RELATED INFORMATION 1
APPLICATION NOTES

NOTE: This related information is not an official part of SEMI E83, but was approved for publication by full letter ballot procedures on July 14, 2000.

R1-1 The intent of this standard is to provide manually guided 300mm carrier transport PGVs a standard flange for docking and to facilitate a safe, quick, and repeatable PGV to load port carrier transfer method or mechanism. Standardization of features on the flange is intended to allow for interoperability between PGV designs and the docking flange.

R1-2 SEMI E64 defines Zone L as an exclusion zone in SEMI E15.1 compliant tools. It is intended that the docking flange be mounted in this zone.

R1-3 The docking interface flange includes features to allow for the following minimum functionality of the PGV to flange docking procedure:

- Stopping PGV motion
- Guidance of PGV to flange
- x, y & theta alignment of the PGV to the flange
- Locking of PGV to flange
- Docking parallel or perpendicular to the flange

R1-4 The PGV side of the interface may include additional features to allow for all or some of the following functionality:

- Compliance to the docking flange
- To dampen impact of docking forces

R1-5 No features on the standard docking flange provide an adjustable feature to indicate the height (dimension as H defined by SEMI E15.1) the load port horizontal datum plane has been adjusted to.

R1-6 It is likely that the alignment error and tolerance stack up between the docking interface flange and the equipment load port will not provide sufficient accuracy alone for accurate pick/placement of a pod onto the kinematic couplings on the load port.

R1-7 Possible sources of alignment error are:

- Cleanroom floor height and level
- PGV wheels and framework
- Installation accuracy of docking interface flange
- Stability of mounting

R1-8 It may be necessary to use additional alignment methods to improve accuracy of pod placement onto the kinematic couplings.

R1-9 It is expected that the interface device be floor mounted. Thus, the equipment must not require the use of support pedestals or other support structures under the floor below Zone L.

R1-10 The docking flange should sustain docking impact for the lifetime of the flange without any performance degradation.

- Assume 90kg (200lb) PGV moving at 0.3m/s (1ft/sec)
- Assume 250,000 docking cycles within a flange lifetime
- Recommended to design for 3x safety factor for single docking cycle

R1-11 Flange must be quick remove, replace, align and calibrate.

R1-12 Surface B' (shown on Figure 2) allows docking mechanism designs to grab onto the docking flange without using the docking pin for support.

R1-13 The method of attaching the vertical pin to the flange is not defined in this standard. Docking flange designers should be aware of the docking forces incurred on this pin and design the attachment method accordingly.

R1-14 The method of attaching the flange to the floor is not defined in this standard. Docking flange designers should be aware of the docking forces incurred on the flange and/or pin and design the attachment method accordingly.

R1-15 This standard specifies the radii of certain edges found on the docking flange. It is recommended that edges that do not have a specified radius are radiused or broken to eliminate sharp edges.

R1-16 It is left to user to define the needed flange length ($w2 \times 2$) at the time of placing an order.

respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their own responsibility.

SEMI E84-0305
SPECIFICATION FOR ENHANCED CARRIER HANDOFF PARALLEL I/O INTERFACE

This specification was technically approved by the Global Physical Interfaces & Carriers Committee and is the direct responsibility of the Japanese Physical Interfaces & Carriers Committee. Current edition approved by the Japanese Regional Standards Committee on November 24, 2004. Initially available at www.semi.org January 2005; to be published March 2005. Originally published June 1999; last published March 2004.

1 Purpose

1.1 Due to the migration to large wafer sizes, future semiconductor factories will use extensive automated material handling systems (AMHS) to transfer wafer carriers, including FOUPs and open cassettes, of increasing weight. The parallel input/output (PI/O) control signals between the production equipment and the AMHS must be better defined for more reliable and efficient carrier handoffs (load/unload) at production equipment load ports.

1.2 The purpose of this specification is to enhance the capabilities of the parallel I/O interface defined in SEMI E23 in order to support improvements in the reliability and efficiency of carrier transfer. The enhanced capabilities include continuous handoff, simultaneous handoff, and the capabilities of error detection on the interface.

NOTE 1: The specifications in this document shall be considered independent from the specifications in SEMI E23; therefore, use of this specification does not require SEMI E23.

2 Scope

2.1 The scope of this specification is limited to communications associated with the material handoff operations between the active equipment (for example, AMHS equipment including AGV, RGV and OHT) and the passive equipment (for example, production equipment including process and metrology equipment; stockers, etc). This scope also extends to interbay AMHS active equipment (i.e., OHS and stockers equipped with transfer devices) and passive equipment (i.e., OHS and stockers not equipped with transfer devices). This specification defines the enhanced parallel I/O interface signals used to handoff carriers between the production equipment and the AMHS. Figures 1 and 2 show examples of types of AMHS equipment.

2.2 This enhanced carrier handoff parallel I/O interface specification includes:

- Signal definition including load port assignment signals (¶6.1),
- Carrier handoff sequence definitions and time diagrams (¶6.2),
- Error indication, detection, and recovery (¶¶6.3 and 6.4),
- Connector type, signal, and pin assignment (¶6.4), and
- Interface sensor unit size to be located at load port defined by SEMI E15.1 (applicable for systems designed to handle 300 mm wafer carriers).

2.3 The enhanced carrier handoff parallel I/O interface controls the handoff of a carrier to and from the passive equipment by the active equipment. This parallel I/O interface only controls the automated handoff operation of the carrier. The handoff is the operation in which a carrier is transferred from one piece of equipment to another. Both the active and passive equipment manage this operation. The factory level controller (i.e., host) does not manage the handoff operation. Figure 3 shows applications for the parallel I/O interface specified in this document.

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 Data for the material that is transferred (handed off) is managed through the equipment's factory interface. Material management by the factory level controller is outside the scope of this document.

3.2 This specification defines the signals used to select a load port. The physical correspondence of the parallel I/O interface to the load port is not defined in this document.

3.3 Error recovery procedures may need operator assistance and/or proprietary procedures specific to the equipment. Therefore, error recovery procedures are not defined in this document.

3.4 Signal time diagrams apply to only one parallel I/O interface.

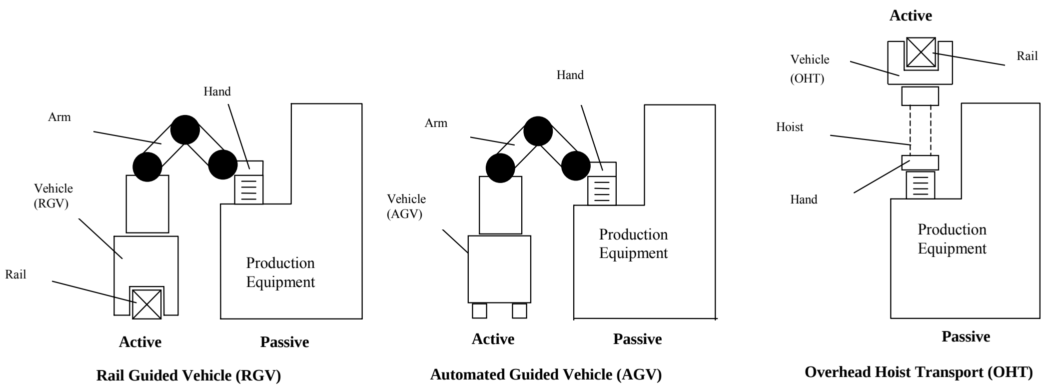

Figure 1
Examples of Automated Material Handling System Equipment (RGV, AGV, and OHT)

Figure 2
Examples of Interbay Automated Material Handling System Equipment (Stockers and OHS)

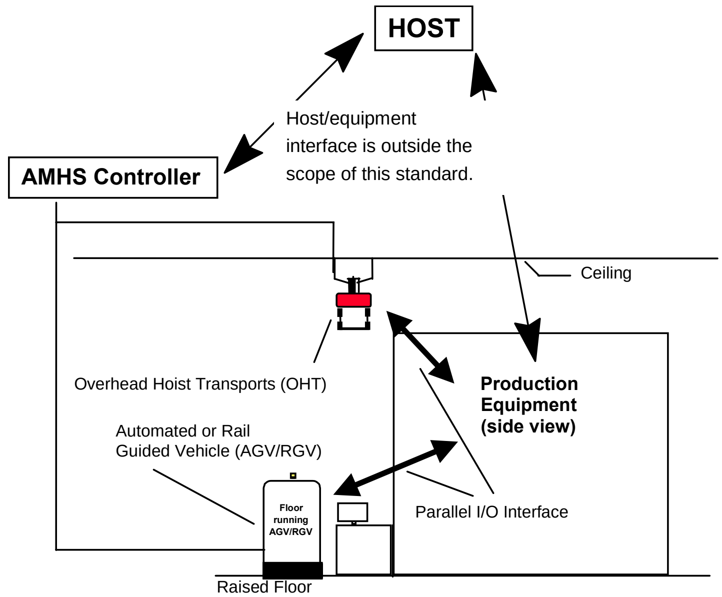

Figure 3
Examples of Enhanced Carrier Handoff Parallel I/O Interface Applications

3.5 The installation positions of the parallel I/O interface and the connector on the active and passive equipment are not defined.

3.6 The swap handoff will be considered beyond the scope of the standard for interbay AMHS equipment (i.e., OHS, stockers). During a swap handoff, loading and unloading occur simultaneously on the same loadport.

4 Referenced Standards

4.1 *SEMI Standards*

SEMI E1.9 — Mechanical Specification for Cassettes Used to Transport and Store 300 mm Wafers

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

SEMI E23 — Specification for Cassette Transfer Parallel I/O Interface

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

SEMI E47.1 — Provisional Mechanical Specification for Boxes and Pods Used to Transport and Store 300 mm Wafers

SEMI E87 — Specification for Carrier Management (CMS)

4.2 *ISO Standard* [1]

ISO 2110:1989 — Information technology — Data communication — 25-pole DTE/DCE interface connector and contact number assignments

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

5 Terminology

5.1 *Definitions*

5.1.1 *access mode* — a mode in which passive equipment knows which AMHS equipment (i.e. RGV, AGV, and OHT/OHV) or operator is permitted to make a material handoff. In the case of interbay AMHS, this is a mode in

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which the passive equipment knows which AMHS equipment (i.e., OHS and stockers equipped with transfer devices) is permitted to make a material handoff.

5.1.2 *active equipment* — equipment that loads a cassette onto the cassette stage of another piece of equipment or unloads a cassette from the cassette stage of another piece of equipment [SEMI E23].

5.1.3 *active OHS vehicle* — an active OHS vehicle that contains a device that loads or unloads the carrier from one piece of equipment to another.

5.1.4 *automated material handling system (AMHS) equipment* — a piece of equipment which has a carrier transfer robot that transfers carriers from and to passive equipment. It includes rail guided vehicles (RGV), automated guided vehicles (AGV), overhead hoist transports (OHT), overhead shuttles (OHS), and stockers.

5.1.5 *automatic access mode* — a mode in which AMHS equipment performs a material handoff rather than an operator.

5.1.6 *boundary* **—** a change in the timing single state.

5.1.7 *carrier* — any cassette, box, pod, or FOUP that contains wafers [SEMI E1.9]. Also known as wafer carrier.

5.1.8 *cassette* — an open structure that holds one or more substrates [SEMI E1.9]. Also known as open cassette (OC).

5.1.9 *continuous handoff* — successive handoffs of two carriers. Continuous handoff is in series, meaning one carrier transfer occurs and is then immediately followed by another. The continuous handoff may involve: load and load, unload and unload, or unload and load operations.

5.1.10 *front opening unified pod (FOUP)* — a box (that complies with SEMI E47.1) with a non-removable cassette (so that its interior complies with SEMI E1.9) and with a front-opening interface (FIMS) [SEMI E47.1].

5.1.11 *handoff* — is the operation in which a carrier is transferred (loaded or unloaded) from one piece of equipment to another.

5.1.12 *handoff conflict area* — an area where the active equipment resource could interfere with the passive equipment resource during the handoff operation.

5.1.13 *handoff interlock abnormal* — the state, which indicates the passive equipment, has detected abnormal conditions in the handoff operation. It may indicate the possibility that the interference of the active equipment resource with the passive equipment resource has occurred in the handoff conflict area.

5.1.14 *handoff unavailable* — the state, which indicates the passive equipment, is not available for material handoff operation.

5.1.15 *load port* — the interface location on a tool where wafer carriers are placed to allow the tool to process wafers [SEMI E15].

5.1.16 *manual access mode* — an access mode in which an operator performs a material handoff of a carrier rather than the AMHS equipment.

5.1.17 *overhead shuttle (OHS)* — an AMHS vehicle that does not use a vertical hoist mechanism to transfer the carrier from one piece of equipment to another. An OHS is typically supported on top of transport rail while overhead hoist transport (OHT) vehicles hang from underneath the transport rail.

5.1.18 *passive equipment* — equipment that is loaded or unloaded by active equipment [SEMI E23]. Passive equipment includes process equipment, metrology equipment, stockers, etc.

5.1.19 *passive OHS vehicle* — An active OHS vehicle that does not contain a device that loads or unloads the carrier from one piece of equipment to another.

5.1.20 *simultaneous handoff* — concurrent handoff operations of two carriers. Simultaneous handoff is in parallel, meaning two carriers are transferred at the same time.

5.1.21 *single arm/double hand AMHS equipment* — AMHS equipment which hands off two carriers using a single arm mechanism with two hands (dual end effectors).

5.1.22 *single arm/single hand AMHS equipment* — AMHS equipment which hands off a carrier using a single arm mechanism with a single hand (single end effector).

5.1.23 *single handoff* — the transfer of a single carrier in a handoff operation.

5.1.24 *zone* — term used for describing the intervals during PIO communication.

6 Enhanced Carrier Handoff Parallel I/O Interface Requirements

6.1 *Signal Definitions*

6.1.1 Table 1 shows the signals required for the enhanced carrier handoff parallel I/O interface. The table defines signal name, the direction of the information (P/A: P represents passive equipment and A represents active equipment), and the description. In the description, the meaning of the signal and the indication of the signal level, and comments. Signals defined in Table 1 are:

VALID	Indicates that the signal transition is active and selected.
CS_0	Carrier Stage 0
CS_1	Carrier Stage 1
TR_REQ	Transfer Request
L_REQ	Load Request
U_REQ	Unload Request
READY	READY for Transfer
BUSY	BUSY for Transfer
COMPT	Complete Transfer
CONT	Continuous Handoff
HO_AVBL	Handoff Available
ES	Emergency Stop
VA	Vehicle arrived ∗
AM_AVBL	Transfer Arm Available ∗
VS_0	Carrier Stage 0 from Passive OHS Vehicle ∗
VS_1	Carrier Stage 1 from Passive OHS Vehicle ∗

∗ The VA, AM_AVBL, VS_0,1 signals are intended only for use with interbay AMHS equipment (passive OHS vehicles).

The VALID, CS_0, CS_1 signals are not intended for use with interbay AMHS equipment (passive OHS vehicles).

6.1.2 *Load Port Assignment Signals*

6.1.2.1 The signals CS_0 and CS_1 are used to select load ports to be used for the handoff. For the parallel I/O interface which is dedicated to a single load port, the signals must be set:

CS_0 ON

CS_1 OFF

See Figures 4 and 5.

6.1.2.2 The capability to control two load ports by a common parallel I/O interface is required; therefore, it is assumed in this specification that a common parallel I/O interface can be used to control handoffs of two load ports.

6.1.2.3 The assignment of the load port is relevant when two load ports use a common parallel I/O interface. The active equipment shall select the load port by means of the CS_0 and/or CS_1 signals (see Figure 6).

CS_0 selects the left hand load port as viewed when facing towards the equipment's load ports.

CS_1 selects the right hand load port as viewed when facing towards the equipment's load ports.

6.1.2.4 For the simultaneous handoff, both of CS_0 and CS_1 must be set to ON at the handoff. Figure 8 shows a piece of passive equipment with four load ports (LP1, LP2, LP3, LP4) and two parallel I/O interfaces (PI/O#1, PI/O#2), where PI/O#1 is common to load ports LP1 and LP2 and PI/O#2 is common to load ports LP3 and LP4. Tables 2 and 3 show the range of signal combinations.

6.1.3 *Load Port Assignment Signals for OHS (Passive type)*

6.1.3.1 The signals VS_0 and VS_1 are used to select load ports to be used for the handoff. For the parallel I/O interface which is dedicated to a single load port, the signals must be set;

VS_0 ON

VS_1 OFF

6.1.3.2 Two load ports can be controlled by using VS_0 and VS_1.

VS_0 ON: Selects left hand Load port.

OFF: Does not select Left hand Load port.

VS_1 ON: Selects Right hand Load port.

OFF: Does not select Right hand Load port.

VS_0 and VS_1 are controlled individually.

Table 1 Signals for the Enhanced Carrier Handoff Parallel I/O Interface

Signal Name	*P/A*	*Description*
VALID	A -> P	Indicates that the interface communication is valid. ON: the communication is valid OFF: the communication is not valid Before this signal is turned ON, the load port must be specified by the signal CS_0 and/or CS_1.
CS_0	A -> P	Specifies the load port used for carrier handoff (¶6.1.2, Load Port Assignment Signals). One PI/O device per load port ON: Use the load port for carrier handoff OFF: N/A One PI/O device per 2 load ports ON: Use the left load port for handoff OFF: Do not use the left load port of handoff
CS_1	A -> P	Specifies the load port used for carrier handoff (¶6.1.2, Load Port Assignment Signals). One PI/O device per load port Not used (OFF) One PI/O device per 2 load ports ON: Use the right load port for handoff OFF: Do not use the right load port of handoff
TR_REQ	A -> P	Requests the handoff to the passive equipment. ON: the active equipment has requested the handoff OFF: the active equipment has not requested the handoff This signal is turned OFF when the BUSY signal transitions to OFF.

Signal Name	*P/A*	*Description*
L_REQ	P -> A	Indicates the load port is assigned to load a carrier. L_REQ always indicates a carrier transfer from Active to Passive equipment. ON: The load port is assigned to load a carrier OFF: The load port is not assigned to load a carrier This signal is turned ON when the load port is specified by CS_0 and/or CS_1 and the VALID signal is turned ON. This signal is turned OFF when the load port detects the carrier in the correct position. In simultaneous handoff, the carrier on both load ports shall not be present when this signal is turned ON, and the carriers shall be present in correct position on both load ports when this signal is turned OFF.
U_REQ	P -> A	Indicates the load port is assigned to unload a carrier. U_REQ always indicates a carrier transfer from Passive to Active equipment. ON: The load port is assigned to unload a carrier OFF: The load port is not assigned to unload a carrier This signal is turned ON when the load port is specified by CS_0 and/or CS_1, and the VALID signal is turned ON. This signal is turned OFF when the carrier on the load port is removed. In simultaneous handoff, the carrier on both load ports shall be present in correct position when this signal is turned ON, and the carriers shall not be present on both load ports when this signal is turned OFF.
READY	P -> A	Indicates the passive equipment has accepted the transfer request from the active equipment. ON: the passive equipment is ready for the handoff OFF: the passive equipment is not ready for the handoff This signal is turned ON when the passive equipment accepts the transfer request, and it is turned OFF when the COMPT signal is turned ON.
BUSY	A -> P	Indicates the handoff is in progress by the active equipment. ON: the handoff is in progress OFF: no handoff is in progress This signal is turned ON when the active equipment starts handoff operation. READY must be ON when BUSY is turned ON. It must be turned OFF after the active equipment has completed the handoff and the active equipment resource position is outside the handoff conflict area. The passive equipment must not perform any mechanical action in the handoff conflict area while this signal is ON. The active equipment turns the BUSY OFF after confirming the L_REQ or U_REQ OFF.
COMPT	A -> P	Indicates the active equipment has completed the handoff operation. ON: the handoff is completed OFF: the handoff is not completed This signal is turned ON when the active equipment has completed the handoff (BUSY OFF), and it is turned OFF after the passive equipment has completed the handoff operation (READY OFF).
CONT	A -> P	Specifies the handoff is continuous handoff. ON: continuous handoff OFF: not continuous handoff This signal is turned ON by BUSY ON for the first carrier handoff, and it is turned OFF by BUSY ON for the last carrier handoff operation. If the passive equipment has a mechanism that interferes with the handoff (such as a shutter door), that mechanism must be held in the non-interfering state (the door must remain open) during the continuous handoff.

Signal Name	*P/A*	*Description*
HO_AVBL	P -> A	Indicates the passive equipment is not available for the handoff. It may also indicate error in the passive equipment. ON: handoff is available OFF: handoff is unavailable with any error This signal is ON while the passive equipment's operation is normal. This signal shall be turned OFF when the passive equipment detects an exception for the handoff. This signal might be kept OFF, when other load ports of the passive equipment detect exceptions. The exceptions include: - Carrier detection is not correct. - The passive equipment has been changed to manual access mode. - The passive equipment is in handoff unavailable state. Examples of exceptions involving HO_AVBL are included in the Application's notes. This signal indicates the state of the passive equipment to the active equipment before the start of the handoff. See SEMI E87 for additional information and requirements about loadport access modes and availability states.
ES	P -> A	Request to stop active equipment activity immediately. ON: normal operation OFF: request to stop Normally active equipment may monitor the ES signal from VALID ON to VALID OFF. This signal is turned OFF to stop the handoff operation immediately when a hazardous situation is detected by the passive equipment. Hazardous situations include possible harm to material, product, or operation. This signal is ON while the passive equipment's operation is normal. It turns OFF when the passive equipment needs to stop the activity of the active equipment. The passive equipment may turn the ES signal off when the ES button is pressed or, a handoff interlock abnormal has occurred.
VA	P -> A	Notifies active entity of passive OHS vehicle arrival. Indicates that the interface communication is valid when the vehicle has arrived at the load port. ON: Vehicle has arrived and communication is valid. OFF: Vehicle has not arrived and communication is not valid. Before this signal is turned ON, the load port must be specified by the signal VS_0 and/or VS_1. Note: This signal is for interbay passive OHS vehicle use only.
AM_AVBL	A -> P	Notifies passive OHS vehicle of handling arm availability. Indicates the active stocker is not available for handoff operation. It may also indicate error in the active stocker. ON: Handoff is available. OFF: Handoff is unavailable with any error. This signal is ON while active stocker's operation is normal. This signal is turned OFF, when the active stocker detects some exceptions. This signal might be kept OFF, when loader's of the active stocker detects exceptions. The exceptions include: - The active stocker has been changed to manual access mode. - The active stocker is in handoff unavailable state. - When the active stocker detected off the HO_AVBL signal of passive OHS. This signal indicates the state of the active stocker to the passive OHS vehicle before the start of handoff operation. Note: This signal is for interbay passive OHS vehicle use only.
VS_0	P -> A	Signal for the passive OHS vehicle to notify the active of the load or unload position. Specifies the load port used for carrier handoff. One PI/O device per Load Port. ON: Use the load port for carrier handoff. OFF: N/A One PI/O device per 2 load ports; but vehicle does not move when accessing to 2 load ports. ON: Use the left load port for handoff. OFF: Do not use the left load port for handoff. Note: This signal is for interbay passive OHS vehicle use only.
VS_1	P -> A	Signal for the passive OHS vehicle to notify the active of the load or unload position.

Signal Name	*P/A*	*Description*
		Specifies the load port used for carrier handoff. One PI/O device per Load Port. OFF: Not used One PI/O device per 2 load ports. ON: Use the right load port for handoff. OFF: Do not use the right load port for handoff. Note: This signal is for interbay passive OHS vehicle use only.

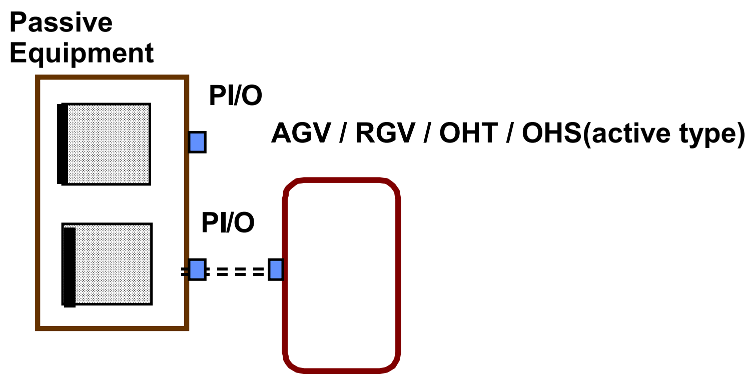
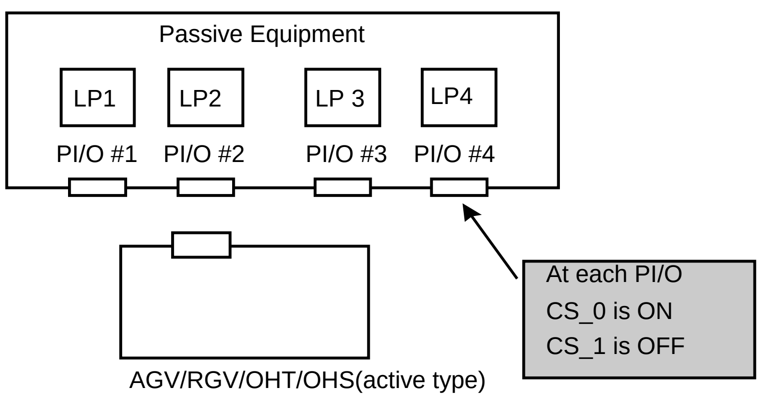
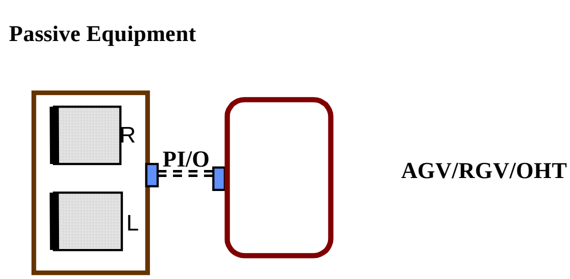


Figure 4
One Parallel I/O Interface for Each Load Port



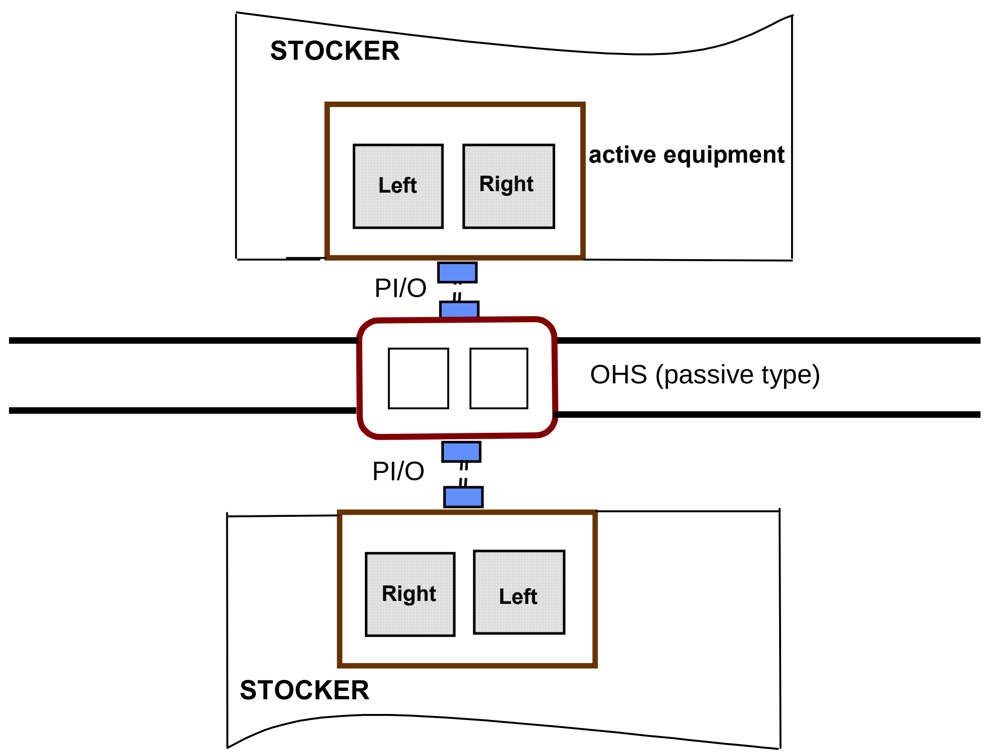
NOTE 1: This figure shows logical concept only. Physical location is not defined by this standard.

Figure 5
Example of Correspondence of CS_0/CS_1 and Load Ports (Top View) - Single PI/O Controls 1 Load Port



NOTE 1: This figure shows logical concept only. Physical location is not defined by this standard.

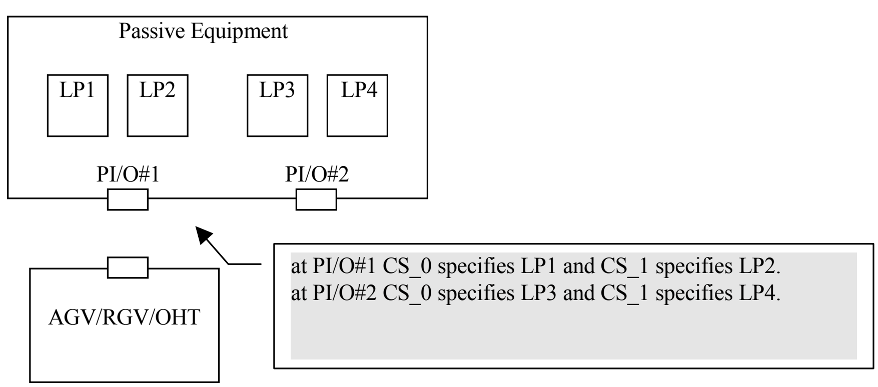
Figure 6
Common Parallel I/O for Two Load Ports



NOTE 1: This figure shows the logical concept only. Physical location is not defined by this standard.

NOTE 2: Decide the left side and right side according to the direction of the equipment from the vehicle.

Figure 7
Common Parallel I/O for Two Load Ports (Interbay AMHS Scenario)



NOTE 1: This figure shows logical concept only. Physical location is not defined by this standard.

Figure 8
Example of Correspondence of CS_0/CS_1 and Load Ports (Top View) - Single PI/O Controls 2 Load Ports

Table 2 Example of the Load Port Specified by CS_0/CS_1 Signal (one PI/O per 2 load ports)

PI/O#	*CS_0*	*CS_1*	*Load Port*	*Comment*
1	ON	OFF	LP1	Single Handoff or Continuous Handoff
1	OFF	ON	LP2	Single Handoff or Continuous Handoff
1	ON	ON	LP1 & LP2	Simultaneous Handoff
2	ON	OFF	LP3	Single Handoff or Continuous Handoff
2	OFF	ON	LP4	Single Handoff or Continuous Handoff
2	ON	ON	LP3 & LP4	Simultaneous Handoff

Table 3 Example of the Load Port Specified by CS_0/CS_1 Signal (one PI/O per load port)

PI/O#	*CS_0*	*CS_1*	*Load Port*	*Comment*
1	ON	OFF	LP1	When a PI/O is dedicated to a single load port, CS_0 is always on, CS_1 is always off.
2	ON	OFF	LP2	
3	ON	OFF	LP3	
4	ON	OFF	LP4	

Table 4 Example of the Load Port Specified by VS_0/VS_1 Signal (One PI/O per 2 load ports)

		Left Load Port	*Right Load Port*
VS_0	ON	○	♦
	OFF	×	♦
VS_1	ON	♦	○
	OFF	♦	×

○ = Select
× = Not Select
♦ = Do not care

6.2 *Carrier Handoff Sequences*

6.2.1 The signals of the enhanced carrier handoff parallel I/O interface compliant to this specification must follow these defined sequences. The time diagrams of the carrier handoff sequences are shown in Figures 10–29. Figure 10 is a summary of various handoffs including load/unload and single/simultaneous/continuous handoff sequences. Figure 11 is a transition model of zones. Each change in signal state is numbered in the time diagrams. These numbers are for reference only and may not correspond with the handoff steps or signal order requirements in ¶6.2.

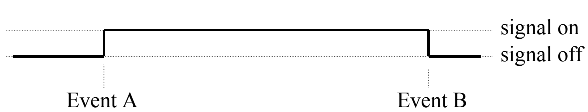


Figure 9
Key for Timing Diagram Signal States

6.2.2 *Load/Unload Boundaries*

6.2.2.1 Changes in the signal state are shown and described as boundaries to clarify each step during handshake and transfer as seen in the signal time diagram in Figure 10 and Tables 5 and 6.

Table 5 Boundary Description

	Description
A	Active equipment starts specifying the port.
B	Active equipment tries to engage with the passive equipment in a transfer validating its request.
C	Passive equipment indicates to the active equipment that it accepts to be engaged in a transfer based in its load port condition (Load or unload).
D	Active equipment agrees with passive equipment intent and indicates is ready for the transfer.
E	Passive Equipment replies it is also ready for transfer.
F	Start of physical handoff (Assign/resign continuous handoff).
G	Passive equipment detects that a carrier has been placed/removed.
H	Active equipmrent signals the end of physical handoff.
I	Active equipment terminates request for transfer.
J	Active equipment signals that the transfer engagement has completed.
K	Passive equipment indicates that no further transfer activity will occur between them.
L	Active equipment signals acknowledgement of completion of intent to transfer.
M	Active equipment indicates passive equipment no intent of further handshake.
N	Active equipment drops port request signal to leave.

6.2.3 *Zone*

6.2.3.1 Specific time intervals are clarified in nesting structure and defined as zones. Each zone is defined in Figure 10 and Table 6.

Table 6 Zones

Zone	*Definition/Description*
Handshake Active B to M	This zone indicates the state of communication that active equipment is intending to communicate with passive equipment. Start at: VALID ON End at: VALID OFF (last VALID OFF for continuous handoff) Requirements – Passive equipment is not bounded to any transfer activity previous to or after these transitions.
Handshake Engaged C to L	This zone is included in “Handshake Active”. This zone indicates the state of communication that passive equipment is responding to active equipment. Start at: L_REQ ON or U_REQ ON End at: COPY OFF (last COMPT OFF for continuous handoff) Requirement – Passive equipment does not perform any physical activity that changes the load or unload conditions in the equipment after setting L-REQ or U-REQ. Passive equipment shall perform necessary operation such as clamping or docking after the load operation only after it sets Ready signal OFF.
Handoff Request C to L	This zone is included in “Handoff Engaged”. The zone indicates the state of communication that load or unload is engaged between active equipment and passive equipment. Load Motion is engaged if L_REQ is ON and unload motion is engaged if U_REQ is ON. Start at: L_REQ ON or U_REQ ON End at: COMPT OFF Requirement – FOUP shall be kept Docked/Clamped while this request is becoming active and passive equipment shall not perform any physical action during the physical handoff other than the actions required to be ready for active handoff.
Handoff Active E to J	This zone is included in “Handoff Request”. This zone indicates the state if communication and physical condition that passive equipment is ready for active equipment to perform “Physical Handoff”. Start at: READY ON End at: COMPT ON Requirement – Passive equipment is required to undock/unclamp the FOUP and place it at the load port if the FOUP is not at the port prior to enter this zone during unload. Passive equipment shall not activate dock/undock motion and clamp/unclamp motion during loading in this zone.

Zone	*Definition/Description*
Physical Handoff F to H	This zone is inclued in “Handoff Active”. This zone indicates that the active equipment is engaged in physically delivering or removing FOUP to/from the equipment. One carrier is loaded or unloaded if CS_0 or CS_1 is ON. Two carriers are loaded or unloaded if CS_0 or CS_1 are ON Start at: BUSY ON End at: BUDY OFF Requirements – Active equipment is required to start the movement to load/unload carrier and completely move out from handoff conflict area.

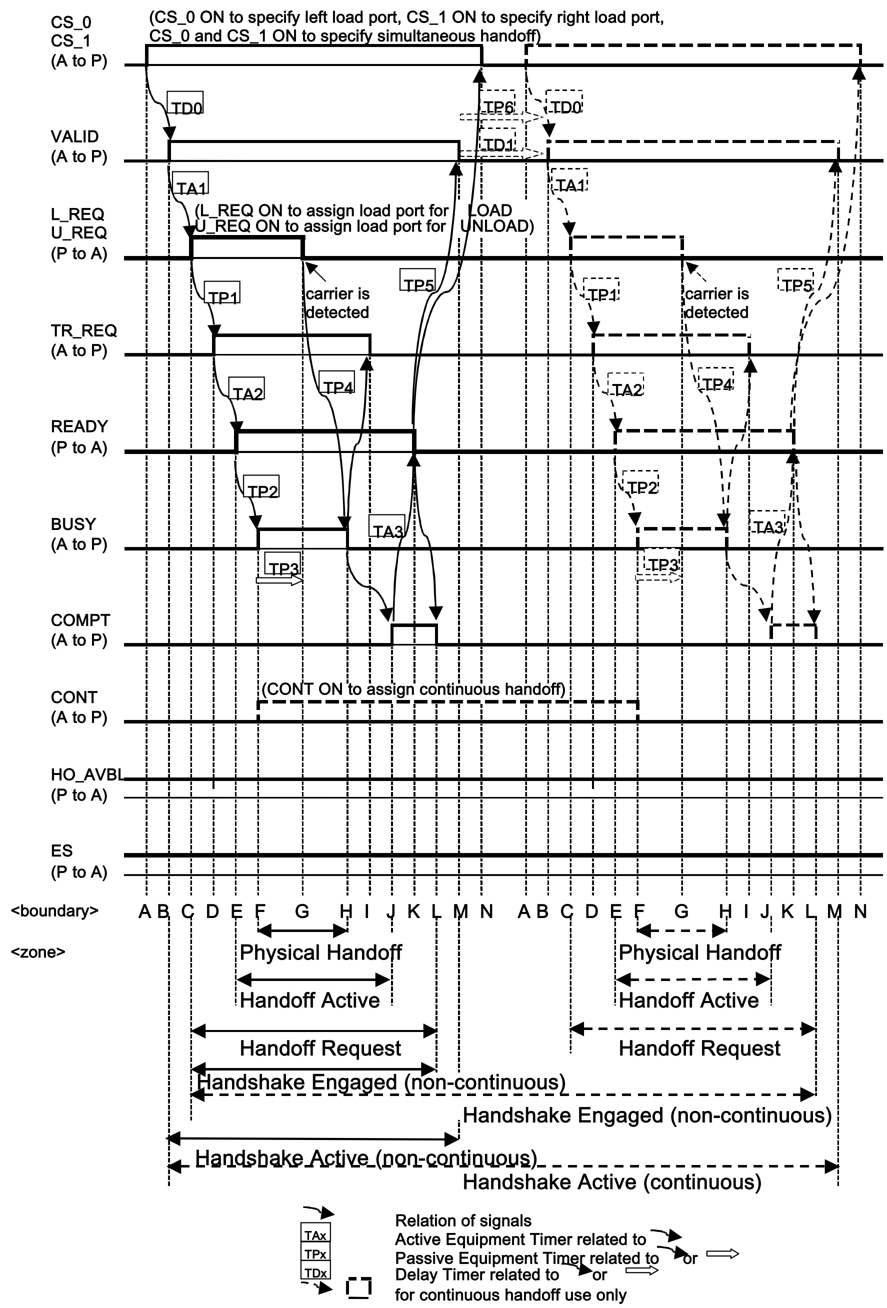
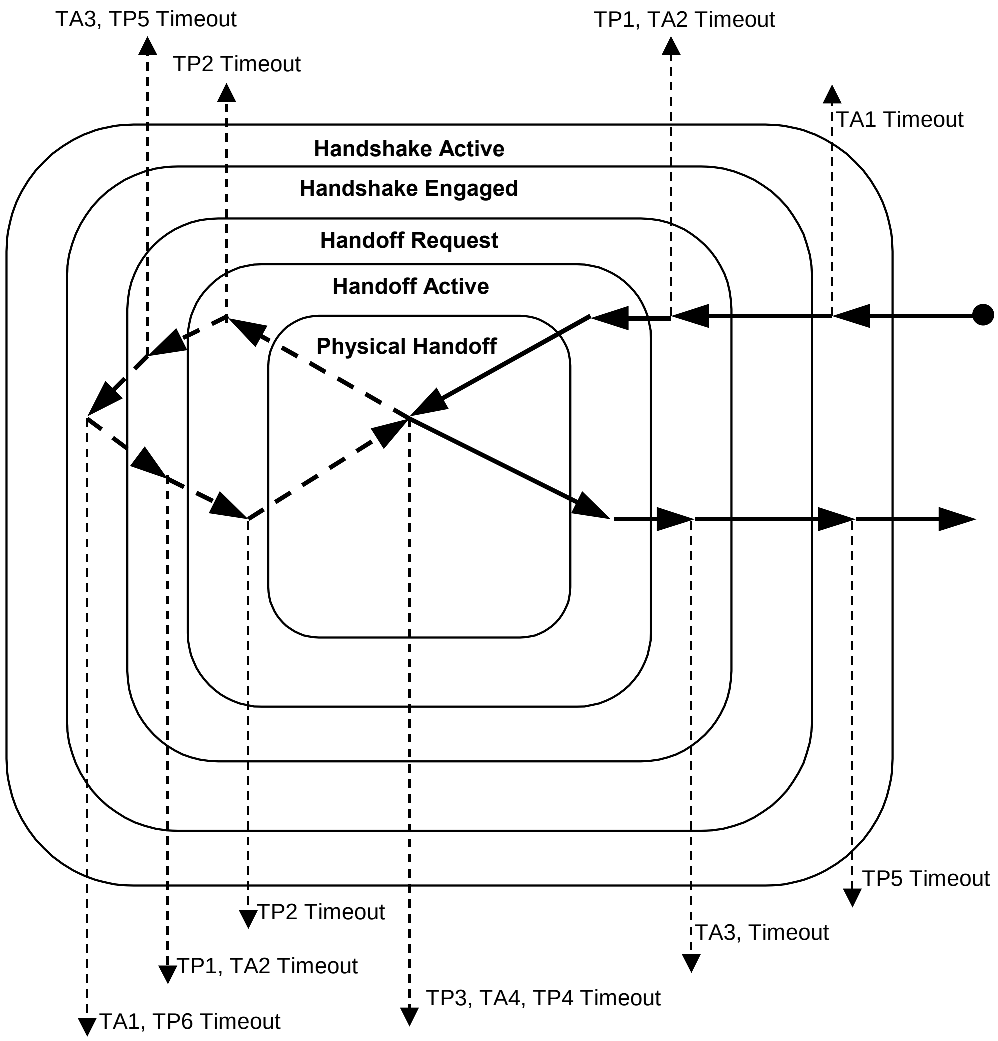


Figure 10
Summary of Time Diagram



for continuous handoff

Handshake Active	Start: VALID ON / End: VALID OFF (last VALID OFF for continuous handoff)
Handshake Engaged	Start: L_REQ ON or U_REQ ON / End: COMPT OFF (last COMPT OFF for continuous handoff)
Handoff Request	Start: L_REQ ON or U_REQ ON / End: COMPT OFF
Handoff Active	Start: READY ON / End: COMPT ON
Physical Handoff	Start: BUSY ON / End: BUSY OFF

Figure 11
State Transition Model

6.2.4 *Single Handoff Sequence (loading/unloading)*

6.2.4.1 The time diagrams of the loading and unload-ing operations in single handoff are shown in Figures 12 and 13, respectively. The sequence shown in Figures 12 and 13 is:

1) After the active equipment (AMHS equipment) reaches the handoff location in front of the load port, the active equipment specifies the load port number at which the active equipment is to handoff a carrier to the passive equipment using CS_0 and CS_1.

2) The active equipment turns the VALID signal ON. It shows that the signal transition of CS_0 and CS_1 is valid.

NOTE 2: The passive equipment should not verify if the CS_0 or CS_1 signals are ON until after the active equipment has turned the VALID signal ON, which signifies the interface communication is valid.

3) The passive equipment turns the L_REQ signal ON if the load port is ready to perform loading operation and turns the U_REQ signal ON if the load port is ready to perform unloading operation.
4) To request the passive equipment to start the carrier handoff operation, the active equipment turns the TR_REQ signal ON.
5) The passive equipment turns the READY signal ON when the passive equipment is ready for the handoff of the carrier.
6) After confirming the READY signal is ON, the active equipment turns the BUSY signal ON and starts the handoff operation.
7) The passive equipment turns the L_REQ (U_REQ) signal OFF when a carrier is placed correctly on the load port (when the carrier on the load port is removed).
8) After the completion of the load or unload operation and after the active equipment is clear of the handoff conflict area, the active equipment turns the BUSY signal OFF. The active equipment must confirm L_REQ signal (U_REQ signal) is turned OFF before the BUSY signal turn OFF.
9) The active equipment turns the TR_REQ signal OFF after the BUSY OFF.
10) The active equipment turns the COMPT signal ON to inform the passive equipment about the completion of the handoff operation.

NOTE 3: If the passive equipment verifies the BUSY and TR_REQ signals are OFF, it should verify these signals only after the active equipment has turned the COMPT signal ON, which signifies the active equipment has completed the handoff operation.

11) After confirming that the active equipment turned the COMPT signal ON, the passive equipment turns the READY signal OFF.
12) After the READY signal is turned OFF, the active equipment turns the COMPT, VALID, CS_0, and CS_1 signals OFF.
13) The handshake with the passive equipment is closed when the VALID signal is turned OFF.

NOTE 4: If the passive equipment checks for COMPT, VALID and CS_0 or CS_1 signals, it should allow the signals to turn OFF in any order without reporting an error.

6.2.4.2 This section defines the Single Handoff Sequence between the OHS (interbay passive type vehicle) and Stocker. The time diagrams of the loading and unloading operations in single handoff are shown in Figures 14 and 15, respectively. The sequence shown in Figures 14 and 15 is:

1) When the passive equipment (i.e., OHS) arrives at the active equipment (i.e., STOCKER), the passive equipment specifies to the active equipment where the handoff will take place using VS_0 and VS_1.
2) At the same time as VS_set, the passive equipment turns the L_REQ signal ON if the load port is ready to perform a loading operation or turns the U_REQ signal ON if the load port is ready to perform an unloading operation.
3) The passive equipment turns the VA signal ON. It shows that the signal transition of VS_0 and VS_1, L_REQ or U_REQ is valid.
4) After the active equipment recognizes the VA signal, it checks the VS_0 and VS_1, L_REQ and U_REQ signal and turns the TR_REQ signal ON to request the passive equipment to start the carrier handoff operation.
5) The passive equipment turns the READY signal ON when the passive equipment is ready for the handoff of the carrier.
6) After confirming the READY signal is ON, the active equipment turns the BUSY signal ON and starts the handoff operation.
7) The passive equipment turns the L_REQ (U_REQ) signal OFF when a carrier is placed correctly on the load port (When the carrier on the load port is removed).

8) After the completion of the load or unload operation and after the active equipment is clear of the handoff conflict area, the active equipment turns the BUSY signal OFF. The active equipment must confirm L_REQ signal (U_REQ) is turned OFF before the BUSY signal is turned OFF.

9) The active equipment turns the TR_REQ signal OFF at the BUSY OFF.

10) The active equipment turns the COMPT signal ON to inform the passive equipment about the completion of the handoff operation.

11) After confirming that the active equipment turned the COMPT signal ON, the passive equipment turns the READY signal OFF.

12) After the READY signal is turned OFF, the active equipment turns the COMPT OFF.

13) After confirming that the active equipment turned the COMPT signal OFF, the passive equipment turns the VS_0, VS_1 and VA OFF.

14) The handshake with the passive equipment is closed when the VA signal is turned OFF.

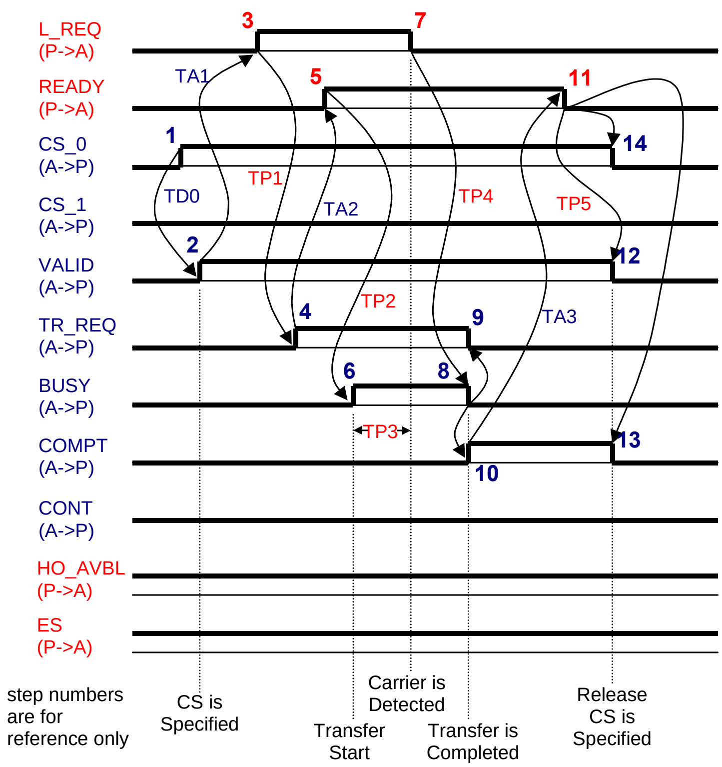


Figure 12
Signal Time Diagram for Single Handoff (LOAD)

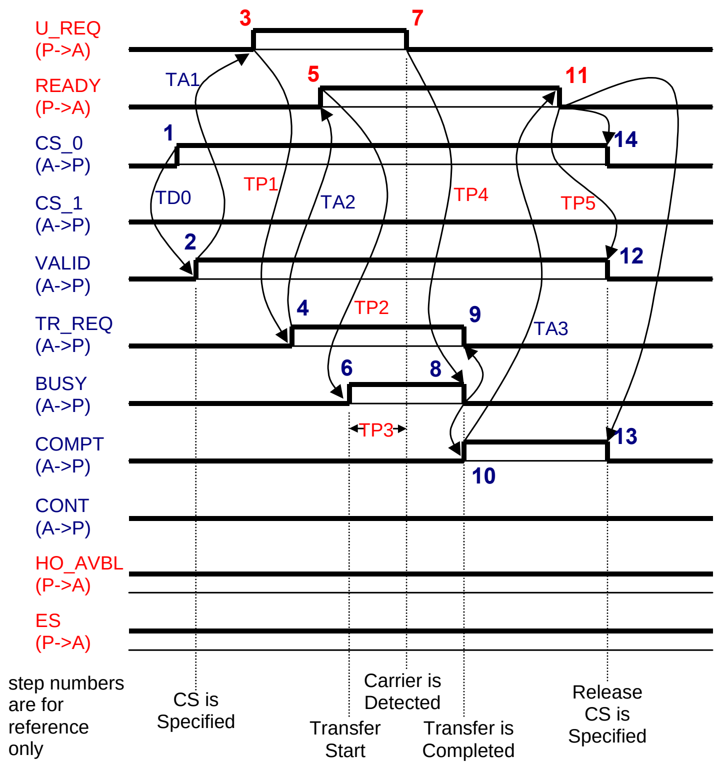


Figure 13
Signal Time Diagram for Single Handoff (UNLOAD)

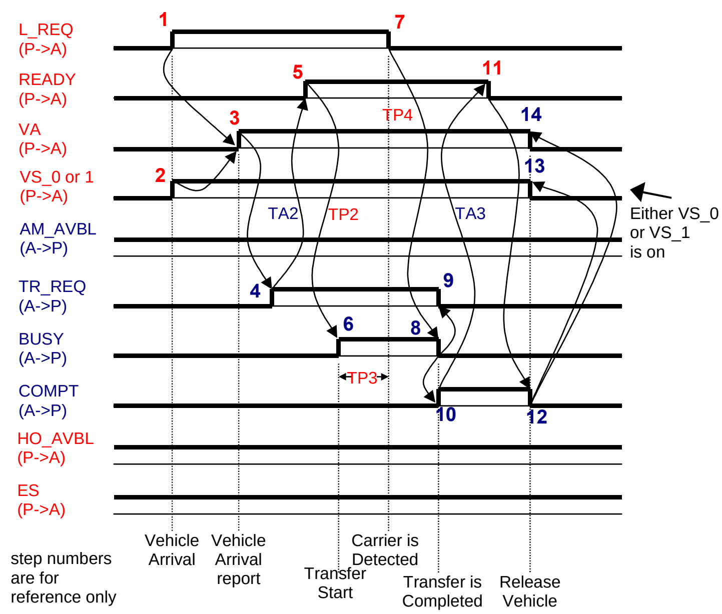


Figure 14
Signal Time Diagram for Single Handoff (LOAD)
(Interbay Passive OHS only)

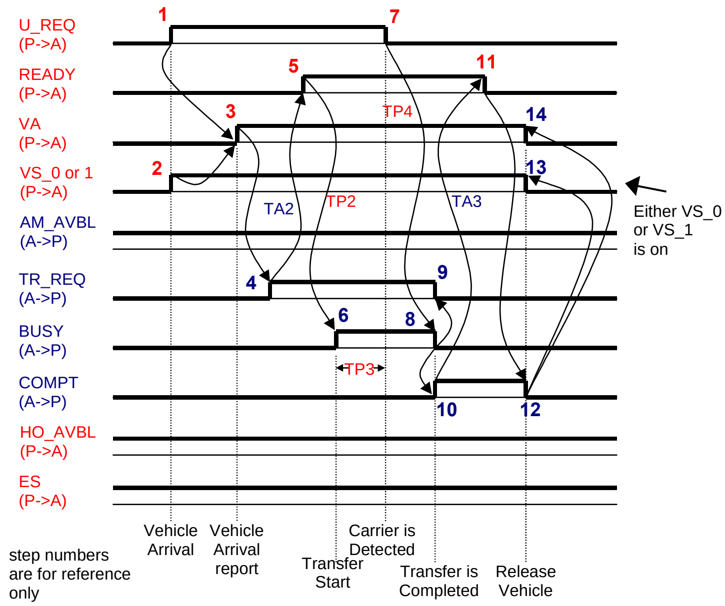


Figure 15
Signal Time Diagram for Single Handoff (UNLOAD)
(Interbay Passive OHS only)

6.2.5 *Simultaneous Handoff Sequence (loading)*

6.2.5.1 This specification defines the capability to control simultaneous handoff. Simultaneous handoff is the handoff operation in which active equipment transfers two carriers to two load ports simultaneously in a single transfer operation. Some types of AMHS equipment are able to transfer two carriers simultaneously in a transfer operation. The capability can be applied to increase the performance of the transfer. For example, simultaneous handoff can be applied to single arm/double hand AMHS equipment capable of transferring two carriers in a single transfer operation.

6.2.5.2 The time diagram of simultaneous handoff is shown in Figure 16. The figure shows only the load operation; however, L_REQ may be changed to U_REQ for the unload operation. The sequence of the simultaneous handoff is the same as that of the single handoff except that the specification of the load port with CS_0 and CS_1 signals and the definition of ON/OFF of the L_REQ and U_REQ signals are different. The following list describes the sequence which is different from Figures 12 and 13:

1) The active equipment turns the signals CS_0 and CS_1 ON to inform the passive equipment it is simultaneous handoff.

2) The active equipment turns the VALID signal ON after the transition of CS_0 and CS_1 is effective.

3) The passive equipment turns the L_REQ (U_REQ) signal ON when both carriers in the specified load ports (load ports of both CS_0 and CS_1) are ready to be loaded (unloaded).

4) When both carriers are detected (removed) at the two load ports, the L_REQ (U_REQ) signal is turned OFF.

6.2.5.3 This specification defines the capability to control simultaneous handoff. Simultaneous handoff is the handoff operation in which active equipment transfers two carriers to two load ports simultaneously in a single transfer operation. Some types of interbay AMHS equipment (i.e. stockers) are able to transfer two carriers simultaneously in a transfer operation. The capability can be applied to increase the performance of the transfer. For example, simultaneous handoff can be applied to single arm/double hand AMHS equipment capable of transferring two carriers in a single transfer operation.

6.2.5.3.1 The time diagram of simultaneous interbay handoff using a passive OHS vehicle is shown in Figure 15. The figure shows only the load operation, however L_REQ may be changed to U_REQ for the unload operation. The sequence of the simultaneous handoff is the same as that of the single handoff except that the specification of the load port with VS_0 and VS_1 signals and the definition of ON/OFF of the L_REQ and U_REQ signals are different.

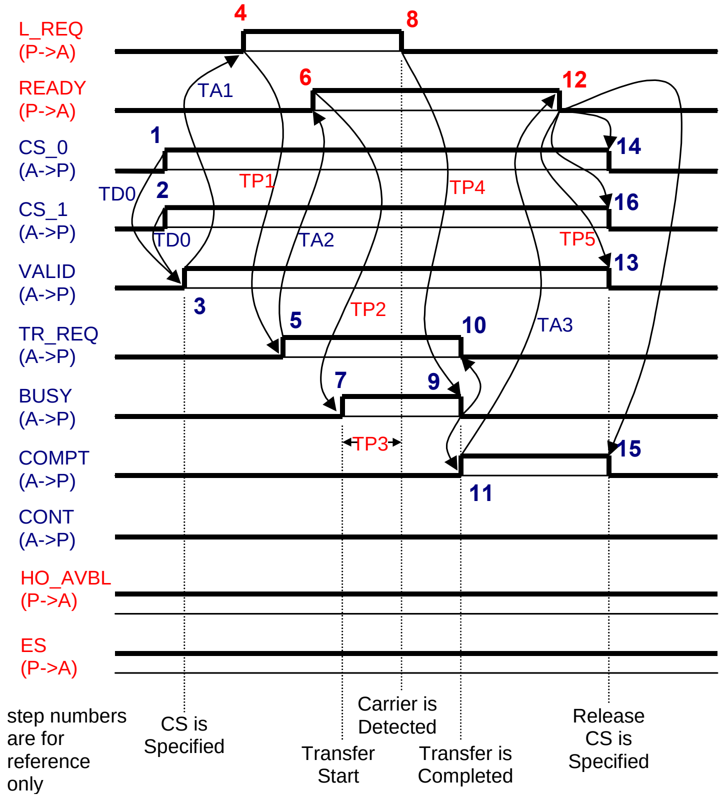


Figure 16
Signal Time Diagram for Simultaneous Handoff (LOAD)

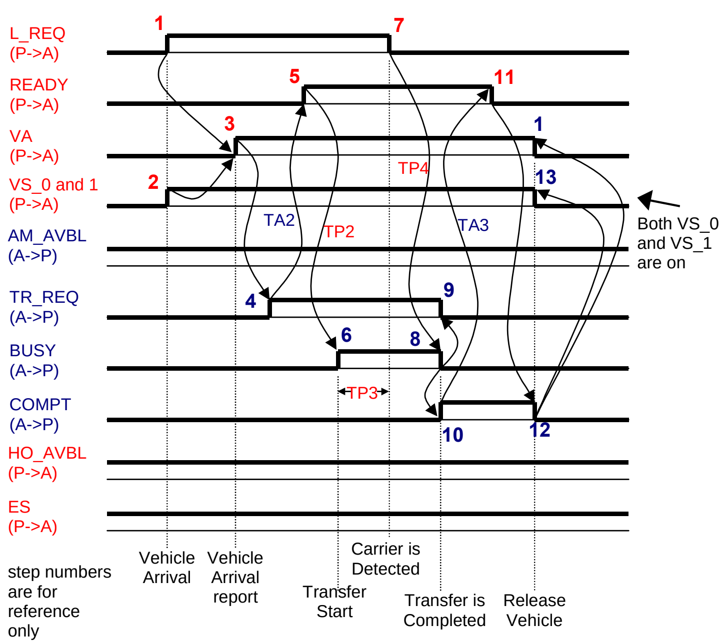


Figure 17
Signal Time Diagram for Interbay Simultaneous Handoff (LOAD) using a Passive OHS Vehicle

6.2.6 *Continuous Handoff Sequence*

6.2.6.1 This specification defines the capability to control continuous handoff. Continuous handoff is the handoff operation in which the active equipment transfers two or more carriers sequentially and continuously in a carrier transfer operation. Some types of AMHS equipment are able to handoff more than two carriers in a transfer operation. This capability can be applied to increase the performance of the transfer.

6.2.6.2 When the passive equipment has a door in front of the load port, the door on passive equipment must be opened before the carrier handoff starts by the active equipment. It is redundant to open and close the door for a carrier handoff when two or more carriers are transferred. Therefore, the door shall be kept open during the carrier transfer operation. Continuous handoff is applied to the transfer operation to avoid redundant operations.

6.2.6.3 Continuous handoff sequence for handoffs at a load port (Unload -> Load): The example time diagram for continuous handoff is shown in Figure 18. This example shows the sequence of unload and load operations performed continuously at the load port. Each sequence in the continuous handoff is the combination of the single handoff sequence. In addition, the CONT signal is used to indicate a continuous handoff. In the sequence shown in Figure 10, the carrier on the load port is unloaded first, and a new carrier is loaded on the load port. The CONT signal is turned ON at the time of active equipment BUSY ON of the first handoff to indicate that the handoff is continuous. In successive load sequences, the same load port number (CS_0 in this example) is specified to use the same load port. In this example, there are no more carriers that are to be transferred after the second load sequence, therefore the active equipment turns the CONT signal OFF when the BUSY signal is turned ON in the second handoff to indicate the continuous handoff is complete.

6.2.6.4 Continuous handoff sequence for handoffs at different load ports (Load -> Load): The example time diagram for continuous handoff on the different load ports is shown in Figure 19. In this example, the active equipment first transfers a carrier to the load port corresponding to CS_0, then another carrier is transferred to the load port corresponding to CS_1. In this example, the sequence is the same as that of the continuous handoff (handoff at a load port: Unload -> Load) shown in section above except for the specification of the load ports.

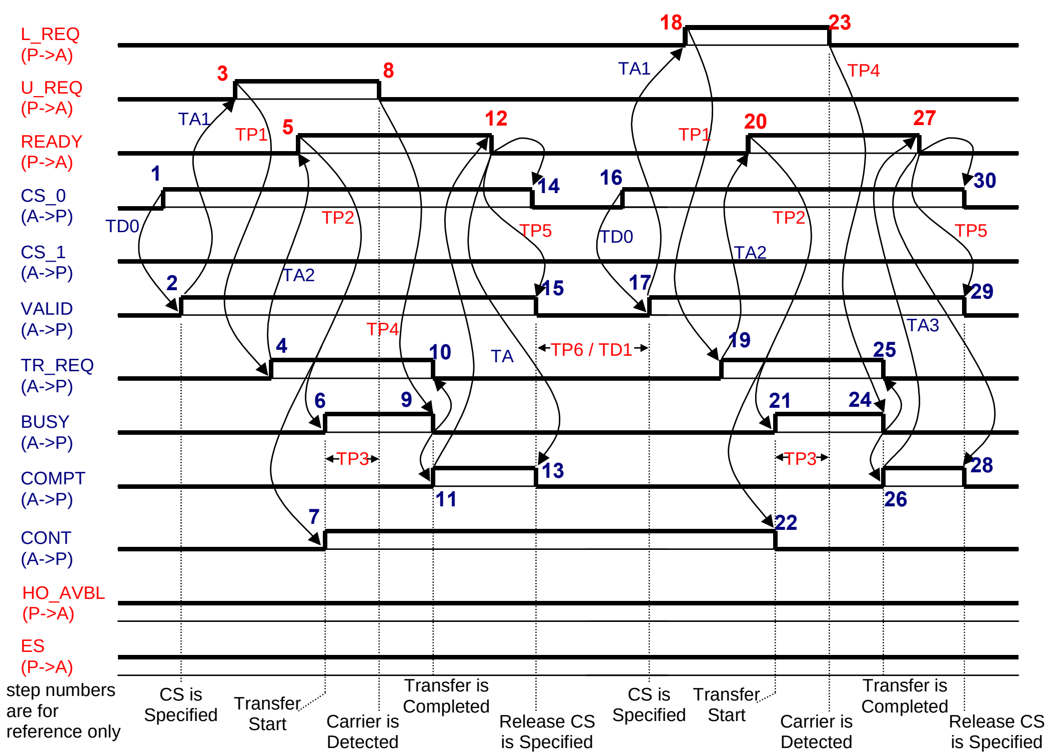


Figure 18
Signal Time Diagram for Continuous Handoff (UNLOAD and LOAD)

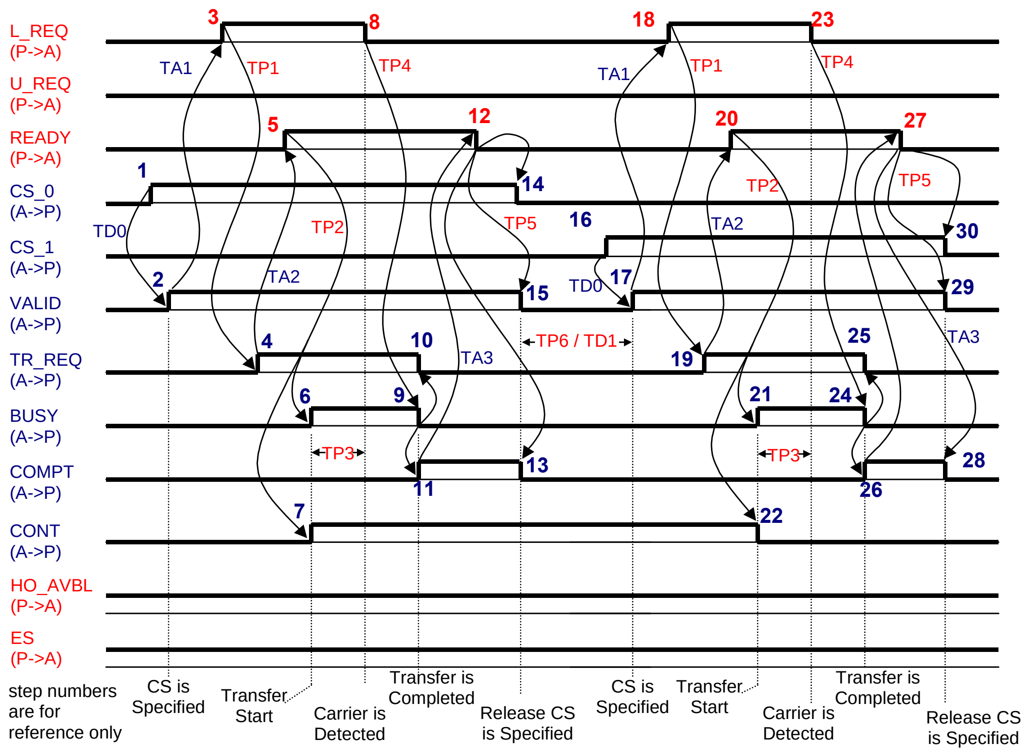


Figure 19
Signal Time Diagram for Continuous Handoff (LOAD and LOAD)

6.2.7 *Handoff Available Signal Operation Sequence (HO_AVBL)*

6.2.7.1 Example time diagrams for the HO_AVBL signal are shown in Figures 20 through 26. The HO_AVBL signal is ON during passive equipment normal operations and shall be turned OFF when the passive equipment detects an exception for the handoff. The active equipment is informed of the exception condition by the HO_AVBL signal. The HO_AVBL signal may be turned OFF independently of the other SEMI E84 signals, prior to or during the handoff. The active equipment is expected to confirm the HO_AVBL signal in the following periods:

a) From the time at which the VALID signal is turned ON to the time at which the L_REQ or U_REQ signal is turned ON.

b) From the time at which the TR_REQ signal is turned ON to the time at which the READY signal is turned ON.

6.2.7.2 Figures 20 through 23 are the time diagrams to explain situation a) in the section above and show examples of potential HO_AVBL signal activity. The active equipment stops the handoff when it detects that the HO_AVBL signal is turned OFF by the passive equipment. The active equipment turns the VALID signal OFF to close the handshake (CS_0 and CS_1 signals must be set to OFF at this time). The passive equipment turns the HO_AVBL signal ON after the VALID signal is turned to OFF (L_REQ or U_REQ must be set to OFF).

6.2.7.3 Figures 24 through 26 are the time diagrams to explain situation b) in the section above and show examples of potential HO_AVBL signal activity. The active equipment stops the handoff when it detects that the HO_AVBL signal is turned OFF by the passive equipment. The active equipment turns the VALID signal OFF to close the handshake (CS_0, CS_1, and TR_REQ signals must be set to OFF). The passive equipment turns the HO_AVBL signal ON after the VALID signal is turned to OFF (L_REQ or U_REQ must be set to OFF).

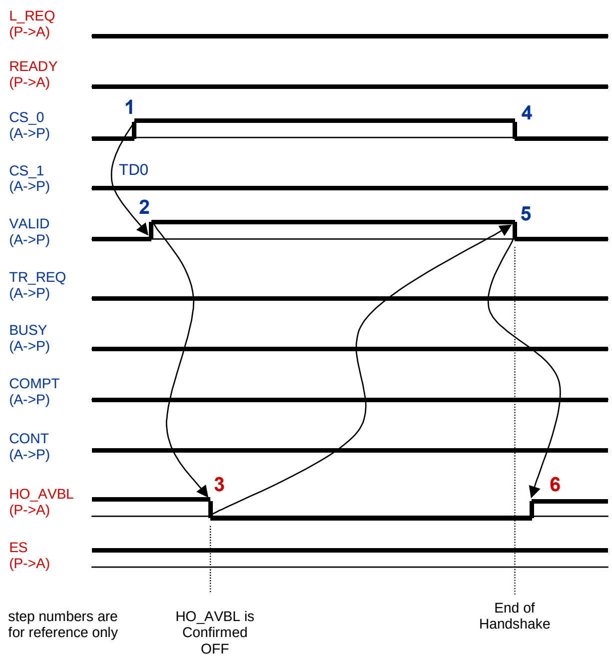
6.2.8 *Handoff Available Signal Operation Sequence (for interbay passive OHS and Stocker)*

6.2.8.1 Example time diagrams for the HO_AVBL signal are shown in Figures 27 through 29. The HO_AVBL signal is ON during passive OHS normal operations and shall be turned OFF when the passive OHS detects an exception for the handoff. The active stocker is informed of the exception condition by the HO_AVBL signal. The

HO_AVBL signal may be turned OFF independently of the other SEMI E84 signals, prior to or during the handoff. The active stocker is expected to confirm the HO_AVBL signal in the following period:

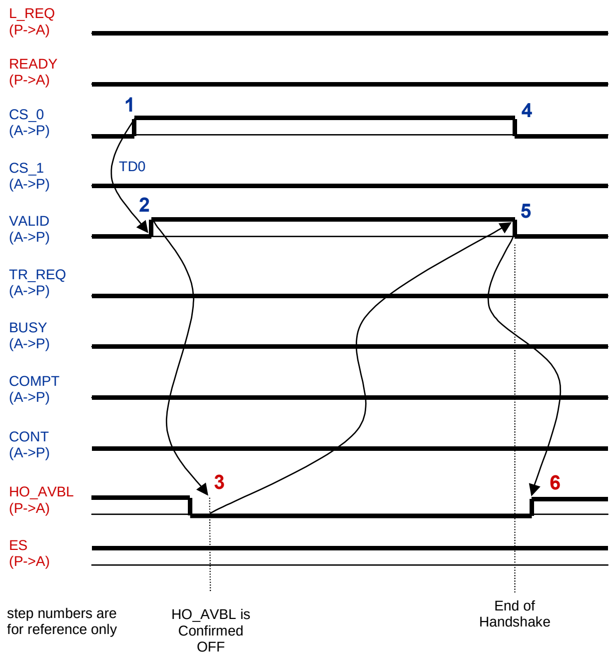
a) From the time at which the TR_REQ signal is turned ON to the time at which the READY signal is turned ON.

6.2.8.2 Figures 27 through 29 are diagrams explaining the above item a) and showing examples of potential HO_AVBL signal activity. The active stocker stops transferring when the active stocker detects that the HO_AVBL signal has been turned OFF by the passive OHS. By turning off the AM_AVBL signal, the active Stocker closes the transfer sequence. In such a case, the TR_REQ signal must go OFF as the transfer sequence has ended. Also, the passive OHS must turn OFF the VS_0 and VS_1 signals. Next, the passive OHS must turn ON the HO_AVBL signal after the VA signal has gone OFF (the L_REQ or U_REQ must be set OFF).



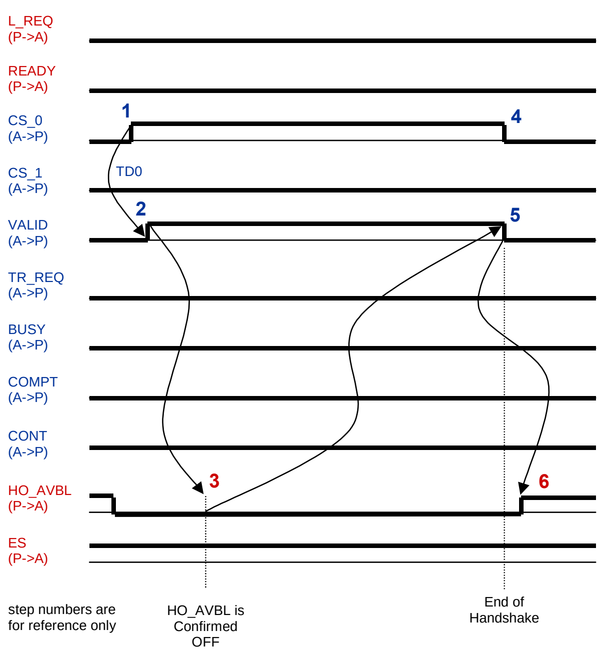
NOTE 1: The HO_AVBL signal turns OFF while the active equipment is confirming the signal in step 3.

Figure 20
Example of Handoff Available Signal



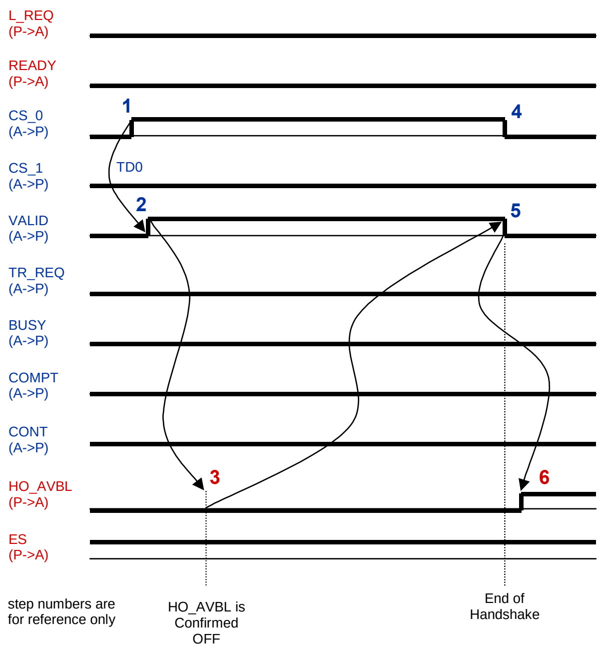
NOTE 1: The HO_AVBL signal turns OFF after the VALID signal is turned ON. The active equipment confirms the signal is OFF in step 3.

Figure 21
Example of Handoff Available Signal



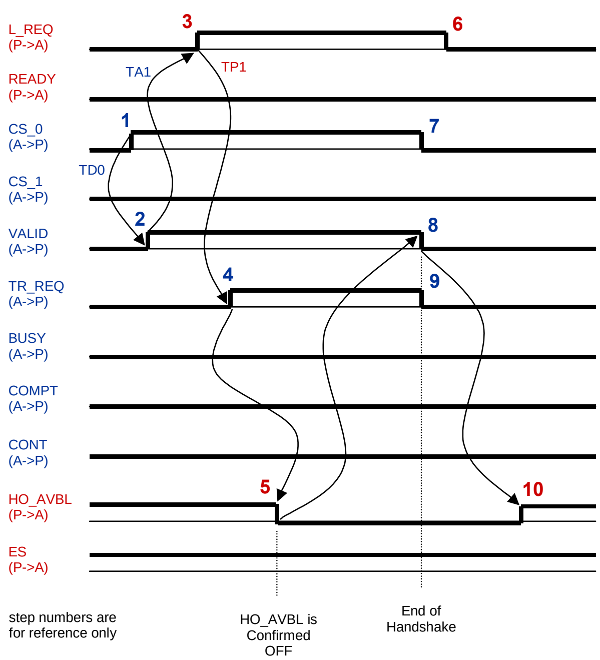
NOTE 1: The HO_AVBL signal turns OFF just before the active equipment arrives. The active equipment confirms the signal is OFF in step 3.

Figure 22
Example of Handoff Available Signal



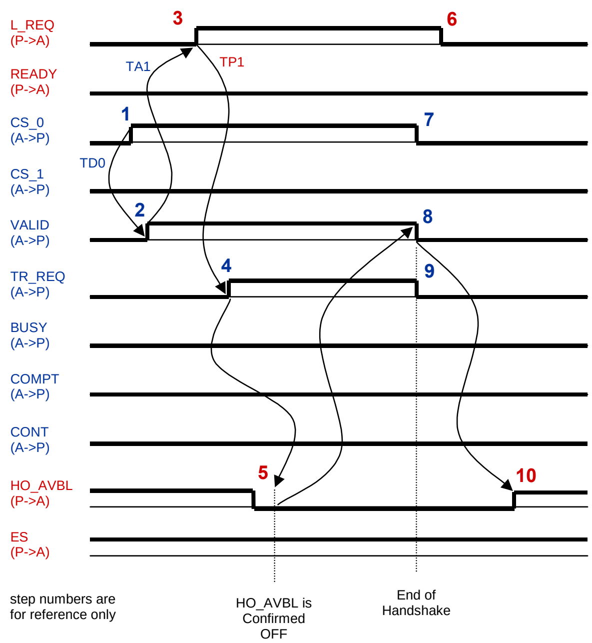
NOTE 1: The HO_AVBL signal turns OFF before the active equipment arrives. The active equipment confirms the signal is OFF in step 3.

Figure 23
Example of Handoff Available Signal



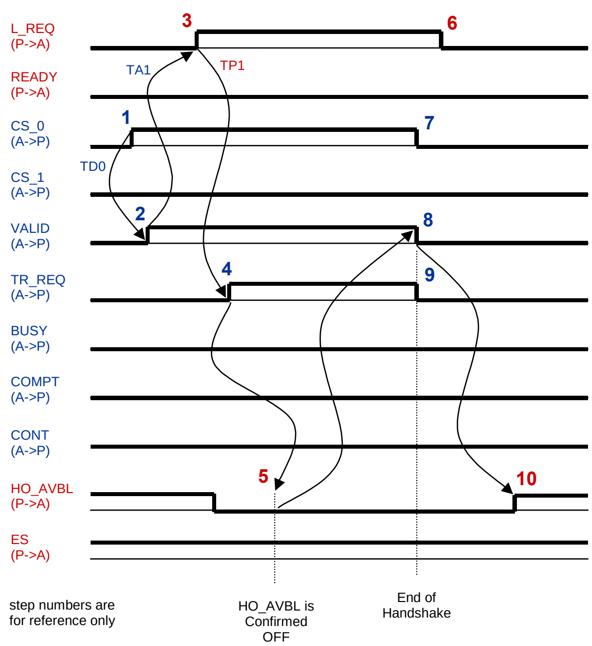
NOTE 1: The HO_AVBL signal turns OFF while the active equipment is confirming the signal in step 5.

Figure 24
Example of Handoff Available Signal



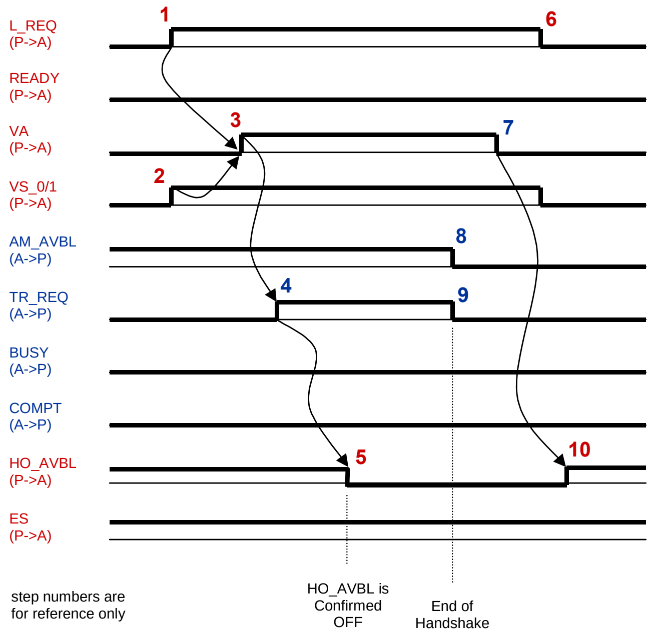
NOTE 1: The HO_AVBL signal turns OFF after the T_REQ signal is turned ON. The active equipment confirms the signal is OFF in step 5.

Figure 25
Example of Handoff Available Signal



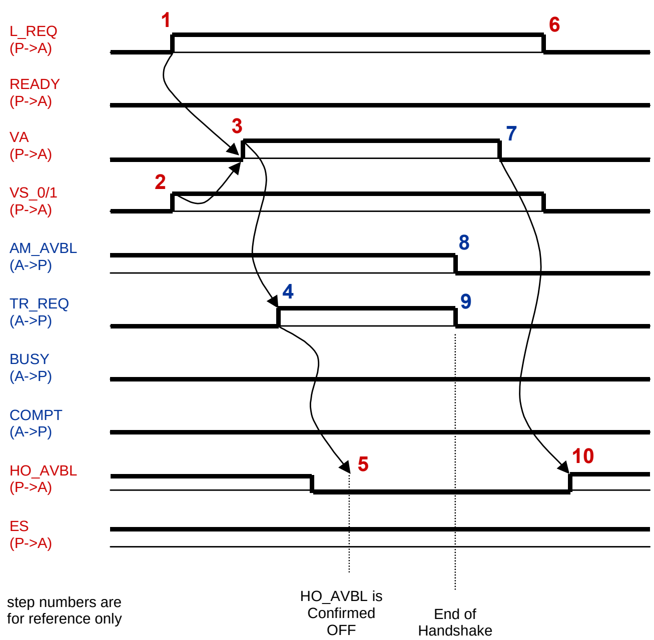
NOTE 1: The HO_AVBL signal turns OFF after the L_REQ signal is turned ON. The active equipment confirms the signal is OFF in step 5.

Figure 26
Example of Handoff Available Signal



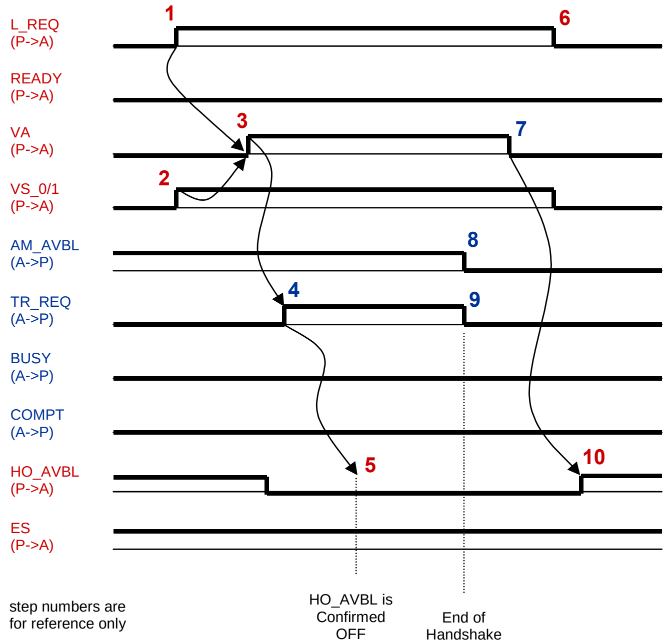
NOTE 1: The HO_AVBL signal turns OFF while the active equipment is confirming the signal in step 5.

Figure 27
Example of Handoff Available Signal



NOTE 1: The HO_AVBL signal turns OFF after the T_REQ signal is turned ON. The active equipment confirms the signal is OFF in step 5.

Figure 28
Example of Handoff Available Signal



NOTE 1: The HO_AVBL signal turns OFF after the VA signal is turned ON. The active equipment confirms the signal is OFF in step 5.

Figure 29
Example of Handoff Available Signal

6.3 *Error Indication and Detection*

6.3.1 *Error Indication*

6.3.1.1 To support operational reliability, this specification will define the following capabilities to indicate errors on the interface:

a) inform handoff unavailable which means the passive equipment (or passive OHS) is not available for material handoff operation to the active equipment.

b) inform emergency stop request to the active equipment (or active stocker).

c) inform handoff timeout error (see the Application Notes in Appendix 1 for examples of appropriate error messages).

6.3.2 *Error Detection*

6.3.2.1 Interlock timeouts are required to detect handoff sequence error between the active and passive equipment. This specification defines the interlock timeouts to be monitored by the active equipment and the passive equipment. Table 7 shows the interlock timeouts for active equipment. Table 8 shows the timeouts for the passive equipment. TAx (x is a number) represents the timer for the active equipment, and TPx (x is a number) represents the timer for the passive equipment. The range for all timers (except TD0) shall be from 1 second to 999 seconds. All timer setpoints shall be user programmable.

6.3.2.2 The delay timer specifies the delay time between VALID signals within one continuous sequence of handoffs. Specifically, it signifies the delay following the VALID signal turning OFF on the completion of the first handoff and the VALID signal turning ON at the start of the second handoff. The delay timer is required because the passive equipment may need a certain time margin to detect the second VALID signal transition to ON. Table 9 shows the delay timer. All timer setpoints shall be user programmable.

6.3.2.3 The recommended and optional delay timer TD0 defines the timing between CS_0 or CS_1 ON and VALID ON for the active equipment as shown in the signal time diagrams. In this way, the passive equipment can predict the timing in which the active equipment will output the signal allowing the transfer interlock to be performed accurately.

Table 7 Active Equipment Timer

Timer Name	*Period (Signal Status) to Monitor the Timer*	*Range (SEC)*	*TYP (SEC)*
TA1	VALID ON - L_REQ ON VALID ON - U_REQ ON	1–999	2
TA2	TR_REQ ON - READY ON	1–999	2
TA3	COMPT ON - READY OFF	1–999	2

#1 The minimum timer value does not define the response time of the active equipment.

#2 These timer values must be implemented for detecting timeouts and are not meant to specify the delay time between signals. The equipment response time must be faster than the timeout of the timer.

Table 8 Passive Equipment Timer

Timer Name	*Period (Signal Status) to Monitor the Timer*	*Range (SEC)*	*TYP (SEC)*
TP1	L_REQ ON - TR_REQ ON U_REQ ON - TR_REQ ON	1–999	2
TP2	READY ON - BUSY ON	1–999	2
TP3	BUSY ON - CARRIER DETECT BUSY ON - CARRIER REMOVE	1–999	60
TP4	U_REQ OFF - BUSY OFF L_REQ OFF - BUSY OFF	1–999	60
TP5	READY OFF - VALID OFF	1–999	2
TP6	VALID OFF - VALID ON (Continuous handoff)	1–999	2

#1 The minimum timer value does not define the response time of the passive equipment.

#2 These timer values must be implemented for detecting timeouts and are not meant to specify the delay time between signals. The equipment response time must be faster than the timeout of the timer.

Table 9 Delay Timer

Timer Name	*Period (Signal Status) to Monitor the Timer*	*Range (SEC)*	*TYP (SEC)*
TD0	CS ON - VALID ON	0.1–0.2	0.1
TD1	VALID OFF - VALID ON	1–999	1

6.3.3 *Error Recovery*

6.3.3.1 Error recovery procedures are not defined in this specification. Recovery procedures may require operator assistance and/or proprietary procedures specific to the equipment. It is recommended that the recovery procedure (ex, abort interlock sequence and set to restart/complete) be provided on the active equipment and the passive equipment.

6.4 *Connector Type, Signal, and Pin Assignment*

6.4.1 The connector type for the passive equipment side must be type DB-25 socket housing (female) as specified in ISO 2110:1989. The connector will have female 4-40 threaded jack screw locks. Suitable 25 pin connectors known as Type "D" are similar to Amphenol MIN RAC 17 series with jack screw locks. It is recommended that the connector on the passive equipment should be appropriately labeled. As shown in Figure 30, this standard specifies the connector on the passive side optical PI/O for floor based vehicles (RGV, AGV, others) (case 1), as well as the active to passive connector between an overhead delivery system and production equipment (case 2). Figure 31 defines the PI/O point of interface for the interbay AMHS (OHS and stocker). If the OHS is the active device in the interbay AMHS then the stocker is the passive device. Likewise, if the OHS is the passive device, then the stocker is the active device.

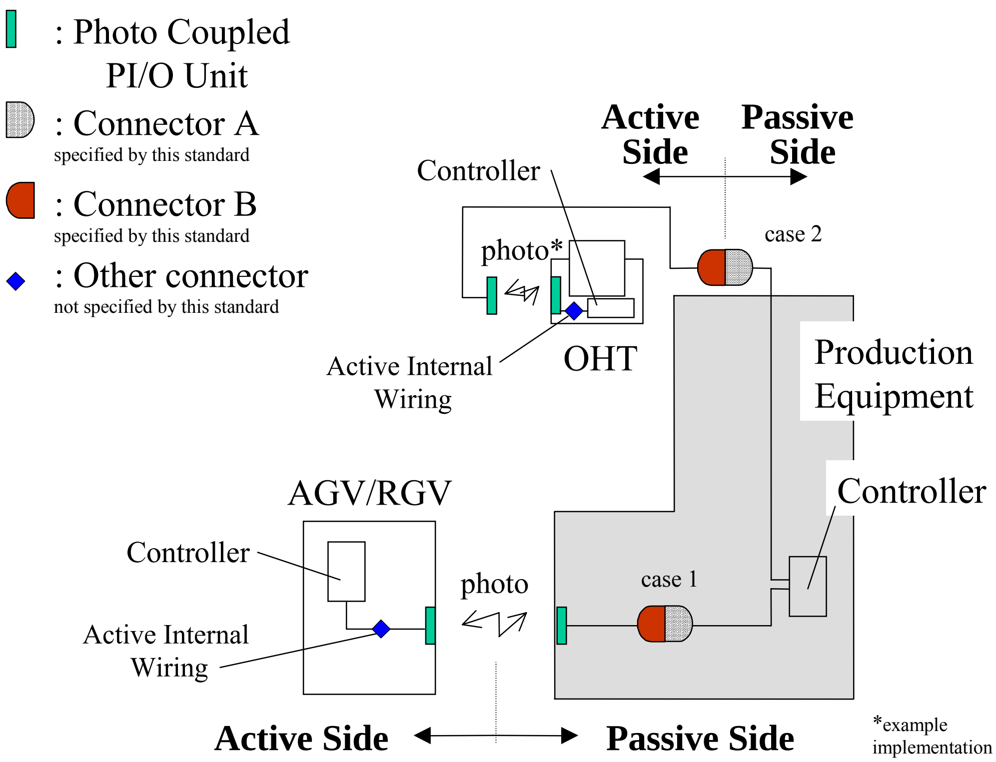


Figure 30
Connector Locations

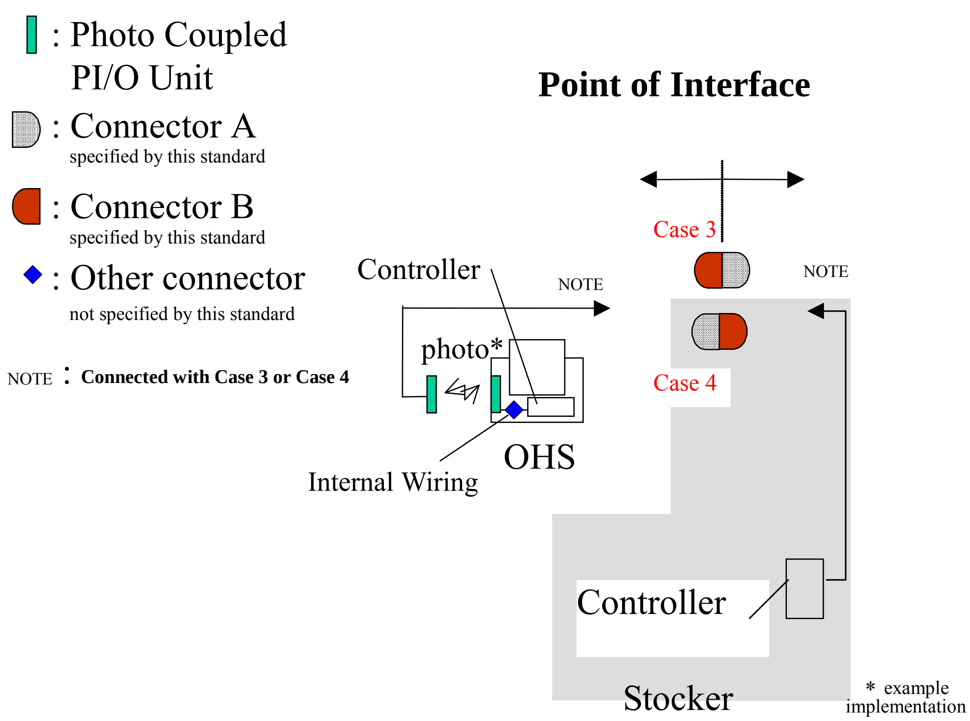


Figure 31
Connector Location Schematic for Interbay AMHS (i.e., OHS and STOKER)

6.4.2 Power and signal specifications are as follows:

Table 10 Input/Output Specifications

Active/Passive	*On State*		*Off State*	
	Current	*Voltage*	*Current*	*Voltage*
Input	Max. 10mA	Max.1.8 Vdc	Max. 200µA	Max. 30 Vdc
Output	Min. 25mA Sink	Max 1.8 Vdc	Max. 100µA Source	Max. 30 Vdc

6.4.2.1 Power Supply Voltage: +24 Vdc Nominal (Min. +18 Vdc, Max. +30 Vdc) from no load to full load (100mA).

6.4.2.2 For hardwired applications the power and power common of the passive must be isolated from the power and power common of the active. Also, internally to either the active or passive equipment, the power and power common must be isolated from the signal common.

6.4.3 Bit assignments are specified in Figure 34.

6.4.4 Connector pin assignments where required in ¶6.4.1 and Figures 30 and 31 are specified in Figures 35 and 36 and Table 11.

6.4.5 All configurations will include signal optoisolation within each equipment conforming to this standard to allow for optical transmission or hardwired configuration to coexist. See Figures 32 and 33 below.

6.4.6 Timing diagram signal state of Off corresponds to no current flow for the hardwired configuration or no optical signal transmitted for the optical transmitter configurations.

6.5 *Interface Sensor Unit Size*

6.5.1 The maximum dimensions in millimeters of the interface sensor are indicated in Figure 37. This size includes volume needed for rigid portions of the sensor's electrical connector and cable. For systems which are designed to handle 300 mm wafer carriers, the interface sensor unit must be designed in a way that allows mounting of the unit within the exclusion volume as defined per SEMI E15.1 with the optical axis centered in this exclusion volume.

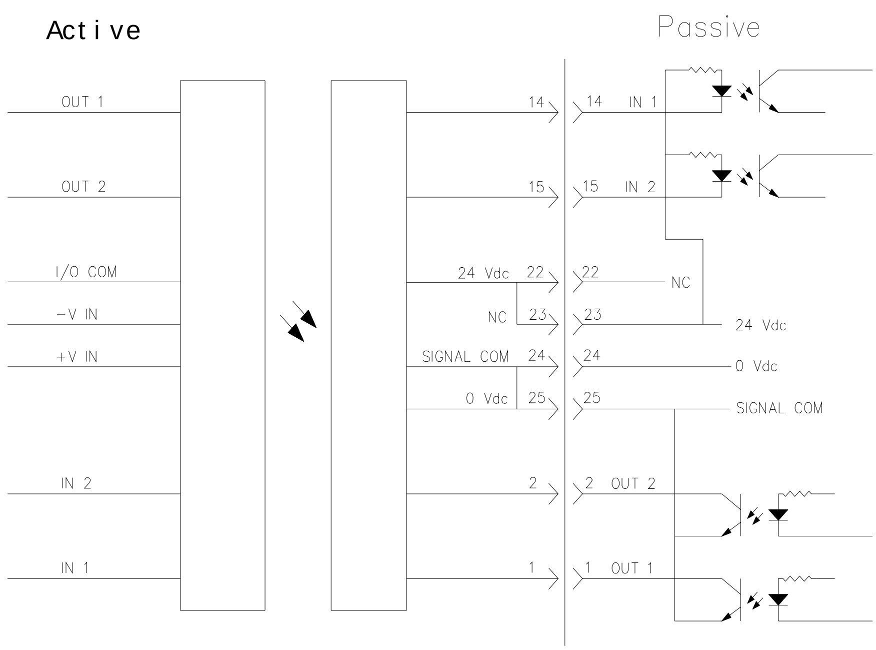


Figure 32
Optoisolated Implementation Using an Optical Transmission Device

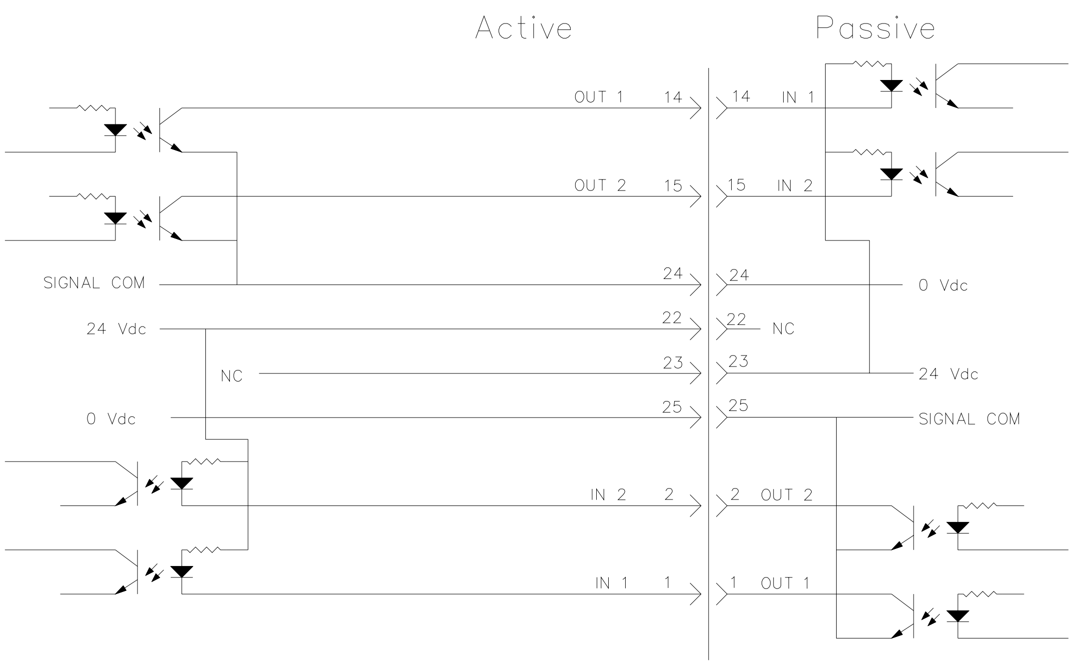
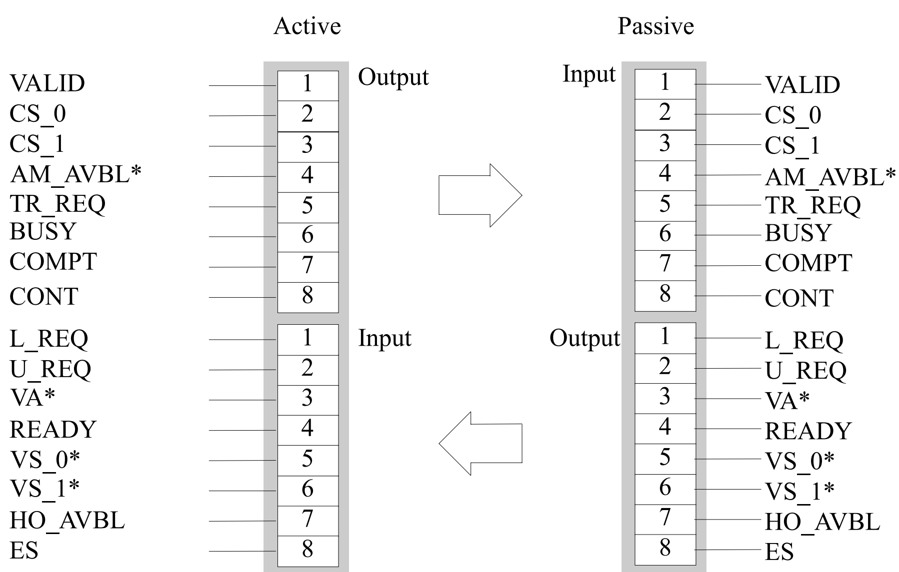
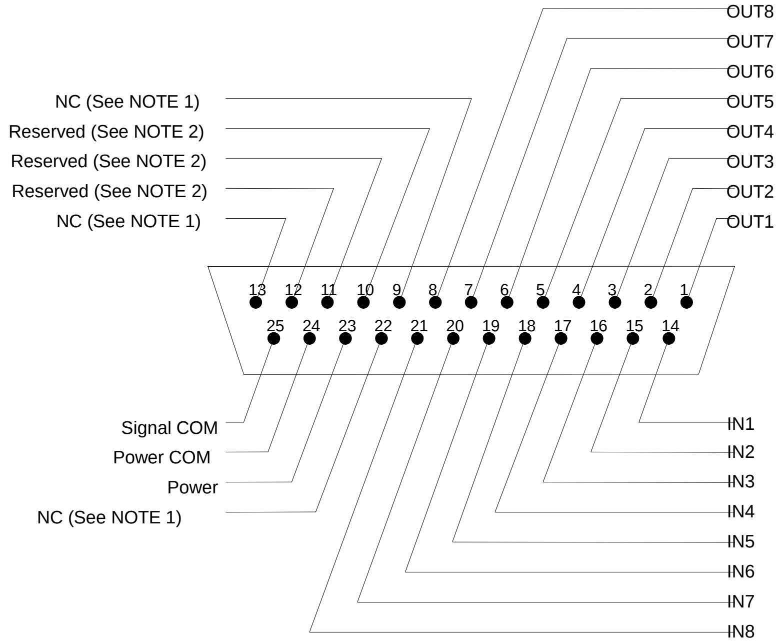


Figure 33
Optoisolated Implementation Using Hardwired Connection



* This signal is for interbay passive OHS vehicle use only.

Figure 34
Bit Assignments for Interlock Signal between Passive and Active



NOTE 1: NC = Not Connected

NOTE 2: Reserved = The pin may be used to support the signal required for a type of any interface unit. It cannot be used for current or future implementations of this specification.

Figure 35
Pin Assignments for Connector of Passive Equipment Side (Pin Side View)

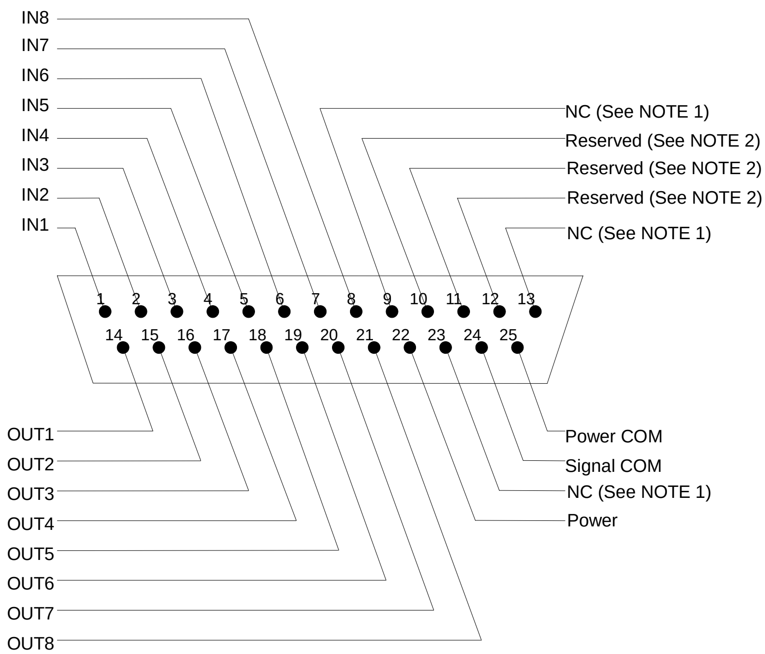


Figure 36
Pin Assignments for Connector of Active Equipment Side (Pin Side View)

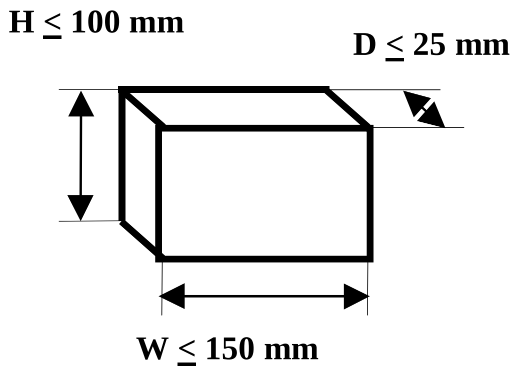


Figure 37
Size of Interface Sensor Unit

Table 11 Pin Assignments for Connector of Passive Equipment Side

Pin #	*Passive Side (connector A) Signal Name (See Figure 16)*	*Active Side (connector B) Signal Name (See Figure 16)*	*Symbol*	*Direction*	*Remarks*
1	OUT 1	IN 1	L_REQ	P -> A	
2	OUT 2	IN 2	U_REQ	P -> A	
3	OUT 3	IN 3	VA	P -> A	Interbay AMHS (used with passive OHS, stockers).
4	OUT 4	IN 4	READY	P -> A	
5	OUT 5	IN 5	VS_0	P -> A	Interbay AMHS (used with passive OHS, stockers).
6	OUT 6	IN 6	VS_1	P -> A	Interbay AMHS (used with passive OHS, stockers).
7	OUT 7	IN 7	HO_AVBL	P -> A	
8	OUT 8	IN 8	ES	P -> A	
9	NC[#1]	NC[#1]	NC[#1]		
10	Reserved[#2]	Reserved[#2]			
11	Reserved[#2]	Reserved[#2]			
12	Reserved[#2]	Reserved[#2]			
13	NC[#1]	NC[#1]	NC[#1]		
14	IN 1	OUT 1	VALID	A -> P	Not for interbay AMHS (used with passive OHS, stockers).
15	IN 2	OUT 2	CS_0	A -> P	Not for interbay AMHS (used with passive OHS, stockers).
16	IN 3	OUT 3	CS_1	A -> P	Not for interbay AMHS (used with passive OHS, stockers).
17	IN 4	OUT 4	AM_AVBL	A -> P	Interbay AMHS (used with passive OHS, stockers).
18	IN 5	OUT 5	TR_REQ	A -> P	
19	IN 6	OUT 6	BUSY	A -> P	
20	IN 7	OUT 7	COMPT	A -> P	
21	IN 8	OUT 8	CONT	A -> P	
22	NC[#1]	Power	not applicable		For wire based communication, power is isolated.

Pin #	*Passive Side (connector A) Signal Name (See Figure 16)*	*Active Side (connector B) Signal Name (See Figure 16)*	*Symbol*	*Direction*	*Remarks*
23	Power	NC[#1]	not applicable		For wire based communication, power is isolated.
24	Power COM	Signal COM	not applicable		For wire base communication, Power COM is routed to Signal COM.
25	Signal COM	Power COM	not applicable		For wire base communication, Power COM is routed to Signal COM.

[#1] NC = Not Connected

[#2] Reserved = The pin may be used to support the signal required for a type of any interface unit. It cannot be used for current or future implementations of this specification.

7 Related Documents

7.1 *SEMI Standards*

SEMI E4 — SEMI Equipment Communications Standard 1 Message Transfer (SECS-I)

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

SEMI E15 — Specification for Tool Load Port

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

SEMI E64 — Provisional Specification for 300 mm Cart to SEMI E15.1 Docking Interface Port

7.2 *Japanese Industrial Standards Committees*[2]

JIS-X-5103 — The Interface between Data Circuit Terminating Equipment (DCE) and Data Terminal Equipment (DTE) (37/9-Pin Interface)

NOTE 5: As listed or revised, all documents cited shall be the latest publications of adopted standards.

2 Japanese Industrial Standards, Available through the Japanese Standards Association, 1-24, Akasaka 4-Chome, Minato-ku, Tokyo 107-8440, Japan. Telephone: 81.3.3583.8005; Fax: 81.3.3586.2014 Website: www.jsa.or.jp

APPENDIX 1
APPLICATION NOTES

NOTICE: The material in this appendix is an official part of SEMI E84 and was approved by full letter ballot procedures on July 21, 2002. The recommendations in this appendix are optional and are not required to conform to this standard. Determination of the suitability of the material is solely the responsibility of the user.

A1-1 General Applications Notes

A1-1.1 If the connection to the equipment for overhead delivery is made using an electrical connector, Figure A1-1 defines a zone on the process or metrology equipment where the plug can be located. This zone is independent of the exclusion zones for parallel I/O devices defined by SEMI E15.1. The zones defined in SEMI E15.1 are designed to be used primarily for photo-coupled floor based delivery systems such as AGVs or RGVs, while the zone defined here on the top of the passive equipment applies primarily to a plug for overhead communication. The plug should be on the top or top edge of the equipment as shown and could be on either side of the bay/chase wall, depending on the location of the wall. In some implementations, the wall may not exist.

A1-1.2 During the first few sequences of the SEMI E84 protocol before the carrier transfer begins if an error occurs the active vehicle should send an error to the host which leads to an automatic recover without human intervention. The active vehicle, on its own or in response to a host-initiated signal, should automatically recover any SEMI E84 error up to the BUSY ON state.

A1-1.3 No application of parallel I/O communication can provide perfect isolation due to Electro-magnetic radiation into and between parallel conductors. Precautions should be taken, by all equipment suppliers, including but not limited to insuring a minimum capacitance of signal lines to reduce susceptibility to noise introduced into the equipment.

A1-1.4 There are two types of equipment, internal buffer equipment and fixed buffer equipment. Internal buffer equipment is equipment that uses locations other than load ports within the equipment to store carriers. Fixed buffer equipment is production equipment that has only fixed load ports and no internal buffer for carrier storage. Wafers are loaded and unloaded directly from the carrier at the load port for processing.

A1-1.5 This standard specifies two different PI/O configurations, one PI/O per load port and one PI/O per two load ports (Figure A1-2). Carrier transfer throughput and efficiency is higher if more than one carrier is transferred at the same time. Carrier transfer time is also reduced if the intrabay AMHS equipment can deliver two or more carriers at the same time from one parked position. Typically internal buffer equipment that allows hand-off of two carriers to two load ports either simultaneously or continuously can best take advantage of these throughput improvements. Thus, internal buffer equipment will require either one PI/O per load port (Figure A1-3, Concept A) or one PI/O per two load ports (Figure A1-3, Concept B), depending on the AMHS delivery system. Fixed buffer equipment will require one PI/O device per load port (Figure A1-4). Based on their production equipment and AMHS systems, end users will specify the SEMI E84 concept (one PI/O per load port or one PI/O per two load ports) and location that will be required on the manufacturing equipment.

A1-1.6 Figure 17 does not define a particular orientation of the PI/O interface sensor unit. Figure A1-5 shows how to orient the PI/O device for AGV/RGV of the exclusion volume in the load port. Refer to SEMI E15.1 for descriptions of D7, D8, H7, H8, and W8.

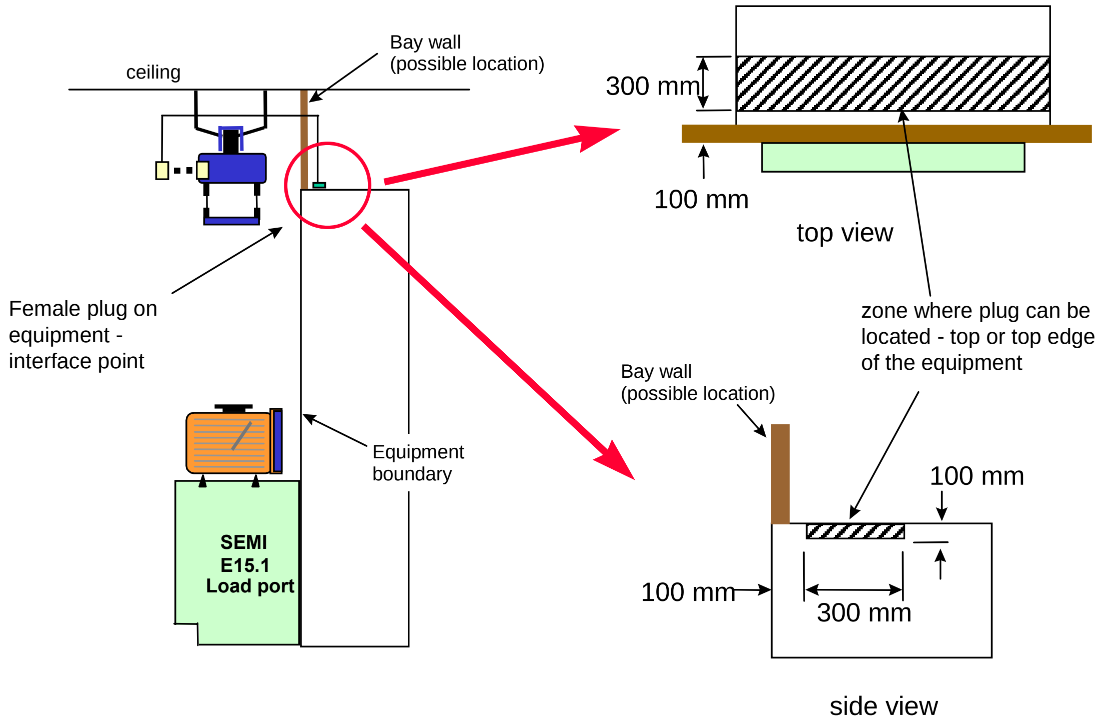


Figure A1-1
Connection Plug Location for Overhead Delivery

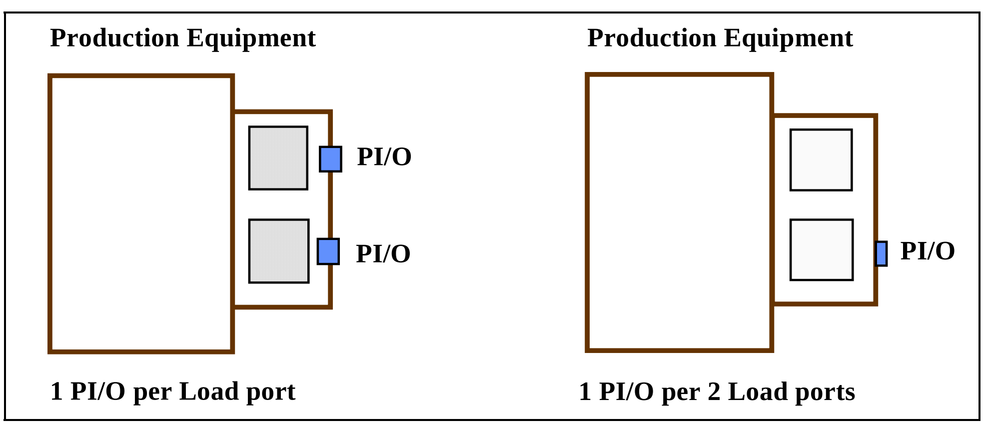
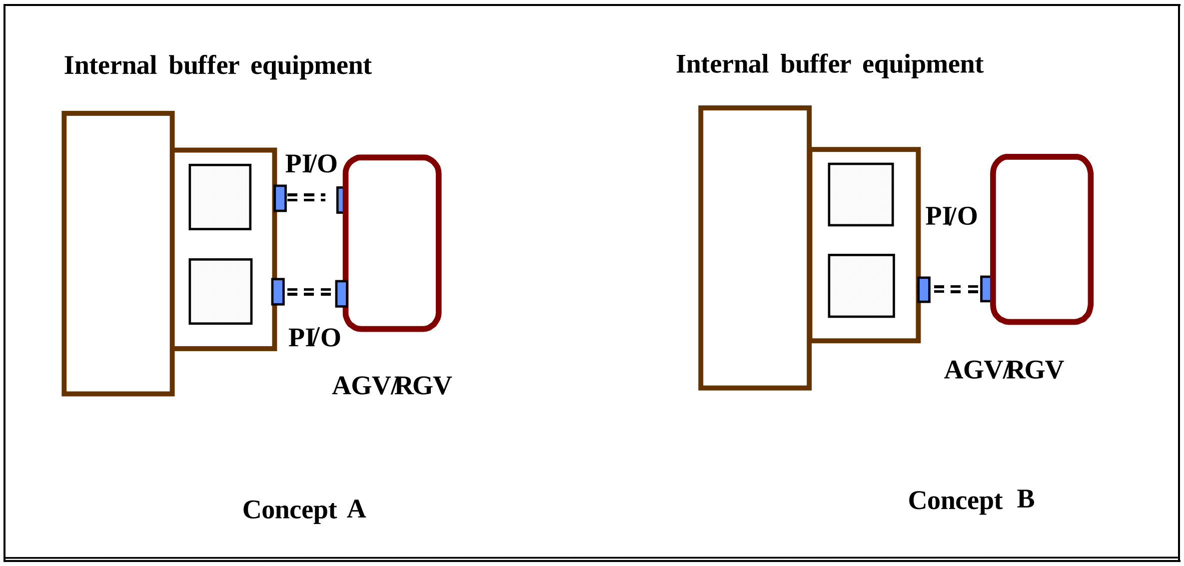


Figure A1-2
Two Different PI/O Configurations



NOTE 1: Simultaneous hand-off: use two PI/O at the same time.

NOTE 2: Continuous hand-off for different load port: use each PI/O sequentially.

Figure A1-3
Optional PI/O Configuration for Internal Buffer Equipment

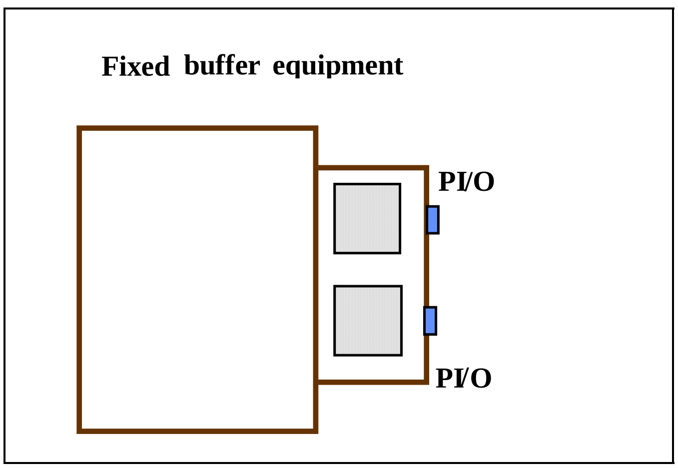


Figure A1-4
Typical PI/O Configuration for Fixed Buffer Equipment

A1-1.7 This standard specifies a signal "on" state as 1.8 Vdc or less. Typical TTL circuits typically require a pull-down to 0.8 Vdc or less. For hard-wired connections, some TTL input circuits might not be able to sense an "on" state between 0.8 Vdc and 1.8 Vdc. One possible implementation is to provide an input receiver circuit.

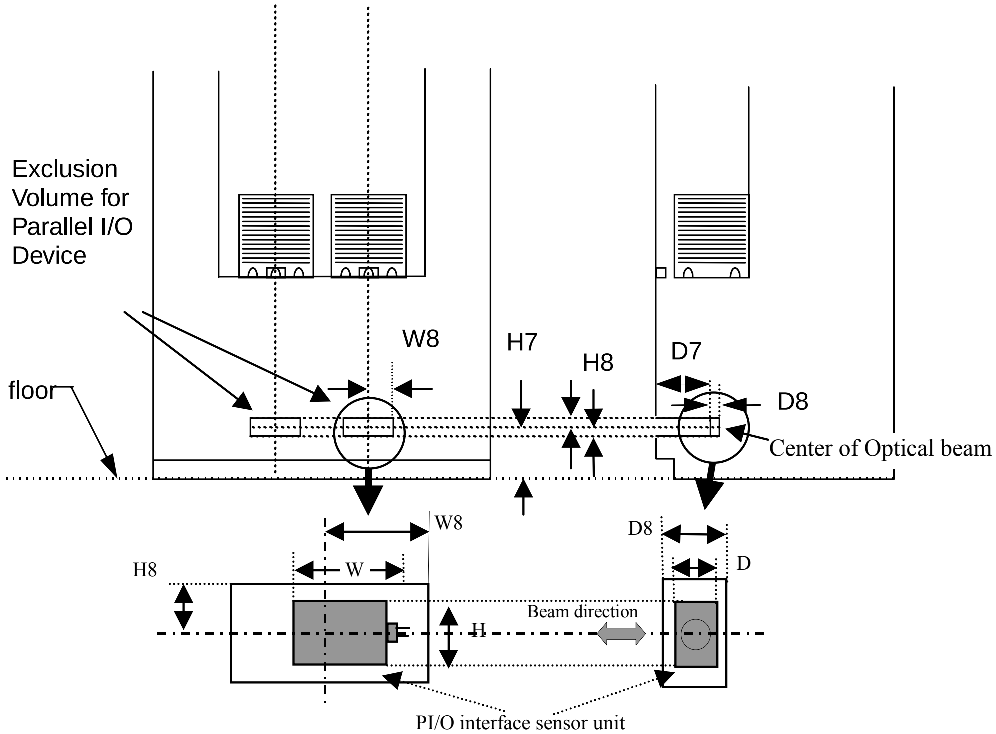


Figure A1-5
Example of the PI/O Interface Sensor Unit Implementation at Load Port for AGV/RGV

A1-1.8 *Equipment Integration Test Mode* — It is recommended that the passive equipment provide a method to disable any physical carrier engagement/movement after the SEMI E84 sequence (example carrier clamping on the load port and docking to the FIMS port) on a load port by load port basis. This functionality will support equipment level testing of automated carrier transfers and SEMI E84 communications at load ports.

A1-2 Reticle Loadport Connector Locations

A1-2.1 For equipment with reticle carrier loadports, if the connection for automated delivery to the equipment is made using an electrical connector, the connector should be located on the top of the equipment outside of the easement for overhead transport. The connector should be no more than 600 mm from the edge of the easement.

A1-3 Additional Interbay AMHS Information

A1-3.1 This section describes error generation and recovery examples (mainly for active equipment) for interbay AMHS (i.e., OHS, stockers). The following are errors that could conceivably occur during transfer operations (load, unload). The procedures are designed for a technician with considerable knowledge of AMHS equipment. Error recovery should always follow the recovery procedures specified in the equipment manuals.

A1-3.2 *OHS (Active Type) Error Examples*

Table A1-1 Load Operation Errors

No.	*Error Description*	*OHS Reaction*
1	The L_REQ does not go OFF in the allotted amount of time during a load transaction.	The load operation sequence is stopped and an error is displayed.
2	Anytime during the transfer a load operation failure or stop positioning failure is detected.	

No.	Error Description	OHS Reaction
3	Anytime during the load operation the load presence status on the loader does not match the actual conditions of the current operation.	
4	The READY signal does not go ON within the specified amount of time after the TR_REQ signal is output.	
5	The READY signal goes OFF during the load operation.	
6	The L_REQ signal remains ON after the load operation is completed.	
7	The READY signal does not go OFF within the specified amount of time after the COMPT signal is output.	
8	Anytime during the load operation the optical transmission beam is interrupted.	

Table A1-2 Unload Operation Errors

No.	Error Description	OHS Reaction
1	The OHS moves to the stocker (for an unload operation) and outputs the VALID signal, but the U_REQ signal remains OFF for a specified amount of time.	The unload operation sequence is stopped and an error is displayed.
2	Anytime during the transfer an unload operation failure or stop positioning failure is detected.	
3	Anytime during the unload operation the load presence status on the loader does not match the actual conditions of the current operation.	
4	The READY signal does not go ON within the specified amount of time after the TR_REQ signal is output.	
5	The READY signal goes OFF during the unload operation.	
6	The U_REQ signal remains ON after the unload operation is completed.	
7	The READY signal does not go OFF within the specified amount of time after the COMPT signal is output.	
8	Anytime during the unload operation the optical transmission beam is interrupted.	

A1-3.2.1 *Example of the Signal Status When an Error is Generated During Transfer Operations*

A1-3.2.1.1 *OHS Side Error Generation*

A1-3.2.1.1.1 OHS Side Signals — When an error is generated, the BUSY signal must stay ON. This is to prevent secondary accidents due to the other device operating on its own.

A1-3.2.1.1.2 *Stocker Side Signals* — When an error is generated, each signal (except for the READY signal) should remain in the status it was in at the time of the error. The READY signal should go OFF.

A1-3.2.1.2 *Stocker Side Error Generation*

A1-3.2.1.2.1 *Stocker Side Signals* — When an error is generated, each signal should remain in the status it was in at the time of the error.

- The READY signal should be OFF.
- The ES signal should be OFF.
- HO_AVBL should be OFF.

A1-3.2.1.3 *OHS Side Signals* — When an error is generated, only the BUSY signal should go ON. All remaining signals should go OFF.

A1-3.2.2 *Recovery Sequences*

A1-3.2.2.1 Should an error occur during transfer operations (refer to Tables 1 and 2), the recovery should begin by returning the carrier to the stocker or OHS. Then, the error should be recovered. The four recovery scenarios are:

1. Load operation, carrier is returned to the stocker.
2. Load operation, carrier is returned to the OHS.
3. Unload operation, carrier is returned to the stocker.
4. Unload operation, carrier is returned to the OHS.

A1-3.2.3 *Recovery Method*

A1-3.2.3.1 *OHS Side*

- In the case of sequence 2 (above), the load/unload sequence should be started over from the beginning.
- In the case of sequence 3 (above), the corresponding transfer operation should be canceled.
- In the case of sequences 1 and 4 (above) the corresponding transfer operation should be considered completed.

A1-3.2.3.2 *Stocker Side*

- In the case of sequences 1 and 4 (above) the corresponding transfer operation should be considered completed.
- In the case of sequences 2 and 3 (above), the load/unload sequence should be started over from the beginning.

Table A1-3 Load Operation Errors

No.	*Error Description*	*Stocker Reaction*
1	The L_REQ does not go OFF in the allotted amount of time during an unload transaction.	The load operation sequence is stopped and an error is displayed.
2	Anytime during the transfer a load operation failure or stop positioning failure is detected.	
3	Anytime during the load operation the load presence status on the loader doesn't match the actual conditions of the current operation.	
4	The READY signal does not go ON within the specified amount of time after the TR_REQ signal is output.	
5	The READY signal goes OFF during the load operation.	
6	The L_REQ signal remains ON after the load operation is completed.	
7	The READY signal does not go OFF within the specified amount of time after the COMPT signal is output.	
8	Anytime during the load operation the optical transmission beam is interrupted.	

Table A1-4 Unload Operation Errors

No.	*Error Description*	*Stocker Reaction*
1	The stocker (for an unload operation) outputs the VALID signal, but the U_REQ signal remains OFF for a specified amount of time.	The unload operation sequence is stopped and an error is displayed.
2	Anytime during the transfer an unload operation failure or stop positioning failure is detected.	
3	Anytime during the unload operation the load presence status on the loader doesn't match the actual conditions of the current operation.	
4	The READY signal does not go ON within the specified amount of time after the TR_REQ signal is output.	
5	The READY signal goes OFF during the unload operation.	
6	The U_REQ signal remains ON after the unload operation is completed.	

No.	Error Description	Stocker Reaction
7	The READY signal does not go OFF within the specified amount of time after the COMPT signal is output.	
8	Anytime during the unload operation the optical transmission beam is interrupted.	

A1-3.3 *Stocker (Active Type) Error Examples*

A1-3.3.1 *Example of the Signal Status When an Error is Generated During Transfer Operations*

A1-3.3.1.1 *Stocker Side Error Generation*

A1-3.3.1.1.1 *Stocker Side Signals* — When an error is generated, the BUSY signal must stay ON. This is to prevent secondary accidents due to the other device operating on its own.

A1-3.3.1.1.2 *OHS Side Signals* — When an error is generated, each signal (except for the READY signal) should remain in the status it was in at the time of the error. The READY signal should go OFF.

A1-3.3.1.2 *OHS Side Error Generation*

A1-3.3.1.2.1 *OHS Side Signals* — When an error is generated, each signal should remain in the status it was in at the time of the error.

- The READY signal should be OFF.
- The ES signal should be OFF.
- HO_AVBL should be OFF.

A1-3.3.1.2.2 *Stocker Side Signals* — When an error is generated, only the BUSY signal should go ON. All remaining signals should go OFF.

A1-3.3.2 *Recovery Sequences*

A1-3.3.2.1 Should an error occur during transfer operations (refer to Tables 3 and 4), the recovery should begin by returning the carrier to the stocker or OHS. Then, the error should be recovered. The four recovery scenarios are:

1. Load operation, carrier is returned to the OHS.
2. Load operation, carrier is returned to the stocker.
3. Unload operation, carrier is returned to the OHS.
4. Unload operation, carrier is returned to the stocker.

A1-3.3.3 *Recovery Method*

A1-3.3.3.1 *Stocker Side*

- In the case of sequences 2 and 3 (above), the load/unload sequence should be started over from the beginning.
- In the case of sequences 1 and 4 (above) the corresponding transfer operation should be considered completed.

A1-3.3.3.2 *OHS Side*

- In the case of sequences 1 and 4 (above) the corresponding transfer operation should be considered completed.
- In the case of sequences 2 and 3 (above), the load/unload sequence should be started over from the beginning.

A1-3.4 If the stocker is the active side of the interbay AMHS (i.e., OHS and stockers) it is conceivable that the loader will interfere with the OHS passing by the stocker in failure scenarios. As a result of this possibility, it is necessary for interbay AMHS equipment makers to establish an OHS “PASS OK” signal separate from the SEMI E84 interlock. However, this note has no direct bearing on the contents of SEMI E84. <u>Therefore, readers of SEMI E84 should only treat this as a reference item.</u>

Pass Interlock

Interlock Signal

Signal Name	*P/A*	*Description*
PASS OK	A->P	When this signal is HIGH (ON), the vehicle may pass. When this signal is LOW (OFF), the vehicle may not pass.

A1-4 Errors and Automated Recovery

A1-4.1 This section describes recommendations for implementation of errors and the associated recovery procedures for Interbay OHS (Active Vehicle) and Intrabay OHT, definition of practical implementation of the HO_AVBL and ES signals, and examples of various L_REQ and U_REQ sequences.

NOTE 6: This application note assumes an SEMI E84 implementation where one parallel I/O device per loadport is used.

A1-4.2 During the first few sequences of the SEMI E84 protocol before the carrier transfer begins if an error occurs the active vehicle should send an error to the host but automatically recover without human intervention. The active vehicle should automatically recover any SEMI E84 error up to the BUSY ON state.

A1-4.3 *Definition of Automated Recovery* — If an error occurs the active vehicle should send an Unsuccessful Transfer Complete command to the HOST, then the HOST will send the active vehicle an alternate location. SEMI E82 Intrabay SEM defines this recovery procedure in detail. Table A1-5 shows some specific scenarios where the active vehicle should automatically recover.

Table A1-5 Example Automatic Recover Scenarios

No.	*Error Description*	*Active Equipment Reaction*
1	TA1 Timeout: The active equipment sends the CS_0, CS_1 signal but does not receive the U_REQ or L_REQ signal.	Unsuccessful Transfer Complete is sent to the Host and automatically recovered on the Active side (no human intervention).
2	TA2 Timeout: The Active equipment sends the TR_REQ signal but does not receive the READY signal.	
3	During the sequence HO_AVBL signal goes low before BUSY turns on.	

A1-4.4 *HO_AVBL Signal*

A1-4.4.1 The HO_AVBL signal specifies if the Passive Equipment is available to accept a Load / Unload from the Active Equipment. The HO_AVBL should also be used to identify situations where harm to the carrier or product may exist. The HO_AVBL signals are loadport specific and should not apply to all of the loadports on the equipment. Table A1-6 shows some specific scenarios for the HO_AVBL Signal.

Table A1-6 Example HO_AVBL Scenarios

No.	*Description of Passive Equipment*	*HO_AVBL Signal Response*
1	Presence Sensor is ON but Placement sensor is OFF.[#1]	OFF
2	Presence Sensor is OFF but Placement sensor is ON.[#1]	OFF
3	Passive Equipment is in Manual Access Mode.	OFF
4	FOUP is docked or moved forward to FIMS interface.	OFF
5	Carrier present on the Input Port (internal buffer equipment or stocker).	OFF
6	Light Curtain Errors on SEMI E15.1 Option 1 Loadports (Reference ¶7.6.1 of SEMI E15.1).	OFF
7	Light Curtain Errors on SEMI E15.1 *non-automated* Option 3 Loadports (Reference ¶7.6.3 of SEMI E15.1).	ON
8	Carrier Handling Robot Errors not at the Active Carrier's destination loadport.	ON

No.	Description of Passive Equipment	HO_AVBL Signal Response
9	Manual Placement of a FOUP onto a Load Port in Auto Access Mode	OFF
10	ES Signal OFF	OFF

#1 During normal load/unload operation the presence and placement sensors may turn on/off for a very short period.

A1-4.5 *ES Signal*

A1-4.5.1 The ES signal allows the Passive Equipment to signify to the Active Equipment any specific instance where the material, product, or operation is in jeopardy. The ES Signal is not loadport specific but rather tool specific. That means, for example, if an EMO is pressed on the Passive Equipment the ES signal should be OFF on all SEMI E84 loadports. Table A1-7 shows some specific scenarios for the ES Signal.

Table A1-7 Example ES Signal Scenarios

No.	*Description*	*ES Signal Response*
1	EMO button is pressed.	OFF
2	Interlocked maintenance door or interlocked panel on the Passive Equipment is opened	OFF
3	Carrier Handling Robot is in Error at the load port (internal buffer equipment or stocker)	OFF

A1-4.6 *L_REQ and U_REQ Signals*

A1-4.6.1 When the L_REQ and U_REQ signals are turned OFF they verify the completion of the Load/Unload sequence as indicated by the presence/placement sensors on the load port.

A1-4.6.1.1 Here are some practical examples of using these signals.

1) During a Load both Presence and Placement sensors are ON once the carrier is detected. This should signal the L_REQ signal to turn OFF. The L_REQ signal should typically not turn OFF unless *both* the presence and placement sensors are ON.

2) When delivering, the Active Equipment should not release the FOUP until L_REQ is OFF.

3) During an Unload both Presence and Placement sensors are OFF once the carrier is not detected. This should signal the U_REQ signal to turn OFF. The U_REQ signal should typically not turn OFF unless *both* the presence and placement sensors are OFF.

4) The L_REQ and U_REQ signals should turn off immediately after the presence and placement sensors have turned ON (load) or OFF (unload). There should be no delay timer between the presence and placement sensor ON/OFF and L_REQ / U_REQ OFF.

5) During an Unload, once the active vehicle has fully gripped the FOUP, in most cases the vehicle should ignore the response from the U_REQ signal until completion of its move. For example, the OHT vehicle should not stop 150 mm – 300 mm above the loadport, check the status of U_REQ and then complete its move. The OHT should fully complete its move, check U_REQ and finish the E84 sequence. If the U_REQ signal is still high after the completion of its move and the active vehicle can be certain the carrier is safely and securely contained aboard the vehicle, in some cases the vehicle should abort the E84 sequence and continue normally to its destination.

A1-4.7 *Error Messages*

A1-4.7.1 Interlock timeouts are required to detect handoff sequence errors between the active and passive equipment. When these timeouts occur, an error message shall be displayed to the user including the following information: Timer Name, Timer Description, and current Timer setting. Some examples of error messages are listed in Tables A1-8, A1-9, and A1-10.

Table A1-8 Example Active Equipment Error Messages

No.	*Timer Name*	*Equipment Error Message*
1	TA1	TA1 Timeout – L_REQ/U_REQ signal did not turn ON within specified time. (TA1 = xxx)
2	TA2	TA2 Timeout – READY signal did not turn ON within specified time. (TA2 = xxx)
3	TA3	TA3 Timeout – READY signal did not turn OFF within specified time. (TA3 = xxx)

#1 "xxx" refers to the time in seconds that the specific timer was set to.

Table A1-9 Example Passive Equipment Error Messages

No.	*Timer Name*	*Equipment Error Message*
1	TP1	TP1 Timeout – TR_REQ signal did not turn ON within specified time. (TP1 = xxx)
2	TP2	TP2 Timeout – BUSY signal did not turn ON within specified time. (TP2 = xxx)
3	TP3	TP3 Timeout – Carrier was not detected/removed within specified time. (TP3 = xxx)
4	TP4	TP4 Timeout – BUSY signal did not turn OFF within specified time. (TP4 = xxx)
5	TP5	TP5 Timeout – VALID signal did not turn OFF within specified time. (TP5 = xxx)
6	TP6	TP6 Timeout – VALID signal did not turn ON within specified time. (TP6 = xxx)

#1 "xxx" refers to the time in seconds that the specific timer was set to.

Table A1-10 Example Delay Timer Error Messages

No.	*Timer Name*	*Equipment Error Message*
1	TD0	TD0 Timeout – VALID signal did not turn ON within specified time. (TD0 = xxx)
2	TD1	TD1 Timeout – VALID signal did not turn ON within specified time. (TD1 = xxx)

#1 "xxx" refers to the time in seconds that the specific timer was set to.

SEMI E85-0705
SPECIFICATION FOR PHYSICAL AMHS STOCKER TO INTERBAY TRANSPORT SYSTEM INTEROPERABILITY

This specification was technically approved by the global Physical Interfaces & Carriers Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on April 7, 2005. It was available at www.semi.org in June 2005 and on CD-ROM in July 2005. Originally published June 1999; previously published November 2001.

1 Purpose

1.1 This specification defines the dimensional requirements for the interbay load ports of 300 mm AMHS equipment. It is intended to promote a list of required features and dimensions that define the physical interfaces between different types of interbay equipment, to facilitate the use of different automated transport systems in order to meet the different material handling requirements found throughout the factory. This is done by defining six options of interfaces that both the stocker and interbay transport system must comply with. Options defined are as follows:

- Option A: Active transport loads a carrier to an internal stocker position
- Option B: Active transport loads a carrier to an external stocker position
- Option C: Passive transport presents a carrier to an internal stocker position
- Option D: Passive transport presents a carrier to an external stocker position (kinematic coupling pin pick-up)
- Option E: Passive transport presents a carrier to an external stocker position (conveyor flange pick-up)
- Option F: Passive transport presents a carrier to an external stocker position for pickup with either (a) all 3 kinematic pins, (b) all 3 secondary kinematic pins or (c) top robotic flange. Carrier is oriented with front of carrier perpendicular to load face plane.

2 Scope

2.1 This is a standard covering physical interface of 300 mm AMHS interbay equipment only. Similar requirements covering 300 mm AMHS intrabay equipment are covered in SEMI E15.1.

2.2 This specification does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this specification to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3 Limitations

3.1 This standard does not specify that every type of 300 mm stocker has to interface with every type of 300 mm interbay transport system. It only specifies six different options of physical interface. Within any option however, all stockers must be able to physically interface with all interbay transports. This standard only specifies single carrier handoff and not dual simultaneous handoffs as implied by the dimensions in the rest of this document.

4 Referenced Standards and Documents

4.1 *SEMI Standards*

SEMI E1.9 — Mechanical Specification for Cassettes Used to Transport and Store 300 mm Wafers

SEMI E15 — Specification for Tool Load Port

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

SEMI E47.1 — Provisional Mechanical Specification for Boxes and Pods Used to Transport and Store 300 mm Wafers

SEMI E57 — Mechanical Specification for Kinematic Couplings Used to Align and Support 300 mm Wafer Carriers

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

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

5 Terminology

NOTE 1: For many of the used terms, see SEMI E15.1.

5.1 *Abbreviations and Acronyms*

5.1.1 *AMHS* — Automated Material Handling Systems

5.2 *Definitions*

5.2.1 *active interbay transport system* — an interbay transport system that transfers the carrier to and from the stocker interbay load port itself using robotics that are located on the transport.

5.2.2 *drive through interbay transport (DT)* — an interbay transport system where the track runs internal to the stocker boundary for the entire width of the stocker (Option C application defined in ¶7.5.3).

5.2.3 *external stocker load port* — an interbay load port that is external to the stocker equipment boundary similar to a shelf or ledge on the stocker.

5.2.4 *horizontal transfer interbay transport (HT)* — an interbay transport system where a section of the track transfers or slides into an opening in the side of the stocker to present a passive interbay transport system to the stocker robot (Option C application defined in ¶7.5.3).

5.2.5 *interbay load port* — the interface location on a stocker where the interbay transport places wafer carriers to allow the stocker to store the carriers.

5.2.6 *interbay transport system* — is defined as the track and vehicle (if applicable) that transports the carrier to and from the interbay stockers.

5.2.7 *internal stocker load port* — an interbay load port that is recessed from the stocker equipment boundary (a cavity or cutout in the stocker).

5.2.8 *overhead delivery* — an interbay transport system that transfers the carrier to and from the stocker interbay load port itself from directly above the load port (raises and lowers the carrier to the load port).

5.2.9 *passive interbay transport system* — an interbay transport system that requires the stocker to transfer the carrier to and from the stocker interbay load port (stocker has robotics that transfers the carrier).

5.2.10 *stocker* — an AMHS storage device.

6 Ordering Information

6.1 Per §6 of SEMI E15, except for ¶6.1.3 and ¶6.1.4.

6.2 The user and AMHS supplier will jointly own the responsibility of defining the height of the interbay load port defined by dimension H (the distance from the horizontal datum plan to the raised floor).

6.3 The user must specify which of the options (defined in ¶7.5) is required for each interbay load port. The user must also specify which carrier will be used: front-opening box or open cassette.

6.3.1 If the user specifies Option C, the user must also specify:

a) Which type of interbay transport system will be used. Dimensions A1 and S do not apply if it is a drive through (DT) type. Dimensions A1 and S do apply if it is a horizontal transfer (HT) type (defined in ¶7.5.3).

b) Which height of exclusion volume in the stocker will be used defined as dimension T3 in Tables 1 and 2.

c) Which length of center exclusion volume in the interbay transport will be used defined as dimension D10 in Tables 1 and 2.

6.3.2 If the user specifies Option D, the user must specify which length of exclusion volume will be used in the interbay transport as defined by dimension D10 in Tables 1 and 2.

6.3.3 If the user specifies Option E, the user must specify which length of exclusion volume will be used in the interbay transport as defined by dimension D10 in Tables 1 and 2.

6.3.4 If the user specifies option F, the user must specify top (robotic flange pickup) or bottom access (secondary kinematic pins pickup).

7 Requirements

7.1 The dimensional requirements for the load port of a storage device and the interbay transport system are given in Table 1 for front-opening box and Table 2 for open cassette.

7.2 The carriers shown in these figures are intended to represent any type of carrier (open cassette or front-opening box). Figure 11 is only applicable for open cassette type carriers.

7.2.1 Except for option F, the carrier shall be loaded and unloaded with its front parallel to and away from the load face plane as illustrated in Figures 1–11.

7.3 The wafers in the front-opening box are to be oriented horizontally face up with zero nominal tilt at the time they are placed on the load port. The tolerance in the horizontal plane is determined by the registration and alignment feature between the carrier and the load port, as specified in SEMI E57. The wafers in the front-opening open cassette are to be oriented horizontally face up with 2 degree nominal tilt at the time they are placed on the load port.

7.4 Dimension H of the load port is to be specified by the user and the AMHS supplier (¶6.2). The height of the interbay transport system is to be fully configurable using the track hangers. The precision with which the interbay transport delivery system height must be maintained is dictated by the needs of the interbay load port.

7.5 AMHS interbay equipment load ports must conform to one of the following configuration options (see ¶6.3).

7.5.1 In Option A, an active transport loads a carrier to an internal stocker position. The stocker interbay load port must therefore maintain the center exclusion volume below the HDP defined in ¶7.6 and shown in Figures 1 and 10. This exclusion volume in the stocker load port facilitates carrier delivery from an active interbay transport system. The interbay transport may transfer the carrier to the passive stocker using the SEMI standard carrier handling features, which are compatible with the exclusion volumes in the stocker defined in this standard. Examples include the secondary set of kinematic pins and the top robotic flange. The use of the primary kinematic pins is reserved for the stocker load port. The two front kinematic pins and a guide are used to interface with a SEMI defined accurate outer carrier surface defined in SEMI E47.1 (front-opening box) or SEMI E1.9 (open cassette). Refer to Figure 1 and the Related Information for detail. The open volume internal to the stocker above the HDP is defined by dimensions A1, S, and a clearance C3 above the maximum height of the carrier.

7.5.2 In Option B, an active transport loads a carrier to an external stocker position. The stocker interbay load-port must therefore maintain the two fork-lift or con-veyor exclusion volumes as defined in SEMI E15.1 to allow for an active interbay transport system to transfer a carrier to the fork-lift or conveyor rails. The stocker interbay load port must also be open from above to facilitate delivery from an overhead transport system. The open volume required for vertical delivery is de-fined by a projection of the stocker load port area. The stocker interbay load port features, exclusion volumes, and dimensions are defined in SEMI E15.1 with the exception of dimension S and H. This option is illustrated in Figure 2.

7.5.3 In Option C, a passive transport presents a carrier to an internal stocker position. The passive interbay transport must therefore maintain the center exclusion volumes defined in ¶7.6 and shown in Figures 3, 4, and 10 in order to facilitate automatic carrier transfer by the active stocker. The stocker may transfer the carrier to the passive interbay transport system using the SEMI standard carrier handling features, which are compatible with the exclusion volumes in the interbay transport system defined in this standard. Examples include the secondary set of kinematic pins and the top robotic flange. The use of the primary kinematic pins is reserved for the interbay transport system. The two front kinematic pins and a guide are used to interface with a SEMI defined accurate outer carrier surface defined in SEMI E47.1 (front-opening box) or SEMI E1.9 (open cassette). Refer to Figure 3 and the Related Information for detail. The open volume internal to the stocker to allow for the interbay transport to enter is defined by dimensions T3 and C5. This option is illustrated in Figures 3 and 4.

7.5.3.1 Option C allows for two different types of interbay transport (¶6.3.1). The first type is a drive though (DT) interbay transport that will drive through the entire length of the stocker as illustrated in Figure 3. Dimensions A1 is therefore not applicable for this type of Option C interbay transport delivery. The other type of interbay transport is a horizontal transfer (HT) were a section of the track slides or advances into a predefined open volume in the side of the stocker as illustrated in Figure 4. Dimensions A1 and S are applicable for this type of Option C interbay transport delivery.

7.5.3.2 Option C prime (C') is different from Option C in that the pins used to transfer the carrier are different. In Option C', the transport vehicle uses the two front secondary, and single rear primary kinematic pins. This enables the stocker end-effector to use the two front primary pins and be of a wider configuration (see Figure 3a). All elevation dimensions for C' are the same as for Option C.

7.5.4 In Option D, a passive transport presents a carrier to an external stocker position. The passive interbay transport must maintain the center exclusion volume shown in Figures 5 and 10 to allow for the stocker to use the secondary kinematic pins or top robotic flange to transfer the carrier. No open volume internal to the stocker is required.

7.5.4.1 Option D prime (D') is different from Option D in that the pins used to transfer the carrier are different. In Option D', the transport vehicle uses the two front secondary, and single rear primary kinematic pins. This enables the stocker end-effector to use the two front primary pins and be of a wider configuration (see Figure 4a). All elevation dimensions for Option D' are the same as for Option D.

7.5.5 In Option E, a passive transport presents a carrier to an external stocker position. The passive interbay transport must maintain the side fork-lift/conveyor rail exclusion volumes shown in Figure 6 to allow the stocker to use the fork-lift/conveyor rails to transfer the carrier. No open volume internal to the stocker is required.

7.5.6 In option F and F' the carrier is oriented with the front of the carrier perpendicular to the load face plane by a passive transport for pickup by an active stocker. In option F the transport uses the kinematic coupling pins (all 3 may be used) and the stocker uses either the secondary kinematic coupling pins (all 3 accessible) or the top robotic flange for pickup. In Option F' (F Prime) the transport uses the kinematic coupling pins, the secondary kinematic coupling pins or the conveyor runners, and the stocker uses the top robotic flange for pickup.

7.6 The center exclusion volume below the horizontal datum plane of the stocker for Option A (¶7.5.1) or interbay transport system for Options C and D (¶7.5.3 and ¶7.5.4), is defined by dimensions H2, A2, and D (Figure 1 and 10). For Options C (¶7.5.3) and D (¶7.5.4), there are additional requirements that the center exclusion volume, defined by H2 and A2 extend from the facial datum plane a distance D10 (¶6.3.1 and ¶6.3.2), increase both in depth de-fined by dimension H4 and in width defined by dimension A3 from the plane defined by dimension D10 extending outwards for the rest of the interbay transport system. The conveyor flange exclusion volume below the horizontal datum plane of the interbay transport system (¶7.5.4), is defined by dimensions H2, H4, A6, A8, and D10 (Figure 6). The center exclusion volume below the horizontal datum plane of the stocker for option F is defined by Figure 10, "Exclusion zone detail for option F". No exclusion volumes are required for option F' since stocker access is with the top robotic flange only. These exclusion volumes need to be open only during the carrier handoff between the stocker and the interbay transport system. For example, the stocker can temporarily occupy these exclusion volumes when transferring the carrier from the interbay load port to an internal shelf location.

7.7 Clearance C3 in Option A is defined with respect to the maximum dimensions of the carrier (defined in SEMI E47.1 for a box or in SEMI E1.9 for an open cassette), not to the rectangular wafer carrier envelope (defined in SEMI E15).

7.8 Dimension S specifies the required range for spacing between carrier centroids.

7.9 For active interbay transports (Option A) and passive interbay transports (Options C, D, and E and F), the communication method will be defined by SEMI E84 (same as OHT), and the available SEMI E84 connector areas are defined by the following dimensions, and are illustrated in Figure 9.

- Dimensions of the SEMI E84 connector zone are as follows:
- Width (measured from BDP) = 225 mm
- Depth (measured from Stocker facial plane) = 200 mm
- Height (measured from HDP) = 300 mm