SEMI E153-0310
SPECIFICATION FOR AMHS SEM (AMHS SEM)

This Standard was technically approved by the Information & Control Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on January 20, 2010. Available at www.semi.org in March 2010; originally published November 2009.

1 Purpose

1.1 This Standard establishes a Specific Equipment Model (SEM) for automated material handling system (AMHS) (AMHS SEM). The model consists of equipment characteristics and behaviors that are to be implemented in addition to the SEMI E30 fundamental requirements and selected additional capabilities. The intent of this Standard is to facilitate the integration of AMHS SEM equipment into an automated (e.g., semiconductor fabrication) factory. This Document accomplishes this by defining an operational model for AMHS SEM equipment as viewed by a factory automation controller (Host). This definition provides a standard host interface and equipment operational behavior (e.g., control, state models, data reports, and reporting levels). Several topics require additional activity that are within the scope of this Standard: traffic management characteristics (queuing), parallel interface for carrier transfer (SEMI E84), transport and storage system controller architecture, and delivery of the transfer unit.

2 Scope

2.1 The scope of this Standard is limited to the usage and description of material handling devices that support transport, storage or a combination of both transport and storage as perceived by a SEMI Equipment Communications Standard 2 (SECS-II) host that complies with the GEM model (as specified in § 11). It defines the view of the equipment through the SECS communication link. It does not define the internal operation of the equipment. It includes a specific transfer command state model and transport and storage system controller (TSSC) state model as the basis for all equipment of this class.

2.2 This Document assumes that the GEM fundamental requirements and selected additional capabilities (as specified in § 11) have been implemented on the AMHS SEM equipment. It expands the GEM standard requirements and capabilities in the areas of state models (TSSC, transfer command, vehicle and carrier state models), collection events, alarm documentation, remote commands, data item variables, and material movement.

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 Referenced Standards and Documents

3.1 *SEMI Standards and Safety Guidelines*

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

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

SEMI E37 — High-Speed SECS Message Services (HSMS) Generic Services

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

3.2 *Other References*

Harel, D., "Statecharts: A Visual Formalism for Complex Systems." Science of Computer Programming 8 (1987): pp. 231–274[1]

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

[1] Elsevier Science, P.O. Box 945, New York, NY, 10159-0945, USA; http://www.elsevier.nl/homepage/browse.htt

SUPERSEDED
Documents Document Sharing Hub
Full document details: SEMI E153-0310

4 Terminology

4.1 *Abbreviations and Acronyms*

4.1.1 *AMHS* — automated material handling system

4.1.2 *FOUP* — front opening unified pod

4.1.3 *GEM* — Generic Equipment Model

4.1.4 *PGV* — person guided vehicle

4.1.5 *TSSC* — transport and storage system controller

4.2 *Definitions*

4.2.1 *carrier* — a container with one or more fixed positions for holding substrates. Examples of carriers include front opening unified pods (FOUPs) and open cassettes.

4.2.2 *carrier location* — a location in the AMHS which may correspond to a physical location or a virtual location.

4.2.3 *front opening unified pod (FOUP)* — a closed carrier for holding wafers.

4.2.4 *host* — the factory computer system, or an intermediate system, that represents the factory and the user to the equipment. Refers to the system that controls or supervises the transport and storage system controller (TSSC) throughout this Document.

4.2.5 *load port* — the interface location on the equipment where carriers are delivered.

4.2.6 *open cassette* — an open structure that holds one or more substrates.

4.2.7 *physical location* — a location that can hold at most one carrier. It includes a port, storage location, vehicle location and transfer location. They are not exclusive each other. For example, a transfer location may be a storage location.

4.2.8 *port* — a specific type of carrier location, which can be accessed by both this TS system and other system(s) or person(s). It can hold at most one carrier.

4.2.9 *port group* — a destination which represents a group of ports.

4.2.10 *production equipment* — equipment used to produce semiconductor devices, including wafer sorting, process, and metrology equipment and excluding material handling equipment.

4.2.11 *storage location* — a specific type of carrier location that is used for carrier storage.

4.2.12 *transfer location* — carrier location where AMHS pickup or set down a carrier (or carriers).

4.2.13 *transfer unit* — the element of movement (assemblage of carriers) of the TS system that consists of a maximum number of carriers allowed in a specific transfer command:

- AA is the maximum number of carriers allowed for acquire 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 maximum size of the transfer unit is the minimum of AA, BB, and CC.

4.2.14 *transport and storage system (TS system)* — a system consisted of whole AMHS devices under control of single TSSC that is used for material transport and/or storage purposes.

4.2.15 *transport and storage system controller* — controller of a transport and storage system that communicates with the Factory host and represents the system as the equipment.

4.2.16 *TS unit* — a physical component of a TS system, such as a vehicle, node, docking unit, port or crane.

4.2.17 *vehicle* — a TS unit which transfers a transfer unit between transfer locations. Vehicle picks up a carrier from transfer location in unloading action, and place a carrier to transfer location in loading action.

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

4.2.18 *virtual location* — a virtual location does not necessarily correspond to a single physical location, and may hold one or more carriers. For example a loop in the AMHS temporarily holding one or more carriers in cycle storage would be a virtual carrier location.

4.2.19 *zone* — a logical assignment referencing a set of one or more storage locations. Each storage location does not need to belong to a zone. A storage location can belong to at most one zone.

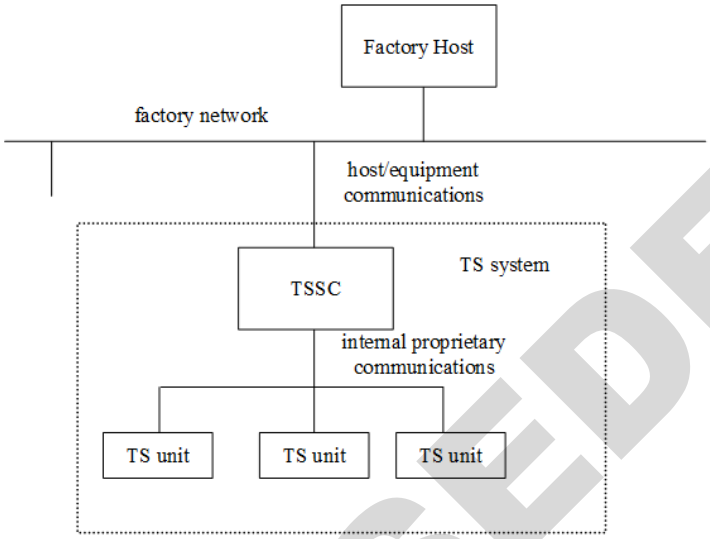

Figure 1
Example of Transport and Storage System

5 Communication Requirements

5.1 It is required that any AMHS SEM compliant equipment follow the Communications State Model in SEMI E30. In addition, AMHS SEM compliant equipment shall support the High-speed SECS Message Services Single-Session Mode (SEMI E37 and SEMI E37.1, HSMS and HSMS-SS) communication standard.

6 State Models

6.1 *State Model Requirements*

6.1.1 The state models included in this Standard are a requirement for AMHS SEM equipment. This Standard requires implementation of all SEMI E30 state models (such as control, communication, on-line/off-line, etc. according to the GEM capabilities required per § 11). 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.

6.1.2 A state model is the host's view of the equipment, and does not necessarily describe the internal equipment operation. All AMHS SEM state model transitions shall be mapped into the appropriate internal equipment 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 AMHS SEM state model for transition to another state. The equipment makes the required transition without any additional actions in this situation.

6.1.3 Some equipment may need to include additional substates other than those in this Standard. Additional substates may be added, but shall not change the AMHS SEM defined state transitions. All expected transitions between AMHS SEM states shall occur.

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

6.2 *TSSC State Model*

6.2.1 *TSSC State Model Requirements*

6.2.1.1 The purpose of the Transport and Storage system state model is to provide information to the host regarding the overall status of the Transport and Storage system. The TSSC state model is valid when the SEMI E30 (GEM) state is ON-LINE. The TSSC state model is not valid when the SEMI E30 (GEM) state is OFF-LINE. Since a transport and storage system may consist of many components (e.g., vehicle, robot arm, ID reader, etc.), it may be possible to continue ON-LINE operation when the operation mode of some transport components (as viewed by the TSSC) is a manual state. The details of what happens when individual components of the transport and storage system enter a manual state are specific to the AMHS SEM equipment supplier. When the SEMI E30 Control state changes from OFF-LINE to ON-LINE, the TSSC State Model is started from the TSSC INIT state.

6.2.2 *TSSC State Model*

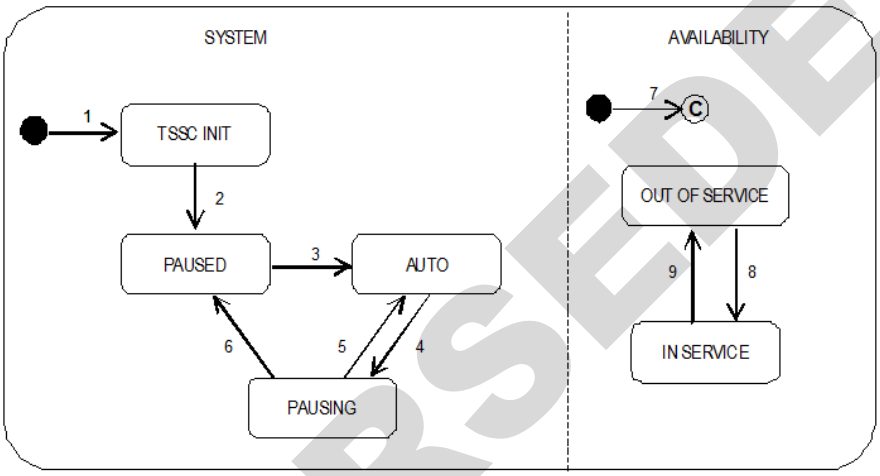

Figure 2
Generic AMHS SEM TSSC State Model Diagram

6.2.3 *TSSC State Definitions*

6.2.3.1 *TSSC INIT* — TSSC initialization of TS components is occurring. This is a non-operational state. No commands from the host will be processed or queued.

6.2.3.2 *PAUSING* — A system PAUSE command has been received and is being processed. All carriers that are currently moving will continue until they reach to safe stop positions (their transfer command may still be active). Carriers that are currently moving may continue to move but they must not begin another movement. TRANSFER commands are accepted and queued. All status requests will be processed. Other remote commands will also be processed as shown in Table 14, Remote Commands versus TSSC and TRANSFER Command States.

6.2.3.3 *PAUSED* — Carriers may be removed by other transport and storage system or by operators. TRANSFER commands are accepted and queued. All status requests will be processed. Other remote commands will also be processed as shown in Table 14, Remote Commands versus TSSC and TRANSFER Command States.

6.2.3.4 *AUTO* — System is in the normal operational state. Commands are actively processed.

6.2.3.5 *IN SERVICE* — The system is able to perform the movement of carriers.

6.2.3.6 *OUT OF SERVICE* — The system is not able to perform the movement of carriers.

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

6.2.4 *TSSC State Transition Table*

Table 1 TSSC State Transition Table

Transition #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comments*
1	None	TSSC Initiation.	TSSC INIT	S6F11 TSSCAutoInitiated	System runs through its startup sequence.
2	TSSC INIT	System started up successfully. All loads and unloads are complete.	PAUSED	S6F11 TSSCPaused	System ready.
3	PAUSED	TSSC is resumed.	AUTO	S6F11 TSSCAutoCompleted	System will now perform all commands. Stopped movement will resume normal motion.
4	AUTO	TSSC is requested to pause.	PAUSING	S6F11 TSSCPauseInitiated	All carriers that are currently moving will continue until they reach to safe stop positions.
5	PAUSING	TSSC is resumed.	AUTO	S6F11 TSSCAutoCompleted	System will now perform all commands. Stopped movement will resume normal motion.
6	PAUSING	All carrier loads and unloads are completed. No new acquires or deposits will occur. Outstanding acquires and deposits will complete.	PAUSED	S6F11 TSSCPauseCompleted	System will accept and queue new commands but will not execute them.
7	None	TSSC Initiation.	OUT OF SERVICE Or IN SERVICE	S6F11 TSSCOutOfService Or TSSCInService	The new state is based on the current status of the TS system or the state prior to system reset.
8	OUT OF SERVICE	The TS system has determined that it can be utilized for transfers.	IN SERVICE	S6F11 TSSCInService	
9	IN SERVICE	The TS system has determined that it should not be used for transfers.	OUT OF SERVICE	S6F11 TSSCOutOfService	

6.3 *TRANSFER Command State Model*

6.3.1 *TRANSFER Command State Model Requirements*

6.3.1.1 The TRANSFER command state model serves as the SEMI E30 Processing State Model. The purpose of the TRANSFER command state model is to provide information to the host regarding the control of the TRANSFER command. The TRANSFER command allows the host to manage delivery and scheduling. The control of each TRANSFER command must independently support the TRANSFER command state model.

6.3.2 *TRANSFER Command State Model Diagram*

6.3.2.1 The TRANSFER command state model is detailed for AMHS SEM equipment in Figure 3.

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

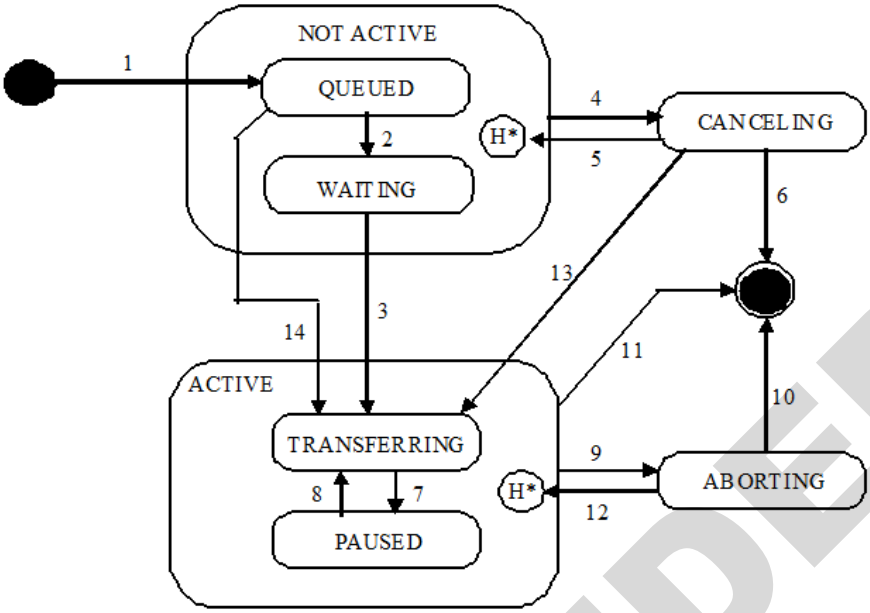

Figure 3
Generic AMHS SEM TRANSFER Command State Model Diagram

6.3.3 *TRANSFER Command State Definitions*

6.3.3.1 *NOT ACTIVE* — The transfer unit is not involved in the physical aspect of the TRANSFER command.

6.3.3.2 *QUEUED (NOT ACTIVE substate)* — TSSC has acknowledged and queued the TRANSFER command. TRANSFER command has not been initiated.

6.3.3.3 *WAITING (NOT ACTIVE substate)* — TRANSFER command has been initiated. For vehicle based system: A vehicle is on its way to the source location to acquire the transfer unit. For non-vehicle based system: This state is a transient state and transition from WAITING to TRANSFERRING occurs just after entering this state.

6.3.3.4 *ACTIVE* — The transfer unit is involved in the physical aspect of the TRANSFER command.

6.3.3.5 *TRANSFERRING (ACTIVE substate)* — The transfer command is actively being executed by the equipment.

6.3.3.6 *PAUSED (ACTIVE substate)* — The transfer command is not actively being executed by the equipment.

6.3.3.7 *CANCELING* — The TRANSFER command cancel procedure is being performed to terminate a transfer command which never entered the ACTIVE state (either QUEUED or WAITING). This state is entered via a CANCEL remote command.

6.3.3.8 *ABORTING* — The TRANSFER command abort procedure is being performed to terminate a transfer command which has entered the ACTIVE state. This state can only be entered via an ABORT remote command.

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

6.3.4 *TRANSFER Command State Transition Table*

Table 2 Transfer Command State Transition Table

Transition #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comments*
1	None	The Host generated TRANSFER command is successfully acknowledged by the TSSC.	QUEUED		
2	QUEUED	The TRANSFER command has been initiated by the TSSC.	WAITING	S6F11 Transfer-Initiated	Transport vehicle is dispatched to acquire the transfer unit. If transport can be initiated without waiting for any vehicle, TS system uses transition 14 instead of transition 2 and 3.
3	WAITING	The acquisition of the first carrier of the transfer unit begins.	TRANSFERRING	S6F11 Transferring	
4	NOT ACTIVE	Host issued cancel for the TRANSFER command is accepted by the TSSC.	CANCELING	S6F11 TransferCancel-Initiated	A CANCEL remote command was issued to terminate a TRANSFER command that has not entered the physical aspect of the command.
5	CANCELING	Transport and storage system is unable to cancel the TRANSFER command.	Previous NOT ACTIVE sub-state	S6F11 TransferCancel-Failed	The ability of the equipment to successfully complete a cancel of the TRANSFER command is specific to the AMHS SEM equipment supplier.
6	CANCELING	The cancel procedure for the TRANSFER command has completed by the transport and storage system and TSSC.	None	S6F11 TransferCancel-Completed	The transfer unit will still be situated at the transfer source location. The carriers in the transfer unit may now be included in a future transfer (either AMHS or PGV based).
7	TRANSFERRING	The TSSC pauses execution of the TRANSFER command due to an anomaly condition.	PAUSED	S6F11 TransferPaused	It is an important distinction to make that the TRANSFER command is paused even though the vehicle may not be.
8	PAUSED	The TSSC resumes execution of the TRANSFER command since the anomaly condition has been cleared.	TRANSFERRING	S6F11 Transfer-Resumed	
9	ACTIVE	Host initiates an abort of a TRANSFER command.	ABORTING	S6F11 TransferAbort-Initiated	An ABORT remote command was issued to terminate a TRANSFER command.

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

Transition #	Previous State	Trigger	New State	Actions	Comments
10	ABORTING	The abort procedure for the TRANSFER command has completed by the transport and storage system and TSSC.	None	S6F11 TransferAbort-Completed	Transfer unit could be located at any location. Located along the path of the ACTIVE transfer. The location of the carrier(s) associated with the aborted transfer command must be legal Source(s) for issuing a new TRANSFER command.
11	ACTIVE	The TRANSFER command has completed by the transport and storage system and TSSC (either successfully or unsuccessfully).	None	S6F11 TransferCompleted sent to Host with appropriate ResultCode ResultCode = 0 if successful ResultCode Not = 0 if unsuccessful	Carrier(s) could be located at any location. Located along the path of the transfer if the TRANSFER command completed unsuccessfully. The location of the carrier(s) associated with an unsuccessful transfer command must be legal Source(s) for a new TRANSFER command.
12	ABORTING	Transport and storage system is physically unable to abort the TRANSFER command.	Previous ACTIVE substate	S6F11 TransferAbort-Failed	The ability of the equipment to successfully complete an ABORT of the TRANSFER command is specific to the AMHS SEM equipment supplier.
13	CANCELING	Transport and storage system is unable to cancel the TRANSFER command because the transfer is now ACTIVE.	TRANSFERRING	S6F11 Transferring	The ability of the equipment to successfully complete a cancel of the TRANSFER command is specific to the AMHS SEM equipment supplier.
14	QUEUED	The TRANSFER command has been initiated by the TSSC.	TRANSFERRING	S6F11 Transferring	If the transfer unit must wait for any vehicle when the transport is initiated, TS system uses transition 2 and 3 instead of transition 14.

6.4 *Vehicle State Model*

6.4.1 *Vehicle State Model Requirements*

6.4.1.1 The purpose of the vehicle state model is to provide information to the host for use of transport vehicle information and metric tracking (i.e., the Host will not control vehicles). Each vehicle must individually comply with the vehicle state model. Implementation of this state model, along with associated events and variables, is not a requirement for AMHS which do not have vehicles. The Host should not be dependent on any events from the vehicle state model.

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

6.4.2 *Vehicle State Model*

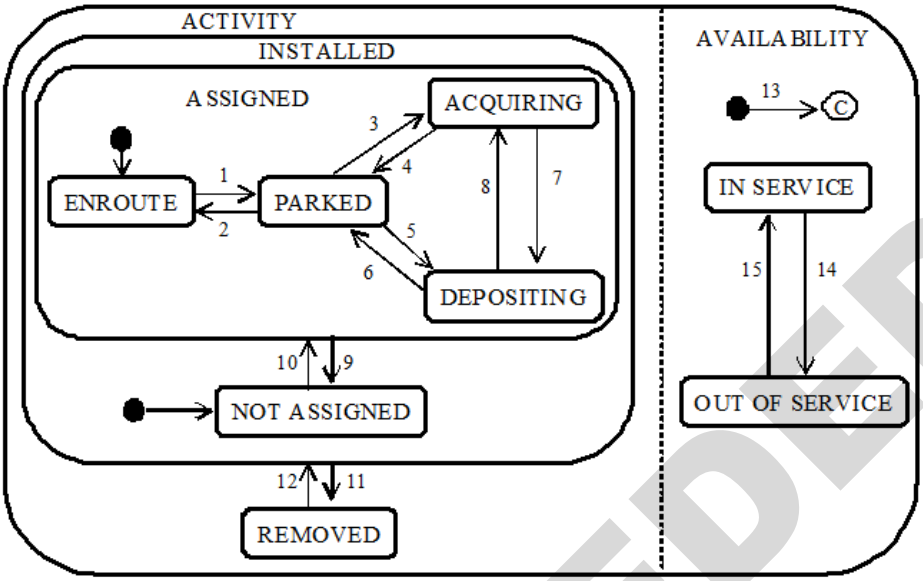

Figure 4
Generic AMHS SEM Vehicle State Model Diagram

6.4.3 *Vehicle State Definitions*

6.4.3.1 *INSTALLED* — The vehicle is available or being used for TRANSFER commands. All enabled collection events and alarms will be sent to the Host for vehicles in this state.

6.4.3.2 *REMOVED* — The vehicle is not available for Host initiated TRANSFER commands. No collection events or alarms will be sent to the Host for vehicles in this state.

6.4.3.3 *ASSIGNED (INSTALLED substate)* — Vehicle is allocated to a TRANSFER command.

6.4.3.4 *NOT ASSIGNED (INSTALLED substate)* — Vehicle is not allocated to a TRANSFER command. The vehicle may contain a carrier as the result of a command being aborted.

6.4.3.5 *IN SERVICE* — The vehicle is able to perform the movement of carriers. The ASSIGNED and NOT ASSIGNED states are not substates of this state because an ASSIGNED to NOT ASSIGNED transition can occur when the vehicle is 'OUT OF SERVICE' due to a command being canceled or aborted.

6.4.3.6 *OUT OF SERVICE* — The vehicle is not able to perform the movement of carriers. If a command is issued by the Host, it shall not be rejected solely because the vehicle is in this state. In other words, the state of the vehicle is not a valid reason to reject a command from the Host.

6.4.3.7 The following are optional substates of the ASSIGNED state.

6.4.3.8 *ENROUTE (ASSIGNED substate)* — The vehicle is on its way to a transfer locations. This is the default entry into the ASSIGNED state since it must be entered for the host to track vehicle metrics completely and adequately.

6.4.3.9 *PARKED (ASSIGNED substate)* — This state occurs when the vehicle is in the following conditions:

- After the arrival of the vehicle is completed and before the action of the transfer agent is started.
- After the action of the transfer agent has completed and before the departure of the vehicle.
- After continuous actions of the transfer agent (e.g., acquire/acquire and deposit/deposit) are completed.

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

6.4.3.10 *ACQUIRING (ASSIGNED substate)* — The vehicle is currently involved in carrier acquire (one or more carriers possible depending on vehicle limitations).

6.4.3.11 *DEPOSITING (ASSIGNED substate)* — The vehicle is currently involved in carrier deposit (one or more carriers possible depending on vehicle limitations).

6.4.4 *Vehicle State Transition Table*

Table 3 Vehicle State Transition Table

Transition #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comment*
1	ENROUTE	Vehicle arrives at a transfer locations associated with an ACTIVE transfer command.	PARKED	S6F11 VehicleArrived	
2	PARKED	Vehicle departs a transfer locations associated with an ACTIVE transfer command.	ENROUTE	S6F11 VehicleDeparted	
3	PARKED	The carrier handoff parallel I/O starts for the vehicle to acquire (load) the transfer unit.	ACQUIRING	S6F11 VehicleAcquire-Started	If the vehicle is a passive type then acquisition occurs by the robot on the other equipment loading the transfer unit to the vehicle.
4	ACQUIRING	The carrier handoff parallel I/O completes for the vehicle to acquire (load) the transfer unit.	PARKED	S6F11 VehicleAcquire-Completed	
5	PARKED	The carrier handoff parallel I/O starts for the vehicle to deposit (unload) the transfer unit.	DEPOSITING	S6F11 VehicleDeposit-Started	If the vehicle is a passive type then the deposit occurs by the robot on the other equipment unloading the transfer unit from the vehicle.
6	DEPOSITING	The carrier handoff parallel I/O completes for the vehicle to deposit (unload) the transfer unit.	PARKED	S6F11 VehicleDeposit-Completed	
7	ACQUIRING	The carrier handoff parallel I/O completes for the vehicle to acquire (load) the transfer unit and starts for the vehicle to deposit (unload) the carrier.	DEPOSITING	S6F11 VehicleDeposit-Started	Carrier Replace See scenario for an example.
8	DEPOSITING	The carrier handoff parallel I/O completes for the vehicle to deposit (unload) the transfer unit and starts for the vehicle to acquire (load) the carrier.	ACQUIRING	S6F11 VehicleAcquire-Started	Carrier Replace See scenario for an example.

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

Transition #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comment*
9	ASSIGNED	Vehicle is no longer being utilized for the specified command.	NOT ASSIGNED	S6F11 Vehicle-Unassigned	This could be the result of the command being completed or aborted. It could also be the result of the TSSC scheduling algorithms assigning this vehicle to another command and/or another vehicle being assigned to this command.
10	NOT ASSIGNED	Vehicle is allocated to a TRANSFER command.	ASSIGNED	S6F11 VehicleAssigned	
11	INSTALLED	Vehicle is removed from use of transfer commands.	REMOVED	S6F11 VehicleRemoved	
12	REMOVED	Vehicle is installed for use of transfer commands.	INSTALLED	S6F11 VehicleInstalled	
13	None	System reset	OUT OF SERVICE Or IN SERVICE	S6F11 VehicleOutOfService Or S6F11 VehicleInService	The new state is based on the current status of the vehicle or the state prior to system reset.
14	IN SERVICE	The equipment has determined that the vehicle should not be used for transfers.	OUT OF SERVICE	S6F11 VehicleOutOfService	This could be the result of an alarm condition.
15	OUT OF SERVICE	The equipment has determined that the vehicle can be utilized for transfers.	IN SERVICE	S6F11 VehicleInService	

6.5 *Carrier State Model*

6.5.1 *Carrier State Model Requirements*

6.5.1.1 The purpose of the carrier state model is to provide information to the host regarding carrier tracking (the Host will not control carriers) while the carrier is in the domain of the physical domain of the TSSC. The equipment shall track each carrier in compliance with the Carrier State Model.

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

6.5.2 *Carrier State Model*

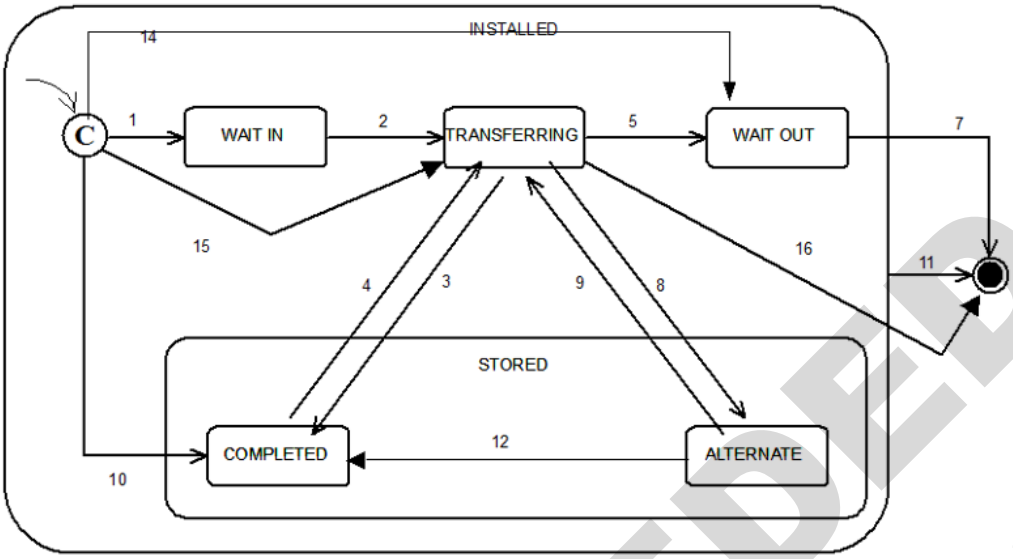

Figure 5
Generic Carrier State Model Diagram

6.5.3 *Carrier State Definitions*

6.5.3.1 *INSTALLED* — The carrier is in physical domain of the TSSC.

6.5.3.2 *WAIT IN (INSTALLED substate)* — Carrier at a port in the system. Carrier is ready to be transferred to storage or output location and no further movement or action should be taken on this carrier prior to transfer. TS system that has no port as a physical part of itself is not required to have this state.

6.5.3.3 *WAIT OUT (INSTALLED substate)* — Carrier at a port in the system. Carrier is ready to be removed by manual or other system. TS system that has no port as a physical part of itself is not required to have this state.

6.5.3.4 *TRANSFERRING (INSTALLED substate)* — Carrier 'moving' between locations in the physical domain of the TSSC. The carrier may not be physically moving but may be on the vehicle (if the system is vehicle-based) waiting for a new TRANSFER command as the result of an anomaly condition.

6.5.3.5 *STORED (INSTALLED substate)* — Carrier is sitting at a storage location. TS system that has no storage location is not required to have this state.

6.5.3.6 *COMPLETED (STORED substate)* — The carrier is stored at a storage location without associated transfer commands. This state may be as a result of completing a transfer for which this storage location represents the destination of the transfer command, or a result of aborting a transfer command when the carrier is in ALTERNATE state, or a result of INSTALL command.

6.5.3.7 *ALTERNATE (STORED substate)* — The carrier is temporarily stored at a storage location. The transfer command completion is pending until the destination and a vehicle (if the system is vehicle-based) become available.

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

6.5.4 *Carrier State Transition Table*

Table 4 Carrier State Transition Table

Transition #	*Previous State*	*Trigger*	*New State*	*Action*	*Comments*
1	none	Carrier arrives at a WaitIn position of the AMHS SEM equipment.	WAIT IN	S6F11 CarrierWaitIn	
2	WAIT IN	AMHS SEM equipment is executing a TRANSFER command for the carrier.	TRANSFERRING	S6F11 Carrier-Transferring	
3	TRANSFERRING	Completion of a TRANSFER command with a DEST of storage location.	COMPLETED	S6F11 CarrierStored	Carrier is at a storage location as its destination.
4	COMPLETED	AMHS SEM equipment is executing a TRANSFER command for the carrier.	TRANSFERRING	S6F11 Carrier-Transferring	
5	TRANSFERRING	Carrier has arrived at the port by the AMHS SEM equipment.	WAIT OUT	S6F11 CarrierWaitOut	
7	WAIT OUT	Carrier is removed from the physical domain of the TSSC.	None	S6F11 CarrierRemoved	
8	TRANSFERRING	The destination of the move command is occupied.	ALTERNATE	S6F11 CarrierStoredAlt	TSSC is waiting for the Destination to become available.
9	ALTERNATE	The port becomes available and transfer command is first in queue.	TRANSFERRING	S6F11 CarrierResumed	Carrier continues with move to the Destination.
10	None	Carrier entry is created or modified in the TSSC database.	COMPLETED	S6F11 CarrierInstall-Completed	Could be due to an INSTALL remote command or initiated by TSSC.
11	INSTALLED	Carrier entry is removed from the TSSC database.	None	S6F11 CarrierRemove-Completed	Could be due to a REMOVE remote command.
12	ALTERNATE	Transfer command is Aborted.	COMPLETED	S6F11 CarrierStored	
14	None	The result of ID read at a port during output action that did not match the expected ID.	WAITOUT	S6F11 CarrierWaitOut	

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

Transition #	*Previous State*	*Trigger*	*New State*	*Action*	*Comments*
15	None	1. AMHS acquires the carrier at SOURCE out of physical domain of the TSSC (e.g., loadport of production equipment). 2. Carrier created directly in the AMHS (as the result of duplicate ID recovery).	TRANSFERRING	S6F11 Carrier-Transferring	
16	TRANSFERRING	AMHS deposits the carrier at out-of-system port (e.g., loadport of production equipment).	None	S6F11 CarrierRemoved	

6.6 *Port Transfer State Model*

6.6.1 *Port Transfer State Model Requirements*

6.6.1.1 The purpose of the port transfer state model is to provide information to the host for the use in accessing ports. This may permit the host and AMHS SEM equipment to utilize ports that are in service while avoiding the use of ports that are not in service.

6.6.2 *Port Transfer State Model*

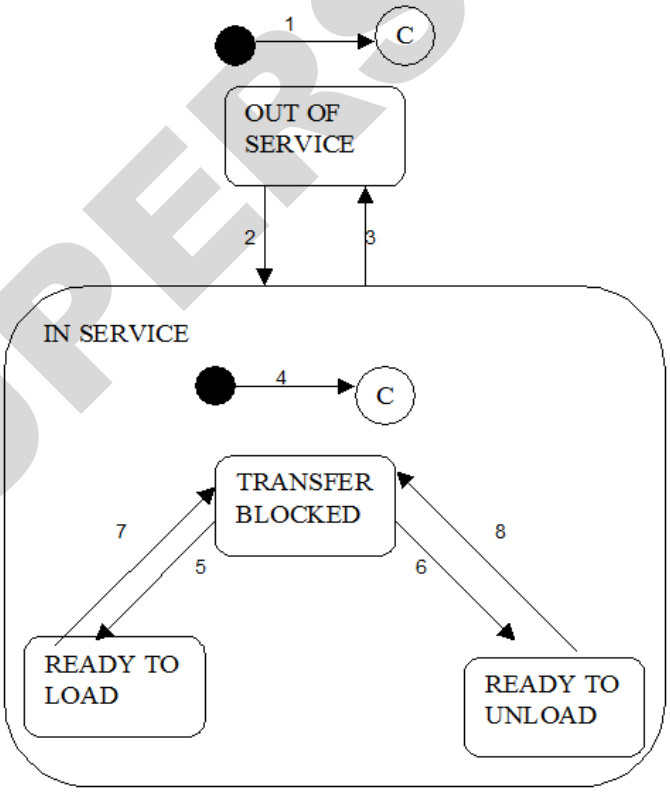

Figure 6
Port State Model Diagram

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

6.6.3 *Port Transfer State Definitions*

6.6.3.1 *OUT OF SERVICE* — Transfer to/from this port is disabled and the port should not be used in any Transfer command issued by the host. If a command is issued by the host which uses this port, it will not be rejected simply because the port is in this state.

6.6.3.2 *IN SERVICE* — Transfer to/from this port is enabled.

6.6.3.3 The following are **optional** substates of the IN SERVICE to provide information to the host for the use in accessing ports. The information is generally obtained by the TSSC via a low-level interface with the connected equipment. The connected equipment should generally, though not required, follow the Load Port Transfer State Model defined in SEMI E87. If these states are implemented, they are **not required** for every port.

6.6.3.4 *TRANSFER BLOCKED* — The state is neither READY TO LOAD nor READY TO UNLOAD.

6.6.3.5 *READY TO LOAD* — The port is able to accept (be loaded with) a carrier from the AMHS SEM equipment out of the system the port belongs.

6.6.3.6 *READY TO UNLOAD* — The port is able to have a carrier removed (unloaded) by the AMHS SEM equipment out of the system the port belongs.

6.6.4 *Port Transfer State Transition Table*

Table 5 Port Transfer State Transition Table

Transition #	*Previous State*	*Trigger*	*New State*	*Action*	*Comments*
1	None	System reset.	OUT OF SERVICE Or IN SERVICE	S6F11 PortOutOfService Or S6F11 PortInService	The new state is based on the current status of the port or the state prior to system reset.
2	OUT OF SERVICE	The equipment has determined that the port can be utilized for transfers.	IN SERVICE	S6F11 PortInService	
3	IN SERVICE	The equipment has determined that the port should not be used for transfers.	OUT OF SERVICE	S6F11 PortOutOfService	This could be the result of an alarm condition.
4	None	System Reset.	TRANSFER BLOCKED READY TO LOAD READY TO UNLOAD	S6F11 PortTransferBlocked S6F11 PortReadyToLoad S6F11 PortReadyToUnload	The new state is based on the current status of the port.
5	TRANSFER BLOCKED	Port ready for carrier delivery.	READY TO LOAD	S6F11 PortReadyToLoad	
6	TRANSFER BLOCKED	Port ready for carrier removal.	READY TO UNLOAD	S6F11 PortReadyToUnload	
7	READY TO LOAD	No carrier transfer allowed.	TRANSFER BLOCKED	S6F11 PortTransferBlocked	
8	READY TO UNLOAD	No carrier transfer allowed.	TRANSFER BLOCKED	S6F11 PortTransferBlocked	

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

6.7 *Storage location State Model*

6.7.1 *Storage location State Model Requirements*

6.7.1.1 The purpose of the storage location state model is to provide information to the host in regarding the status of individual storage locations and to allow an operator to prevent the equipment from accessing the location.

6.7.1.2 The status of a storage location may be modified for both empty and occupied locations.

6.7.1.3 Carriers are permitted to be logically installed and removed from both disabled and enabled storage locations, including the use of the REMOVE and INSTALL host commands.

6.7.2 *Storage location State Model*

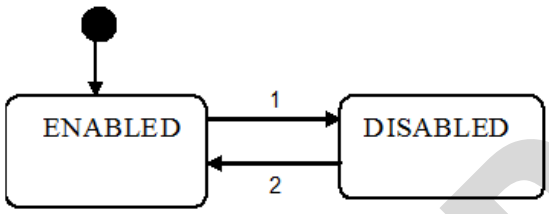

Figure 7
Storage Location State Model Diagram

6.7.3 *Storage Location State Definitions*

6.7.3.1 *ENABLED* — Transfer to/from this storage location is enabled and permitted.

6.7.3.2 *DISABLED* — The equipment shall not utilize the location for the transfer of a carrier. If the host issues a TRANSFER command which would cause the location to be accessed, the TRANSFER shall be rejected with an HCACK of 2 (cannot perform now).

6.7.4 *Storage Location State Transition Table*

Table 6 Storage Location State Transition Table

Transition #	*Previous State*	*Trigger*	*New State*	*Action*	*Comments*
1	ENABLED	The storage location has been disabled.	DISABLED	S6F11 StorageLocationStatus Changed	This is generally performed by an operator at the equipment's interface; when it is desired that a storage location not be utilized.
2	DISABLED	The storage location has been enabled.	ENABLED	S6F11 StorageLocationStatus Changed	

7 Collection Event List

7.1 This section identifies data collection events and defines (Stream 6) suggested associated variable data items. The host can use the report definition scenario defined in SEMI E30 to define reports at AMHS SEM defined levels. The intent of this section is to demonstrate that certain suggested data is available at specific events.

7.2 *Requirements*

7.2.1 This Standard requires all collection events listed in the SEMI E30 Standard (according to the GEM capabilities required per § 11).

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

7.2.2 *Collection Event Table*

Table 7 Collection Event Table (State Transition Based)

Collection Event Name	*From State*	*To State*	*Required DVVALs*
TSSC STATE TRANSITION EVENTS			
TSSCInService	None OUT OF SERVICE	IN SERVICE	N/A
TSSCOutOfService	None IN SERVICE	OUT OF SERVICE	N/A
TSSCAutoCompleted	PAUSED PAUSING	AUTO AUTO	N/A
TSSCAutoInitiated	None	TSSC INIT	N/A
TSSCPauseCompleted	PAUSING	PAUSED	N/A
TSSCPaused	TSSC INIT	PAUSED	N/A
TSSCPauseInitiated	AUTO	PAUSING	N/A
TRANSFER COMMAND STATE TRANSITION EVENTS			
TransferAbortCompleted	ABORTING	None	CommandID TransferCompleteInfo
TransferAbortFailed	ABORTING	ACTIVE (History)	CommandID
TransferAbortInitiated	ACTIVE	ABORTING	CommandID
TransferCancelCompleted	CANCELING	None	CommandID
TransferCancelFailed	CANCELING	NOT ACTIVE (History)	CommandID
TransferCancelInitiated	NOT ACTIVE	CANCELING	CommandID
TransferCompleted	ACTIVE	None	CommandInfo TransferCompleteInfo ResultCode
TransferInitiated	QUEUED	WAITING	CommandID
TransferPaused	TRANSFERRING	PAUSED	CommandID
TransferResumed	PAUSED	TRANSFERRING	CommandID
Transferring	WAITING CANCELING	TRANSFERRING TRANSFERRING	CommandID
VEHICLE STATE TRANSITION EVENTS			
VehicleArrived	ENROUTE	PARKED	VehicleID TransferLocationList
VehicleAcquireStarted	PARKED DEPOSITING	ACQUIRING ACQUIRING	VehicleID TransferLocation CarrierID (If Multi-position vehicles) TransferLocationList CarrierIDList
VehicleAcquireCompleted	ACQUIRING	PARKED	VehicleID TransferLocation CarrierID (If Multi-position vehicles) TransferLocationList CarrierIDList
VehicleAssigned	NOT ASSIGNED	ASSIGNED	VehicleID CommandID

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

Collection Event Name	*From State*	*To State*	*Required DVVALs*
VehicleDeparted	PARKED	ENROUTE	VehicleID TransferLocationList
VehicleDepositStarted	PARKED ACQUIRING	DEPOSITING DEPOSITING	VehicleID TransferLocation (If multi-position vehicles) TransferLocationList CarrierIDList
VehicleDepositCompleted	DEPOSITING	PARKED	VehicleID TransferLocation CarrierID (If multi-position vehicles) TransferLocationList CarrierIDList
VehicleInstalled	REMOVED	INSTALLED	VehicleID
VehicleRemoved	INSTALLED	REMOVED	VehicleID
VehicleUnassigned	ASSIGNED	NOT ASSIGNED	VehicleID CommandID
VehicleInService	None OUT OF SERVICE	IN SERVICE	VehicleID
VehicleOutOfService	None IN SERVICE	OUT OF SERVICE	VehicleID
CARRIER STATE TRANSITION EVENTS			
CarrierInstallCompleted	None	COMPLETED	CarrierID CarrierLoc CarrierZoneName
CarrierRemoveCompleted	INSTALLED	None	CarrierID CarrierLoc CarrierZoneName
CarrierRemoved	WAIT OUT TRANSFERRING	None None	CarrierID CarrierLoc CommandID HandoffType VehicleID
CarrierResumed	ALTERNATE	TRANSFERRING	CommandID CarrierID CarrierLoc CarrierZoneName Dest VehicleID
CarrierStored	TRANSFERRING	COMPLETED	CarrierID CarrierLoc CarrierZoneName
CarrierStoredAlt	TRANSFERRING	ALTERNATE	CommandID CarrierID CarrierLoc CarrierZoneName Dest

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

Collection Event Name	*From State*	*To State*	*Required DVVALs*
CarrierTransferring	WAIT IN COMPLETED None	TRANSFERRING TRANSFERRING TRANSFERRING	CarrierID CarrierLoc CommandID CarrierZoneName VehicleID
CarrierWaitIn	None	WAIT IN	CarrierID CarrierLoc CarrierZoneName
CarrierWaitOut	TRANSFERRING None	WAIT OUT WAIT OUT	CarrierID CarrierLoc CarrierZoneName
ZoneCapacityChange	Any State or None	Any State or None	ZoneData
ZoneStatusChanged	Any State or None	Any State or None	ZoneName ZoneCapacity ZoneSize DisabledLocations
PORT TRANSFER STATE TRANSITION EVENTS			
PortInService	None OUT OF SERVICE	IN SERVICE	PortID
PortOutOfService	None IN SERVICE	OUT OF SERVICE	PortID
PortTransferBlocked	Any	TRANSFER BLOCKED	PortID
PortReadyToLoad	Any	READY TO LOAD	PortID
PortReadyToUnload	Any	READY TO UNLOAD	PortID
STORAGE LOCATION STATE TRANSITION EVENTS			
StorageLocationStatusChanged	ENABLED	DISABLED	ZoneName ZoneCapacity DisabledLocations
StorageLocationStatusChanged	DISABLED	ENABLED	ZoneName ZoneCapacity DisabledLocations

7.2.3 'Required DVVALs' column that corresponds to more than one transition means that each of these transitions are required all specified DVVALs.

7.2.4 Variable 'CarrierLoc' in 'CarrierRemovedCompleted' event is set to the carrier location where the carrier was just before issuing of this event. 'CarrierLoc' in 'CarrierRemoved' event is set to the port where this event occurs. It means that in case of transition from TRANSFERRING to None, it is set to a port out of the TS system (e.g., a tool load port) and in case of transition from WAIT OUT to None, it is set to a port that is a part of the TS system.

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

7.3 *Non-Transition Collection Event Table*

Table 8 Non-Transition Collection Event Table

Collection Event Name	*Event Description*	*Required DVVALs*
CarrierIDRead	A carrier identification has been performed by the transport and storage system.	CarrierLoc IDReadStatus ReadCarrierID OrgCarrierID
CarrierInstallFailed	An INSTALL command has failed.	CarrierID FailureCode
CarrierLocationChanged	TSSC issues this event when a carrier enters into a carrier location predefined by supplier. The supplier is responsible to list up the predefined carrier locations.	CarrierID, CarrierLoc
CarrierRemoveFailed	A REMOVE command has failed.	CarrierID FailureCode
CarrierRenameCompleted	When TSSC changes the Carrier ID, TSSC send this event to the host.	CarrierID OrgCarrierID
OperatorInitiatedAction	The operator initiated an action from the TSSC. The related State Transition Events defined in Table 7 shall be required after this 'OperatorInitiatedAction' event.	CommandID CommandType CarrierID Source Dest Priority
UnitStatusCleared	An Informational Status has been cleared on a 'TS unit'. This event is not required for compliance with the specification but shall be generated for every UnitStatusOccurred event that is generated with a UnitStatusClearable value of 'Y'.	UnitID, UnitStatusID, UnitStatusText, VehicleState, VehicleLocation The Vehicle variables are only required if a vehicle based system is being implemented.
UnitStatusOccurred	An Informational Status occurred on a 'TS unit'. The supplier determines when and what 'status' information is to be supplied to the host. This event is not required for compliance with the specification.	UnitID, UnitStatusID, UnitStatusText, UnitStatusClearable, VehicleState, VehicleLocation The Vehicle variables are only required if a vehicle based system is being implemented.

8 Variable Data Items

8.1 The purpose of this section is to define the list of variable data item requirements for AMHS SEM equipment. Values of these variables will be available to the host via collection event reports and host status queries.

8.2 *Requirements*

- All variable data items defined in GEM and data item restrictions defined in SEMI E30 are required on AMHS SEM equipment (according to the GEM capabilities required per § 11).
- All variable data items in the AMHS SEM Variable Data Item Dictionary for specific equipment classifications are required for AMHS SEM equipment. The data item restrictions are also required.
- Some SVs in the Variable Data Item Dictionary are referenced by an 'i' subscript (e.g., $CarrierID_i$). The 'i' subscript denotes a specific instance of the SV. This is necessary since there is usually more than one instance of such an SV active in the system at the same time (e.g., if there are 20 carriers active at the same time then 'i' could range from 1 to 20 for $CarrierID_i$). Variable Data Items containing the 'i' subscript should not have Variable IDs assigned to them.

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

- All variable data items with a format of ASCII (A) shall be limited to printable characters in the decimal range of 32 to 126 with the exception of the following non-permitted characters: '*' (decimal 42), '\'(decimal 92).

8.2.1 Variable data items are documented in the AMHS SEM Variable Data Item Dictionary using the following format:

Variable Name	*Type*	*Description*	*Class*	*Format*	*Comment*

where:

Variable Name = A unique name for the variable data item.

Type = CV – meaning common variables, variables that are general to all vehicles. CSV – meaning configuration specific variables.

Description = If class is DVVAL, then the description shall contain a statement of when data is valid in terms of collection events.

Class = The data type of the item.

Format = < SECS Message Language (SML) mnemonic > acceptable formats are SEMI E5 lists, ASCII, floating point, unsigned integer or signed integer. A description of 'ANY,' indicates that only the above formats are acceptable and is left to the supplier to decide.

Comments = Any additional information pertinent to the variable name.

8.3 *Variable Data Item Types*

8.3.1 *Equipment Constants (ECV)* — The value can be changed by the host using S2F15. The operator may have the ability to change some or all of the values. The value of equipment constant may be queried at any time by the host using the S2F13/14 transaction or Stream 6 reports.

8.3.2 *Status Variables (SV)* — The values are valid at all times. A SV may not be changed by the host or operator, but may be changed by the equipment. A host or operator command may change an equipment status thus changing a SV. The value of status variables may be queried by the host at any time using the S1F3/4 or Stream 6 reports.

8.3.3 *Data Variables (DVVAL)* — These are variables which are valid upon the occurrence of a specific collection event, and may or may not be valid at other times depending upon the equipment. An attempt to read a variable data item when it's invalid will not result in an error, but the data reported may not have relevant meaning.

8.3.4 *Variable Data (V)* — This is a class of variable data which includes all the previously defined types of variables.

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

8.4 *Variable Data Item Dictionary*

Table 9 Variable Data Item Dictionary

Variable Name	*Type*	*Description*	*Class*	*Format*	*Comment*
CarrierID	CV	ID of the carrier being moved. CarrierID must be unique for each carrier within the TSSC.	DVVAL	A[1–64]	If an Id is created by the equipment (not obtained via an id reader, the host interface, or the user interface) it must be of the following format: UNKNOWNEqpNameSeq Where: UNKNOWN are the exact characters 'UNKNOWN' EqpName is the value of the EqpName ECV (truncated if required) Seq is a unique sequence identifier determined by the vendor.
$CarrierID_i$	CV	ID of the ith carrier.	SV	A[1–64]	See comment for CarrierID.
CarrierIDList	CV	The Ids of the Carriers being moved.	DVVAL	L,n 1.<$CarrierID_1$> . . n.<$CarrierID_n$>	'n' is the number of carriers being simultaneously transferred.
CarrierLoc	CSV	Location of the carrier within transport and storage system as reported by the TSSC. It is either physical or virtual location.	DVVAL	A[1–64]	For multiple position vehicles, the 'CarrierLoc' must be unique for each position on the vehicle and must be distinct from a location on any other vehicle.
$CarrierLoc_i$	CSV	Location of the ith carrier within transport and storage system as reported by the TSSC. It is either physical or virtual location.	SV	A[1–64]	
$CarrierState_i$	CV	The Carrier State	SV	U2	0 = NONE 1 = WAIT IN 2 = TRANSFERRING 3 = COMPLETED 4 = ALTERNATE 5 = WAIT OUT
CarrierZone Name	CV	The name of the zone associated with the carrier's current location.	DVVAL	A[0–64]	A location may not be associated with a particular zone.
$CarrierZone\ Name_i$	CV	The name of the zone associated with the carrier's current location.	SV	A[0–64]	A location may not be associated with a particular zone.

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

Variable Name	*Type*	*Description*	*Class*	*Format*	*Comment*
CommandID	CV	Remote Command ID Command ID generated by TSSC.	DVVAL	A[1–64]	Used to subsequently refer to a specified remote command (e.g., to cancel a remote command). If a command is generated by the TSSC using Non-Transition Collection Event 'OperatorInitiatedAction', the commandId must begin with the string 'MANUAL' followed by any arbitrary sequence identifier.
$CommandID_i$	CV	The ith Remote Command ID. The ith Command ID generated by TSSC.	SV	A[1–64]	Used to subsequently refer to a specified remote command (e.g., to cancel a remote command).
Command Info	CV	Command information associated with a particular transfer command.	DVVAL	L,3 1. <CommandID> 2. <Priority> 3. <Replace>	
Command $Info_i$	CV	Command information associated with the ith transfer command.	SV	L,3 1. <$CommandID_i$> 2. <$Priority_i$> 3. <$Replace_i$>	
CurrentPort States	CV	Current State of all the ports.	SV	L,n 1. <$PortInfo_1$> . . n. <$PortInfo_n$>	
Command Type	CV	The type of Command being initiated.	DVVAL	A[1-20]	Valid Values are 'TRANSFER' 'CANCEL' 'ABORT'
Dest	CV	Destination location identifier. A valid carrier location, zone or port group. A carrier location could be a port, storage location, or transfer location.	DVVAL	A[1–64]	
$Dest_i$	CV	The ith Destination location identifier. valid carrier location, zone or port group. A carrier location could be a port, storage location, or transfer location.	SV	A[1–64]	
Disabled Locations	CV	List of All Disabled Locations within a Zone.	DVVAL	L,n 1. <$DisabledLoc_1$> . n. <$DisabledLoc_n$>	
Disabled $Locations_i$	CV	List of All Disabled Locations within a Zone.	SV	L,n 1. <$DisabledLoc_1$> . n. <$DisabledLoc_n$>	

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

Variable Name	*Type*	*Description*	*Class*	*Format*	*Comment*
DisabledLoc	CV	A Disabled Location	DVVAL	L,2 1. <CarrierLoc> 2. <CarrierId>	If the location is empty then the CarrierId is empty.
DisabledLoc$_i$	CV	A Disabled Location	SV	L,2 1. <CarrierLoc$_i$> 2. <CarrierId$_i$>	If the location is empty then the CarrierId is empty.
Enhanced Carriers	CV	List Current status of all carrier information in the TSSC database. This includes all carriers for which there are Transfer commands.	SV	L,n 1. <EnhancedCarrierInfo$_1$> . . n. <EnhancedCarrierInfo$_n$>	
Enhanced CarrierInfo$_i$	CV	All database information associated with a particular carrier.	SV	L,5 1. <CarrierID$_i$> 2. <VehicleID$_i$> 3. <CarrierLoc$_i$> 4. <CarrierZoneName$_i$ > 5. <InstallTimei>	If Carrier is not on a vehicle, the VehicleID is empty. If the Carrier is on a vehicle then CarrierZoneName is empty. CarrierLoc always have a value.
Enhanced Transfers	CV	List current status of ALL transfer commands.	SV	L,n 1. <EnhancedTransfer Command$_1$> . . n. <EnhancedTransfer Command$_n$>	
Enhanced Transfer Command$_i$	CV	Information associated with a particular Transfer command.	SV	L,3 1. <CommandInfo$_i$> 2. <TransferState$_i$> 3. L,n 1. <TransferInfo$_1$> . n. <TransferInfo$_n$>	
Enhanced Vehicles	CV	List current status of all vehicles available or being used for TRANSFER commands.	SV	L,n 1. <EnhancedVehicle$_1$Info> . . n.<EnhancedVehicleInfo$_n$>	
Enhanced VehicleInfo$_i$	CV	Information associated with a particular vehicle.	SV	L,3 1. <VehicleID> 2. <VehicleState> 3. <VehicleLocation>	
EqpName	CV	Unique ID of the TSSC.	ECV	A[1–80]	Like a device name.

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

Variable Name	*Type*	*Description*	*Class*	*Format*	*Comment*
Extended ActiveZones	CV	List current status associated with all zones.	SV	L,n 1. <ExtendedZoneData1> .. n. <ExtendedZoneDataₙ>	
Extended ZoneDataᵢ	CV	Information associated with a particular zone.	SV	L,5 1. <ZoneNameᵢ> 2. <ZoneCapacityᵢ> 3. <ZoneTotalSizeᵢ> 4. <ZoneTypeᵢ> 6. <DisabledLocationsᵢ>	
FailureCode	CV	The failure reason used in the CarrierInstallFailed and CarrierRemoveFailed events.	DVVAL	U2	1 = Undefined Failure 2 = Location Occupied (Install) 3 = Carrier Doesn't Exist (Remove) 4–63 = Reserved
HandoffType	CV	Denotes the type of handoff that occurred at the equipment ownership transfer point (e.g., from port to vehicle).	DVVAL	U2	MANUAL = 1 means that no handoff handshake occurs (e.g., PGV handoff). AUTOMATED = 2 means that a handshake occurs (e.g., SEMI E84).
IDRead FailureOption	CV	Indicates manner in which IDRead Failures must be processed.	ECV	U1	0 = TSSCControlled 1 = HostControlled See Carrier ID Error Scenarios (Table R1-2) for detailed information.
IDReadStatus	CV	Result Code of an ID read event.	DVVAL	U2	Success = 0 Failure = 1 Duplicate = 2 Mismatch = 3
InstallTimeᵢ	CV	Time the carrier was created in the TSSC database.	SV	TIME (A16)	yyyymmddhhmmsscc
OrgCarrierID	CV	Original Carrier ID	DVVAL	A[0–64]	
PortID	CV	ID of the port.	DVVAL	A[1–64]	
PortIDᵢ	CV	ID of the port.	SV	A[1–64]	
PortInfoᵢ	CV	Port information associated with a particular port.	SV	L,2 1. <PortIDᵢ> 2. <PortTransferStateᵢ>	
PortTransfer Stateᵢ	CV	Port Transfer State.	SV	U2	1 – OutOfService 2 – InService 4 – TransferBlocked 5 – ReadyToLoad 6 – ReadyToUnload
Priority	CV	Remote command priority.	DVVAL	U2	0 is not valid. 1 is the LOWEST priority, 99 is the highest priority.

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

Variable Name	*Type*	*Description*	*Class*	*Format*	*Comment*
$Priority_i$	CV	The ith Remote command priority.	SV	U2	0 is not valid. 1 is the LOWEST priority, 99 is the highest priority.
Replace	CV	Flag to denote if a transfer command involves a carrier replace at the Dest.	DVVAL	U2	0 = OFF > 0 = ON
$Replace_i$	CV	The ith flag used to denote if a transfer command involves a carrier replace at the Dest.	SV	U2	0 = OFF > 0 = ON
ReadCarrier ID	CV	CarrierID read by ID Reader.	DVVAL	A[0-64]	
ResultCode	CV	Result Code of a transport and storage system command. Associated with the command completion event.	DVVAL	U2	Values of ResultCode will correspond to meaningful completion results (0 always signifies normal successful completion). The following Result Codes are required: 0 = Success 1 = Other Error 2 = Zone is FULL 3 = Duplicate ID 4 = Mismatch ID 5 = Failure to Read ID 6 = Source Empty 7 = Destination Occupied
Source	CV	Source location unique identifier.	DVVAL	A[1–64]	
$Source_i$	CV	The ith Source location unique identifier.	SV	A[1–64]	
SpecVersion	CV	Version of SEMI E153 to which the equipment is compliant.	SV	A[0–20]	Example values are: SEMI E153-1109. If the equipment is not compliant, a zero length value may be specified.
Transfer Command	CV	Information associated with a particular TRANSFER command.	DVVAL	L,2 1. <CommandInfo> 2. L, m 1. <$TransferInfo_1$> . . . m. <$TransferInfo_m$>	m ≤ Number of carriers in the Transfer Unit
Transfer $Command_i$	CV	Information associated with the ith TRANSFER command.	SV	L,2 1. <$CommandInfo_i$> 2. L, m 1. <$TransferInfo_1$> . . . m. <$TransferInfo_m$>	m = Number of carriers in the Transfer Unit

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

Variable Name	*Type*	*Description*	*Class*	*Format*	*Comment*
Transfer CompleteInfo	CV	Carrier information associated with a transfer.	DVVAL	L,n 1. <L,2 1. <TransferInfo$_1$> 2. <CarrierLoc$_1^{\#1}$> : : n.<L,2> 1. <TransferInfo$_n$> 2. <CarrierLoc$_n^{\#1}$>	N = size of Transfer Unit
TransferInfo	CV	Carrier information associated with a particular transfer command.	DVVAL	L,3 1. <CarrierID> 2. <Source> 3. <Dest>	
TransferInfo$_i$	CV	Carrier information associated with the ith transfer command.	SV	L,3 1. <CarrierID$_i$> 2. <Source$_i$> 3. <Dest$_i$>	
Transfer Location	CV	Transfer location unique identifier.	DVVAL	A[1–64]	Must be the name of the transfer location where the transfer is taking place, not the corresponding transport and storage system node name or number. Transfer location does not necessarily correspond to a valid Source or Dest value.
Transfer LocationList	CV	Transfer location information associated with a particular vehicle arrival or departure event.	DVVAL	L,n 1. <TransferLocation$_1$> 2. <TransferLocation$_2$> . . . n. <TransferLocation$_n$>	n > 1 for simultaneous transfers
TransferStatei	CV	State of Transfer Command.	SV	U2	1. QUEUED 2. TRANSFERRING 3. PAUSED 4. CANCELING 5. ABORTING 6. WAITING
TSSCAvail	CV	TSSC State (AVAILABILITY).	SV	U2	0 = OUT OF SERVICE 1 = IN SERVICE
TSSCState	CV	TSSC State (SYSTEM).	SV	U2	1 = TSSC INIT 2 = PAUSED 3 = AUTO 4 = PAUSING
UnitID	CV	The Id of the 'TS unit'.	DVVAL	A[1–64]	This is the id of a port, vehicle, etc.
UnitLocation	CV	The location of the 'TS unit'.	DVVAL	A[0-64]	This is the id of the location of the 'TS unit'. It could be the id of a port, a section of track, etc.

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310

Variable Name	*Type*	*Description*	*Class*	*Format*	*Comment*
UnitStatus Clearable	CV	When a UnitStatusOccured event is generated this flag indicates if the equipment is going to generate a UnitStatusCleared event when the status is corrected.	DVVAL	A[1]	'Y' – A UnitStatusCleared event will be generated. 'N' – A UnitStatusCleared event will be NOT be generated.
UnitStatusID	CV	The identification of the status.	DVVAL	A[1–64]	This is generally a vendor determined id which identifies the status. For example it could be 'LostCommunication' or 'SensorMalfunction' or '1234'.
UnitStatus Text	CV	Vendor specific information relating to the UnitStatusID.	DVVAL	A[0-80]	Information that may be helpful to an operator. This could include more precise location information or other related information.
VehicleID	CV	Unique identification of a vehicle associated with an event.	DVVAL	A[1–32]	
$VehicleID_i$	CV	Unique identification of the ith vehicle.	SV	A[1–32]	
VehicleInfo	CV	Information associated with a particular vehicle.	DVVAL	L,2 1. <VehicleID> 2. <VehicleState>	
$VehicleInfo_i$	CV	Information associated with the ith vehicle.	SV	L,2 1. <$VehicleID_i$> 2. <$VehicleState_i$>	
Vehicle Location	CV	Location of the vehicle.	DVVAL	A[0–64]	The vehicle's transfer location. The data is only valid if the vehicle is Parked, Acquiring, or Depositing.
Vehicle $Location_i$	CV	Location of the vehicle.	SV	A[0–64]	The vehicle's transfer location. The data is only valid of the vehicle is Parked, Acquiring, or Depositing.
VehicleState	CV	The state of the vehicle.	DVVAL	U2	1 = REMOVED 2 = NOT ASSIGNED 3 = ASSIGNED 4 = ENROUTE 5 = PARKED 6 = ACQUIRING 7 = DEPOSITING
$VehicleState_i$	CV	The state of the ith vehicle.	SV	U2	See VehicleState above.
ZoneCapacity	CV	Available capacity (in carriers) of a particular zone. This only includes locations which are NOT disabled.	DVVAL	U2	Example: If a zone can store 100 carriers and 25 of the locations are currently occupied and an additional 5 locations are disabled, then the ZoneCapacity is 70.

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI E153-0310

Variable Name	*Type*	*Description*	*Class*	*Format*	*Comment*
ZoneCapacity$_i$	CV	Available capacity (in carriers) of a particular zone. This only includes locations which are NOT disabled.	SV	U2	Example: If a zone can store 100 carriers and 25 of the locations are currently occupied and an additional 5 locations are disabled, then the ZoneCapacity is 70.
ZoneData	CV	Information associated with a particular zone.	DVVAL	L,2 1. <ZoneName> 2. <ZoneCapacity>	
ZoneData$_i$	CV	Information associated with a particular zone.	SV	L,2 1. <ZoneName$_i$> 2. <ZoneCapacity$_i$>	
ZoneName	CV	Alphanumeric name of a particular zone.	DVVAL	A[1–64]	
ZoneName$_i$	CV	Alphanumeric name of a particular zone.	SV	A[1–64]	
ZoneSize$_i$	CV	Size (in carriers) of a particular zone.	SV	U2	The physical size of the zone.
ZoneTotal Size$_i$	CV	The size of the zone, including Disabled Locations.	SV	U2	The value includes the number of disabled locations in the zone.

#1 Current location (transfer location or vehicle id) of the carrier is reported in 'CarrierLoc'. This may be used as a SOURCE in a following transfer command.

9 Alarm List

9.1 Since each model of AMHS SEM equipment differs in configuration, it is not practical to provide an exhaustive list of all possible alarms. Instead, the AMHS SEM is requiring the two tables provided as described in SEMI E30 (Document Section). Alarm List Table which is intended to provide for equipment configuration specific alarms and Alarm ID, Alarm Set/Cleared Event Table. Any alarm that is displayed locally at the equipment, if enabled, is required to be sent to the host. To be compliant, Tables 10 and 11 must be completed by the supplier, documenting all alarms.

9.2 *Alarm List Table*

9.2.1 The alarm list table contains examples of alarms that pertain to various configuration aspects of equipment. These examples are intended to illustrate that alarms pertain to situations in which there exists a potential for exceeding physical safety limits associated with people, equipment, and material being transported as per the SEMI E30 definition of an alarm. See SEMI E30 for further reference. The supplier is responsible for supplying documentation associated with these alarm definitions. Each alarm will have an associated alarm text (ALTX) and alarm identifier (ALID). Table 10 contains example alarm list information that is intended to be augmented when the AMHS SEM equipment supplier documents its interface.

Table 10 Alarm List Table

Equipment Cfg.	*Alarm Text*	*ALID*	*Danger*		*Affected*		
			Potential	*Imminent*	*Operator*	*Equipment*	*Material*
common	transport and storage system failure		X			X	X
	carrier Handoff Parallel I/O failure		X		X	X	X
	database error		X			X	

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI E153-0310