SEMI E30.2-0698
HANDLER EQUIPMENT SPECIFIC EQUIPMENT MODEL (HSEM)

CONTENTS

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1 Purpose

1.1 This document establishes a Specific Equipment Model (SEM) for Handling equipment (HSEM). The SEM consists of equipment characteristics and behaviors that are applicable to this class of equipment and are required to be implemented in addition to the SEMI E30 fundamental requirements and additional capabilities. The intent of this document is to facilitate the integration of Handling equipment into an automated (semiconductor) factory. This document accomplishes this by defining an operational model for Handling equipment as viewed by a factory automation controller. This definition provides a standard host interface and equipment operational behavior.

2 Scope

2.1 The scope of this document is limited to the definition of Handling equipment behavior as perceived by a SECS-II host that complies with the SEMI E30 model. It defines the view of the equipment through the SECS communications link. It does not define the internal operation of the equipment. It includes a specific processing state model as the basis for the behavior of all equipment of this class.

2.2 This document requires that the SEMI E30 fundamental requirements and applicable additional capabilities (see Section 13,Additional SEMI E30 Capabilities) have been implemented on the handling equipment. This document expands the SEMI E30 standard requirements and capabilities in the areas of the processing state model, collection event, alarm documentation, remote commands, variable item, and process program management.

3 Limitations

3.1 *Communications* — It is required that any HSEM-compliant equipment follow the Communications State Model in SEMI E30. In addition, HSEM-compliant equipment shall support the High Speed Messaging Service (HSMS) communication standard sending SEMI E5 messages over TCP/IP. The reason behind this requirement is the amount of data available for monitoring from this class of equipment. This specification deals only with the behavior of the handler in communicating with the host. It is recognized that the handler may also have a communications link with other process equipment and that the other equipment may also have a communications link with the host. This specification is intentionally non-specific on the communications link requirements between handler and other process equipment to allow the user the greatest amount of flexibility in specific factory configurations.

3.2 *Multi-Process-Site HSEM Implementations* — This SEM makes some demands and assumptions about the Handler with multiple process-sites in a configuration. These requirements are as follows:

Handling equipment in a multiple process-site configuration (i.e., lead conditioning site, electrical test-site) provides identification and status information (see Variable Item) at both the site level and the subsite level. An example could be a handler with both a lead conditioning site and an electrical test-site, with the electrical test-site containing multiple subsites (i.e., test heads).

4 Referenced Documents

4.1 *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 E10 — Standard for Definition and Measurement of Equipment Reliability, Availability, and Maintainability (RAM)

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

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

SEMI E37.1 — High-Speed SECS Message Services Single-Session Mode (HSMS-SS)

SEMI E58 — Automated Reliability, Availability, and Maintainability Standard (ARAMS): Concepts, Behavior, and Services

5 Terminology

5.1 *alignment location* — Location that individual packaged units are placed at the process-site (e.g., electrical test).

5.2 *chaining* — The process of execution over multiple lots or runs with the same Process Program and the same handler operating conditions.

5.3 *electrical test-site* — A process-site on the equipment which is coupled with electrical testing equipment for purposes of performing package electrical testing.

5.4 *execution area* — The area from which a current copy of the process program instructions is executed.

5.5 *handling equipment* — An equipment class generally consisting of integrated mechanisms and controls for the purpose of manipulating packaged devices, trays, and tubes during the manufacturing process.

5.6 *indexing* — The controlled stepped movement of material through the handler.

5.7 *kit* — Specific items of hardware and software as specified by the equipment manufacturer that adapt the equipment for a specific unit or unit package.

5.8 *leadconditioning site* — A process-site on the handler where some form of conditioning occurs on the package leadfingers (i.e., warming).

5.9 *leadfinger (or substrate connector lead)* — (1) In ceramic packages, an area of refractory metal that has been plated and is designated for the attachment to a process-site. (2) The area of the unit designated for attachment to a process-site.

5.10 *leadframe* — A sheet metal framework upon which a chip (sometimes chips) is attached, wirebonded, and then either molded with plastic epoxy or with ceramic and/or metal.

5.11 *media* — A temporary material carrier used to hold and transport units/devices (tubes, trays, etc.).

5.12 *media map* — Formatted data used to map functionally good and bad units/devices to an X, Y, Z location in the media. Maps can be requested by the handler for use prior to processing and then updated after processing.

5.13 *off-line programming (OLP) utility* — Utility to create, edit, and format process programs on a computer, as opposed to creating process programs at the equipment.

5.14 *process-site* — A location on the equipment where work is performed on a packaged device (i.e, electrical test-site, lead conditioning site).

5.15 *process subsite* — An addressable portion of a process-site.

5.16 *reset* — The action of changing the value of a variable, such as wafer count (usually to zero).

5.16.1 *safe state* — A state in which the equipment presents no danger to the product or user. This implies that safety interlocks are in place such that the equipment can be serviced without harm to the operator and that the material being processed has been removed from the processing station into an accessible location.

5.17 *slot* — A position in a carrier where a leadframe, tray, tube, or other media element may reside.

5.18 *tray* — A flat rectangular form of media for holding singulated packaged units. Also referred to as waffle packs or matrix trays. A tray is generally molded plastic with a defined matrix of cells or pockets tailored for specific packages.

5.19 *tube* — A hollow form of media for holding packaged units. Also referred to as rails or sticks. A tube is generally composed of extruded polymer with internal section dimensions and features tailored for a specific package.

5.20 *unit* — The functional integrated circuit (or chip) that is being handed to a specific process-site.

6 Requirements

6.1 *State Models* — The purpose is to define the equipment-specific processing state model and other state models necessary to portray the expected operational states of the equipment to enable host tracking and control in place of a local operator.

6.2 *State Model Requirements*

6.2.1 The processing state models in this document are required for implementing an HSEM-compliant handler in addition to the required state models in SEMI E30. A state model consists of the following state model diagram, state definitions, and state transition tables.

6.2.2 A state model represents the host's view of the handler, not necessarily the actual handler's internal operations.

6.2.3 All HSEM state model transitions shall be mapped sequentially into the actual equipment events that satisfy the requirements of those transitions. In certain implementations, the handler may enter a state and have already satisfied all of the conditions required by the HSEM state model for transition to another state. The handler makes the required transition without any additional actions in this situation.

6.2.4 Some equipment may need to include additional states. However, any additional states must not change the HSEM-defined state transitions. All expected transitions between HSEM states must occur.

6.3 *HSEM State Model*

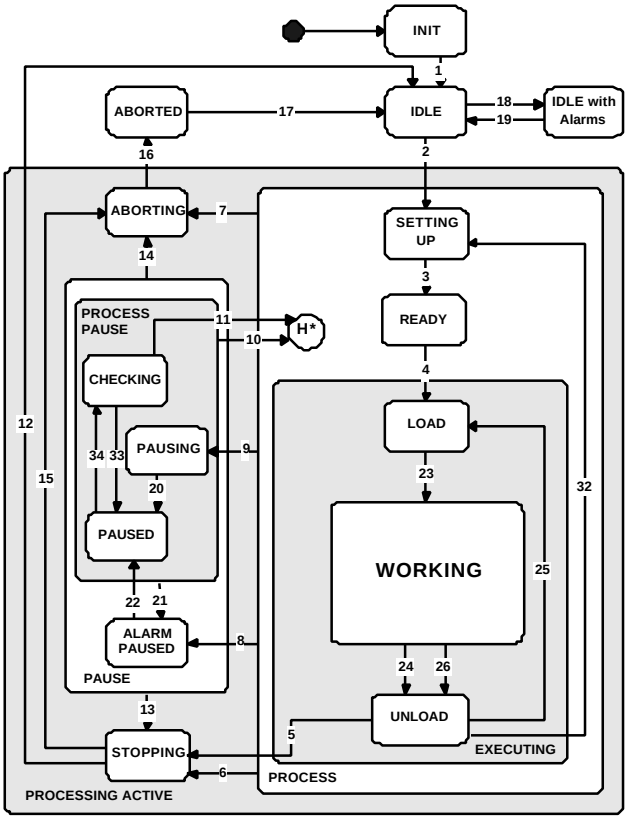

Figure 1
HSEM Processing State Model

6.4 *Description of Handler Processing States*

6.4.1 *ABORTED* — All activity is suspended as a result of an ABORT command. Any alarm and abort conditions must be cleared and verified by an operator before exit from this state.

6.4.2 *ABORTING (PROCESSING ACTIVE Sub-State)* — The handler has received an ABORT command. All activity is suspended. The handler is taking appropriate action to bring itself and material to a "safe" state where possible. Unit or Lot data may be invalid or not available.

6.4.3 *ALARM PAUSED (PAUSE Sub-State)* — An alarm has occurred in the PROCESS or PROCESS PAUSE states, and the handler is waiting for the alarm to be cleared.

6.4.4 *CHECKING (PROCESS PAUSED Sub-State)* — The handler verifies that updates made to the process program are valid (i.e., possible errors induced via an operator during the pause). This is a similar procedure to that which is done in SETTING UP before the handler is ready to transition to the READY state. At the completion of verification, an event is generated when the verification succeeds, and the operator or host must issue a RESUME command to the handler before it will resume processing from the point where it was paused.

6.4.5 *EXECUTING (PROCESS Sub-State*) — The handler is processing material automatically and can continue to do so without external intervention. This state may include interaction with the host or operator.

6.4.6 *IDLE* — Awaiting a command. IDLE is free of ALARMS and error conditions.

6.4.7 *IDLE with ALARMS* — An alarm has occurred in the IDLE state, and the handler is waiting for all alarms to be cleared.

6.4.8 *INIT* — Handler initialization is occurring.

6.4.9 *LOAD (EXECUTING Sub-State)* — This is the state the next unit or units are transferred from the input media to the process-site.

6.4.10 *PAUSE (PROCESSING ACTIVE Sub-State)* — The PROCESS state will be suspended at the completion of the current unit or next opportunity. Actions to put the handler in a safe state are performed. The handler is awaiting a command (RESUME, STOP, or ABORT) or for alarm(s) to be cleared.

6.4.11 *PAUSED (PROCESS PAUSE Sub-State)* — The PROCESS state has been suspended, and the handler is waiting for a command (RESUME, STOP, or ABORT). In this state, the operator may correct error conditions that do not affect the current Process Program selection. One of the possible corrective actions is for the operator to manually align the units being processed.

6.4.12 *PAUSING (PROCESS PAUSE Sub-State)* — The PROCESS state will be suspended at the completion of the current unit or next opportunity. The handler cannot transition to PAUSED state until the current unit is completed and the handler is in a "safe state".

6.4.13 *PROCESSING (WORKING Sub-State)* — Unit is moved to process-site (e.g., for electrical test, to insert into contactor).

6.4.14 *PROCESS COMPLETE (WORKING Sub-State)* — Unit process is complete. Unit is unloaded or returns to alignment for a step and repeat.

6.4.15 *PROCESS (PROCESS Sub-State)* — This state is the parent of those sub-states which refer to the preparation and execution of a process program.

6.4.16 *PROCESS PAUSE (PAUSE Sub-State)* — The handler is free of alarm conditions in the PAUSE state.

6.4.17 *READY (PROCESS Sub-State)* — The handler is ready to begin processing and is awaiting a START command from the operator or host.

6.4.18 *SETTING UP (PROCESS Sub-State)* — The handler is satisfying conditions so that processing can begin. This includes the receipt of any process programs, the material to be processed, and machine-specific calibration. While in this state, the handler can be single-stepped through each process in order for the operator to ensure that the handler is moving the unit correctly.

6.4.19 *STOPPING (PROCESSING ACTIVE Sub-State)* — The handler has completed a Process Program or has been instructed to stop processing and shall do so at the next opportunity. All necessary cleanup is completed within this state with regard to material, data, control system, etc. Data is preserved. Any error condition is cleared before exiting from this state.

6.4.20 *UNLOAD (EXECUTING Sub-State)* — The unit is being removed from the process-site, and the handler determines which transition to take.

6.4.21 *WORKING (EXECUTING Sub-State)* — The handler is processing a specific unit.

6.5 *HSEM Processing State Transitions Table*

Table 1. Processing State Transitions Table

#	*Current State*	*Trigger*	*New State*	*Actions*	*Comments*
1	INIT	All handler initialization is complete with no alarms or error conditions.	IDLE	None	None
2	IDLE	A Process Program is selected.	SETTING UP	Handler-dependent	Commit has been made to setup.
3	SETTING UP	All setup activity has completed, and the handler is ready to receive a START command.	READY	The handler is waiting for a START command.	The selected Process Program is available for execution, and material is present at the input port.
4	READY	The handler receives a START command.	LOAD	Transfers the next unit to the process-site.	LOAD is an EXECUTING sub-state.
5	UNLOAD	The material unloaded completes.	STOPPING	The handler completes the last unit.	None
6	PROCESS	The handler has received a STOP command.	STOPPING	The handler completes the current unit in the WORKING state and unloads it.	The handler begins its cleanup procedure.
7	PROCESS	The handler has received an ABORT command from operator, host, or self-generated.	ABORTING	The handler is put in a "safe" state.	Unit or lot data may be invalid or not available.
8	PROCESS	An alarm occurs.	ALARM PAUSED	PROCESS activity is suspended, and the handler is waiting for all alarms to be cleared.	ALARM PAUSED is a PAUSE sub-state.
9	PROCESS	The handler has received a PAUSE command.	PAUSING	The PROCESS state shall be suspended at the completion of the current unit. Any necessary actions to put the handler in a safe state are performed.	PAUSING is a PAUSE sub-state.
10	PROCESS PAUSE	The handler has received a RESUME command.	Previous PROCESS State	Proceeds from the point where processing was previously suspended.	None
11	CHECKING	Parameter checking completes successfully.	STATE based on conditional table.	Return to previous state.	None

Table 1. Processing State Transitions Table

12	STOPPING	The handler cleanup is complete, and the handler is free of alarms.	IDLE	None	None
13	PAUSE	The handler has received a STOP command.	STOPPING	The handler proceeds with cleanup.	Data is preserved and is valid.
14	PAUSE	The handler has received an ABORT command.	ABORTING	Any unsafe condition is resolved, if possible.	Data may be invalid or unavailable.
15	STOPPING	The handler has received an ABORT command.	ABORTING	Any unsafe condition is resolved, if possible.	Data may be invalid or unavailable.
16	ABORTING	Unsafe conditions have been resolved where possible.	ABORTED	The handler is waiting for alarm and ABORT conditions to be cleared.	The only state change allowed is to IDLE.
17	ABORTED	An operator has verified that all alarms and abort conditions have been cleared.	IDLE	None	None
18	IDLE	An alarm is set.	IDLE with ALARMS	The handler waits for all alarms to be cleared.	None
19	IDLE with ALARMS	All alarms have been cleared.	IDLE	None	The IDLE state is free of alarms.
20	PAUSING	The handler has completed Process-ing the Current unit in the WORKING state and achieved a safe condition.	PAUSED	The handler is waiting for a command (RESUME, STOP, or ABORT).	None
21	PROCESS PAUSED	An alarm is set by the handler.	ALARM PAUSED	The handler waits for all alarms to be cleared or for a STOP or ABORT command.	None
22	ALARM PAUSED	All alarms are cleared.	PAUSED	The handler is waiting for a command (RESUME, STOP, or ABORT).	None
23	LOAD	A unit(s) is loading to the process-sites.	WORKING	The unit(s) is being processed.	None
24	WORKING	The processing of the current unit(s) completes normally.	UNLOAD COMPLETED UNIT	This unit(s) is transferred from the process sites.	"Normal" completion of the unit(s).

Table 1. Processing State Transitions Table

25	UNLOAD COMPLETED	The material unloaded is complete, and material is available.	LOAD	Transfers the next unit(s) to the processing location.	None
26	WORKING	The processing of the current unit(s) completes abnormally.	UNLOAD COMPLETED	This unit(s) is transferred from the process-site.	"Abnormal" completion of the unit(s).
32	UNLOAD UNIT	The last unit *p* of a lot completes, and a new lot or last carrier is received.	SETTING UP	The handler waits for another SELECT command.	None
33	CHECKING	Error was detected in new parameter setting being validated in the CHECKING state.	PAUSED	None	None
34	PAUSED	A RESUME command was received.	CHECKING	Validation of the Process Program Parameters.	Host or operator is required to issue a RESUME command before processing shall continue.

6.6 *Process Model Conditions Table*

Table 2. Process Resume Conditions

Condition	*Next State*
Checking determines that process program conditions were changed.	SETTING UP
Previous State WORKING.	UNLOAD
Previous State READY.	READY
Previous State was SETTING UP.	SETTING UP

7 Collection Event List

7.1 *Requirements*

7.1.1 ALL SEMI E30-required Events are required by the HSEM. Since a Processing State Model is required by the HSEM, all state transitions are required Events.

7.1.2 All SEMI E30-required Events associated with the GEM Control, Communications, Alarm, and Spooling State Models are required.

7.1.3 This section of the HSEM lists only those collection events that are not associated with a change of state or those requiring specific data variables (DVVALs) or Reports defined in the HSEM.

7.2 *Collection Event Tables* — The first table contains required events and associated reports. The second table contains required events and associated data variables.

Table 3. Processing State Transitions Requiring Report Levels

Transition	*From State*	*To State*	*Required DVVALs or Report*
SETUP COMPLETE (3)	SETTING UP	READY	Setup Report

Table 4. Other Required Collection Events

Collection Event Name	*Required DVVALs*
LotComplete	See Lot Report.
DockStatusChange	DockingStatus
BinDataAvailable	See Bin Data Report.
LotStart	Lot/SubLot Start Report
CarrierEmpty	Media-ID, Lot-ID
CarrierFull	Media-ID, Lot-ID
SubLotComplete	SubLot-Report
ReaderFailed	Reader-Type, Barcode-Error-Type
UnitCntInterval	Unit-Count-Interval, Time-Stamp
MediaCntInterval	Media-Count-Interval
SkipCntInterval	Skip-Count-Interval
MediaChange	Media-ID, Product-ID, Media-Type
SubLotStart	Lot/SubLot Start Report

8 Variable Items

The purpose of this section is to define the list of variable items required by the HSEM. Values of these variables are available to the host through collection event reports and host status queries.

8.1 *Requirements*

8.1.1 All generic variable items defined in SEMI E30 are required by all HSEM equipment.

8.1.2 Variable items required by HSEM are categorized as follows:

- *Common Variables (CVs)* — Variables common to all testers.
- *Configuration-Specific Variables (CSVs)* — Variables associated with a specific configuration of the above equipment class.

8.1.3 Any supplier-defined variables shall be documented in the same format used by this document. The following minimum information is required:

<variable name> **Class:** <ECV, SV, or DVVAL> **Format:** <SML>

Description: <If class = DVVAL, description must contain statement of when data is valid.>

<If format = ASCII, then a length is required. It is assumed to be left-justified unless otherwise noted.>

8.2 *Data Types*

8.2.1 Equipment Constants (ECVs) can be changed by the host using S2,F15. The operator may be able to change some values, but the equipment does not change the values on its own. The value of an equipment constant may be queried by the host at any time, using the S2,F13/14 transaction. They reside in non-volatile memory of the equipment. Equipment constants remain in effect until they are overwritten, either by manual entry or by a NEW EQUIPMENT CONSTANT SEND.

8.2.2 Equipment constants have various uses in HSEM, including the following:

- Equipment offsets that match the performance of several pieces of equipment that would otherwise perform differently due to inherent manufacturing differences. Examples are home values and motion axis scaling factors.
- Setting the configuration of the equipment to allow for different material specifications, equipment options, material flows, frequency of automatic functions, etc. Examples are media and yield check frequency.
- Managing optional machine features. Examples are constants that indicate whether optional features, such as automated media stackers, are present and control the configuration and function of these optional subsystems when they are present.

8.2.3 Status Variables (SVs) are valid at all times. An SV may not be changed by the host but may be changed by the equipment or operator. The value of status variables may be queried by the host at anytime using the S1,F3/4 or S6,F19/20 transactions.

8.2.4 DVVALs are variables that are valid only upon the occurrence of specific collection events. An attempt to read a data variable at the wrong time shall not generate an error, but the data reported may not have relevant meaning.

8.2.5 *Data Item Requirements for Multi-Head, Multi-Site Equipment* — The identification for multi-head and multi-site data (data variable, status variables, events, etc.) is addressed in this specification through the use of status variables with list structures. In the table below, the subheading "Process-Site Group" contains variables which must be available for all process-sites on the handler equipment. When multiple process-sites exist, either a list structure or table structure may be used to show multiple occurrences of a specific variable.

8.3 *Variable Item Table*

Table 5. Variable Item Table

Variable Name	*Category*	*Description*	*Class*	*Format*	*Comments*
Physical Handler Group					
EquipSerialID	CV	Identification of Equipment	SV	A[1..16]	Valid in all states.
HandlerComStatus	CSV	Status of comm link between handler/s (0 = Disabled, 1 = 1-way enabled, 2 = 2-way enabled, 3 = Not communicating)	SV	U4	Valid in all states.
KitID	CSV	ID of unique tooling unit	SV	A[1..24]	Valid in all states.
LightPoleStatus	CSV	Color/status (i.e., Red/flash)	SV	A[1..16]	Valid in all states.
LinkPortStatus	CSV	(3 = Input/Output linked, 2 = Input linked, 1 = Output linked, 0 = HANDLER not Linked)	SV	U4	Valid in all sub-states.
MediaID	CV	Media Serial Number	SV	A[1..24]	Valid in Executing state.
OperationType	CSV	Current Operation Mode (i.e., maintenance, production)	ECV	A[1..24]	Valid in all states.
OperatorID	CSV	Current Operator ID	ECV	A[1..24]	Valid in all states.
QueueStatus	CV	PPID Queued to be run	SV	U4	Valid in all states.
ReaderErrorType	CSV	Type of error detected by the material reader.	DVVAL	A[1..24]	Supplier-defined.
Process-Site Components					
AlignmentCount	CSV	Number of units since last alignment (i.e., Homing/ Adjustment).	SV	U4	Valid in all states.
DockingStatus	CSV	Information on handler/ docking status (0 = Yes, 1 = No)	SV	U4	Valid in all states.
HardBinID	CV	Process-Site Bin Out Number	DVVAL	U4	Valid at BIN-DATA-AVAILABLE Event.
HardBinName	CV	Process-Site Bin Out Name	DVVAL	A[1..40]	Valid at BIN-DATA-AVAILABLE Event.
InsertionForce	CSV	Insertion-Force energy	DVVAL	F8	Valid in PROCESSING state.

Table 5. Variable Item Table

InsertionForceSetpoint	CSV	Insertion-Force set point (setpoint)	ECV	F8	Valid in all states.
LotID	CV	Lot Identification	SV	A[1..40]	Valid in all states.
LotProcessingTime	CV	The time since start of current Lot. HHMMSSCC	DVVAL	A[16]	Valid in Process-Sub-State.
MediaChangeTime	CV	Elapsed time to replace media and send ready.	SV	A[16]	Valid in all states.
MediaCount	CV	Number of media since last reset.	SV	U4	Valid in all states.
MediaCountInterval	CV	Event generated when number of media is completed.	SV	U4	Valid in all states.
PresentPositionActual	CSV	Present position actual.	ECV	U4	Valid in all states.
PresentPositionSetpoint	CSV	Present position set points (setpoint).	ECV	U4	Valid in all states.
ProcessSiteTemp	CSV	Process-site temperature (setpoint).	SV	F8	Celsius - Set point.
ProcessSiteID	CV	ID of process-site in configuration.	SV	U4	Valid in all states.
ProcessSiteStatus	CV	$Site_n$ Availability (1 = enabled, 0 = disabled)	DVVAL	F8	Valid in all states.
ProcessSubsiteID	CV	Subsite matrix location within process-site.	SV	U4	Valid in all states.
ProcessSubsiteStatus	CV	$Subsite_n$ Availability (1 = enabled, 0 = disabled)	DVVAL	F8	Valid in all states.
ProductID	CV	ID of product for which tester is currently configured.	DVVAL	A[1..40]	Valid in PROCESS states.
SkipCount	CSV	Number of units skipped since last reset (Skip + Process = Total)	SV	U4	Valid in all states.
SkipCountInterval	CSV	Event generated when number of units is skipped.	SV	U4	Valid in all states.
StartProcessPortID	CSV	Start process source (i.e., hand, keyboard, host)	SV	U4	Valid in all states.
SubLotID	CV	SubLot Identification	SV	A[1..40]	Valid in all states.

Table 5. Variable Item Table

UnitCount	CV	Number of units since last reset.	SV	U4	Valid in all states.
UnitCountInterval	CV	Event generated when number of units is completed.	SV	U4	Valid in all states.
UnitPosition	CSV	X, Y, Z media location of a unit.	SV	U4	Valid in all states.
UnitStatus	CSV	(1 = Processed, 0 = Skipped)	SV	U4	Valid in all states.

8.4 *HSEM Required Reports* — The reports below are required as "canned" or preconfigured reports by HSEM. HSEM does not require the equipment to guarantee the accuracy of data identified in these reports outside the PROCESSING ACTIVE state defined in the HSEM process state model.

8.4.1 *Setup Report* — Table 6 contains variables that are required to be available at the setup complete event.

Table 6. Required Variables at Setup Complete Event

Variable Name	*Notes*
KitID	Configuration Kit
MediaID	Serial # of Media
LotID	
PPExecName	(per SEMI E30)
EquipID	
ProductID	Current
InsertionForceSetPoint	

8.4.2 *Process Report* — Table 7 contains variables that must be available when the equipment is in the PROCESSING state.

Table 7. Required Variables for PROCESSING State

Variable Name	*Notes*
AlignmentCount	
ProcessSiteTemp	
LotProcessTime	
OperatorID	
OperationType	

8.4.3 *Lot/SubLot Report* — Table 8 below contains variables that must be available at the completion of a wafer.

Table 8. Lot/SubLotStartVariables

Variable Name	*Notes*
OperatorID	
LotID	
SubLotID	
PPExecName	(per SEMI E30)
ProductID	
SkipCount	

8.4.4 *SPC Report* — The table below contains variables that must be available and reported at the completion of a unit.

Table 9. Required Variables at Completion of Unit

Variable Name	*Notes*
UnitCount	
SkipCount	
SkipCountInt	
UnitCountInt	
MediaCount	
MediaCountInterval	
HardBinID	
MediaID	
OperatorID	

9 Process Program Management

9.1 *Process Program Requirements*

9.1.1 The HSEM requires that the SEMI E30 capability of process program management be fully supported for this class of equipment. The HSEM also requires that the process program have a structure that enables the user to build process programs with default conditions that can be overridden for a run. The concepts of process program structure and process program variable parameters are discussed in the following sections.The HSEM also requires the following:

- Minimum, maximum, and default parameter values must be defined for all process programs.
- Verification will occur when a process program is downloaded to the equipment; the program syntax must be verified by the equipment manufacturer.
- Parameter validation will occur when a process program is downloaded. Parameters must be type and range checked.

- Equipment should provide the functionality to manually or interactively modify the parameters set in the process program.
- An error message must be generated from the handler if the process program parameters are outside the range of the machine calibration.

9.2 *Process Program Structure*

9.2.1 A handler process program must contain the following information:

- Machine-specific configuration parameters
- Process-Site-specific information section
- Media-Type-specific information section
- Unit (Unit/Package) information section

9.2.2 When combined, this information constitutes a complete process program. It is emphasized that the HSEM does not enforce the exact format and data type of each section. However, it does provide direction as to what each section should consist of.

9.2.3 *Machine-Specific Configuration Parameters* — Each brand or type of handler may have one or more machine-specific configuration parameters. Examples of such parameters would be input configuration, number of process-sites, and output configuration. Even though they are supplier-specific, these parameters nevertheless play a vital role in the overall generation or creation of a process program. Since the machine-specific parameters can differ from one equipment manufacturer to another, the HSEM does not specify the exact number, data types, and format of these parameters. These details are left to the sole discretion of the equipment manufacturer.

9.2.4 *Process-Site-Specific Information* — This process-site-specific section contains information necessary for the configuration and execution of the various process-sites configured on the equipment. Each equipment may contain different process-site configurations. Since these configurations will differ, the HSEM does not specify the exact number, data types, and format of these parameters. HSEM does recommend a minimum list of data items for the common handler process-sites. These include:

9.2.5 *Thermal Conditioning Site Parameters*

- Temperature Set Point
- Upper-Temp Guardband Set Point
- Lower-Temp Guardband Set Point
- Soak Time
- Test-Site Temp

9.2.6 *Test-Site Parameters*

- Device Pick Up/Place
- Speed of Device Pick Up/Place
- Device Insertion/Retraction
- Speed of Device Insertion/Retraction
- Speed of Index Mechanism
- Insertion/Place Force/Stroke

9.2.7 *Lead Condition Site Parameters*

- Device Pick Up/Place
- Speed of Device Pick Up/Place
- Speed of Insertion
- Insertion Force/Stroke

9.2.8 *Sort Sites Parameters*

- Device Pick Up/Place
- Speed of Device Pick Up/Place
- Device Index
- Insertion Force/Stroke
- Sort Category Set
- *Sort Category* – Full/Empty/Partial
- *Sort Media* – In place or empty.

9.2.9 *Unit/Device-Specific Information* — The unit/device-specific section contains information necessary for the configuration and execution of the specific units to be handled by the equipment. HSEM requires a minimum list of data items be available to determine package dimensions, terminal dimensions, package height, and coplanarity.

9.2.10 *Media-Type-Specific Information* — The media-type-specific information section contains information necessary for the configuration and execution of the specific media type in use on the equipment. HSEM requires a minimum list of data items be available to determine row/column count, X/Y distance to a cell, device height in tray, media height, and X/Y pitch.

9.3 *Methods of Process Program Creation* — The method by which an equipment manufacturer creates a process program may be unique to that manufacturer. However, it is required that the customer at least be given both of the following options for the creation of a process program.

9.3.1 *Off-Line Development* — Using this method, the customer is given a set of software tools (process program compilers, decompilers, and debuggers) that enables him/her to generate or create a process program using the above mentioned information (flow, parameter, functional test, etc.). The newly generated process program then is downloaded onto a specific handler, verified, and is now ready to be selected and executed locally by the operator or remotely by the host computer. If this process is used, the supplied software tools should closely mimic or simulate a handler so that a user can create a complete process program. In many situations, minor adjustments may be needed to the process program on the equipment before it is completely ready for execution.

9.3.2 *On-Line Development* — The second option is to enable the user to download the above-mentioned information (tables or files) onto the equipment and create the actual process program on the equipment itself.

10 Remote Commands

The purpose of this section is to identify remote commands, command parameters, and valid commands versus states in the processing state models.

10.1 *Requirements*

- The equipment must support the GEM-required remote commands. (Some of the SEMI E30-required remote commands are restated here to define HSEM-specific requirements.)
- All the remote commands defined by HSEM are required.
- The alphanumeric strings defined by HSEM for remote commands (RMCD) and command parameters (CPNAME) are required.
- If additional remote commands are supported, then the "Remote Command Versus Valid States" matrix must be generated for these additional commands. Place an "X" in the table for each state in which a given command is valid.

10.2 *Remote Command Descriptions*

10.2.1 *ABORT-LOT* — This command terminates the current processing. ABORT makes no guarantee about completion of the current unit. Levels of ABORT may be specified (see Table 10, Remote Command Descriptions, for details).

10.2.2 *PAUSE* — This command transitions the handler to the PAUSING process state when the current unit/media completes processing.

10.2.3 *RESUME* — This command resumes processing from the point where the process was PAUSED. This command is only recognized if the handler is in the PAUSED state.

10.2.4 *PP-SELECT* — This command instructs the handler to copy the indicated Process Program from non-volatile storage to the handler's Process Program execution area. Process Program Variable Parameters can be specified in this command which modify the default values for these Variable Parameters in the Process Program.

10.2.5 *START* — This command is only available to the host or operator when a process program has been selected and the handler is in the READY processing state. The START command instructs the handler to initiate processing.

10.2.6 *STOP* — This command completes the current unit, stops in a safe condition, and returns to the IDLE processing state. STOP has the intent of bringing about a normal termination after completion of the current unit.

10.2.7 *LAST-CARRIER* — This command instructs the handler to treat the current carrier being processed on the handler as the last carrier of the lot. This forces the subsequent carrier to be considered the first carrier of the next lot.

10.2.8 *NEW-LOT* — This command instructs the handler to treat the next carrier to be processed as a new lot. A new LOT-ID and carrier-list must accompany the new lot command. This command forces subsequent carriers to be considered part of the lot, until all carriers in the carrier list have been processed or until a LAST-CARRIER command is received.

10.2.9 *RESET-TOOL-COUNTS* — This command will initialize equipment tool counts. The minimum set are those contained in the Variable Items section.

10.2.10 *PURGE* — Purge flush or clean the equipment of process material.

10.3 *Associated Remote Command Parameters*

Table 10. Remote Command Descriptions

Command	*Parameter*			
Name	*Name*	*Opt./Req.*	*Description*	*Format*
ABORT	"PROCESSSITEID"	OPT	ID of handler process-site.	U4
	"CLEANUP"	OPT	The handler finishes processing the current unit and removes all carriers that belong to the lot and enters the Aborting state.	A[7]
ABORT-CARRIER	"PROCESSSITEID"	OPT	ID of handler process-site.	U4
	"CLEANUP"	OPT	The handler will finish processing the current carrier.	A[7]
NEW-LOT	"PROCESSSITEID"	OPT	ID of handler process-site.	U4
	"LOTID"	REQ	ID of new LOT.	A[1..40]
PAUSE	"PROCESSSITEID"	OPT	ID of handler process-site.	U4
PP-SELECT	"PROCESSSITEID"	OPT	ID of handler process-site.	U4
	"LOTID"	OPT	Lot to be processed with this program.	A[1..40]
	"PPID"	REQ	The ID of the program to be used.	A[80]
	"MEDIALIST"	OPT	One or more media to be processed with this program.	ASCII List
RESET-TOOL-COUNTS	"PROCESSSITEID"	OPT	ID of handler process-site.	U4
	"SVIDLIST"	REQ	List of SVIDs to reset.	ASCII List
RESUME	"PROCESSSITEID"	OPT	ID of handler process-site.	U4
START	"PROCESSSITEID"	OPT	ID of handler process-site.	U4
STOP	"PROCESSSITEID"	OPT	ID of handler process-site.	U4
	"CLOSELOT"	OPT	Automatically close lot.	BOOL
PURGE			Purge handler of all material.	NO PARAMS

10.4 *Remote Commands and HSEM Process Model Mapping* — Table 11 illustrates the relationship between remote commands and states of the HSEM processing state model. An "X" indicates that a command is valid for use in this state. If a remote command is attempted during a non-valid state, the equipment would reject the remote command.

Table 11. Remote Commands vs. Process States

COMMAND	ABORT	ABORT-MEDIA	PAUSE	PP-SELECT	RESUME	START	STOP
PROCESSING STATE							
IDLE				X			
PROCESSING ACTIVE							
PROCESS							
SETTING UP					X		X
READY	X	X			X		X
EXECUTING							
LOAD	X					X	X
WORKING	X				X	X	X
UNLOAD	X					X	X
PROCESS PAUSE							
PAUSING							X
PAUSED	X		X			X	X
CHECKING				X			X
ALARM PAUSED			X				X
ABORTED						X	

Table 12. Remote Commands vs. Process States (cont.)

COMMAND				
RESET-TOOL-COUNTS				
LAST-CARRIER				
NEW-LOT				
PURGE				
PROCESSING STATE				
IDLE		X		X
PROCESSING ACTIVE				
PROCESS				
SETTING UP			X	
READY	X	X	X	X
EXECUTING				
LOAD				
PROCESSING				
UNLOAD				
PROCESS PAUSE				
PAUSING				
PAUSED	X	X	X	X
CHECKING		X	X	
ALARM PAUSED	X			
ABORTED	X			

11 Scenarios

The purpose of this section is to document possible HSEM-specific operational scenarios.

11.1 *Normal Run Scenario*

This is an error-free run of a single lot with a single test-site. All optional SEMI E30 events are turned off by default.

COMMENT	HOST	EQUIPMENT	COMMENT
Host selects process program.	S2,F41-->		
		<--S2,F42	Equipment Ack
Setting Up			
Setup Complete			
		<--S6,F11	Event : PPLoadOk
Host Ack	S6,F12-->		
Process			
Process.SettingUp			
Process.Ready			
Host commands start-of-lot.	S2,F41-->		
		<--S2,F42	Equipment Acks Start.
			Handler cycles devices... ...until empty...
		<--S6,F11	Event : Empty
Host Acks Event	S6,F12-->		
Host commands end-of-lot.	S2,F41-->		
		<--S2,F42	Handler acks Rmt.Cmd.
Stopping			
		<--S6,F11	Event : Lot Completed
Host Acks Event	S6,F12-->		
Idle			

11.2 *Normal SPC Scenario* — This is a normal SPC run with all optional SEMI E30 events turned off by default.

COMMENT	HOST	EQUIPMENT	COMMENT
Host selects GEM Alarms to enable (list).	S5,F3-->		
		<--S5,F4	Alarms xyz ON
Host selects GEM Events to enable (list).	S2,F37-->		
		<--S2,F38	Events xyz ON
Host selects process program.	S2,F41-->		
		<--S2,F42	Equipment Ack
Setting Up			
Setup Complete			
		<--S6,F11	Event : PPLoadOk
Host Ack	S6,F12-->		
Process			
Process.SettingUp			
Process.Ready			
Host requests start-of-lot report.	S6,F15-->		
		<--S6,F16	Equipment sends report items.
Host commands start-of-lot.	S2,F41-->		
		<--S2,F42	Equipment Acks Start.
		<--S5,F1	Alarm : NoDevicesPresent
Host Acks Alarm	S5,F2-->		
			Time Passes.
		<--S6,F11	Event : PortLoaded
Host Acks Event	S6,F12-->		
			Handler cycles devices... ... until ...
		<--S5,F1	Alarm : LoadDeviceFail
Host Acks Alarm	S5,F2-->		

ProcessPause

Host sends operator to clear jam.			
Host sends resume.	S2,F41-->		
		<--S2,F42	Handler Acks and resumes.

Processing

			Handler cycles devices... ... until ...
Host asks for Temperature x.	S6,F15-->		
		<--S6,F16	Handler sends Temp.x.
			...
		<--S6,F11	Event : HandlerEmpty
Host Acks Event	S6,F12-->		
Host commands end-of-lot.	S2,F41-->		
		<--S2,F42	Handler acks Rmt.Cmd.

Stopping

		<--S6,F11	Event : Lot Completed
Host Acks Event	S6,F12-->		

Idle

Host requests end-of-lot-report.	S6,F15-->		
		<--S6,F16	Handler sends report.

11.3 *Multi-Site Run Scenario* — This is a run scenario with 64 test-sites and optional GEM events all turned on with no errors of any type occurring.

COMMENT	HOST	EQUIPMENT	COMMENT
Host selects GEM Alarms to enable (list).	S5,F3-->		
		<--S5,F54	Alarms xyz ON.
Host selects GEM Events to enable (list).	S2,F37-->		
		<--S2,F38	Events xyz ON.
Host selects Trace Data Item(s).	S2,F23-->		
		<--S2,F24	Trace Data Item x ON.
Host selects process program.	S2,F41-->		
		<--S2,F42	Equipment Ack
Setting Up			
Setup Complete			
		<--S6,F11	Event : PPLoadOk
Host Ack	S6,F12-->		
Process			
Process.SettingUp			
Process.Ready			
Host requests start-of-lot report.	S2,F41-->		
		<--S2,F42	Equip sends report items.
Host commands start-of-lot.	S2,F41-->		
		<--S2,F42	Equip Acks Start.
			... for each trace item period.
		<--S6,F1	Trace Event x SEND.
Host receives and Acks Trace Item x.	S6,F2-->		
			... for each port event (tray/ tube).
		<--S6,F11	Event : PortLoaded

```
Host Acks Event          S6,F12-->

                                          ... Handler cycles devices ...
                                          ... for each device report
                                              internal states.

                         <--S6,F11          Event : DeviceClearsInput

Host Acks Event          S6,F12-->

                         <--S6,F11             Event : DeviceEntersTemp

Host Acks Event          S6,F12-->

                         <--S6,F11          Event : DeviceClearsTemp

Host Acks Event          S6,F12-->

                         <--S6,F11          Event : DeviceEntersQueue.x

Host Acks Event          S6,F12-->

                         <--S6,F11          Event : StartTest.Contactor.x

Host Acks Event          S6,F12-->

                         <--S6,F11          Event : EndTestReceived.x

Host Acks Event          S6,F12-->

                         <--S6,F11          Event : DeviceBinReceived.x

Host Acks Event          S6,F12-->

                         <--S6,F11          Event : DeviceClearsContactor.x

Host Acks Event          S6,F12-->

                         <--S6,F11         Event:DeviceEntersUnloadQueue.x

Host Acks Event          S6,F12-->

                         <--S6,F11          Event : DeviceUnloaded.HardbinX

Host Acks Event          S6,F12-->

                                        ... for each full/empty tray/tube on
                                            input,output.

                         <--S5,F1      Alarm : ContainerReplaceRequest.x

Host Acks request.       S5,F2-->
```

Note that the messages reporting the above internal states may require sub-addressing of test-sites and ports similar to the tester SEM.

```
                                                    Handler cycles devices...
                                                    ... random messages
                                                    (e.g., ... variable request)

Host asks for variable    S6,F15-->
x (devices tested).

                                    <--S6,F16       Handler sends variable.
                                                    ...
                                                    ... eventually ends

                                    <--S6,F11          Event : HandlerEmpty

Host Acks Event           S6,F12-->

Host commands             S2,F41-->
end-of-lot.

                                    <--S2,F42          Handler acks Rmt.Cmd

Stopping

                                    <--S6,F11             Event : Lot

Completed

Host Acks Event           S6,F12-->

Idle

Host requests             S6,F15-->
end-of-lot report.

                                    <--S6,F16       Handler sends report.
```

12 Additional GEM Requirements

The purpose of this section is to specify any GEM additional capabilities that are required to be supported by this class of equipment.

12.1 *Requirements* — The following GEM additional capabilities required by HSEM are:

- Establish Communications
- Dynamic Event Report Configuration
- Variable Data Collection
- Status Data Collection
- Alarm Management
- Remote Control
- Equipment Constants
- Process Program Management
- Equipment Terminal Services

- Clock
- Spooling
- Control (Host-Initiated)

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