertiesList	C		The PropertiesList of the carrier to instantiate.
CMStatus	-	M	Information concerning the result of the service.

16.4.12 CarrierOut

16.4.12.1 The CarrierOut service is sent to internal buffer production equipment, to request that the equipment move the specified carrier to a load port, as soon as the carrier is completed. When the CarrierOut service is started, the destination load port state becomes TRANSFER BLOCKED, and the load port's association state becomes ASSOCIATED.

16.4.12.2 CarrierOut Queuing

16.4.12.2.1 This service request can be queued by the production equipment. The production equipment is required to support a queue of n size, where n is equal to the sum of the number of internal buffer locations and the number of internal FIMS ports. The order of the queue is FIFO for each load port. If the load port is not specified in service request, the equipment chooses which load port queue to place the CarrierOut service. The queued service does not



take effect until the current substrate handling action is complete (i.e., filling, emptying of the carrier) and the load port is in the NOT ASSOCIATED state. When a CarrierOut service is queued and the production equipment load port is currently in the TRANSFER BLOCKED state, the production equipment shall keep the load port in the TRANSFER BLOCKED state. Then, after the port is cleared, the CarrierOut service shall begin.

Table 28 CarrierOut Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
CarrierID	M	-	CarrierID for the carrier to be moved out.
PortID	C	-	If omitted, the production equipment shall select an appropriate port at the time the carrier is ready to be moved.
CMStatus	-	M	Information concerning the result of the service.

16.4.13 CarrierRelease

16.4.13.1 CarrierRelease request is used to tell the equipment that the carrier is ready to be moved away from the read or write position. Equipment shall deny the request if PortID and CarrierID are mismatched.

Table 29 CarrierRelease Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
PortID	C	-	The ID for the location of the carrier. Either PortID or CarrierID must be used. For internal buffer equipment when the service is used at an internal location, only the CarrierID is required.
CarrierID	C	-	The CarrierID of the carrier. Either PortID or CarrierID must be used.
CMStatus	-	M	Information concerning the result of the service.

16.4.14 CarrierReCreate

16.4.14.1 CarrierReCreate request is used to re-create the carrier object specified by the service. This will allow a repeated introduction of the same carrier on the loadport. After the service is issued, the equipment shall treat the carrier occupying the respective loadport identically to one that was physically removed and replaced, deleting the original carrier and then re-instantiating it. If no PropertiesList is provided with the service, then the host verification scenarios for re-instantiating the carrier object shall be followed. For example, the carrier ID would be re-read (at which point Carrier State transition #3, (no state) to Waiting for Host occurs) and subsequently verified by host, followed by slot map re-read and verification by host. Alternatively, if PropertiesList is provided with this service, then the equipment shall follow the equipment based verification steps. For example, the carrier object is re-instantiated with the CarrierID (and possibly content/slot map) information provided within the CarrierReCreate Service. In this equipment based verification scenario, the equipment is responsible for verifying the contents of the carrier against the received information. If the equipment supports other SEMI Standards (i.e., SEMI E40/SEMI E90/SEMI E94), then from the perspective of those Standards, when CarrierReCreate service is received, the scenario would resemble that of a carrier being removed and a new carrier placed. The service shall be accepted only if the load port is in the 'Ready to Unload' state.

Table 30 CarrierReCreate Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
CarrierID	M	-	Carrier ID for the carrier object the service is to be performed upon.
PropertiesList	C	-	If sent by the host, then equipment based verification scenario. If not, then host based verification scenario.
CMStatus	-	M	Information concerning the result of the service



16.4.15 CarrierTagReadData

16.4.15.1 CarrierTagReadData is used to request a block of data from the carrier ID tag. Equipment shall deny the request if LocationID and CarrierID are mismatched.

Table 31 CarrierTagReadData Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
LocationID	C	-	The ID for the location of the carrier. Either LocationID or CarrierID must be used.
CarrierID	C	-	The CarrierID of the carrier. Either LocationID or CarrierID must be used.
DataSeg	C	-	Indicates a specific section of data.
DataSize	C	-	Indicates the number of bytes to read.
Data	-	C	Data from the carrier ID tag. May be NULL if no data exists for the given section.
CMStatus	-	M	Information concerning the result of the service.

16.4.16 CarrierTagWriteData

16.4.16.1 CarrierTagWriteData is used to request that a block of data be written to the carrier ID tag. Equipment shall deny the request if LocationID and CarrierID are mismatched.

Table 32 CarrierTagWriteData Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
LocationID	C	-	The ID for the location of the carrier. Either LocationID or CarrierID must be used.
CarrierID	C	-	The CarrierID of the carrier. Either LocationID or CarrierID must be used.
DataSeg	C	-	Indicates a specific section of data.
DataSize	C	-	Indicates the number of bytes to read.
Data	M	-	Data from the carrier ID tag. May be NULL if no data exists for the given section.
CMStatus	-	M	Information concerning the result of the service.

16.4.17 ChangeAccess

16.4.17.1 The ChangeAccess message requests a change of access mode for the load ports specified in the PortList.

Table 33 ChangeAccess Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
AccessMode	M	-	The new desired access mode.
PortList	M	-	The list of ports to use the new access mode.
CMStatus	-	M	Information concerning the result of the service.

16.4.18 ChangeServiceStatus

16.4.18.1 The ChangeServiceStatus service is used to request the production equipment change a load port service state.



Table 34 ChangeServiceStatus Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
PortID	M	-	PortID to designate the new service status.
ServiceStatus	M	-	The new service state.
CMStatus	-	M	Information concerning the result of the service.

16.4.19 ProceedWithCarrier

16.4.19.1 The ProceedWithCarrier service is sent by the host to indicate that the carrier operations may continue. When using host based verification it is used by the host to indicate to the production equipment that the verification of Carrier ID and/or the Carrier Slot Map is correct. For successful production equipment based verification the production equipment shall not require this message before proceeding with the carrier. For failed production equipment based verification the production equipment shall require either a CancelCarrier or ProceedWithCarrier service.

16.4.19.2 Using Table 34, for the Host based CarrierID verification case, the ProceedWithCarrier service sent by the host after the first carrier ID read is referred to as ProceedWithCarrier #1, the ProceedWithCarrier service sent after slot map read is referred to as ProceedWithCarrier #2.

Table 35 ProceedWithCarrier Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
PortID	C	-	The PortID for which processing may proceed.
CarrierID	M	-	The CarrierID for which processing may proceed.
PropertiesList	C	-	A list of name value pairs providing attributes for the carrier object.
CMStatus	-	M	Information concerning the result of the service.

16.4.20 ReserveAtPort

16.4.20.1 The ReserveAtPort service is sent by the host to indicate future activity at the load port. This allows for reserving the port but doing host based ID verification. The load port will enter the RESERVED State after receiving this service. The equipment shall move a carrier to a reserved load port.

Table 36 ReserveAtPort Service Parameter Definitions

<i>Parameter Name</i>	<i>Req/Ind</i>	<i>Rsp/Conf</i>	<i>Description</i>
PortID	M	-	The Port ID to reserve
CMStatus	-	M	Information concerning the result of the service.

17 Carrier Tag Read/Write

17.1 Some technologies allow data to be stored on a carrier ID tag where it can be subsequently read and/or modified. In this case, it is the host that specifies when this data is written and read, because the equipment has no knowledge of the contents of the data. The read operations shall be performed only when the carrier is at the read position. The write operations shall be performed only when the carrier is at the write position. NOTE: The read and write positions may be the same position. The host shall be able to both read and write whenever CarrierHold switch is set to Host Release and the carrier is at the respective read or write position. Once the host has completed all of its read and write operations for that carrier, then the host sends the CarrierRelease request to the equipment. In all cases, the CarrierAccessingStatus state shall be set to either CARRIER COMPLETE or CARRIER STOPPED before the carrier may be undocked. The CarrierRelease service informs the equipment that carrier read or carrier write is complete. For internal buffer equipment the CarrierRelease service shall allow the equipment to move the carrier away from the read or write position.



NOTE 3: The CarrierRelease service has a different purpose from the CarrierOut service. The intent of the CarrierOut service request is to move the carrier to a loadport, while the intent of the CarrierRelease service request is to inform equipment that it may move the carrier away from the read or write position. Therefore, CarrierOut may also be used with the CarrierRelease command. If CarrierHold is Host Release, then the carrier shall be kept at the write position until a CarrierRelease service request is received, regardless of when a CarrierOut is sent. If CarrierHold is set to Equipment Release, then the CarrierRelease request has no effect.

18 Additional Events

18.1 This section identifies data collection events that are not related to State transitions for variable data items. The intent of this section is to ensure certain data is available for specific events that are not related to state transitions, not to define all the additional collection events for CMS. Also, all state transitions in CMS state models are required to have associated event reports.

18.2 *Buffer Capacity Changed Event*

18.2.1 An event shall be generated whenever Buffer Capacity changes. This applies to all internal buffers and internal buffer partitions.

18.2.2 Data required to be available for this event report:

- BufferPartitionInfo.

18.3 *Carrier Approaching Complete Event*

18.3.1 In some cases, for carrier transfer efficiency, the host needs to know carrier completion timing a little faster than actual. For example:

- If the equipment is internal buffer type, QTAT carriers need to be moved out directly from internal FIMS to a load port to shorten moving out time.
- If the equipment uses non-product carriers, such as dummy, they need to be changed before it becomes not reusable to prevent stopping the equipment operation.
- If the equipment uses non-product carriers, such as test, reject, they need to be changed before it becomes empty or full to prevent stopping the equipment operation.

18.3.2 This event shall be generated when the access by the equipment to the carrier is approaching complete. How the timing of the event is determined shall be configurable.

18.3.3 Detailed definition of the event timing depends upon the type of usage of the carrier. Some examples of event timing for different types of usage are shown below.

18.3.3.1 *PRODUCT* — When remaining time until the carrier starts moving from internal FIMS to internal buffer reaches the configurable variable time (internal buffer equipment only).

18.3.3.2 *DUMMY* — When remaining times until substrates of the carrier becomes not reusable reaches the configurable variable times.

18.3.3.3 *TEST* — When remaining substrates until the carrier becomes empty reaches the configurable variable number.

18.3.3.4 *REJECT* — When remaining slots until the carrier becomes full reaches the configurable variable number.

18.3.4 Suppliers shall document the interpretation and the configurable variable(s) in the equipment specification document.

18.3.5 Data required to be available for this event report:

- CarrierID

18.4 *Carrier Clamped Event*

18.4.1 An event shall be generated whenever a carrier is clamped. Clamped means the load port has engaged a device that would inhibit removal or movement of the carrier by any entity external to the load port. Some load ports



may include more than one clamping device. This event should be generated only when the first clamping is engaged. This applies to all load ports.

18.4.2 There is no standard for when load ports clamp a carrier. Therefore the IC makers host systems and personnel will need some signal from the equipment to know if a carrier is clamped. This event provides that signal. This applies to all load ports that provide clamping. If a load ports does not clamp the carrier no event is required.

18.4.3 Data required to be available for this event report:

- Port ID,
- Carrier ID (if available), and
- Location ID.

18.5 *Carrier Closed Event*

18.5.1 If the carrier is equipped with a door, an event shall be generated when a carrier door has been closed.

18.5.2 Data required to be available for this event report:

- CarrierID,
- LocationID, and
- PortID (if valid).

18.6 *Carrier Location Change Event*

18.6.1 An event shall be generated whenever a carrier has changed location. This applies to both load ports, substrate ports, and internal buffer locations.

18.6.2 Data required to be available for this event report:

- CarrierID,
- LocationID (new destination location), and
- CarrierLocationMatrix.

18.7 *Carrier Opened Event*

18.7.1 If the carrier is equipped with a door, an event shall be generated when a carrier door has been opened.

18.7.2 Data required to be available for this event report:

- CarrierID,
- LocationID, and
- PortID (if valid).

18.8 *Carrier Unclamped Event*

18.8.1 An event shall be generated whenever a carrier is unclamped. Unclamped means that the load port has disengaged any devices that would inhibit removal or movement of the carrier by any entity external to the load port. Some load ports may include more than one clamping device. This event should be generated only when all clamping or locking devices are disengaged.

18.8.2 There is no standard for when load ports unclamp a carrier. Therefore the IC makers host systems and personnel will need some signal from the equipment to know if a carrier is unclamped. This event provides that signal. This applies to all load ports that provide clamping and unclamping. If a load ports does not clamp and unclamp the carrier no event is required.

18.8.3 Data required to be available for this event report:

- Port ID,
- Carrier ID (if available), and



- Location ID.

18.9 *CarrierID Read Fail Event*

18.9.1 An event shall be generated when the equipment attempts to read a CarrierID and fails at a port in the NOT ASSOCIATED STATE.

18.9.2 Data required to be available for this event report:

- PortID

18.10 *ID Reader Available Event*

18.10.1 An event shall be generated whenever an id reader becomes available. This applies to all load ports.

18.10.2 Data required to be available for this event report:

- PortID

18.11 *ID Reader Unavailable Event*

18.11.1 An event shall be generated whenever an id reader becomes unavailable for any reason. This applies to all load ports.

18.11.2 Data required to be available for this event report:

- PortID

18.12 *UnknownCarrierID Event*

18.12.1 An event shall be generated when a carrier arrives at a 'NOT ASSOCIATED' load port where the CarrierID reader is unavailable.

18.12.2 Data required for this event report:

- PortID

18.12.3 Equipment shall wait for a 'ProceedWithCarrier', 'CancelCarrier', or 'CancelCarrierAtPort' service before initiating any action.

18.12.4 If a ProceedWithCarrier service is received from the host by the equipment the carrier object is instantiated via transition 4 in the Carrier State Model.

18.12.5 If a CancelCarrier service is received, the equipment uses the host provided CarrierID to instantiate the carrier object via transition 5, associates the carrier to the load port and prepares carrier for unload.

18.12.6 If a CancelCarrierAtPort service is received, the equipment prepares the carrier for unload.

18.13 *Duplicate CarrierID In Process Event*

18.13.1 An event shall be generated if the equipment received a carrier with a CarrierID that is the same as that of another carrier present at the equipment and processing of the first carrier has begun.

18.13.2 Data required for this event report:

- CarrierID

19 **Variable Data**

19.1 The purpose of this section is to define the list of variable data requirements for CMS equipment. Values of these variables are available to the host via collection event reports and host status queries. Some of the data items listed are valid for internal buffer production equipment only, and are marked as such.

19.2 *Variable Data Definitions*

19.2.1 The following table defines variable data that shall be provided by the production equipment. Also, for the objects defined by Carrier Management, the identifier of that object and all of the attributes of that object shall be available for inclusion in event reports associated with that object. The object attribute variables in event reports linked to non-extinction event(s) shall contain the values of the attributes after the transition. This requirement



allows the receiver of the report to know the current condition of the object. The object attribute variables in event reports linked to extinction event(s) shall contain the values of the attributes before the transition unless it is specifically stated that the destruction transition modifies the attribute value. This requirement allows the receiver of the report to know the final condition of the object at the time it was deleted. Subscripted variables are used either as items within a list or to differentiate data representing different entities. Subscripted variables are always valid.

Table 37 Variable Data Definitions

<i>Variable Name</i>	<i>Description</i>	<i>Type</i>	<i>Access</i>	<i>Comment</i>
AccessMode	The access mode of the loadport.	Enumerated: MANUAL, AUTO	RO	
AccessMode _i	The access mode for the i th load port.	Enumerated: MANUAL, AUTO	RO	
AvailPartitionCapacity	The current available buffer capacity for a logical partition inside internal buffer equipment (PartitionCapacity - # of carriers in partition).	Non-negative integer	RO	Only applicable to internal buffer production equipment.
AvailPartitionCapacity _i	The AvailPartitionCapacity for the i th PartitionID within the internal buffer.	Non-negative integer	RO	Only applicable to internal buffer production equipment.
BufferCapacityList	The current PartitionType, AvailPartitionCapacity, and PartitionCapacity for all logical buffer partitions.	List of n groups of items 1. BufferPartitionInfo ₁ . . n. BufferPartitionInfo _n	RO	Only applicable to internal buffer production equipment.
BufferPartitionInfo	The related information for a logical buffer partition.	Structure of 5 items PartitionID PartitionType AvailPartitionCapacity PartitionCapacity UnallocatedPartitionCapacity	RO	Only applicable to internal buffer production equipment.
BufferPartitionInfo _i	The related information for the i th buffer partition.	Structure of 5 items PartitionID _i PartitionType _i AvailPartitionCapacity _i PartitionCapacity _i UnallocatedPartitionCapacity _i	RO	Only applicable to internal buffer production equipment.
BypassReadID	Enables or disables automatic ID acceptance when the carrier ID reader is unavailable.	Boolean.	RW	If TRUE, the ID provided with Bind is used automatically.
CarrierAccessingStatus	The state of the carrier accessing status.	Enumerated: NOT ACCESSED, IN ACCESS, CARRIER COMPLETE, CARRIER STOPPED	RO	
CarrierID	The ID of the carrier.	Text	RO	
CarrierID _i	The CarrierID at the i th locationID.	Text	RO	



<i>Variable Name</i>	<i>Description</i>	<i>Type</i>	<i>Access</i>	<i>Comment</i>
CarrierIDStatus	State of the carrier ID status.	Enumerated: ID NOT READ, [ID]WAITING FOR HOST, ID VERIFICATION OK, ID VERIFICATION FAILED	RO	
CarrierLocationMatrix	A list all the carriers at/in the equipment. Both internal to the equipment, and on equipment load ports.	List of n pairs of items 1. LocationID ₁ CarrierID ₁ . . n. LocationID _n CarrierID _n	RO	The CarrierID _i shall be null if there is no carrier at the locationID _i . If a carrier is at LocationID _i , but the CarrierID _i is not known, the value of CarrierID _i shall be 'UNKNOWN'.
LocationID	The ID of a carrier location.	Text	RO	Carrier locations are any location at/in the production equipment where a carrier may rest.
LocationID _i	The LocationID of the i th carrier location.	Text	RO	Carrier locations are any location at/in the production equipment where a carrier may rest.
LoadPortReservation-State	The reservation state of a Load Port.	Enumerated: NOT RESERVED, RESERVED	RO	
LoadPortReservation-State _i	The reservation state of the i th Load Port.	Enumerated: NOT RESERVED, RESERVED	RO	
LoadPortReservation-StateList	The current reservation state of all the load ports.	A list of n items 1. LoadPortReservationState ₁ . . n. LoadPortReservationState _n	RO	This can be used to resynchronize the host.
PartitionCapacity	The total PartitionCapacity for a logical internal buffer partition.	Non-negative integer	RO	Only applicable to internal buffer production equipment.
PartitionCapacity _i	The PartitionCapacity for the i th PartitionID of the internal buffer.	Non-negative integer	RO	Only applicable to internal buffer production equipment.
PartitionID	The ID of a logical internal buffer partition.	Text	RO	Used to identify separate material types in an internal buffer.
PartitionID _i	The ID of the i th logical partition of the internal buffer.	Text	RO	Used to identify separate material types in an internal buffer.
PartitionType	The type of a logical partition within an internal buffer.	Text	RO	Only applicable to internal buffer production equipment. Some examples of logical buffer PartitionType are Product, Dummy, Substrate, and Seed.



<i>Variable Name</i>	<i>Description</i>	<i>Type</i>	<i>Access</i>	<i>Comment</i>
PartitionType _i	The PartitionType corresponding with the i th PartitionID.	Text	RO	Only applicable to internal buffer production equipment. Some examples of logical buffer PartitionType are Product, Dummy, Substrate, and Seed.
PortAssociationState	The association state of a load port.	Enumerated: ASSOCIATED, NOT ASSOCIATED	RO	
PortAssociationState _i	The association state of the i th load port.	Enumerated: ASSOCIATED, NOT ASSOCIATED	RO	
PortAssociationState-List	The current association state for all load ports.	A list of n items 1. PortAssociationState ₁ . . n. PortAssociationState _n	RO	This can be used to re-synchronize the host.
PortID	ID of a load port.	Positive integer	RO	
PortID _i	ID of the load port where the carrier transfer is taking place. One PortID exists for each load port.	Positive integer	RO	
PortStateInfo	The PortAssociationState combined with the PortTransferState.	List of 2 items PortAssociationState PortTransferState	RO	A combination of both port states.
PortStateInfo _i	The PortAssociationState combined with the PortTransferState for the i th load port.	List of 2 items PortAssociationState _i PortTransferState _i	RO	A combination of both port states.
PortStateInfoList	List of PortStateInfo for all load ports.	List of n items 1. PortStateInfo ₁ . . n PortStateInfo _n	RO	A list of all the port states for all the ports.
PortTransferState	The current transfer state of a load port.	Enumerated: OUT OF SERVICE, TRANSFER BLOCKED, READY TO LOAD, READY TO UNLOAD	RO	Super states are not included, only sub states.
PortTransferState _i	The current transfer state of the i th load port.	Enumerated: OUT OF SERVICE, TRANSFER BLOCKED, READY TO LOAD, READY TO UNLOAD	RO	Super states are not included, only sub states.
PortTransferStateList	The current Load Port Transfer State for all load ports.	A list of n items 1. PortTransferState ₁ . . n. PortTransferState _n	RO	This can be used to re-synchronize the host.



<i>Variable Name</i>	<i>Description</i>	<i>Type</i>	<i>Access</i>	<i>Comment</i>
Reason	The reason for transition 14, SLOT MAP NOT READ to WAITING FOR HOST.	Enumerated: VERIFICATION NEEDED, VERIFICATION BY EQUIPMENT UNSUCCESSFUL, READ FAIL, IMPROPER SUBSTRATE POSITION	RO	Information to aid host in deciding appropriate action.
SlotMap	The SlotMap of a carrier.	Ordered list of n, where n is equal to the value of the Capacity attribute of the carrier. Each value in the list is from the enumeration defined for the attribute SlotMap in Table 6 “Carrier Attribute Definition.”	RO	
SlotMapStatus	State of the carrier slot map status.	Enumerated: SLOT MAP NOT READ, [SLOT]WAITING FOR HOST, SLOT MAP VERIFICATION OK, SLOT MAP VERIFICATION FAILED	RO	
UnAllocatedPartition-Capacity	The current unallocated capacity for a logical partition inside internal buffer equipment, (PartitionCapacity - # of carriers in partition - # of carriers allocated for the partition (via reception of a Bind, CarrierIn, CarrierNotification, ReserveAtPort, or ProceedWithCarrier service). Any carriers allocated for a partition will be de-allocated if the corresponding Cancel service is received (e.g., Bind-CancelBind, CarrierNotification – CancelCarrierNotification, ReserveAtPort – CancelReservationAtPort, ProceedWithCarrier – CancelCarrier).	Non-negative integer	RO	Only applicable to internal buffer equipment.
UnAllocatedPartition-Capacity _i	The UnallocatedPartitionCapacity for the i th Partition ID within the internal buffer	Non-negative integer	RO	Only applicable to internal buffer equipment.

20 Alarms

20.1 This section includes specific alarms that are required to be implemented by CMS compliant equipment.

20.2 Alarm List Table

20.2.1 Table 38 is a listing of required alarms for both fixed buffer and internal buffer equipment. This list is only a subset of the carrier transfer alarms. There may be more carrier transfer related alarms that are not listed here.



Table 38 Alarm List

<i>Equipment</i>		<i>Danger</i>		<i>Affected</i>		
		Potential	Imminent	Operator	Equipment	Material
Configuration	Alarm Text					
Fixed and Internal Buffer Equipment	PIO Failure	X		X	X	X
	Access Mode Violation	X		X	X	X
	Carrier Verification Failure	X				X
	Slot Map Read Failed	X		X	X	X
	Slot Map Verification Failed	X			X	X
	Attempt To Use Out Of Service Load Port	X			X	X
	Carrier Presence Error	X		X	X	X
	Carrier Placement Error	X		X	X	X
	Carrier Dock/UnDock Failure	X			X	X
	Carrier Open/Close Failure	X			X	X
Fixed and Internal Buffer	Duplicate CarrierID	X				X
Internal Buffer Equipment Only	Internal Buffer Carrier Move Failure	X			X	X
Fixed and Internal Buffer Equipment	Carrier Removal Error	X		X	X	X

20.3 Duplicate CarrierID

20.3.1 If the equipment receives a carrier with a CarrierID that is the same as that of another carrier present at the equipment, the following rules shall apply:

1. Duplicate CarrierID alarm shall be set to notify the host.
2. The second carrier with a CarrierID shall not be processed.
3. If processing on the first carrier with the CarrierID has not begun, it should not be processed.
4. If processing on the first carrier has begun a Duplicate CarrierID In Process event shall be issued to notify the host.

20.4 Carrier Verification Failure

20.4.1 This alarm shall be set only when equipment-based CarrierID verification fails.

20.5 Slot Map Verification Failed

20.5.1 This alarm shall be set only when equipment-based Slot Map verification fails.

21 Requirements for Compliance

21.1 Table 39 provides a checklist for CMS compliance.

Table 39 CMS Compliance Statement

<i>Fundamental CMS Requirements</i>	<i>CMS Section</i>	<i>Implemented</i>	<i>CMS Compliant</i>
Load Port Numbering	9.2	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Carrier Slot Numbering	9.3	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Load Port Transfer State Model	9.5–9.5.4	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Carrier Object Implementation	10	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No



<i>Fundamental CMS Requirements</i>	<i>CMS Section</i>	<i>Implemented</i>	<i>CMS Compliant</i>
Load Port Reservation State Model (internal buffer equipment)	12	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Load Port/Carrier Association State Model	13	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
CarrierID Verification Support	14.2	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Slot Map Verification Support	14.3	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Services Implementation	16	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Additional Events Implementation	18	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Variable Data Definitions	19	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Alarms Implementation	20	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Additional CMS Capabilities	CMS Section	Implemented	CMS Compliant
Load Port Reservation State Model (fixed buffer equipment)	12	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Reservation Visible Signal	12.2	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No



RELATED INFORMATION 1 CARRIER OBJECT ID

NOTICE: This Related Information is not an official part of SEMI E87 and was derived from the work of the global Information & Control Technical Committee. This Related Information was approved for publication by full letter ballot procedures on December 15, 1999.

R1-1 Carrier Object ID

R1-1.1 The Carrier Object ID is derived as stated in the Table R1-1 CarrierID derivation.

Table R1-1 CarrierID Derivation

	<i>Method of Original Instantiation</i>	<i>CarrierID Read</i>	<i>ID Verification</i>	<i>Following Actions</i>	<i>CarrierID =</i>	<i>Parameter Required by Service</i>
1	Bind	Successful	Successful and equipment based	Production equipment continues with the carrier.	CarrierID in Bind service.	<i>Bind:</i> CarrierID, PortID, and PropertiesList
2	Bind	Successful	Fails	The carrier object instantiated via the Bind message is destroyed and a new carrier object with the CarrierID equal to the one determined by the CarrierID is instantiated. ProceedWithCarrier service is received.	CarrierID provided by the CarrierID read.	<i>ProceedWith-Carrier:</i> CarrierID, PropertiesList
3	Bind	Successful	Fails	The carrier object instantiated via the Bind message is destroyed and a new carrier object with the CarrierID equal to the one determined by the CarrierID is instantiated. CancelCarrier service is received.	CarrierID provided by the CarrierID read.	<i>CancelCarrier:</i> CarrierID
4	Bind	Fails	NA	ProceedWithCarrier service is received and the CarrierID matches the CarrierID provided by the Bind service.	CarrierID provided by the Bind service.	<i>ProceedWith-Carrier:</i> CarrierID
5	Bind	Fails	NA	CancelCarrier service is received and the CarrierID matches the CarrierID provided by the Bind service.	CarrierID provided by the Bind service.	<i>CancelCarrier:</i> CarrierID
6	Carrier-Notification	Successful	Successful and equipment based	Production equipment continues with the carrier.	CarrierID in Carrier-Notification.	<i>Carrier-Notification:</i> CarrierID and PropertiesList
7	Carrier ID read	Successful	Successful and Host based	ProceedWithCarrier service is received and the CarrierID matches the CarrierID read by the production equipment.	CarrierID read by production equipment.	<i>ProceedWith-Carrier:</i> CarrierID and PropertiesList, PortID may be included.
8	CarrierID read	Successful	Fails and Host based	A CancelCarrier service is received and the CarrierID matches the CarrierID read by the production equipment.	CarrierID read by production equipment.	<i>CancelCarrier:</i> CarrierID



	<i>Method of Original Instantiation</i>	<i>CarrierID Read</i>	<i>ID Verification</i>	<i>Following Actions</i>	<i>CarrierID =</i>	<i>Parameter Required by Service</i>
9	The method of original instantiation is defined following the CarrierID read fail and is described in column titled following actions.	Fails	NA	A ProceedWithCarrier service is received and the CarrierID is provided in the service.	CarrierID provided by the Proceed-WithCarrier service.	<i>ProceedWith-Carrier</i> : CarrierID, PortID, PropertiesList
10	The method of original instantiation is defined following the CarrierID read fail and is described in the column titled <i>Following Actions</i> .			A CancelCarrier service is received and the CarrierID is the one provided by the CancelCarrier.	CarrierID provided by the Cancel-Carrier service.	<i>CancelCarrier</i> : CarrierID, PortID

R1-2 Scenarios

R1-2.1 The scenarios listed here are not a requirement of this Standard. They are provided to aid in the understanding of the Document. These scenarios are not an exhaustive set of all possible scenarios. The scenarios presented are typical or common scenarios encountered when using this Standard.

R1-2.2 Normal Roundtrip 1

R1-2.2.1 Assumptions: Fixed buffer production equipment, FOUP, Host based verification.

R1-2.2.2 Indicated states: LTS = Load Port Transfer State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-2 Normal Roundtrip 1

#	Comment	Dir	Message	LTS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NA	(T)	(T)
1	Loading transfer starts.	H<-E	TransferBlocked	TB			
2	Loading transfer completes.						
3	CarrierID is read.	H<-E	WaitingForHost		A	WFH	SNR
4	CarrierID is verified by host, and result is OK.						
5	Host commands to proceed.	H->E	ProceedWithCarrier			IVO	
6	Carrier is docked.						
7	Slot map is read.	H<-E	WaitingForHost				
8	Slot map is verified by host, and result is OK.					SVO	
9	Host commands to proceed.	H->E	ProceedWithCarrier				
10	Process starts.						
11	Process completes.						
12	Carrier is undocked.	H<-E	ReadyToUnload	RTU	NA	(T)	(T)
13	Unloading transfer starts.	H<-E	TransferBlocked	TB			
14	Unloading transfer completes.	H<-E	ReadyToLoad	RTL			



R1-2.3 Normal Roundtrip 2

R1-2.3.1 Assumptions: Fixed buffer production equipment, FOUP, Production equipment based verification, Bind Service received.

R1-2.3.2 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-3 Normal Roundtrip 2

#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NR	NA	(T)	(T)
1	Load port is associated with specified carrierID, and reserved for loading.	H->E	Bind		R	A	INR	SNR
2	Loading transfer starts.	H<-E	TransferBlocked	TB				
3	Loading transfer completes.				NR			
4	CarrierID is read.							
5	CarrierID is verified by production equipment, and result is OK.	H<-E	IDVerificationOK				IVO	
6	Carrier is docked.							
7	Slot map is read.							
8	Slot map is verified by production equipment, and result is OK.	H<-E	SlotMapVerificationOK					SVO
9	Process starts.							
10	Process completes.							
11	Carrier is undocked.	H<-E	ReadyToUnload	RTU				
12	Unloading transfer starts.	H<-E	TransferBlocked	TB				
13	Unloading transfer completes.	H<-E	ReadyToLoad	RTL		NA	(T)	(T)

R1-2.4 Normal Roundtrip 3

R1-2.4.1 Internal buffer production equipment, FOUP, Host based verification.

R1-2.4.2 Indicated states: LTS = Load Port Transfer State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status, LCAS = Load Port/Carrier Association State.

Table R1-4 Normal Roundtrip 3

#	Comment	Dir	Message	LTS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NA	(T)	(T)
1	Loading transfer starts.	H<-E	TransferBlocked	TB			
2	Loading transfer completes.						
3	CarrierID is read.	H<-E	WaitingForHost		A	WFH	SNR
4	CarrierID is verified by host, and result is OK.						
5	Host commands to proceed.	H->E	ProceedWithCarrier			IVO	
6	Carrier-in starts.	H<-E	BufferCapacityChange				
7	Carrier-in completes.			RTL	NA		
8	Process starts.						
9	Slot map is read at FIMS port.	H<-E	WaitingForHost				WFH
10	Slot map is verified by host, and result is OK.						



#	Comment	Dir	Message	LTS	LCAS	CIDS	CSMS
11	Host commands to proceed.	H->E	ProceedWithCarrier				SVO
12	Process completes.						
13	Carrier completes.	H<-E	CarrierComplete				
14	Host commands to carrier-out.	H->E	CarrierOut		A		
15	Carrier-out starts.	H<-E	TransferBlocked	TB			
16	Carrier-out completes.	H<-E H<-E	ReadyToUnload BufferCapacityChange	RTU			
17	Unloading transfer starts.	H<-E	TransferBlocked	TB			
18	Unloading transfer completes.	H<-E	ReadyToLoad	RTL	NA	(T)	(T)

R1-2.5 Normal Roundtrip 4

R1-2.5.1 Internal buffer production equipment, FOUP, Production equipment based verification, Bind service received.

R1-2.5.2 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-5 Normal Roundtrip 4

#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS	
0	Initial condition.			RTL	NR	NA	(T)	(T)	
1	Load port is associated with specified CarrierID, and reserved for loading.	H->E	Bind		R	A	INR	SNR	
2	Loading transfer starts.	H<-E	TransferBlocked	TB	NR		IVO		
3	Loading transfer completes.								
4	CarrierID is read.								
5	CarrierID is verified by equipment, and result is OK.	H<-E	IDVerificationOK	RTL		NA		SVO	
6	Carrier-in starts.	H<-E	BufferCapacityChange						
7	Carrier-in completes.								
8	Process starts.								
9	Slot map is read at FIMS port.								
10	Slot map is verified by equipment, and result is OK.	H<-E	SlotMapVerificationOK						
11	Process completes.								
12	Carrier completes.	H<-E	CarrierComplete	TB	R	A			
13	Host commands to carrier-out.	H->E	CarrierOut						
14	Carrier-out starts.	H<-E	TransferBlocked						
15	Carrier-out completes.	H<-E H<-E	ReadyToUnload BufferCapacityChange						RTU
16	Unloading transfer starts.	H<-E	TransferBlocked						TB
17	Unloading transfer completes.	H<-E	ReadyToLoad						RTL



R1-2.6 Normal Roundtrip 5

R1-2.6.1 Assumptions: Fixed buffer production equipment, FOUP, Production equipment based verification, Carrier Notification service received.

R1-2.6.2 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-6 Normal Roundtrip 5

#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NR	NA	(T)	(T)
1	Equipment is notified of future Carrier arrival.	H->E	CarrierNotification				INR	SNR
2	Loading transfer starts.	H<-E	TransferBlocked	TB				
3	Loading transfer completes.							
4	CarrierID is read.					A		
5	CarrierID is verified by production equipment, and result is OK.	H<-E	IDVerificationOK				IVO	
6	Carrier is docked.							
7	Slot map is read.							
8	Slot map is verified by production equipment, and result is OK.	H<-E	SlotMapVerificationOK					SVO
9	Process starts.							
10	Process completes.							
11	Carrier is undocked.	H<-E	ReadyToUnload	RTU				
12	Unloading transfer starts.	H<-E	TransferBlocked	TB				
13	Unloading transfer completes.	H<-E	ReadyToLoad	RTL		NA	(T)	(T)

R1-2.7 Normal Roundtrip 6

R1-2.7.1 Internal buffer production equipment, FOUP, Production equipment based verification, CarrierNotification service received.

R1-2.7.2 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-7 Normal Roundtrip 6

#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NR	NA	(T)	(T)
1	Load port notified of future carrier arrival.	H->E	CarrierNotification				INR	SNR
2	Loading transfer starts.	H<-E	TransferBlocked	TB				
3	Loading transfer completes.							
4	CarrierID is read.					A		
5	CarrierID is verified by equipment, and result is OK.	H<-E	IDVerificationOK				IVO	
6	Carrier-in starts.	H<-E	BufferCapacityChange					
7	Carrier-in completes.			RTL		NA		
8	Process starts.							



#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS
9	Slot map is read at FIMS port.							
10	Slot map is verified by equipment, and result is OK.	H<-E	SlotMapVerificationOK					SVO
11	Process completes.							
12	Carrier completes.	H<-E	CarrierComplete					
13	Host commands to carrier-out.	H->E	CarrierOut					
14	Carrier-out starts.	H<-E	TransferBlocked	TB	R	A		
15	Carrier-out completes.	H<-E H<-E	ReadyToUnload BufferCapacityChange	RTU	NR			
16	Unloading transfer starts.	H<-E	TransferBlocked	TB				
17	Unloading transfer completes.	H<-E	ReadyToLoad	RTL		NA	(T)	(T)

R1-2.8 Normal Roundtrip 7

R1-2.8.1 Assumptions: Fixed buffer production equipment, FOUP, Host based verification, ReserveAtPort service received.

R1-2.8.2 Indicated states: LTS = Load Port Transfer State, LRS= Load Port Reserve State, LCAS = Load Port/Carrier State Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-8 Normal Roundtrip 7

#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NR	NA	(T)	(T)
1	Reserve a port for future activity.	H->E	ReserveAtPort		R			
2	Loading transfer starts.	H<-E	TransferBlocked	TB				
3	Loading transfer completes.				NR			
4	CarrierID is read.	H<-E	WaitingForHost			A	WFH	SNR
5	CarrierID is verified by host, and result is OK.							
6	Host commands to proceed.	H->E	ProceedWithCarrier				IVO	
7	Carrier is docked.							
8	Slot map is read.	H<-E	WaitingForHost					WFH
9	Slot map is verified by host, and result is OK.							
10	Host commands to proceed.	H->E	ProceedWithCarrier					SVO
11	Process starts.							
12	Process completes.							
13	Carrier is undocked.	H<-E	ReadyToUnload	RTU				
14	Unloading transfer starts.	H<-E	TransferBlocked	TB				
15	Unloading transfer completes.	H<-E	ReadyToLoad	RTL		NA	(T)	(T)

R1-2.9 Normal Roundtrip 8

R1-2.9.1 Internal buffer production equipment, FOUP, Host based verification, ReserveAtPort service received.

R1-2.9.2 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status, CPS = Carrier Processing Status.



Table R1-9 Normal Roundtrip 8

#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NR	NA	(T)	(T)
1	Reserve Port for future activity.	H->E	ReserveAtPort		R			
2	Loading transfer starts.	H<-E	TransferBlocked	TB				
3	Loading transfer completes.				NR			
4	CarrierID is read.	H<-E	WaitingForHost			A	WFH	SNR
5	CarrierID is verified by host, and result is OK.							
6	Host commands to proceed.	H->E	ProceedWithCarrier				IVO	
7	Carrier-in starts.	H<-E	BufferCapacityChange					
8	Carrier-in completes.			RTL		NA		
9	Process starts.							
10	Slot map is read at FIMS port.	H<-E	WaitingForHost					WFH
11	Slot map is verified by host, and result is OK.							
12	Host commands to proceed.	H->E	ProceedWithCarrier					SVO
13	Process completes.							
14	Carrier completes.	H<-E	CarrierComplete					
15	Host commands to carrier-out.	H->E	CarrierOut			A		
16	Carrier-out starts.	H<-E	TransferBlocked	TB	R			
17	Carrier-out completes.	H<-E H<-E	ReadyToUnload BufferCapacityChange	RTU	NR			
18	Unloading transfer starts.	H<-E	TransferBlocked	TB				
19	Unloading transfer completes.	H<-E	ReadyToLoad	RTL		NA	(T)	(T)

R1-2.10 Abnormal CarrierID Verification 1

R1-2.10.1 Host based verification, CancelCarrier.

R1-2.10.2 Indicated states: LTS = Load Port Transfer State, LAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-10 Abnormal CarrierID Verification 1

#	Comment	Dir	Message	LTS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NA	(T)	(T)
1	Loading transfer starts.	H<-E	TransferBlocked	TB			
2	Loading transfer completes.						
3	CarrierID is read.	H<-E	WaitingForHost		A	WFH	SNR
4	CarrierID is verified by host, and result is Failed.						
5	Host commands to return.	H->E	CancelCarrier			IVF	
6	Carrier is made ready to unload.	H<-E	ReadyToUnload	RTU			

R1-2.11 Abnormal CarrierID Verification 2

R1-2.11.1 Production equipment based verification, Bind service received, CancelCarrier.



R1-2.11.2 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-11 Abnormal CarrierID Verification 2

#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NR	NA	(T)	(T)
1	Load port is associated with specified CarrierID, and reserved for loading.	H->E	Bind		R	A	INR	SNR
2	Loading transfer starts.	H<-E	TransferBlocked	TB	NR		(T) / WFH	(T) / SNR
3	Loading transfer completes.							
4	CarrierID is read.							
5	CarrierID is verified by production equipment, and result is Failed. The carrier object created by the Bind service is destroyed. A carrier object with the id determined by read is created.	H<-E	WaitingForHost					
6	Host commands to return.	H->E	CancelCarrier	RTU			IVF	
7	Carrier is made ready to unload.	H<-E	ReadyToUnload					

R1-2.12 Abnormal CarrierID Verification 3

R1-2.12.1 Production equipment based verification, Bind Service received, ProceedWithCarrier.

R1-2.12.2 Production equipment based verification, ProceedWithCarrier.

R1-2.12.3 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-12 Abnormal CarrierID Verification 3

#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NR	NA	(T)	(T)
1	Load port is associated with specified carrierID, and reserved for loading.	H->E	Bind		R	A	INR	SNR
2	Loading transfer starts.	H<-E	TransferBlocked	TB	NR		(T) / WFH	(T) / SNR
3	Loading transfer completes.							
4	CarrierID is read.							
5	CarrierID is verified by production equipment, and result is Failed.	H<-E	WaitingForHost					
6	Host commands to proceed.	H->E	ProceedWithCarrier				IVO	
7	(Go to next step.)							

R1-2.13 Abnormal Slot Map Verification 1

R1-2.13.1 Fixed buffer production equipment, FOUP, Host based verification, CancelCarrier.

R1-2.13.2 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State, LAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.



Table R1-13 Abnormal Slot Map Verification 1

#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NR	NA	(T)	(T)
1	Loading transfer starts.	H<-E	TransferBlocked	TB				
2	Loading transfer completes.							
3	CarrierID is read.	H<-E	WaitingForHost					
4	CarrierID is verified by host, and result is OK.							
5	Host commands to proceed.	H->E	ProceedWithCarrier					
6	Carrier is docked.							
7	Slot map is read.	H<-E	WaitingForHost					
8	Slot map is verified by host, and result is Failed.							
9	Host commands to return.	H->E	CancelCarrier					
10	Carrier is made ready to unload.		ReadyToUnload	RTU				

R1-2.14 Abnormal Slot Map Verification 2

R1-2.14.1 Internal buffer production equipment, FOUP, Production equipment based verification, CancelCarrier.

R1-2.14.2 Indicated states: LTS = Load Port Transfer State, LRS = Load Reservation State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-14 Abnormal Slot Map Verification 2

#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NR	NA	(T)	(T)
1	Load port is associated with specified carrierID, and reserved for loading.	H->E	Bind		R	A	INR	SNR
2	Loading transfer starts.	H<-E	TransferBlocked	TB	NR		IVO	
3	Loading transfer completes.							
4	CarrierID is read.							
5	CarrierID is verified by equipment, and result is OK.	H<-E	IDVerificationOK					
6	Carrier-in starts.	H<-E	BufferCapacityChange	RTL		NA		
7	Carrier-in completes.							
8	Process starts.							
9	Slot map is read at FIMS port.							
10	Slot map is verified by production equipment, and result is Failed.	H<-E	WaitingForHost					
11	Host commands to return.	H->E	CancelCarrier					
12	Carrier returns to internal buffer.							

R1-2.15 Carrier-Out Queuing

R1-2.15.1 Internal Buffer Equipment

R1-2.15.2 Initial condition: Two more carriers are within the production equipment.

R1-2.15.3 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State, LCAS = Load Port/Carrier Association State.



Table R1-15 Carrier-Out Queuing

#	Comment	Dir	Message	LTS	LRS	LCAS
0	Initial condition.			RTL	NR	NA
1	Host commands to carrier-out #1.	H->E	CarrierOut			
2	Carrier-out #1 starts.	H<-E	TransferBlocked	TB	R	A
3	Host commands to carrier-out #2 (Queued).	H->E	CarrierOut			
4	Carrier-out #1 completes.	H<-E H<-E	ReadyToUnload BufferCapacityChange	RTU	NR	
5	Unloading transfer #1 starts.	H<-E	TransferBlocked	TB		
6	Unloading transfer #1 completes.					
7	Carrier-out #2 starts.				R	
8	Carrier-out #2 completes.	H<-E H<-E	ReadyToUnload BufferCapacityChange	RTU	NR	
9	Unloading transfer #2 starts.	H<-E	TransferBlocked	TB		
10	Unloading transfer #2 completes.	H<-E	ReadyToLoad	RTL		NA

R1-2.16 Carrier-Out Dequeuing (Cancellation)

R1-2.16.1 Internal Buffer Production Equipment

R1-2.16.2 Initial condition: One more carrier-out services are queued, One carrier-out service is active.

R1-2.16.3 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State, LCAS = Load Port/Carrier Association State.

Table R1-16 Carrier-Out Dequeuing (Cancellation)

#	Comment	Dir	Message	LTS	LRS	LCAS
0	Initial condition.			TB	R	A
1	Host commands to cancel all carrier-out services from queue.	H->E	CancelAllCarrierOut			
2	All carrier-out services are canceled from queue.					
3	Current carrier-out service completes.	H<-E H<-E	ReadyToUnload BufferCapacityChange	RTU	NR	
4	Unloading transfer starts.	H<-E	TransferBlocked	TB		
5	Unloading transfer completes.	H<-E	ReadyToLoad	RTL		NA

R1-2.17 Carrier Association Cancellation

R1-2.17.1 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-17 Carrier Association Cancellation

#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NR	NA	(T)	(T)
1	Load port is associated with specified carrierID, and reserved for loading.	H->E H<-E	Bind Associated		R	A	INR	SNR
2	Host decides to cancel current carrier delivery.							



#	Comment	Dir	Message	LTS	LRS	LCAS	CIDS	CSMS
3	Host commands to cancel association.	H->E H<-E	CancelBind NotAssociated		NR	NA	(T)	(T)

R1-2.18 Access Mode Change

R1-2.18.1 Initial condition: Access mode = AUTO.

R1-2.18.2 Indicated states: AMS = Access Mode State.

Table R1-18 Access Mode Change

#	Comment	Dir	Message	AMS
0	Initial condition.			A
1	Host commands to change access mode to MANUAL.	H->E	ChangeAccess	M
2	Access mode is changed to MANUAL.	H<-E	Manual	

R1-2.19 Load Port Service Status Change

R1-2.19.1 Initial condition: Load port service status = IN SERVICE.

R1-2.19.2 Indicated states: LTS = Load Port Transfer State.

Table R1-19 Load Port Service Status Change

#	Comment	Dir	Message	LTS
0	Initial condition.			IS
1	Host commands to change service status to OUT OF SERVICE.	H->E	ChangeServiceStatus	OS
2	Service status is changed to OUT OF SERVICE.	H<-E	OutofService	

R1-2.20 Correct Carrier Delivery to Wrong Port 1 Scenario

R1-2.20.1 Assumptions: Fixed Load Port Equipment based verification.

R1-2.20.2 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-20 Correct Carrier Delivery to Wrong Port 1 Scenario

#	Comment	Dir	Message	LTS1	LRS1	LCAS1	LTS2	LRS2	LCAS2	CIDS	CSMS
0	Initial condition.			RTL	NR	NA	RTL	NR	NA	(T)	(T)
1	Load port 1 is associated with specified CarrierID, and reserved for loading.	H->E H<-E	Bind (lp1) LP1 Associated		R	A				INR	SNR
2	Transfer starts at load port 2.	H<-E	LP2 TRANSFER BLOCKED				TB				
3	Transfer Completes at load port 2.	H<-E	Transfer Complete								



#	Comment	Dir	Message	LTS1	LRS1	LCAS1	LTS2	LRS2	LCAS2	CIDS	CSMS
4	CarrierID read at load port 2. Equipment based verification indicates the carrier is at the correct equipment.	H<-E H<-E H<-E	LP1 NOT ASSOCIATED LP2 ASSOCIATED IVO		NR	NA			A	IVO	

R1-2.21 Correct Carrier Delivery to Wrong Port 2 Scenario

R1-2.21.1 Assumptions: Fixed Load Port Equipment based verification.

R1-2.21.2 Indicated states: LTS = Load Port Transfer State, LRS = Load Port Reservation State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-21 Correct Carrier Delivery to Wrong Port 2 Scenario

#	Comment	Dir	Message	LTS1	LRS2	LCAS3	LTS2	LRS2	LCAS2	CIDSA	CSMS A	CIDS B	CSMS B
0	Initial condition.			RTL	NR	NA	RTL	NR	NA	(T)	(T)	(T)	(T)
1	Load port 1 is associated with specified carrierID A, and reserved for loading.	H->E H<-E	Bind (CA, LP1) Lp1 Associated		R	A				INR	SNR		
2	Load port 2 is associated with specified carrierID B, and reserved for loading.	H->E H<-E	Bind (CB, LP2) Lp2 Associated					R	A			INR	SNR
2	Carrier A Transfer starts at load port 2.	H<-E	LP2 TRANSFER BLOCKED				TB						
3	Transfer Completes at load port2.	H<-E	Transfer Complete					NR					
4	CarrierID read at load port 2, Equipment based verification indicates that a correct carrier was delivered to the wrong load port.	H<-E H<-E H<-E	LP1 NOT ASSOCIATED Carrier B object destroyed Alarm LP2 verification failed		NR	NA				WFH		(T)	(T)
5	Host oks processing.	H->	ProceedWith Carrier							IVO			

R1-2.22 CarrierID Read Fail Scenario 1

R1-2.22.1 Assumptions: Fixed buffer Equipment, Equipment based Verification, Bind service has been received.



R1-2.22.2 Indicated states: LTS = Load Port Transfer State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-22 CarrierID Read Fail Scenario 1

#	Comment	Dir	Message	LTS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	A	INR	SNR
1	Carrier Arrives.	E>H	Transfer Blocked	TB	A	INR	SNR
2	ID read attempt fails.	E>H	State change to Waiting For Host	TB	A	WFH	SNR
3	Decision to continue is made.						
4	Host sends ProceedWithCarrier service.	H>E E>H	ProceedWithCarrier State change to Id Verification OK	TB	A	IVO	SNR

R1-2.23 CarrierID Read Fail Scenario 2

R1-2.23.1 Assumptions: Fixed buffer Equipment, Equipment based Verification, Bind service has been received.

R1-2.23.2 Indicated states: LTS = Load Port Transfer State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-23 CarrierID Read Fail Scenario 2

#	Comment	Dir	Message	LTS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	A	INR	SNR
1	Carrier Arrives.	E>H	Transfer Blocked	TB		WFH	
2	ID read attempt fails.	E>H	State change to Waiting For Host	TB			
3	Decision to stop is made.						
4	Host sends CancelCarrier service.	H>E E>H	CancelCarrier State change to Id Verification Failed	TB		IVF	

R1-2.24 CarrierID Read Fail Scenario 3

R1-2.24.1 Assumptions: Fixed buffer Equipment, Host based Verification.

R1-2.24.2 Indicated states: LTS = Load Port Transfer State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-24 CarrierID Read Fail Scenario 3

#	Comment	Dir	Message	LTS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NA	(T)	(T)
1	Carrier Arrives.	E>H	Transfer Blocked	TB			
2	ID read attempt fails.	E>H	ID read fail event				
3	Decision to continue is made.	H>E					
4	Host sends ProceedWithCarrier service.	H>E E>H E>H	ProceedWithCarrier State change to Id Verification OK State change to Load Port Associated		A	IVO	SNR

R1-2.25 CarrierID Read Fail Scenario 4

R1-2.25.1 Assumptions: Fixed buffer Equipment, Host based Verification.



R1-2.25.2 Indicated states: LTS = Load Port Transfer State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-25 CarrierID Read Fail Scenario 4

#	Comment	Dir	Message	LTS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NA	(T)	(T)
1	Carrier Arrives.	E>H	Transfer Blocked	TB			
2	ID read attempt fails.	E>H	ID read fail event				
3	Decision to stop is made.	H>E					
4	Host sends CancelCarrier.	H>E E>H E>H	CancelCarrier State change to Id Verification Failed State change to Load Port Associated		A	IVF	SNR

R1-2.26 CarrierID Read Fail Scenario 5

R1-2.26.1 Assumptions: Fixed buffer Equipment, Host based Verification.

R1-2.26.2 Indicated states: LTS = Load Port Transfer State, LCAS = Load Port/Carrier Association State, CIDS = Carrier ID Status, CSMS = Carrier Slot Map Status.

Table R1-26 CarrierID Read Fail Scenario 5

#	Comment	Dir	Message	LTS	LCAS	CIDS	CSMS
0	Initial condition.			RTL	NA	(T)	(T)
1	Carrier Arrives.	E>H	Transfer Blocked	TB			
2	ID read attempt fails.	E>H	ID read fail event				
3	Decision to stop is made.	H>E					
4	Host sends CancelCarrierAtPort.	H>E	CancelCarrierAtPort				

R1-3 Example Equipment Logic for Carrier Delivery

R1-3.1 To summarize the CMS carrier object behavior, following flow-charts are provided. The charts show the example of an equipment logic for the CMS definitions.



R1-3.2 Bind and Notify

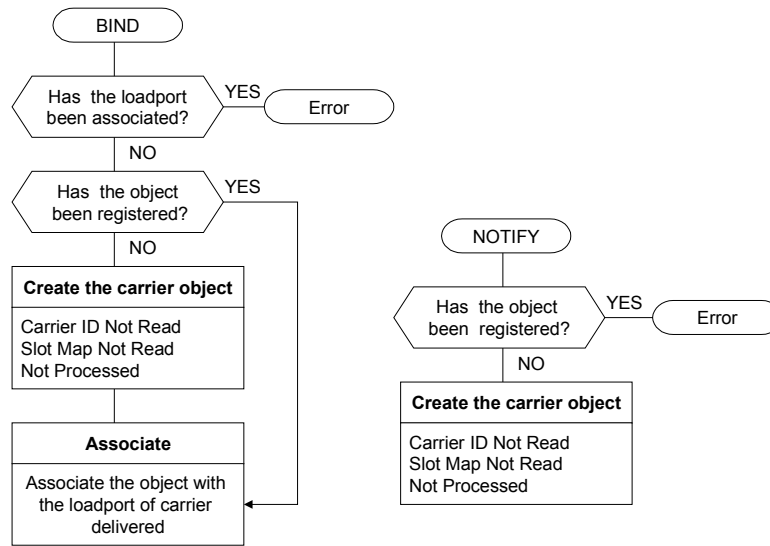


Figure R1-1

R1-3.2.1 Bind Service Request from the Host

R1-3.2.1.1 Verify no object has been associated with designated loadport. If it is associated the Bind service shall be failed.

R1-3.2.1.2 Verify no object having the same ID specified in Bind service has been registered.

R1-3.2.1.2.1 If it is registered, the Bind service shall associate the object that is already registered with the designated loadport.

R1-3.2.1.2.2 If it is not registered, then create the object and associate it to the loadport. The initial states of the object are Carrier ID Not Read, Carrier Slot Map Not Read, Carrier Not Processed and Associated to the loadport.

R1-3.2.2 Notify service request from the host.

R1-3.2.2.1 Verify no object having the same ID specified in Notify service has been registered.

R1-3.2.2.1.1 If it is registered, the Notify service shall be failed.

R1-3.2.2.1.2 If it is not registered, then create the carrier object. The initial states of the object are Carrier ID Not Read, Carrier Slot Map Not Read, Carrier Not Processed and Not Associated.



R1-3.3 Carrier ID Read

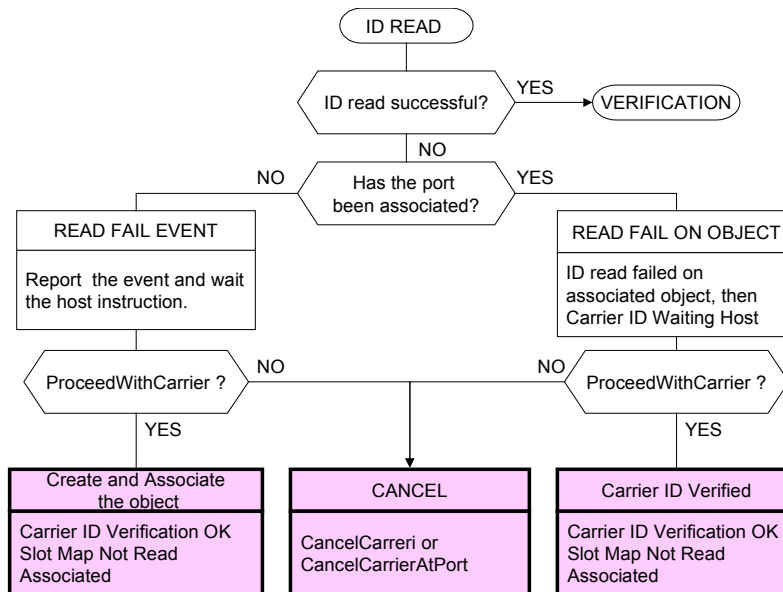


Figure R1-2

R1-3.3.1 Carrier ID Read Event

R1-3.3.1.1 If CarrierID has been read successfully then ID DETERMINATION (ID DET) is executed.

R1-3.3.1.2 If CarrierID has been failed to be read and the port is not associated with any object;

R1-3.3.1.2.1 Report the host the event to inform CarrierID read fail when the loadport has no Bind.

R1-3.3.1.2.2 If the host requests ProceedWithCarrier service, then create the object and associate it with the loadport. CarrierID state shall be changed to Carrier ID Verification OK.

R1-3.3.1.2.3 If the host requests CancelCarrier service, then create the object and associate it with the loadport. CarrierID state shall be changed to Carrier ID Verification Fail. Take the carrier to Ready to Unload.

R1-3.3.1.2.4 If the host requests CancelCarrierAtPort service, no object is created. Take the carrier to Ready to Unload.

R1-3.3.1.3 If CarrierID has been failed to be read and the port is associated with any object;

R1-3.3.1.3.1 Change the CarrierID status of the associated object to Waiting for Host. The event shall be reported to indicate carrier ID read for associated object has been failed.

R1-3.3.1.3.2 If the host requests ProceedWithCarrier service, then change the CarrierID status of the associated object to Carrier ID Verification OK.

R1-3.3.1.3.3 If the host requests CancelCarrier service, then change the CarrierID status of the associated object to Carrier ID Verification Fail. Take the carrier to Ready to Unload.



R1-3.4 *BypassReadID*

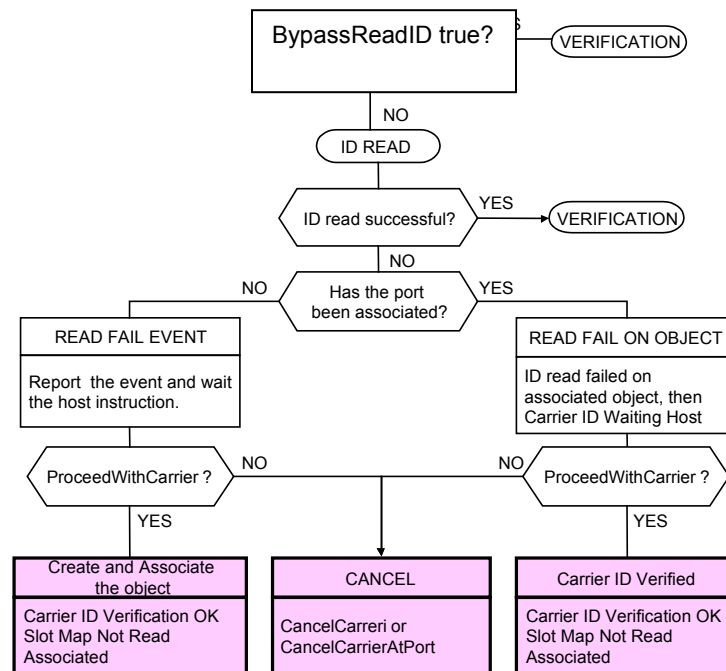


Figure R1-3

R1-3.4.1 *BypassReadID*

R1-3.4.1.1 If Bind has been received, then decision should be made if ID read is necessary.

R1-3.4.1.2 If BypassReadID is equal to True.

R1-3.4.1.2.1 No ID read is required and carrier object enters ID Verification OK state.

R1-3.4.1.3 If BypassReadID is equal to False.

R1-3.4.1.3.1 ID Read is required.



R1-3.5 Carrier Object Verification

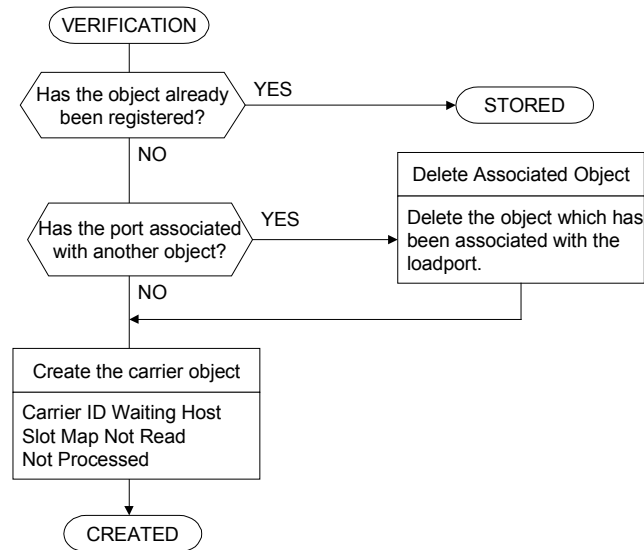


Figure R1-4

R1-3.5.1 If the object having the ID read from the carrier has been registered, then STORED object logic shall be executed.

R1-3.5.2 If no object having the ID read from the carrier has been registered;

R1-3.5.2.1 Create the object.

R1-3.5.2.2 If an object has been associated with the loadport on which the carrier is delivered, the event means the carrier delivered is not expected by the associated object. That is CarrierID verification fail. Then, delete the associated object.

R1-3.5.2.3 CREATED logic shall be executed.



R1-3.6 *CREATED*

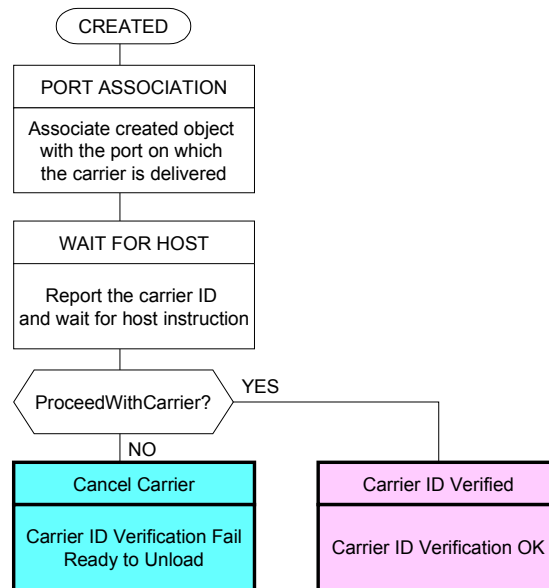


Figure R1-5

R1-3.6.1 Associate the object just created with the loadport on which the carrier is delivered.

R1-3.6.2 Report the carrier ID and wait for host instruction.

R1-3.6.3 If the host requests ProceedWithCarrier service, change the Carrier ID Status to Carrier ID Verification OK.

R1-3.6.4 If the host requests CancelCarrier service, change the Carrier ID Status to Carrier ID Verification Fail. The carrier shall be taken to Ready to Unload.



R1-3.7 STORED

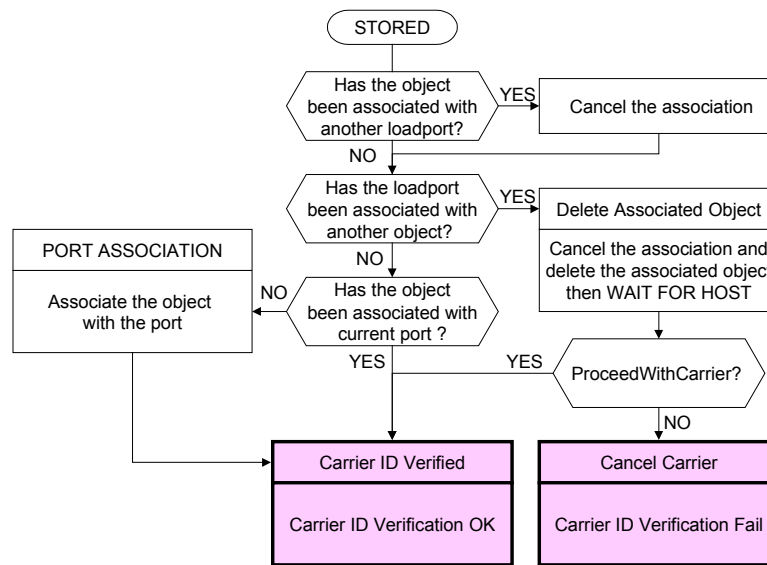


Figure R1-6

R1-3.7.1 If the object has been already associated with the loadport other than the carrier is delivered;

R1-3.7.1.1 This is the case for misloading to a wrong loadport.

R1-3.7.1.2 Cancel the association.

R1-3.7.2 And if the loadport on which the carrier has been delivered is associated to another object, then delete the object associated with the port on which the carrier is delivered.

R1-3.7.2.1 This is the case for equipment base ID VERIFICATION FAIL.

R1-3.7.2.2 Associate the object with the loadport on which the carrier has been delivered.

R1-3.7.2.3 Then enter WAITING FOR HOST.

R1-3.7.2.4 If ProceedWithCarrier is given, then the carrier is verified.

R1-3.7.2.5 If CancelCarrier is given, then the carrier verification is failed.

R1-3.7.3 If the object has been associated with the loadport on which the carrier is delivered, the carrier is verified. Change the Carrier ID status to Carrier ID Verified.

R1-3.7.4 If no object has been associated with the loadport on which the carrier is delivered, associate the object with the loadport. This is the case for associating object created by Notify.

R1-4 Flowcharts for Access Mode Violation

R1-4.1 General Usage

R1-4.1.1 The flowcharts in this section are showing the recommended behavior of the passive equipment at the occurrence of an access mode violation during loading and unloading of a carrier. Scenarios for the active equipment are incomplete and for better explanation only. The activities on the passive equipment, like state model transitions, events, alarms, clearing of alarms, and PI/O signal modifications may be asynchronous. The order in which the equipment initiates such activities may vary if the general logic is not violated.



R1-4.1.2 Legend:

- LPTSM Load Port Transfer State Model (SEMI E87)
- RTL READY TO LOAD (state of the LPTSM – SEMI E87)
- RTU READY TO UNLOAD (state of the LPTSM – SEMI E87)
- TB TRANSFER BLOCKED (state of the LPTSM – SEMI E87)
- AMHS Automated Material Handling System
- SCT State Change Transition
- AMV Access Mode Violation
- AMV_LOAD alarm text for access mode violation triggered by loading of a carrier
- AMV_UNLOAD alarm text for access mode violation triggered by unloading of a carrier
- ES PIO signal “Emergency Stop” (see SEMI E84)
- HO_AVBL PIO signal “Handoff Available”(see SEMI E84)

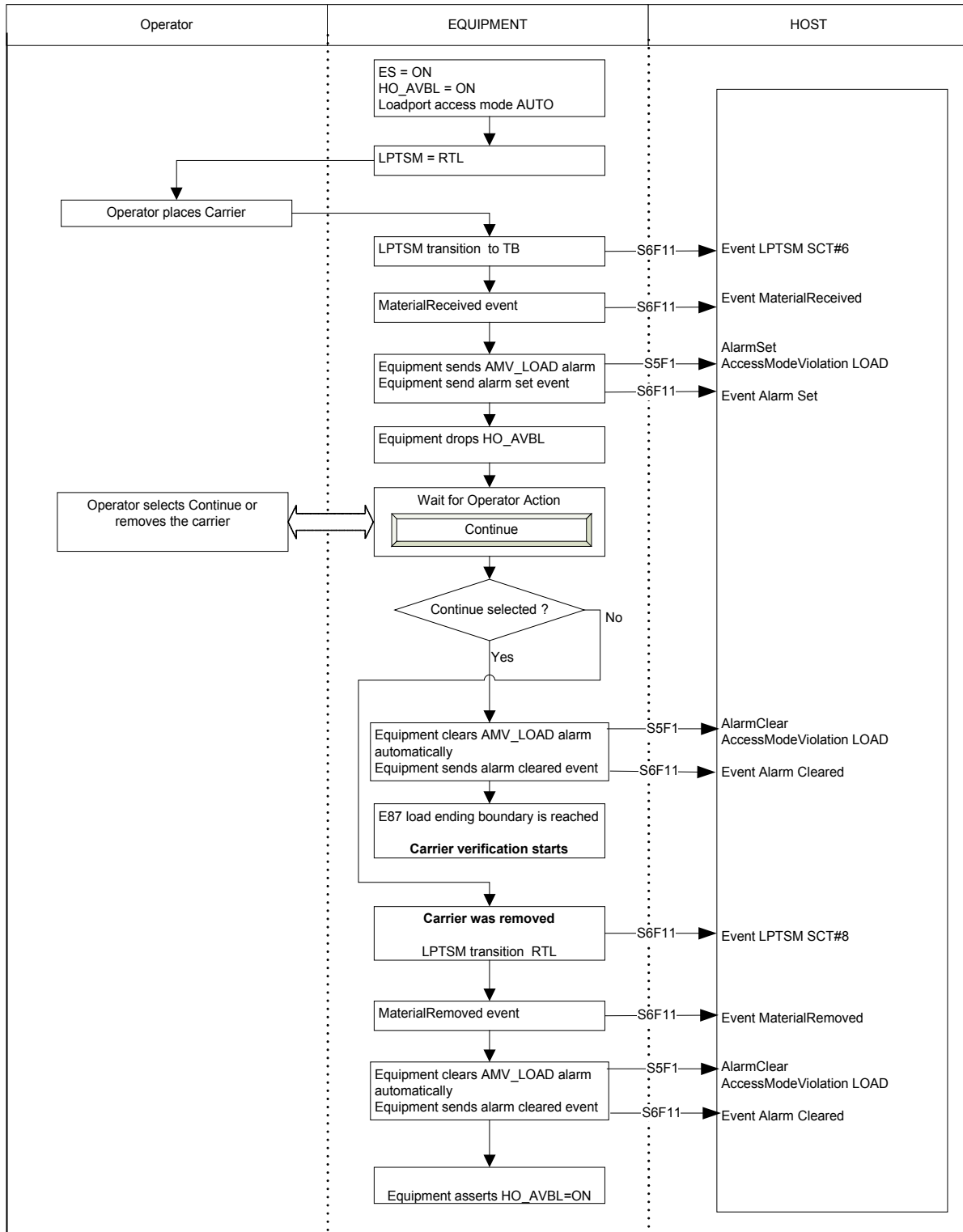


Figure R1-7
Scenario 1 Access Mode Violation During Load

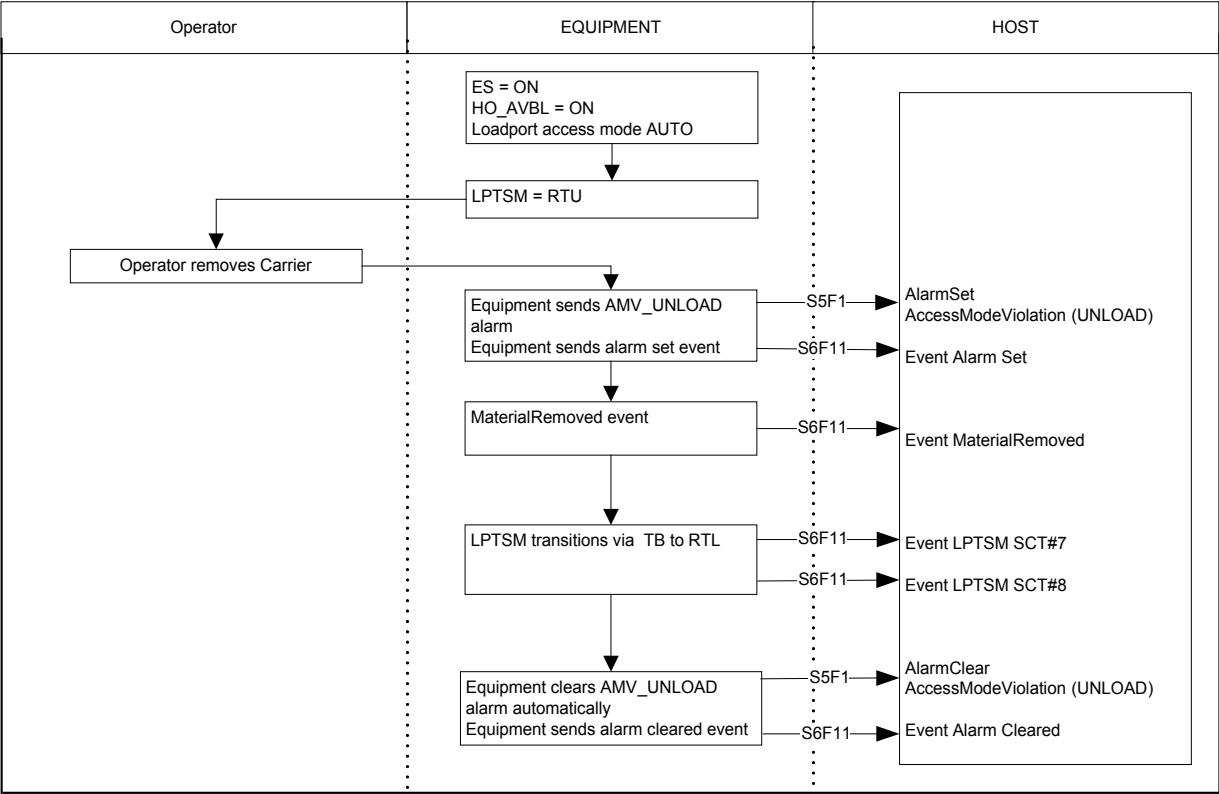


Figure R1-8
Scenario 2 Access Mode Violation During Unload

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SEMI E87.1-0707

PROVISIONAL SPECIFICATION FOR SECS-II PROTOCOL FOR CARRIER MANAGEMENT (CMS)

This standard was technically approved by the global Information & Control Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on April 25, 2007. It was available at www.semi.org in June 2007 and on CD-ROM in July 2007. Originally published February 2000; previously published November 2005.

1 Purpose

1.1 This document maps the services and data of SEMI E87 to SECS-II streams and functions, and data definitions.

2 Scope

2.1 This is a provisional specification covering equipment supporting automated access to load ports from the host point-of-view. The provisional status is required because of the immaturity of implementations of integrated equipment with AMHS, and additional specifications may yet be defined. Also, further exception handling and error recovery scenarios need to be defined.

2.2 This document applies to all implementations of SEMI E87 that use the SECS-II message protocol [SEMI E5]. Compliance to this standard requires compliance to both SEMI E87 and SEMI E5.

NOTICE: This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard 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 applies to semiconductor equipment with SEMI E15.1 compliant load ports. It may also be applied to other manufacturing equipment that supports automated carrier transfer and or contains an internal buffer.

3.2 This is a provisional specification. The following areas must be completed before the provisional status is removed:

- Any additional services, or changes to existing services, in Carrier Management must be mapped to SECS-II messages.

4 Referenced Standards and Documents

4.1 SEMI Standards

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

SEMI 15.1 — Provisional Specification for 300 mm Tool Load Port

SEMI E39.1 — SECS-II Protocol for Object Services Standard (OSS)

SEMI E87 — Specification for Carrier Management (CMS)

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

5 Services Mapping

5.1 This section shows the specific SECS-II streams and functions that shall be used for SECS-II implementation of the services defined in SEMI E87, as well as the parameter mapping for data attached to services.

5.2 Services Message Mapping

5.2.1 Table 1 defines the relationships between SEMI E87 services and SECS-II messages.



Table 1 Services Message Mapping Table

<i>Service Name</i>	<i>Stream, Function</i>	<i>SECS-II Message Name</i>
Bind	S3,F17/18	Carrier Action Request/Acknowledge
CancelBind	S3,F17/18	Carrier Action Request/Acknowledge
CancelAllCarrierOut	S3,F19/20	Cancel All Carrier Out Request/Acknowledge
CancelCarrier	S3,F17/18	Carrier Action Request/Acknowledge
CancelCarrierAtPort	S3,F17/18	Carrier Action Request/Acknowledge
CancelCarrierNotification	S3,F17/18	Carrier Action Request/Acknowledge
CancelCarrierOut	S3,F17/18	Carrier Action Request/Acknowledge
CancelReservationAtPort	S3,F25/26	Port Action Request/Acknowledge
CarrierIn	S3,F17/18	Carrier Action Request/Acknowledge
CarrierNotification	S3,F17/18	Carrier Action Request/Acknowledge
CarrierOut	S3,F17/18	Carrier Action Request/Acknowledge
CarrierReCreate	S3,F17/18	CarrierReCreate Rquest/Acknowledge
CarrierRelease	S3,F17/18	Carrier Action Request/Acknowledge
CarrierTagReadData	S3,F29/30	Carrier Tag Read Data Request/Acknowledge
CarrierTagWriteData	S3,F31/32	Carrier Tag Write Data Request/Acknowledge
ChangeAccess	S3,F27/28	ChangeAccess
ChangeServiceStatus	S3,F25/26	Port Action Request/Acknowledge
ProceedWithCarrier	S3,F17/18	Carrier Action Request/Acknowledge
ReserveAtPort	S3,F25/26	Port Action Request/Acknowledge

5.3 Services Parameter Mapping

5.3.1 Table 2 maps the SEMI E87 service parameters to SECS-II Data Items.

NOTE 1: Use of parameters not specified for a given message in SEMI E87 is prohibited. SECS-II data items not used for a given message shall be sent as zero-length items.

Table 2 Service Parameters to SECS-II Data Items Mapping

<i>Parameter Name</i>	<i>Range</i>	<i>SECS-II Data Item</i>
AccessMode	Enumerated: MANUAL, AUTO	ACCESSMODE
AttributeData	Any	CATTRDATA
AttributeID	Text format restrictions per SEMI E39.1, § 6.	CATTRID
CarrierID	1 to 80 characters	CARRIERID
CMAcknowledge	Enumerated	CAACK
CMStatus	Structure	L,2 1. <CAACK> 2. Status
Data	ASCII (20)	DATA
DataLength	Integer (Un or Sn)	DATALength
DataSeg	ASCII (20)	DATASEG
ErrorCode	Enumerated	ERRCODE
ErrorText	1 to 80 characters	ERRTEXT
LocationID	ASCII (20)	LOCID



<i>Parameter Name</i>	<i>Range</i>	<i>SECS-II Data Item</i>
PropertiesList	Non-identifier properties	L,n 1. L,2 1. <CATTRID ₁ > 2. <CATTRDATA ₁ > . . n. L,2 1.< CATTRID _n > 2. <CATTRDATA _n >
PortID	U1 (1-255)	PTN
ServiceStatus	Enumerated: IN SERVICE, OUT OF SERVICE	U1 0 = OUT OF SERVICE 1 = IN SERVICE
Status	n errors	L,n 1. L,2 1. <ERRCODE ₁ > 2. < ERRTEXT ₁ > . . n. 1.< ERRCODE _n > 2. <ERRTEXT _n >

5.4 SECS-II Data Items Without Corresponding SEMI E87 Parameters

5.4.1 Table 3 contains the SECS-II data items that do not correspond to SEMI E87's service parameter.

Table 3 Additional Data Item Requirements Table

<i>Function</i>	<i>SECS-II Data Item</i>
Used by S3,F17 to differentiate between Bind, CancelCarrierOut, CancelCarrierAtPort, CancelBind, CarrierIn, ProceedWithCarrier, CancelCarrierNotification CarrierNotification services, and CarrierReCreate.	CARRIERACTION
Used to satisfy SECS-II conventions for linking a multi-block inquiry with a subsequent multi-block message. Neither required nor specified by CMS.	DATAID
Used to inform receiver of total message length size for SECS-II multi-block conventions. May also be used to indicate the length of a section of data being transmitted to or from a carrier tag.	DATALLENGTH
Used to satisfy SECS-II multi-block requirements. Neither required nor specified by SEMI E87.	GRANT
Used by S3,F25 to differentiate between port related, CancelReservationAtPort, and ReserveAtPort services.	PORTACTION
Used by S3F27 to specify desired Port Access Mode.	ACCESSMODE

6 Variable Data Item Mapping

6.1 This section shows the specific SECS-II data classes, and formats needed for SECS-II implementations of SEMI E87 variable data items.



Table 4 Variable Data Item Mapping Table

<i>Variable Name</i>	<i>Class</i>	<i>Format</i>
AccessMode	DVVAL	51 (U1) Enumerated: 0 = MANUAL 1 = AUTO
AccessMode _i	SV	51 (U1) Enumerated: 0 = MANUAL 1 = AUTO
AvailPartitionCapacity	DVVAL	51
AvailPartitionCapacity _i	SV	51
BufferCapacityList	SV	L,n 1. <BufferPartitionInfo ₁ > . . n. <BufferPartitionInfo _n >
BufferPartitionInfo	DVVAL	L, 5 1. <PartitionID> 2. <PartitionType> 3. <AvailPartitionCapacity> 4. <PartitionCapacity> 5. <UnallocatedPartitionCapacity>
BufferPartitionInfo _i	SV	L, 5 1. <PartitionID _i > 2. <PartitionType _i > 3. <AvailPartitionCapacity _i > 4. <PartitionCapacity _i > 5. <UnallocatedPartitionCapacity _i >
CarrierAccessingStatus	DVVAL	51 (U1) Enumerated as: 0 = NOT ACCESSED 1 = IN ACCESS 2 = CARRIER COMPLETE 3 = CARRIER STOPPED
CarrierID	DVVAL	A[1–80] (Conforms to restrictions of ObjID as specified in SEMI E39.1, § 6.)
CarrierID _i	SV	A[1–80] (Conforms to restrictions of ObjID as specified in SEMI E39.1, § 6.)
CarrierIDStatus	DVVAL	51 (U1) Enumerated as: 0 = ID NOT READ 1 = [ID] WAITING FOR HOST 2 = ID VERIFICATION OK 3 = ID VERIFICATION FAILED
CarrierLocationMatrix	SV	L,n 1. L,2 1. <LocationID ₁ > 2. <CarrierID ₁ > . . n. L,2 1. <LocationID _n > 2. <CarrierID _n >



<i>Variable Name</i>	<i>Class</i>	<i>Format</i>
LoadPortReservationState	DVVAL	51 (U1) Enumerated as: 0 = NOT RESERVEED 1 = RESERVED
LoadPortReservationState _i	SV	51 (U1) Enumerated as: 0 = NOT RESERVED 1 = RESERVED
LoadPortReservationStateList	SV	L,n 1.<LoadPortReservationState _i > . . n.<LoadPortReservationState _N >
LocationID	DVVAL	A[1–80] (Conforms to restrictions of ObjID as specified in SEMI E39.1, § 6.)
LocationID _i	SV	A[1–80] (Conforms to restrictions of ObjID as specified in SEMI E39.1, § 6.)
PartitionCapacity	DVVAL	51
PartitionCapacity _i	SV	51
PartitionID	DVVAL	A[1–80] (Conforms to restrictions of ObjID as specified in SEMI E39.1, § 6.)
PartitionID _i	SV	A[1–80] (Conforms to restrictions of ObjID as specified in SEMI E39.1, § 6.)
PartitionType	DVVAL	A[1–64]
PartitionType _i	SV	A[1–64]
PortAssociationState	DVVAL	51 (U1) Enumerated as: 0 = NOT ASSOCIATED 1 = ASSOCIATED
PortAssociationState _i	SV	51 (U1) Enumerated as: 0 = NOT ASSOCIATED 1 = ASSOCIATED
PortAssociationStateList	SV	L,n 1. <PortAssociationState ₁ > . . n. <PortAssociationState _n >
PortID	DVVAL	51
PortID _i	SV	51
PortStateInfo	DVVAL	L,2 1. <PortAssociationState> 2. <PortTransferState>
PortStateInfo _i	SV	L,2 1. <PortAssociationState _i > 2. <PortTransferState _i >
PortStateInfoList	SV	L,n 1. <PortStateInfo ₁ > . n. <PortStateInfo _n >



<i>Variable Name</i>	<i>Class</i>	<i>Format</i>
PortTransferState	DVVAL	51 (U1) Enumerated as: 0 = OUT OF SERVICE 1 = TRANSFER BLOCKED 2 = READY TO LOAD 3 = READY TO UNLOAD
PortTransferState _i	SV	51 (U1) Enumerated as: 0 = OUT OF SERVICE 1 = TRANSFER BLOCKED 2 = READY TO LOAD 3 = READY TO UNLOAD
PortTransferStateList	SV	L,n 1. <PortTransferState ₁ > . . n. <PortTransferState _n >
Reason	DVVAL	51 (U1) Enumerated as: 0 = VERIFICATION NEEDED 1 = VERIFICATION BY EQUIPMENT UNSUCCESSFUL 2 = READ FAIL 3 = IMPROPER SUBSTRATE POSITION
SlotMapStatus	DVVAL	51 (U1) Enumerated as: 0 = SLOT MAP NOT READ 1 = [SLOT] WAITING FOR HOST 2 = SLOT MAP VERIFICATION OK 3 = SLOT MAP VERIFICATION FAILED
SlotMap	DVVAL	L, n n= capacity (1...25) 1. Enumerated 2. Enumerated 3. . . n Each as 51 (U1) Enumerated as: 0 = UNDEFINED 1 = EMPTY 2 = NOT EMPTY 3 = CORRECTLY OCCUPIED 4 = DOUBLE SLOTTED 5 = CROSS SLOTTED
UnAllocatedPartitionCapacity	DVVAL	51
UnAllocatedPartitionCapacity _i	SV	51

7 SECS-II Attribute Definitions

7.1 Carrier Object SECS-II Attributes Definitions

7.1.1 The following are the SECS-II structure definitions for the SEMI E87 Carrier Object.



Table 5 Carrier Object Attribute Definitions

<i>Attribute Name</i>	<i>Attribute Data Form: SECS-II Structure</i>
“ObjType”	1. “Carrier”
“ObjID”	1. <CARRIERID> (Conforms to the restrictions of ObjID as specified in SEMI E39.1, § 6.)
“Capacity”	51 (U1) Capacity Capacity Range: 1..25 Capacity Examples: 1, 13, 25
“CarrierAccessingStatus”	51 (U1) CarrierAccessingStatus CarrierAccessingStatus enumerated per Variable CarrierAccessingStatus
“CarrierIDStatus”	51 (U1) CarrierIDStatus CarrierIDStatus enumerated per Variable CarrierIDStatus
“ContentMap”	L, n n=Capacity 1. L,2 1. 20 (A) LotID 2. 20 (A) SubstID ... n. L,2 1. 20 (A) LotID 2. 20 (A) SubstID SubstID conform to the restrictions of ObjID as specified in SEMI E39.1, § 6.
“LocationID”	20 (A) LocationID LocationID conforms to the restrictions of ObjID as specified in SEMI E39.1, § 6.
“SlotMap”	L, n n=Capacity 1. 51 (U1) enumerated ... n. 51 (U1) enumerated enumerated per variable SlotMap
“SlotMapStatus”	51 (U1) SlotMapStatus SlotMapStatus enumerated per Variable SlotMapStatus.
“SubstrateCount”	51 (U1) SubstrateCount SubstrateCount Range: 0..25 SubstrateCount Examples: 1, 3, 21, 25
“Usage”	20 (A) Usage Usage is equipment defined, examples: “TEST”, “DUMMY”, “PRODUCT”

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