7 SECS-II Message Subset

This section lists the required set of SECS-II messages as referenced in this document. Definitions for these messages can be found in SEMI E5. All primary messages (for which SEMI E5 defines replies) should have replies available. Replies are required or optional as specified in SEMI E5.

STREAM 1: Equipment Status

S1,F1 Are You There Request (R)	S,H<->E
S1,F2 On-Line Data (D)	S,H<->E
S1,F3 Selected Equipment Status Request (SSR)	S,H->E
S1,F4 Selected Equipment Status Data (SSD)	M,H<-E
S1,F11 Status Variable Namelist Request (SVNR)	S,H->E
S1,F12 Status Variable Namelist Reply (SVNRR)	M,H<-E
S1,F13 Establish Communications Request (CR)	S,H<->E
S1,F14 Establish Communications Request Acknowledge (CRA)	S,H<->E
S1,F15 Request OFF-LINE (ROFL)	S,H->E,reply
S1,F16 OFF-LINE Acknowledge (OFLA)	S,H<-E
S1,F17 Request ON-LINE (RONL)	S,H->E,reply
S1,F18 ON-LINE Acknowledge (ONLA)	S,H<-E

STREAM 2: Equipment Control and Diagnostics

S2,F13 Equipment Constant Request (ECR)	S,H->E
S2,F14 Equipment Constant Data (ECD)	M,H<-E
S2,F15 New Equipment Constant Send (ECS)	S,H->E
S2,F16 New Equipment Constant Acknowledge (ECA)	S,H<-E
S2,F17 Date and Time Request (DTR)	S,H<->E
S2,F18 Date and Time Data (DTD)	S,H<->E
S2,F23 Trace Initialize Send (TIS)	S,H->E
S2,F24 Trace Initialize Acknowledge (TIA)	S,H<-E
S2,F29 Equipment Constant Namelist Request (ECNR)	S,H->E
S2,F30 Equipment Constant Namelist (ECN)	M,H<-E
S2,F31 Date and Time Send (DTS)	S,H->E
S2,F32 Date and Time Acknowledge (DTA)	S,H<-E
S2,F33 Define Report (DR)	M,H->E
S2,F34 Define-Report Acknowledge (DRA)	S,H<-E
S2,F35 Link Event Report (LER)	M,H->E
S2,F36 Link Event Report Acknowledge (LERA)	S,H<-E

S2,F37 Enable/Disable Event Report (EDER)	S,H->E,reply
S2,F38 Enable/Disable Event Report Acknowledge (EDEA)	S,H<-E
S2,F39 Multi-Block Inquire (DMBI)	S,H->E
S2,F40 Multi-Block Grant (DMBG)	S,H<-E
S2,F41 Host Command Send (HCS)	S,H->E
S2,F42 Host Command Acknowledge (HCA)	S,H<-E
S2,F43 Reset Spooling Streams and Functions (RSSF)	S,H->E
S2,F44 Reset Spooling Acknowledge (RSA)	M,H<-E
S2,F45 Define Variable Limit Attributes (DVLA)	M,H->E
S2,F46 Variable Limit Attribute Acknowledge (VLAA)	M,H<-E
S2,F47 Variable Limit Attribute Request (VLAR)	S,H->E
S2,F48 Variable Limit Attributes Send (VLAS)	M,H<-E
S2,F49 Enhanced Remote Command	M,H->E
S2,F50 Enhanced Remote Command Acknowledge	M,H<-E

STREAM 5: Exception (Alarm) Reporting

S5,F1 Alarm Report Send (ARS)	S,H<-E
S5,F2 Alarm Report Acknowledge (ARA)	S,H->E
S5,F3 Enable/Disable Alarm Send (EAS)	S,H->E
S5,F4 Enable/Disable Alarm Acknowledge (EAA)	S,H<-E
S5,F5 List Alarms Request (LAR)	S,H->E
S5,F6 List Alarm Data (LAD)	M,H<-E

STREAM 6: Data Collection

S6,F1 Trace Data Send (TDS)	S,H<-E
S6,F2 Trace Data Acknowledge (TDA)	S,H->E
S6,F5 Multi-block Data Send Inquire (MBI)	S,H<-E
S6,F6 Multi-block Grant (MBG)	S,H->E
S6,F11 Event Report Send (ERS)	M,H<-E
S6,F12 Event Report Acknowledge (ERA)	S,H->E
S6,F15 Event Report Request (ERR)	S,H->E
S6,F16 Event Report Data (ERD)	M,H<-E
S6,F19 Individual Report Request (IRR)	S,H->E
S6,F20 Individual Report Data (IRD)	M,H<-E
S6,F23 Request Spooled Data (RSD)	S,H->E
S6,F24 Request Spooled Data Acknowledgement Send (RSDAS)	S,H<-E

STREAM 7: Process Program Load

S7,F1 Process Program Load Inquire (PPI)	S,H<->E, reply
S7,F2 Process Program Load Grant (PPG)	S,H<->E
S7,F3 Process Program Send (PPS)	M,H<->E
S7,F4 Process Program Acknowledge (PPA)	S,H<->E
S7,F5 Process Program Request (PPR)	S,H<->E
S7,F6 Process Program Data (PPD)	M,H<->E
S7,F17 Delete Process Program Send (DPS)	S,H->E
S7,F18 Delete Process Program Acknowledge (DPA)	S,H<-E
S7,F19 Current EPPD Request (RER)	S,H->E
S7,F20 Current EPPD Data (RED)	M,H<-E
S7,F23 Formatted Process Program Send (FPS)	M,H<->E
S7,F24 Formatted Process Program Acknowledge (FPA)	S,H<->E
S7,F25 Formatted Process Program Request (FPR)	S,H<->E
S7,F26 Formatted Process Program Data (FPD)	M,H<->E
S7,F27 Process Program Verification Send (PVS)	S,H<-E
S7,F28 Process Program Verification Acknowledge (PVA)	S,H->E
S7,F29 Process Program Verification Inquire (PVA)	
S7,F30 Process Program Verification Grant (PVG)	
S7,F37 Large Process Program Send	S,H <-> E,reply
S7,F38 Large Process Program Acknowledge	S,H <-> E
S7,F39 Large Formatted Process Program Send	S,H <-> E,reply
S7,F40 Large Formatted Process Program Acknowledge	S,H <-> E
S7,F41 Large Process Program Request	S,H <-> E,reply
S7,F42 Large Process Program Acknowledge	S,H <-> E
S7,F43 Large Formatted Process Program Request	S,H <-> E,reply
S7,F44 Large Formatted Process Program Acknowledge	S,H <-> E

STREAM 9: System Errors

S9,F1 Unrecognized Device ID (UDN)	S,H<-E
S9,F3 Unrecognized Stream Type (USN)	S,H<-E
S9,F5 Unrecognized Function Type (UFN)	S,H<-E
S9,F7 Illegal Data (IDN)	S,H<-E
S9,F9 Transaction Timer Timeout (TTN)	S,H<-E
S9,F11 Data Too Long (DLN)	S,H<-E
S9,F13 Conversation Timeout (CTN)	S,H<-E

STREAM 10: Terminal Services

S10,F1 Terminal Request (TRN)	S,H<-E
S10,F2 Terminal Request Acknowledge (TRA)	S,H->E
S10,F3 Terminal Display, Single (VTN)	S,H->E
S10,F4 Terminal Display, Single Acknowledge (VTA)	S,H<-E
S10,F5 Terminal Display, Multi-block (VMN)	M,H->E
S10,F6 Terminal Display, Multi-block Acknowledge (VMA)	S,H<-E
S10,F7 Multi-block Not Allowed (MNN)	S,H<-E

STREAM 14: Object Services

S14,F1 GetAttr Request	S,H <-> E
S14,F2 GetAttr Data	M,H <-> E

STREAM 15: Recipe Management

S15,F1 Recipe Management Multi-block Inquire	S,H <-> E
S15,F2 Recipe Management Multi-block Grant	S,H <-> E
S15,F21 Recipe Action Request	M,H <-> E
S15,F22 Recipe Action Acknowledge	M,H <-> E
S15,F27 Recipe Download Request	M,H -> E
S15,F28 Recipe Download Acknowledge	M,H <- E
S15,F29 Recipe Verify Request	M,H -> E
S15,F30 Recipe Verify Data	M,H <- E
S15,F31 Recipe Upload Request	S,H -> E
S15,F32 Recipe Upload Data	M,H <- E
S15,F35 Recipe Delete Request	M,H -> E
S15,F36 Recipe Delete Acknowledge	M,H <- E
S15,F49 Large Recipe Download Request	S,H -> E,reply
S15,F50 Large Recipe Download Acknowledge	S,H <- E
S15,F51 Large Recipe Upload Request	S,H -> E,reply
S15,F52 Large Recipe Upload Acknowledge	S,H <- E
S15,F53 Recipe Verification Send	M,H <- E,reply
S15,F54 Recipe Verification Acknowledge	S,H -> E

8 GEM Compliance

This section defines compliance to the GEM standard. It describes the fundamental GEM requirements and additional GEM capabilities. It provides references to other sections of the standard where detailed requirements are located. This section also defines standard terminology and documentation that can be used by equipment suppliers and device manufacturers to describe compliance with this standard.

The GEM standard contains two types of specifications:

— fundamental GEM requirements and

— requirements pertaining to additional GEM capabilities.

The fundamental GEM requirements form the foundation of the GEM standard. The additional GEM capabilities provide functionality required for some types of factory automation or functionality applicable to specific types of equipment. Figure 8.1 illustrates the relationship of the fundamental GEM requirements and the additional GEM capabilities.

8.1 *Fundamental GEM Requirements* — All equipment shall comply with the fundamental GEM requirements listed in Table 8.1. Compliance to these requirements involves precise and complete adherence to all sections of the GEM standard referenced in Table 8.1.

Table 8.1 Fundamental GEM Requirements

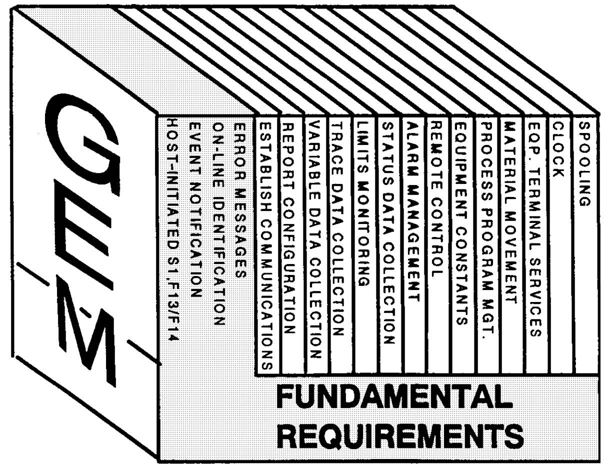
Requirement	*Section References*
State Models	3.0, 3.1, 3.3
Equipment Processing States	3.4
Host-Initiated S1,F13/F14 Scenario	4.1.5.1
Event Notification	4.2.1.1
On-line Identification	4.2.6
Error Messages	4.9
Control (Operator-Initiated)	4.12 (except 4.12.5.2)
Documentation	8.4

In addition, compliance requires adherence to the portions of the following sections that are applicable to the fundamental GEM requirements:

— Variable data items (GEM, Section 5)

— SECS-II data item restrictions (GEM, Section 5)

— Collection events (GEM, Section 6)



Vertical text represents capabilities.
Some capabilities are also fundamental requirements.

Figure 8.1
GEM Requirements and Capabilities

8.2 *GEM Capabilities* — The following table lists all GEM capabilities and the sections of the GEM standard where they are specified. These sections contain the detailed requirements for implementing a GEM capability. Requirements for an individual capability include any referenced portions of the document. As an example, the Alarm Management capability requires implementation of the status variables “AlarmsEnabled” and “AlarmsSet” as defined in Section 5.

Table 8.2 Section References for GEM Capabilities

Capability	*Section References*
Establish Communications	4.1, 3.2
Event Notification	4.2.1.1
Dynamic Event Report Configuration	4.2.1.2
Variable Data Collection	4.2.2
Trace Data Collection	4.2.3
Limits Monitoring	4.2.4
Status Data Collection	4.2.5
On-line Identification	4.2.6
Alarm Management	4.3
Remote Control	4.4
Equipment Constants	4.5
Process Program Management	4.6
Material Movement	4.7
Equipment Terminal Services	4.8

Capability	*Section References*
Error Messages	4.9
Clock	4.10
Spooling	4.11
Control (Operator-Initiated)	4.12 (except 4.12.5.1)
Control (Host-Initiated)	4.12.5.1

8.3 *Definition of GEM Compliance* — The term "GEM Compliance" is defined with respect to individual GEM capabilities to indicate adherence to the GEM standard for a specific capability. Equipment is GEM-compliant for a specific GEM capability if, and only if, the following three criteria are met:

— The fundamental GEM requirements are satisfied.

— The capability is implemented to conform with all applicable definitions, descriptions, and requirements defined for the capability in this standard.

— The equipment does not exhibit behavior related to this capability that conflicts with the GEM behavior defined for the capability.

For example, equipment that provides SECS-II messages for management of process programs must precisely implement the GEM Process Program Management capability to be "GEM-Compliant for Process Program Management."

Equipment may supply additional functionality not specified in the GEM standard by using any messages defined in the SECS-II standard as long as the additional functionality does not conflict with compliance to GEM capabilities.

Figure 8.2 illustrates the host view of equipment communications in relationship to the components of the GEM standard. The GEM capabilities are built upon the fundamental GEM requirements and present GEM-compliant behavior to the host when they are not obstructed by conflicting functionality. Additional non-GEM capabilities and non-obstructing extensions to GEM capabilities provide additional functionality while maintaining GEM behavior from the host view.

One additional term is defined to facilitate discussion of GEM capability. Equipment is "Fully GEM Capable" if and only if it meets the following two criteria:

— The equipment supplies all the GEM capabilities listed in Section 8.2.

— Every implemented GEM capability is GEM-Compliant.

8.4 *Documentation* — This section describes documentation requirements in addition to those specified in Sections 3 and 4 of this standard. All documentation of the SECS-II interface shall be supplied as a single volume, including Message Documentation, a Compliance Statement and the documentation required by Sections 3 and 4.

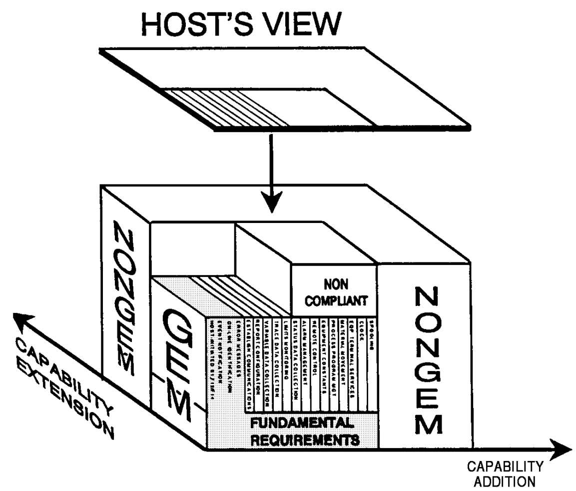


Figure 8.2
Host View of GEM

8.4.1 *Message Documentation* — The equipment supplier shall provide message documentation in conformance with Chapter 8 (Message Documentation) of SEMI E5.

8.4.2 *GEM Compliance Statement* — The SECS-II interface documentation provided by an equipment supplier shall address GEM compliance. This documentation shall include a GEM Compliance Statement that accurately indicates for each capability whether it has been implemented and whether it has been implemented in a GEM-compliant manner. The format for this statement is supplied as Table 8.3.

The table consists of three columns. The first column lists the requirements and capabilities. The other two columns pose questions to the supplier:

Implemented: Does the equipment provide functionality that is similar to that defined for the GEM requirement or capability?

GEM-Compliant: Has that requirement or capability been implemented in a GEM-compliant manner?

8.4.3 The equipment supplier may provide documentation on the format of required data items (see Section 5) using SECS Message Language™ Notation (SML®). The SML formats are provided in Table 8.4.

Table 8.3 GEM Compliance Statement

GEM COMPLIANCE STATEMENT		
FUNDAMENTAL GEM REQUIREMENTS	**IMPLEMENTED**	**GEM-COMPLIANT**
State Models	❒ Yes ❒ No	❒ Yes (See NOTE 1.) ❒ No
Equipment Processing States	❒ Yes ❒ No	
Host-Initiated S1= F13/F14 Scenario	❒ Yes ❒ No	
Event Notification	❒ Yes ❒ No	
On-Line Identification	❒ Yes ❒ No	
Error Messages	❒ Yes ❒ No	
Documentation	❒ Yes ❒ No	
Control (Operator Initiated)	❒ Yes ❒ No	
ADDITIONAL CAPABILITIES	**IMPLEMENTED**	**GEM-COMPLIANT** (See NOTE 2.)
Establish Communications	❒ Yes ❒ No	❒ Yes ❒ No
Dynamic Event Report Configuration	❒ Yes ❒ No	❒ Yes ❒ No
Variable Data Collection	❒ Yes ❒ No	❒ Yes ❒ No
Trace Data Collection	❒ Yes ❒ No	❒ Yes ❒ No
Status Data Collection	❒ Yes ❒ No	❒ Yes ❒ No
Alarm Management	❒ Yes ❒ No	❒ Yes ❒ No
Remote Control	❒ Yes ❒ No	❒ Yes ❒ No
Equipment Constants	❒ Yes ❒ No	❒ Yes ❒ No
Process Program Management	❒ Yes ❒ No	❒ Yes ❒ No
Material Movement	❒ Yes ❒ No	❒ Yes ❒ No
Equipment Terminal Services	❒ Yes ❒ No	❒ Yes ❒ No
Clock	❒ Yes ❒ No	❒ Yes ❒ No
Limits Monitoring	❒ Yes ❒ No	❒ Yes ❒ No
Spooling	❒ Yes ❒ No	❒ Yes ❒ No
Control (Host-Initiated)	❒ Yes ❒ No	❒ Yes ❒ No

NOTE 1: Do not mark YES unless all fundamental GEM requirements are implemented and GEM-compliant.

NOTE 2: Additional capabilities may not be marked GEM-compliant unless the fundamental GEM requirements are GEM-compliant.

Table 8.4 SML Notation

Item Format	*SECS-II Format Code*		*SML Item Format Mnemonic*
	Binary	*Octal*	
LIST	000000	00	L [length]
Binary	001000	10	B
Boolean	001001	11	BOOLEAN
ASCII	010000	20	A [length] or A [min., max.]
JIS-8	010001	21	J [length] or J [min., max.]
8-byte integer (signed)	011000	30	I8
1-byte integer (signed)	011001	31	I1
2-byte integer (signed)	011010	32	I2
4-byte integer (signed)	011100	34	I4
8-byte floating point	100000	40	F8
4-byte floating point	100100	44	F4
8-byte integer (unsigned)	101000	50	U8
1-byte integer (unsigned)	101001	51	U1
2-byte integer (unsigned)	101010	52	U2
4-byte integer (unsigned)	101100	54	U4

A. Application Notes

NOTE: The material contained in these Application Notes is not an official part of this SEMI standard and is not intended to modify or supersede the official standard. Rather, these notes are auxiliary information describing possible methods for implementing the protocol described by the standard and are included as reference material. The standard should be referred to in all cases. SEMI makes no warranties or representations as to the suitability of the material set forth herein for any particular application. The determination of the suitability of the materialis solely the responsibility of the user.

A.1 Factory Operational Script

An Operational Script is a series of capabilities arranged in a typical factory operation sequence. The intent of having an Operational Script is to help put the SECS-II message Scenarios into a context. Although this context will vary, it represents a typical operational sequence found in most semiconductor device manufacturers' applications.

— System Initialization

— Synchronization

— Machine Setup

— Production Setup

— Processing

— Post-Processing

— Shutdown

The following script is not intended to be complete, but to serve as an example to be further developed on an implementation basis.

A1.1 *Anytime Capabilities* — All capabilities can generally occur at anytime during the operational script sequence.

A1.2 *System Initialization and Synchronization* — Upon system initialization, the default setting for communication (enabled or disabled) becomes effective, as well as any equipment constants or other information retained in non-volatile storage. The initial communication status is displayed at the equipment.

Assuming the communication state is enabled, the equipment will attempt to establish communication with a host computer. See Section 4.1 for a description of the scenario for establishing communications.

Upon receiving an indication that the equipment was previously not communicating, the host would typically perform synchronization activities including setting the equipment's clock and requesting selected status information. Note that synchronization activity is host application-dependent and may be implemented using various scenarios.

A1.3 Production Set-Up — The host typically has the following information:

— what material

— what process step

— what process program to use (PPID)

— current equipment status, VID's, SVID's

— data collection requirements (trace data & event data)

— VID's needed

— Equipment constants (ECID's)

Based upon the above information, the host will perform setup activities as required. It must be verified that the correct process program is available and selected at the equipment.

A1.3.1 *Auxiliary Material and Manual Set-Up* — Auxiliary material can be checked and verified at this point. If status variables exist for auxiliary material, they may be requested by the host.

Any other manual, non-process, and/or non-product specific set-up also may take place at this point. The operator may interact with the equipment and the host. If the operator interacts with the equipment, the equipment communications link with the host should stay operational.

The operator and the host may exchange information via equipment terminal services.

A1.3.2 *Product/Process Set-Up* — Specific product and/or process information is communicated to the equipment prior to processing material.

A1.3.3 *Material Load* — The host may instruct an operator or a material handling system to deliver material to the equipment.

Once the material has arrived at the equipment, the equipment or the operator will notify the host.

A1.3.4 *Production Data Collection Set-Up* — The host instructs the equipment to collect event-based data. Reports are defined and linked to events. Event reports can be enabled or disabled.

The host instructs the equipment to collect data from the equipment based on time intervals.

The host configures the equipment to monitor specific variables and to send event reports when variables transition between monitoring zones.

A1.4 *Processing*

A1.4.1 *Start Process Executing* — The host or operator issues a command to start.

A1.4.2 *Equipment Signals End of Run* — When process execution is completed, the equipment generates events. If any of the events are enabled, they will be sent as event reports.

A1.5 *Post-Processing* — The equipment has completed processing material. It now makes the material available to the operator or material handling system for removal. The equipment signals the host that it is available for more work.

A1.5.1 *Material Unload* — Material is unloaded from the equipment by an operator or material handling system.

A.2 Equipment Front Panel

In the GEM standard, several requirements are stated that involve the display or input of information at the equipment front panel. The "equipment front panel" refers to an area on the equipment that is available to the operator under normal use (i.e., without removing maintenance access panels). This may include a CRT display, keyboard, switches, and lights.

This application note provides some guidance for implementation of the GEM front panel capabilities. All of these requirements map directly to state models and capabilities defined in Sections 3 and 4. All capabilities may be implemented in either hardware (buttons, switches, lights) or in a software/CRT equivalent.

A2.1 *Displays and Indicators* — The intent of various displays is to inform the operator of either the current state of the equipment or of a recent change of state (or both). Therefore, it is most useful if these displays are continuously visible and easily recognized at a distance. Required displays/indicators include:

Communications State: This means that three distinct states must be represented: DISABLED, ENABLED/NOT COMMUNICATING, and ENABLED/COMMUNICATING.

Terminal Services: An "New Host Message" indicator must be supplied.

A2.2 *Switches/Buttons* — Note that discrete switches also contain information for the user. However, these tend to represent the desired states of the operator/user. The equipment's response to a change of a switch may not be instantaneous. Still, the current position of switches should be available to the operator.

It may be appropriate to limit the access to some switches and buttons. This might be done via any of the standard methods, keys, passwords, combinations, etc. This is especially true for system default switches that would not often be changed. Required switches/buttons include:

Communications State System Default: In what communications state should the equipment be when system initialization is complete? The choices are DISABLED and ENABLED.

Communications State Selector: This is a toggle or button that will initiate a transition from ENABLED to DISABLED or vice versa.

Message Recognition Button: This button is used to initiate an event message to the host which indicates that the "New Host Message" has been read. This button should function only when the New Host Message Indicator is activated and when the received message is displayed in the terminal display.

A.3 Examples of Equipment Alarms

Table A.3 provides alarm examples pertaining to various configurational aspects of equipment.

NOTE: It is important to stress that these are just examples intended to illustrate that alarms pertain to situations in which there exists a potential for exceeding physical safety limits associated with people, equipment, and material being processed as per the GEM definition of an alarm.

NOTE: The alarm capability is intended as an addition to standard safety alarms (e.g., lights, horns). There is no intent to replace direct operator reaction to such problems. Nor is there the expectation that the host can necessarily prevent or directly address such alarms.

An actual machine shall have an associated set of alarms defined by the manufacturer that pertains to its specific configuration and design. The equipment manufacturer is responsible for supplying documentation associated with these alarm definitions.

Table A.3 Alarm Examples Per Equipment Configuration

Subsystem	*Alarm Description*	*ALID*	*Trigger*	*Reset*	*Operator*	*Equipment*	*Material*
Mainframe Power Supply	Overvoltage		Voltage supply over maximum limit			X	
	Undervoltage		Voltage supply under minimum limit			X	
Internal Power Distribution Bus	AC Low		AC under minimum limit			X	X
Cooling System	Overtemp		Temperature over maximum		X		X
	Pressure Low		Pressure below minimum				X

Subsystem	The subsystem of the equipment to which the alarm is related
Alarm Description	Description of the alarm
ALID	The Alarm ID as specified by SECS-II
Trigger	Text description of what caused the alarm
Reset	Description of how to resolve the alarm condition
Affected	Who or what is affected by the alarm trigger: Operator, Equipment, and Material

A.4 Trace Data Collection Example

This example shows an implementation of the Trace Data Collection capability defined in Section 4.2.3.

S2,F23 sent by host:

```
   TRID = ABCD
   DSPER = 000100 (One minute per
period)
   TOTSMP = 9
   REPGSZ = 3
   SVID1 =  Temperature
   SVID2 =  Relative humidity
```

S6,F1 looks like this (starting at time 1 a.m.):

1st transmission <L,4>

```
   1. ABCD (trace ID)
   2. 3 (last sample of the
transmission)
   3.    88    5   01   01   03   00
       Year Month Day  Hour Min  Sec
   4. <L, n> n = 2 SVID's x REPGSZ of
      3 = 2 x 3 = 6
      72 (temperature)
      0.29 (relative humidity)
      73 (temp.)
      0.30 (r.h.)
      71 (temp.)
      0.30 (r.h.)
```

2nd transmission <L,4>

```
   1. ABCD
   2. 6
   3. 88  05  01  01  06  00
                  hr  min
   4. <L,6>
         73
         0.31
         71
         0.32
         71
         0.31
```

3rd and last transmission <L,4>

```
1. ABCD
2. 9
3. 88  05  01  01  09  00
               hr  min
4. <L,6>
   71
   0.30
   72
   0.30
   71
   0.31
```

A.5 Harel Notation

Harel’s statecharts extend traditional state-transition diagrams with several additional concepts, most important of which are hierarchy and concurrence. Statecharts depict the behavior of a system by showing states it may take, events that prompt a change of state, and the composition of states. What follows is a very brief description of the symbols defined for use and how these are useful to describe a system. See Figure A.5.1 for the basic notational symbols.

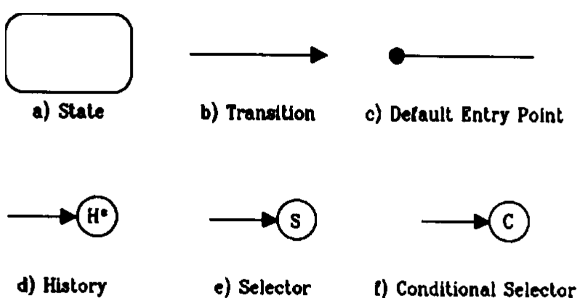


Figure A.5.1
Harel Statechart Symbols

States are represented by rounded boxes. A state transition is shown graphically with a line from the old state terminating with the arrow symbol at the new state. Transitions are unidirectional-while the reverse transition may be possible, it is considered a different transition with different conditions for initiation and different resultant actions.

States may be subdivided into substates to facilitate more concise definition of behavior. Thus, a hierarchy is defined whereby any state may be a substate of some parent state and in turn be the parent of its own substates. Substates must be one of two types, termed AND substates and OR substates.

A parent maybe divided into two or more OR substates of which one and only one is the active substate at any time. The accepted term for this exclusivity is XOR. Figure A.5.2 gives an example of a simple case of OR substates. In this example, some system (perhaps a motor) has a state named FUNCTIONAL. When the motor is FUNCTIONAL, it may be either ON or OFF, but never both.

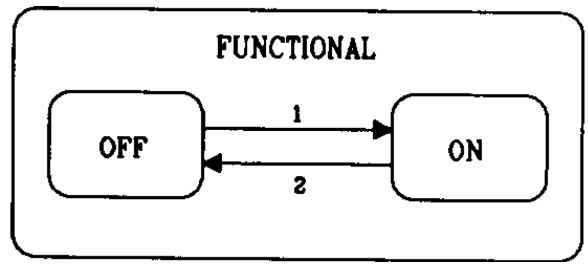


Figure A.5.2
Example of OR Substates

Another way of dividing a parent state corresponds roughly to subsystems. These AND substates represent parallelism, such that every AND substate of an active parent state is considered active. Harel also uses the term “Orthogonal Component” to refer to AND substates. However, these parallel substates tend to be highly interactive and interdependent. For this reason, the word orthogonal is considered confusing and has been excluded from use in this document. Figure A.5.3 shows an example of AND substates representing (in part) an automobile. Note the convention of attaching the name of the parent state AUTOMOBILE to the outside of the state in a small box. The substates shown are independent components and may have their own substates (of either the AND or OR type):

— LIGHTS may be ON or OFF;

— DOOR may be OPEN or CLOSED;

— ENGINE is constructed of components such as pumps, pistons, carburetor, etc.

Exiting one of a set of AND substates requires the exit of all others. In some cases, a transition arrow will be shown from only one of the substates with the others implied.

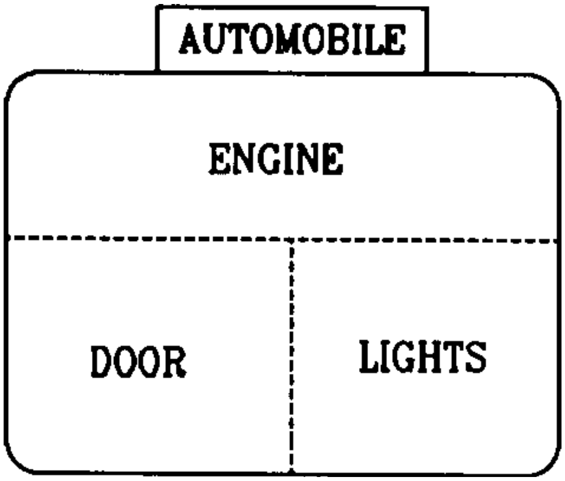


Figure A.5.3
Example of AND Substates

A simplification that also helps to prevent in determinacy is implemented with the symbol for default entry point. This symbol will indicate which OR substate is initially active when there is not an explicit choice. This lack of specification is indicated by a transition arrow from one state to another that does not cross the boundary of the parent to point specifically to a substate.

An entrance to a state terminating in a history symbol (see Figure A.5.1) indicates that the OR substate to be entered should be that which was active the last time the parent state was active (i.e., last time the car was running, the radio was on). The history symbol H refers to the choice of substates of the parent. The symbol H* extends further to the lowest level substates defined. In the absence of memory of a "last time", the default entry is used.

The selector and conditional selector symbols serve to abbreviate complex entrances to states. Their meaning is similar and indicate that the choice of OR substate upon entry of a parent state depends on some condition that is not shown. The selector is usually used to combine several similar transition events, while the conditional selector will typically require some computation or test of conditions external to the stimulus for state transition. Please examine the referenced article for more detail.

NOTE: Within the body of this document, the term statechart is not used in favor of the more traditional term state diagram.

A5.1 *State Definitions* — The state diagram provides a concise description of the function of a system. However, a full definition requires detail that cannot be included on the diagram. A description of each state is required that covers the boundaries of the state and any responses that occur within that state to the environment. The convention in this document is to provide state names in ALL CAPS to help the reader identify where these are used. A sample state description of the ON state depicted in the Figure A.5.2 might be:

ON

The switch is in the on position. Power is available to the motor. Speed of the motor will change in proportion to the speed knob adjustment.

A5.2 *Transition Table* — The last piece of the state model is the transition table. It consists of several columns that list the transition number from the diagram, the starting and ending state for the transition, and three columns titled trigger, action, and comment. The trigger column describes the combination of events and conditions that initiates the transition (e.g., message Sx,Fy received). The trigger should be related to a single clearly defined event at the equipment. The action column identifies the activities associated directly with the transition. These activities may be of three types: a) actions taken upon exit of the old state, b) actions taken upon entry to the new state, and c) actions not associated with either state. These are not differentiated in this document. The final column allows for additional comments that help to clarify the transition. Table A.5, an example of transition table, illustrates the motor example in Figure A.5.2.

Table A.5 Transition Table for Motor Example

#	*Current State*	*Trigger*	*New State*	*Action*	*Comment*
1	OFF	Switch turned to on position.	ON	Power supplied to motor.	Power supply assumed available. Motor begins to turn.
2	ON	Switch turned to off position.	OFF	Power supply to motor dis-connected.	Motor begins deceleration.

A.6 Example Control Model Application

This section provides one example of a host's interaction with an equipment's control model. A host system must have a view of the control model to understand and predict equipment behavior. However, the implementor may simplify the host's view by assuming that some configuration settings are fixed and that the host-initiated features are not implemented. Applying these assumptions simplifies the behavior the host expects to see.

Figure A.6.1 shows the effective control model[24] based on the following host assumptions:

— The fundamental requirements are met, but the additional host-intiated control capability is not implemented.

— The configuration for the default entry to CONTROL is set to an OFF-LINE substate (either ATTEMPT ON-LINE or EQUIPMENT OFF-LINE).

— The destination state for transition 4 (failure of S1,F1 transaction) is configured to EQUIPMENT OFF-LINE.

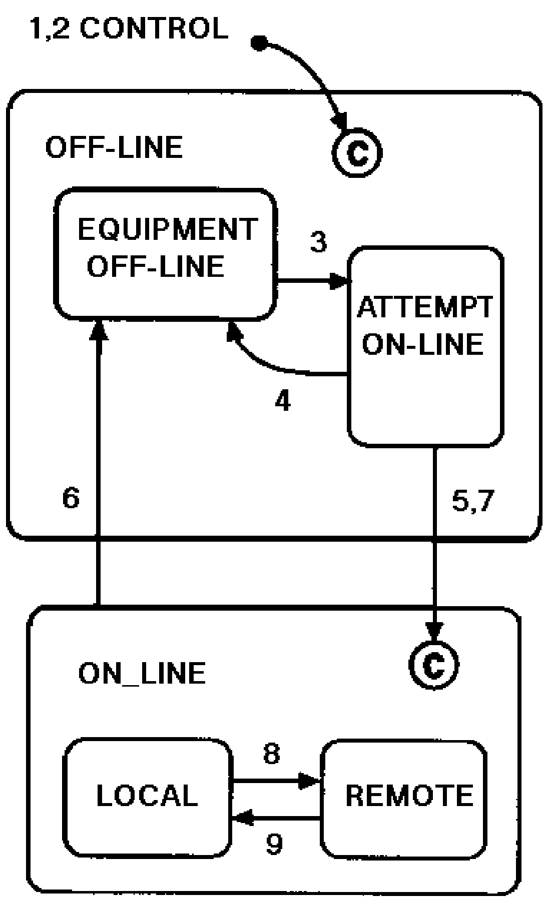


Figure A.6.1
Example of the Simplified "Effective" Control Model

This view of the model has two further settings that the host <u>recognizes</u> as changeable at the equipment. The first is the configuration of which substate of OFF-LINE to be activated upon system initialization. The second is the front panel switch that determines whether the active system substate is LOCAL or REMOTE when ON-LINE.

This application has the following implications:

— This application requires that the equipment begin with the OFF-LINE state active. Thus, an equipment initiated S1,F1/F2 transaction must be completed before the equipment will begin sending all messages to the host.

— If a failed attempt to go ON-LINE is made by the equipment, it will not allow the host to complete the transition at a later time. An operator will be required to re-initiate the transition to ON-LINE when the host becomes ready.

— Once ON-LINE, the equipment will remain ON-LINE until an operator sets the equipment OFF-LINE at the equipment front panel.

— Since all transitions into the HOST OFF-LINE state are eliminated, this state is effectively eliminated from the host view of the control model.

This application retains the following features:

— The ON-LINE state is achieved only after the host acknowledges the equipment by replying to the S1,F1 with and S1,F2. This confirms to the operator attempting to put the equipment ON-LINE that the host application is ready for work to begin.

— It provides the operator the means to set the equipment OFF-LINE for non-host-related activities[25] (e.g., maintenance, test lots).

— The operator has the ability to operate the equipment with either the REMOTE or LOCAL state active. As the equipment transitions to ON-LINE, the preferred substate is automatically chosen (based on a front panel switch).

— The user may configure which substate of OFF-LINE the equipment will initially activate at system initialization. If ATTEMPT ON-LINE is chosen, the equipment will automatically attempt the transition to the ON-LINE state as system initialization.

24 See Section 3.3 for details of the control model.

25 Which activities are "non-host-related" varies from factory to factory. In general, fewer activities are "non-host-related" as a factory's automation level increases.

A.7 Examples of Limits Monitoring

A7.1 *Introduction*

A7.1.1 Four limits monitoring examples are included below to help clarify the use of limits and to illustrate typical applications. The first example shows how to apply limits to boolean values. The second illustrates application of several limits to a floating point variable in a classical control zone style. The third example shows an integer counter variable used to prompt for equipment maintenance.

A7.2 *Examples*

A7.2.1 Example 1 — Valve Monitoring

A7.2.1.1 The ACME Shine-Um-Rite Model 13 includes a sump which contains the chemical agent used to clean bare wafers. A chemical feeder system serves to refill the sump when the level drops below a certain level. The fill is accomplished via an on-off value driven by sensors in the sump. Facilities must be informed of the proportion of the time the valve is open (approximates usage) and any time the value remains open for more than 5 minutes (valve likely broken).

A7.2.1.2 To implement this requirement, a limit was defined for the Boolean status variable which contains the current state of the valve (i.e., 0 = Closed, 1 = Open). See Figure A7.1 for illustration. LIMITID1 was defined with UPPERDB = LIMITMAX = 1 (Open) and LOWERDB = LIMITMIN = 0 (Closed). As a result, any time the valve opens, a collection event is generated with TransitionType = 0 and when the valve closes, a collection event is generated with TransitionType = 1. An event report containing the DVVAL LimitVariable was attached to each collection event and reporting for the event was enabled.

NOTE: Boolean values are defined as 0 = False/Closed/Off and any value > 0 = True/Open/On — never depend on a value of 1.

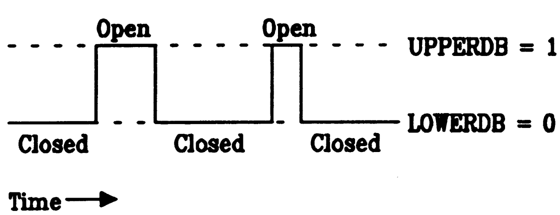


Figure A7.1
Valve Monitoring Example

A7.2.2 Example 2 — Environment Monitoring

A7.2.2.1 ACME also makes a Model 2 Stepper. The environmental control system of this equipment is designed to hold the internal temperature relatively constant, but is sensitive to large changes in the external environment, opening of access doors, etc. To ensure that processing conditions are appropriate, the internal stepper temperature is monitored to ensure it remains in a safe operating zone (within “Shutdown” limits). In addition, a second set of limits are used within the Shutdown limits to bound the “Normal” operating range. Frequent excursions from the normal range into the “warning” range will prompt service on the environmental control system. The target temperature range is specified as 98–100° , the shutdown limits as 95–103° .

A7.2.2.2 Event reports are desired when the internal temperature moves outside of the normal operating zone into a warning zone (above or below), when the temperature moves back into the normal operating zone from the warning zones, and when the temperature moves out of the warning zones into the shutdown zones. Furthermore, temperature fluctuations of 0.5° should not trigger multiple event reports.

A7.2.2.3 Probably the most intuitive use of the limits monitoring capability is in establishing normal, warning, and shutdown zones for a particular equipment variable. Limits may be combined to provide such a scenario. The method is described below and illustrated in Figure A7.2. Please note that in the figure, limits are denoted as solid lines for simplicity, with deadbands indicated using the ± notation.

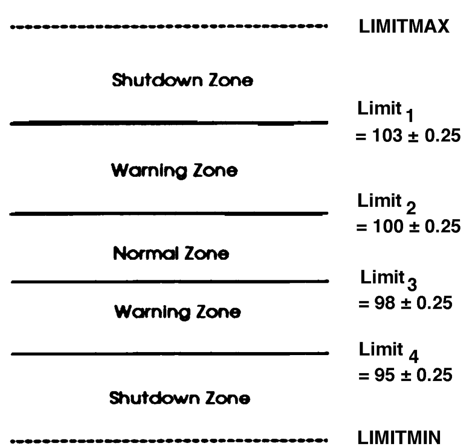


Figure A7.2
Environment Monitoring Example

A7.2.3 Example 3 — Calibration Counter

A7.2.3.1 Another ACME equipment is the multi-chamber Duz-It-All Model 7. This machine includes redundant chambers to increase throughput. One particular chamber on this equipment requires periodic calibration. The need for calibration is a non-linear function of the number of wafers processed in that chamber. A status variable exists which contains the number of wafers processed since the last calibration was performed. Maintenance is definitely required after every 8 cycles, but the machine must be checked after 5 and 7 cycles to determine whether early calibration is necessary. This checking may be done by examining certain other equipment status variables.

A7.2.3.2 To meet this need, three limits are defined for the counter variable. Three limits were set, at 5, 7, and 8. Deadbands are set to zero, since chattering is not a problem. All the pertinent information is placed in an event report which is attached to the CEID for the limits of the counter to negate the need for further message exchange. Event reports are generated as each limit is reached (one zone transition each), and when the counter is reset following calibration (one, two, or three zone transitions referenced in one report). Figure A7.3 illustrates this example. Note that disabling the report upon counter reset (downward transitions) is not possible.

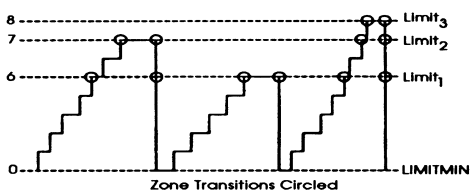


Figure A7.3
Calibration Counter Example

A7.2.4 Example 4 — Derived Variables

A7.2.4.1 The flagship of the ACME line is the new HotDog Furnace. This is a vertical furnace which exposes wafers to a variety of temperatures during processing. The temperature profile during the run is critical to the process and is typically contains a number of plateau's at different levels during the run. The owner wishes to monitor the temperature and be alerted whenever the actual temperature profile differs from the ideal by > 0.5° . The derived variable was created to provide a steady target range during the run, no matter what the desired temperature range happened to be. Deviation from "ideal temperature profile" was chosen as the new variable to be monitored. The equipment already had access to the profile for the run, which described the desired temperature at a given time into the process. The manufacturer added a calculation each time the actual temperature was sampled, subtracting the ideal temperature from the actual. They provided as status variables the actual temperature, the ideal temperature, and the new "deviation from profile" variable. One limit was activated and set to 0.5 degrees and a second set to –0.5 degrees (each with a deadband width of 0.05). Thus, when the temperature deviation from setpoint exceeds ± 0.5, an event is generated containing the current desired temperature and the actual temperature. For good measure, additional data was added, providing time since start of run to document the precise point in the process that the problem occurred.

A7.2.4.2 In order to achieve the desired behavior, the host defines four monitoring limits. Two of the limits establish the target zone. These are responsible for reporting transitions from normal to warning zones in either direction. The other two limits establish the transitions between the warning zones and the error zones. The difference between UPPERDB and LOWERDB for each limit is 0.5. This may also be expressed as limit ± 0.25. Combining limits does not change the way the equipment treats limits monitoring, but rather builds a method of interpreting limits from the host's point of view.

A.8 Process Parameter Modification for Process and Equipment Control

A8.1 *Introduction*

A8.1.1 In many equipment control applications there is a need for a GEM host to modify one or a small set of process parameters associated with a recipe. The number of parameters modified, frequency of modification (e.g., wafer-to-wafer, batch-to-batch, etc.), range of modification, etc., is largely a function of the equipment control application. Utilizing GEM, at least two methods are envisioned for modifying process parameters on a tool. With the first method, "Equipment Constants" can be used to relate process parameters of the updated recipe. Equipment Constants can also be used in a mode where they relate suggested modifications to process parameters from the stored recipe, i.e., the constants contain only the +/- differential from a nominal value. The former mode is preferred because it better ensures data integrity between the controller and tool. With the second method the entire recipe could be downloaded, but this results in an enormous amount of communication overhead. Note that, in all cases, the Equipment Constants do not replace the process parameters inside a recipe, but are associated with (e.g., linked to) these parameters to relate modifications. The remainder of this application note provides a description of how process parameter modification can be implemented using existing GEM capabilities. The method may be used in a GEM compliant system provided that the specific GEM capabilities described are supported.

A8.2 *Equipment Constants*

A8.2.1 Incremental process parameter modification for process and equipment control can be supported over a GEM interface by using the *Equipment Constants* GEM capability (see Section 4.5). With this capability, each process parameter (or process parameter at a step) that can be modified, e.g., for purposes of process control, is associated with an equipment constant. Using the Equipment Constant GEM scenarios (see Section 4.5.5) the host can (1), send process parameters or parameter modifications, (2), request current values of modifiable recipe parameters, (3), retrieve name lists of equipment constants associated with modifiable parameters, and (4), be informed by the equipment when an operator changes one of the modifiable process parameters.

A8.2.2 The equipment constants should represent the actual values of the process parameters with which they are associated. Depending on the equipment operation and control application, the equipment constant could represent the actual value of a process parameter at a recipe step, or over the entire recipe. The equipment constants could also be utilized to represent the differentials of process parameters from nominal values. However it is important to note that, when using differential values to relate process parameter modifications, any loss of synchronization between equipment and host could result in an incorrect assessment of the value of a process setpoint by the host. Note also that, upon system startup, and whenever the appropriate process parameters are modified, the equipment constants should also be modified as necessary to always reflect the (absolute or relative) values of the associated process parameters.

A8.2.3 In order to maintain synchronization between equipment and host, it is recommended that equipment constants associated with recipe parameters be applied to only override the currently selected and active recipe. A selected recipe is considered to be active whenever the equipment is in the "PROCESSING" state and the recipe is the currently selected recipe (process program). If multiple recipes are utilized during one process event, e.g., cluster tool scenario, it is recommended that separate equipment constants be utilized for each recipe/process parameter pair.

A8.2.4 Note that timing and traceability issues associated with utilizing the equipment constants capability (for process control) are application specific and beyond the scope of this application note. Equipment that provides for recipe parameter overrides though setting of Equipment Contstants should also provide additional Equipment Constants for the set that includes the name of the associated process program and a Boolean variable to enable and disable the override feature. In addition, the supplier should document for each parameter: (1), the associated Equipment Constant, and (2), any restrictions on the state (active or not) or the recipe in which the parameter may be modified. Also, since override of the process setpoints may be provided by a Host controller application element, it is recommended that the equipment provide an event report whenever the associated recipe has been modified.

A8.3 *Example*

A8.3.1 In the example of Figure A.8.1, a Chemical-Mechanical Planarizer (CMP) single wafer "polishing" system includes a GEM compliant planarizer (equipment), a thickness metrology unit and a (host) controller. The tool polishes a wafer to a target thickness. The post-process thickness is measured by the metrology unit and reported to the host controller. The controller utilizes a feedback control algorithm to determine the appropriate polish "time" recipe parameter for the next wafer. This time should be reported to the CMP equipment utilizing the equipment's GEM interface so that the information can be utilized for the next wafer processing event.

A8.3.2 The mechanism described in this application note could be utilized to implement process control as follows. A settable equipment constant is associated or "linked" with the "time" parameter on the equipment. Equipment system documentation indicates the linkage and the conditions under which the linkage is valid. When the controller determines an appropriate "time" parameter value for the next wafer to be polished, it sets the equipment constant to this value (see Section 4.5). The equipment is configured to accept this equipment constant change and, if the equipment is in (or possibly when the equipment reaches) the appropriate state, the recipe parameter is modified.

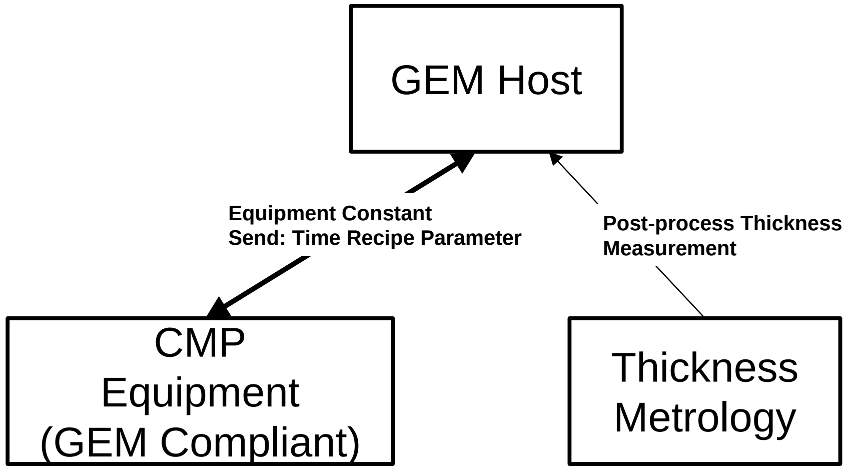


Figure A.8.1
CMP Single Wafer "Polishing" System with Host Recipe Parameter Modification Capability

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SEMI E30.1-0200
INSPECTION AND REVIEW SPECIFIC EQUIPMENT MODEL (ISEM)

This standard was technically approved by the Global Information and Control Committee and is the direct responsibility of the North American Information and Control Committee. Current edition approved by the North American Regional Standards Committee on September 3, 1999. Initially available at www.semi.org November 1999; to be published February 2000. Originally published June 1998.

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1 Purpose

1.1 This standard establishes a Specific Equipment Model (SEM) for Inspection and Review Equipment (ISEM). The model consists of equipment characteristics and behavior that are to be implemented in addition to the SEMI E30 fundamental requirements and additional capabilities. The intent of this standard is to facilitate the integration of ISEM equipment into an automated (semiconductor fabrication) factory. This document accomplishes this by defining an operational model for ISEM equipment as viewed by a factory automation controller. This definition provides a standard host interface and equipment operational behavior (e.g., control, state models, data reports, and reporting levels). Several topics require additional activity that are within the scope of this standard: substrate pattern maps; defect classification code management; and review data management.

2 Scope

2.1 The scope of this standard is limited to the definition of Inspection, Review, and Inspection/ Review equipment behavior as perceived by a SEMI Equipment Communications Standard II (SEMI E5/SECS-II) host that complies with SEMI E30. It defines the external view of the equipment through the SECS link; it does not define the internal operation of the equipment. This standard expands the SEMI E30 requirements and capabilities in the areas of the processing state model, remote commands, variable items, alarms, and data collection.

2.2 This standard is intended for ISEM equipment that generates data and information about anomalies and defects found on substrates. Inspection equipment finds anomalies. Anomalies are occurrences on a substrate that have been judged to be unexpected, abnormal, incongruous, or inconsistent. Anomalies may be examined using review equipment, at which time they may be classified as defects or non-defects. Some inspection equipment may generate, and some review equipment may use, coordinate data to locate anomalies on a substrate. The accuracy of the coordinate data generated or used is equipment-dependent.

2.3 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 limitations prior to use.

3 Limitations

3.1 This document addresses three distinct types of equipment: inspection, review, and inspection/review. The term ISEM equipment refers to all three types of equipment. These three equipment types are differentiated by the basic functions they perform:

3.1.1 Inspection Equipment that looks for anomalies on a substrate and reports information regarding those anomalies. Inspection equipment may determine the location of anomalies relative to a coordinate system. Inspection equipment may also provide other types of data related to the anomaly.

3.1.2 Review Equipment that accepts information about anomalies on a substrate, gathers information on those anomalies, and reports that data.

3.1.3 Inspection/Review Equipment having the characteristics of both inspection and review equipment.

4 Referenced Standards

4.1 *SEMI Standards*

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

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

SEMI M20 — Specification for Establishing a Wafer Coordinate System

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

4.2 *Other References*

Harel, D., “Statecharts: A Visual Formalism for Complex Systems,” Science of Computer Programming 8, (1987), 231-274

NOTE 1: As listed or revised, all documents cited shall be the latest publications of adopted standards.

5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *GEM* — generic equipment model

5.1.2 *PE* — pattern element

5.1.3 *TCP/IP* — Transmission Communication Protocol/Internet Protocol

5.2 *Definitions*

5.2.1 *align* — to put into proper relative position or orientation.

5.2.2 *alignment* — a procedure in which a coordinate system is established on a substrate.

5.2.3 *alignment mark* — a feature on the substrate selectively used for alignment.

5.2.4 *anomaly* — an occurrence on a substrate that has been judged to be unexpected. Something abnormal, incongruous, or inconsistent.

NOTE 2: After an anomaly is reviewed, it may be classified as a defect.

5.2.5 *batch* — a group of substrates or lots intended for a process sequence versus single substrate processing.

5.2.6 *carrier* — a container with one or more fixed positions at which material can be held.

5.2.7 *carrier location* — a physical place within the equipment capable of holding a carrier.

5.2.8 *cassette* — a container with one or more substrate locations (see *slot*).

5.2.9 *defect* — 1) A physical, optical, chemical, or structural irregularity that degrades the ideal substrate structure or the thin films built over the substrate. 2) An undesirable classified anomaly.

5.2.10 *defect classification* — the categorization of defects according to some systematic division based on their physical, optical, chemical, or structural properties.

5.2.11 *die* — 1) A field sub-unit. 2) An area of substrate that contains the device being manufactured.

5.2.12 *ended* — the end of a state that may be when it is normally completed, or its early end due to an allowed or atypical condition (e.g., a STOP command, or an error or alarm condition).

5.2.13 *factory automation controller* — a computer system that provides integration of factory shop control and business systems with semiconductor equipment.

5.2.14 *feature* — 1) A line or a point (as a feature within a pattern). 2) A physical characteristic of the substrate (e.g., a substrate flat).

5.2.15 *field* — the printed pattern from a reticle.

5.2.16 *field of view* — the imaging area as seen at magnification of the inspection or review equipment.

5.2.17 *global alignment* — a procedure which establishes a coordinate system for the entire substrate (see *alignment*).

5.2.18 *group* — a logical collection of regions.

5.2.19 *group alignment* — a procedure which establishes a coordinate system for an area, which is a contiguous group (see *alignment*).

5.2.20 *inspect* — to detect anomalies and/or information about anomalies.

5.2.21 *inspection* — an examination to detect anomalies.

5.2.22 *inspection equipment* — equipment that looks for anomalies on a substrate and reports information regarding those anomalies. Inspection equipment may determine the location of anomalies relative to a coordinate system. Inspection equipment may also provide other types of data related to the anomaly.

5.2.23 *inspection/review equipment* — equipment having the characteristics of both inspection and review equipment.

5.2.24 *ISEM job* — the information required to specify an inspection or review that may include material identification and location and process program identifications as well as any other parameters required to obtain a desired result.

5.2.25 *layer* — one of a sequential series of overlaying photomasks that make up a device series.

5.2.26 *lot* — a group of one or more substrates of the same type (e.g., wafers, masks, CDs).

5.2.27 *major flat* — the flat of longest length that is commonly located with respect to a specific crystal plane (ASTM F 1241-89).

5.2.28 *mask* — a selective barrier to the passage of radiation. For example, a transparent plate containing an opaque pattern that is used to transfer that pattern to another substrate.

5.2.29 *material* — a piece or pieces of substrate, one or more substrates, a lot, a batch, or a run.

5.2.30 *metrology equipment* — any equipment that collects and reports information on specific predetermined locations or features on a substrate with consistent data structure or that reports general information about the entire substrate.

5.2.31 *notch* — a U-shaped cut on the edge of a substrate that is commonly located with respect to a specific crystal plane.

5.2.32 *overlay* — the actual distance between two features on different layers of a substrate, compared to the expected distance.

5.2.33 *pattern* — 1) The physical features on a substrate surface. 2) An ideal pattern is the arrangement of features expressed in a calculated or mathematical manner.

5.2.34 *pattern element* — 1) Any recognizable set of features. 2) A rectangular sub-unit of a pattern or a pattern element. There may be multiple levels of pattern elements.

5.2.35 *primary fiducial* — a key characteristic of a substrate used to align the substrate during processing (such as a *notch* or *major flat*).

5.2.36 *region* — a single field of view which may be a collection of sites.

5.2.37 *registration* — the actual distance between two features on the same layer of a substrate, compared to the expected distance.

5.2.38 *reticle* — a mask that contains the patterns to be reproduced on a substrate; the image may be equal to or larger than the final projected image.

5.2.39 *review* — the process of classification of anomalies which may result in the appending of additional data to inspection data. Used to create a field on a substrate.

5.2.40 *review equipment* — equipment that accepts information about anomalies on a substrate, gathers information on those anomalies, and reports that data.

5.2.41 *run (noun)* — the material processed during the EXECUTING state.

5.2.42 *run (verb)* — the actions of a process between the READY state and the STOPPING state.

5.2.43 *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.

5.2.44 *site* — a single x,y coordinate where an action can be performed (e.g., *alignment* or *review*). The area associated with a site is determined by the equipment accuracy (e.g., optics, stage algorithms).

5.2.45 *slot* — a physical location within a Carrier capable of containing a substrate. Also referred to as a carrier location.

5.2.46 *substrate* — the basic unit of material, processed by semiconductor equipment, such as wafers, CDs, flat panels, or masks.

6 Communication Requirements

6.1 It is required that any ISEM-compliant equipment follow the Communications State Model in SEMI E30. In addition, ISEM-compliant equipment shall support the High Speed Messaging Service Standard (SEMI E37/HSMS). It is a minimum requirement to support Single Session (SEMI E37.1/HSMS-SS) sending SECS-II messages over TCP/IP. The reason behind this requirement is the size of the process programs used by this class of equipment and the amount of data produced.

7 State Models

7.1 *Processing State Model Requirements*

7.1.1 The processing state model included in this standard is a requirement for ISEM equipment. This standard requires implementation of all SEMI E30 state models (such as control, communication, and on-line/off-line). A state model consists of state model diagrams, state definitions, and a state transition table. All state transitions in this standard, unless otherwise specified, shall correspond to collection events.

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

7.1.3 Some equipment may need to include additional states other than those in this standard. Additional states may be added but shall not change the ISEM-defined state transitions. All expected transitions between ISEM states shall occur.

7.2 *Processing State Model Diagram* — Processing state models are detailed for ISEM equipment in Figure 1. This diagram contains all states and transitions that are common to all three types of ISEM equipment. The WORKING state is different for each type of equipment. The same state names and transition identifiers are used to identify common states and transitions of the three types of equipment. The working states for the three types of equipment are presented in the following sections. All states and transitions are described in the section following the diagrams.

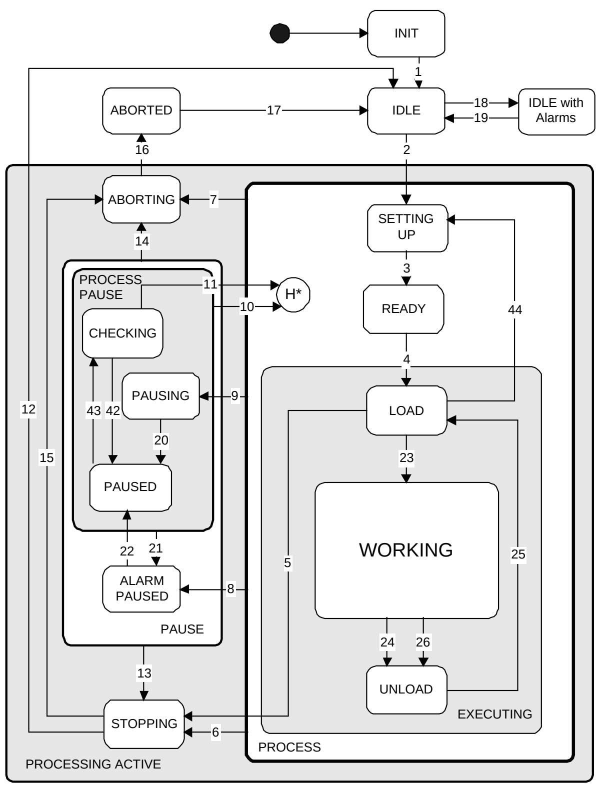

Figure 1
Generic ISEM Processing State Model Diagram

7.2.1 *Working State for Inspection Equipment Model* — The processing state model for inspection equipment is identical to the Generic ISEM Processing State Model (Figure 1). Only the WORKING state is unique to the inspection equipment processing state model. This is shown in Figure 2.

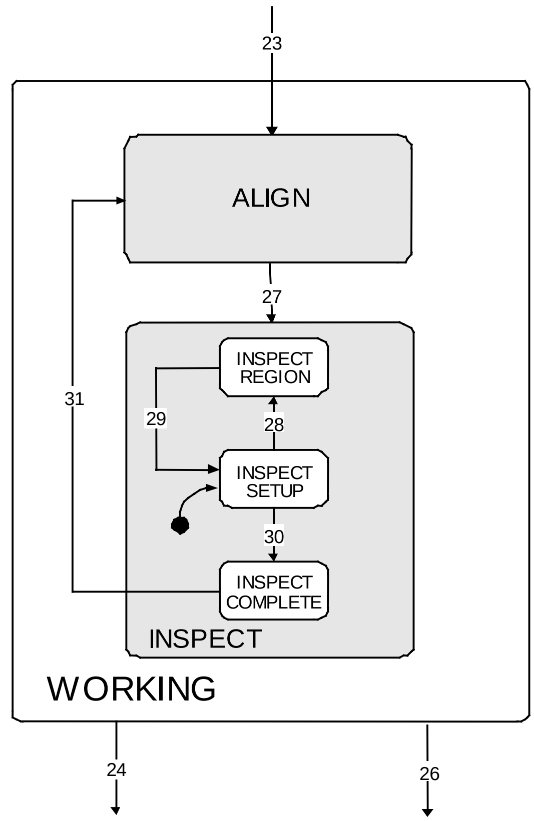

Figure 2
Working State for Inspection Equipment

7.2.2 *Working State for Review Equipment* — The processing state model for review equipment is identical to the generic ISEM Processing State Model (Figure 1). Only the WORKING state is unique to the review equipment processing state model. This is shown in Figure 3.

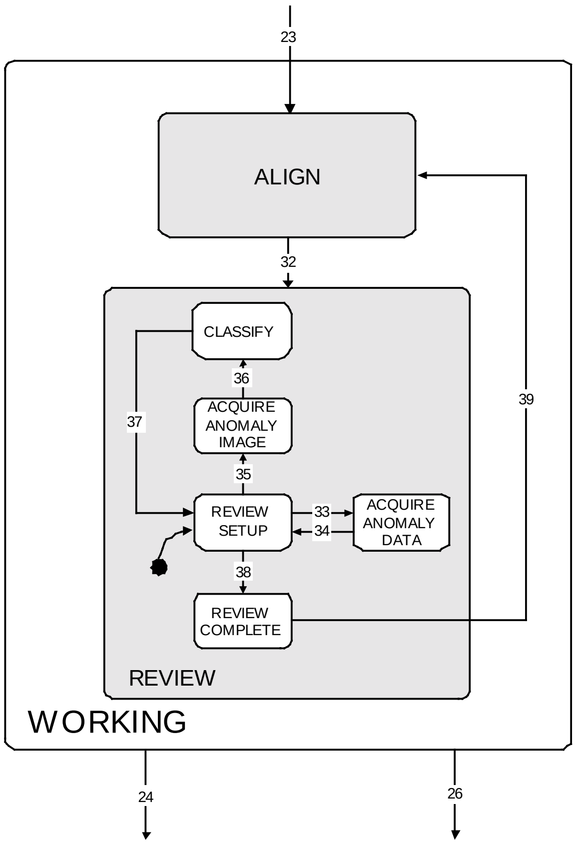

Figure 3
Working State for Review Equipment

7.2.3 *Working State for Inspection/Review Equipment* — The processing state model for inspection/review equipment is identical to the generic ISEM Processing State Model (Figure 1). Only the WORKING state is unique to the inspection/review equipment processing state model. This is shown in Figure 4.

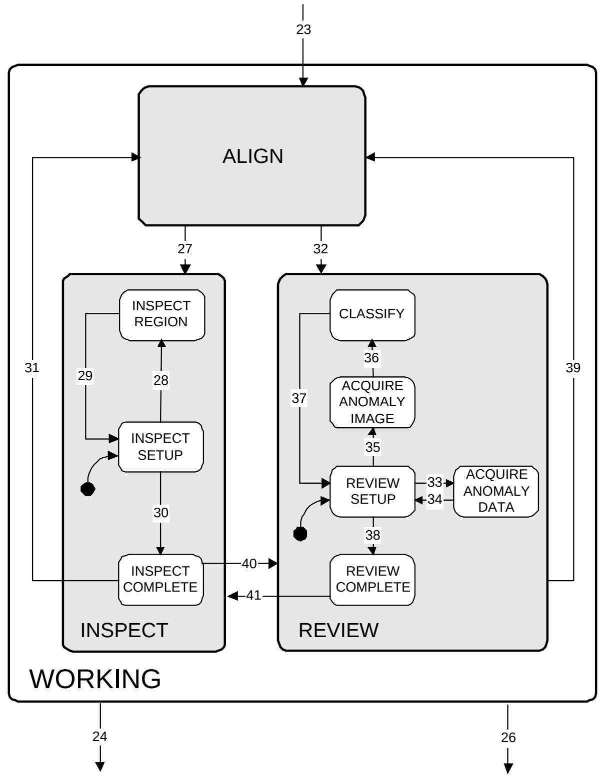

Figure 4
Working State for Inspection and Review Equipment

7.3 *Processing State Definitions*

7.3.1 *ABORTED* — All activity is suspended as a result of an ABORT command. Any alarm and abort conditions shall be cleared before exit from this state. The CLEANUP command is available to the operator or host to transition the equipment from the ABORTED state to IDLE state.

7.3.2 *ABORTING (PROCESSING ACTIVE Sub-State)* — The equipment has received an ABORT command. All normal activity is suspended. The equipment is taking appropriate action to put the equipment and material in a “safe state” where possible. Data may be invalid or not available.

7.3.3 *ACQUIRE ANOMALY DATA (REVIEW Sub-State)* — Data is being acquired about anomaly locations.

7.3.4 *ACQUIRE ANOMALY IMAGE (REVIEW Sub-State)* — The equipment is obtaining a view of the anomaly.

7.3.5 *ALARM PAUSED (PAUSE Sub-State)* — An alarm has occurred in the PROCESS or PROCESS PAUSE states, and the equipment is waiting for the alarm to be cleared or a command (STOP or ABORT).

7.3.6 *ALIGN (WORKING Sub-State)* — The equipment or operator is performing an alignment of the material to the equipment. If needed, within this state, the equipment shall refine or establish its SEMI M20 coordinate system and establish any secondary coordinate systems.

7.3.7 *CHECKING (PROCESS PAUSE Sub-State)* — The equipment verifies that the process program update request is valid. No process program parameters are changed unless "all" reported updates are valid. This is a similar procedure to that which is done in SETTING UP before the equipment is ready to transition to the READY state. Valid commands in this state are STOP, ABORT, and RESUME.

7.3.8 *CLASSIFY (REVIEW Sub-State)* — The operator or equipment is determining the classification of an anomaly.

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

7.3.10 *IDLE* — Checks for queued ISEM jobs or awaits a PP-SELECT, MAP-CARRIER, or PP-ASSIGN command. IDLE is free of alarm and error conditions. Any transition into this state shall deselect any selected Process program(s).

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

7.3.12 *INIT* — Equipment initialization is occurring. Equipment remains in this state unless initialization is successful.

7.3.13 *INSPECT (WORKING Sub-State)* — The current alignment area of the substrate is being inspected for anomalies.

7.3.14 *INSPECT COMPLETE (INSPECT Sub-State)* — The equipment has completed inspection of the current alignment area. Based on the recipe, the equipment determines if (a) additional alignment areas are required to do more inspections, (b) the recipe on this material is complete, or (c) a review of the current inspection area is required.

7.3.15 *INSPECT REGION* — A region on a substrate is being inspected for anomalies.

7.3.16 *INSPECT SETUP (INSPECT Sub-State)* — The equipment is in this sub-state immediately upon entering the INSPECT state. The equipment is determining if all conditions are satisfied to begin inspecting the regions in the current alignment as defined by the recipe and any commands.

7.3.17 *LOAD (EXECUTING Sub-State)* — The equipment is determining if the process program has completed. When additional processing is required, then the next unprocessed substrate shall be transferred to the equipment processing location, such as the stage. If equipment determines that there are more process programs in the "CARRIERBLD" ISEM job, the equipment makes the transition to setup for the next process program specified. Otherwise, the equipment transitions to IDLE through STOPPING.

7.3.18 *PAUSE (PROCESS ACTIVE Sub-State)* — PROCESS shall be suspended at the next opportunity. Actions to put the equipment in a "safe state" shall be performed. The equipment is awaiting a command (STOP or ABORT).

7.3.19 *PAUSED (PROCESS PAUSE Sub-State)* — PROCESS has been suspended, and the equipment is waiting for a command (RESUME, PP-UPDATE, STOP, or ABORT).

7.3.20 *PAUSING (PROCESS PAUSE Sub-State)* — PROCESS shall be suspended at the next opportunity, and the equipment shall be put in a "safe state." ABORT, STOP, and RESUME commands are valid in this state.

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

7.3.22 *PROCESSING ACTIVE* — This state is the parent of all sub-states where the context of a process program execution exists.

7.3.23 *PROCESS PAUSE (PAUSE Sub-State)* — The equipment is free of alarm conditions in the PAUSE state. The equipment is awaiting for a command (ABORT, RESUME, or STOP).

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

7.3.25 *REVIEW (WORKING Sub-State)* — Classification is being done on anomalies previously found in the current alignment area of the substrate.

7.3.26 *REVIEW COMPLETE (REVIEW Sub-State)* — The equipment has completed review of the current alignment area. Based on the recipe, the equipment determines if (a) additional alignment areas are required to do more classifications, (b) the recipe on this material is complete, or (c) an inspection is required.

7.3.27 *REVIEW SETUP (REVIEW Sub-State)* — The equipment is in this sub-state immediately upon entering the REVIEW state. The equipment is determining if all conditions are satisfied to begin reviewing the anomalies in the current alignment as defined by the recipe and any commands.

7.3.28 *SETTING UP (PROCESS Sub-State)* — The equipment is being setup so that external conditions are satisfied to start processing the material. This includes the receipt of any process programs and material to be processed and their validation. Any of these conditions may be satisfied on entry to SETTING UP. For example, the selected process program may have already been loaded (e.g., if it was the default process program), or the specified material may have already been placed on the equipment material port. Additional information may come from the host during the execution of this state.

7.3.29 *STOPPING (PROCESSING ACTIVE Sub-State)* — The equipment has completed all process programs within a "CARRIERBLD" ISEM job or has been instructed to stop processing and shall do so gracefully at the next opportunity. All cleanup necessary is being completed within this state with regard to material, data, control system, etc. Data is normally preserved. Any alarm or error condition in this state causes a transition to ABORTING.

7.3.30 *UNLOAD (EXECUTING Sub-State)* — The substrate is being removed from the processing location.

7.3.31 *WORKING (EXECUTING Sub-State)* — The equipment is processing a specific material.

7.4 *Processing State Transition Table*

Table 1 Processing State Transition Table

Transition #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comments*
1	INIT	All equipment initialization is complete with no alarms or error conditions.	IDLE	Equipment awaits for a PP-SELECT, PP-ASSIGN, or MAP-CARRIER command.	All equipment requires INIT to be free of errors and alarms when exited. IDLE state entry requires that no process program is selected.
2	IDLE	A ISEM job has been or is queued (PP-ASSIGN) or selected (PP-SELECT).	SETTING UP	The setup procedure is equipment-dependent.	Commit has been made to setup. Material may have been placed on the equipment before SETUP is entered. When the job becomes active, the process program gets selected.
3	SETTING UP	All setup activity has completed, and the equipment is ready to receive a START command.	READY	The equipment is waiting for a START command. START may be initiated by an operator or may be included in the process program.	The selected process program is available for execution. When running multiple process programs within a ISEM job, the equipment makes the next process program available for execution.
4	READY	The equipment receives a START command from the user or from within the body of the process program selected for execution.	LOAD	The equipment determines if processing is completed. If not, it transfers the next substrate to the processing location.	Equipment transitions to STOPPING when all process programs in the selected ISEM job are executed. If a new process program within the ISEM job needs to be executed, the equipment transitions to SETTING UP.
5	LOAD	The processing job is complete, and there are no more substrates to load or process programs to run.	STOPPING	Equipment initiates a cleanup to remove the completed ISEM job and process program.	Normal completion of the run.
6	PROCESS	The equipment has received a STOP command.	STOPPING	The equipment unloads the material and brings the equipment to a "safe state."	Data is typically preserved and is valid.

Transition #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comments*
7	PROCESS	The equipment has received an ABORT command.	ABORTING	The equipment is put in a “safe state” if necessary.	Data may be invalid or not available.
8	PROCESS	An alarm occurs.	ALARM PAUSED	PROCESS activity is suspended, and the equipment is waiting for all alarms to be cleared.	ALARM PAUSED is a PAUSE Sub-State.
9	PROCESS	The equipment has received a PAUSE command.	PAUSING	PROCESS shall be suspended at the next opportunity. Actions to put the equipment in a “safe state” will be performed.	This transition is required if the user wants to make changes to the current process program being executed.
10	PROCESS PAUSE	The equipment has received a RESUME command.	Previous PROCESS State	Proceed with the suspended process Sub-State.	If a RESUME command is received in the CHECKING state, then the PP-UPDATE command is canceled. Some equipment may only allow RESUME remote command from the PAUSE state.
11	CHECKING	The equipment has validated “all” requested updates to the current process program being executed; changes are done before entering into the next state.	Previous PROCESS State	Verification is appropriate in this state to check the changes made to the process program updated.	If an alarm occurs in the CHECKING state, then the PP-UPDATE command is canceled.
12	STOPPING	The equipment cleanup is complete, and the equipment is free of alarms.	IDLE	Equipment waits for a command/or determines if there is a ISEM job queued.	IDLE state entry requires that no process program is selected.
13	PAUSE	The equipment has received a STOP command.	STOPPING	The equipment proceeds with cleanup.	Normally, data is preserved and is valid.
14	PAUSE	The equipment has received an ABORT command.	ABORTING	Any unsafe condition is resolved if possible.	Data may be invalid or not available.
15	STOPPING	The equipment has received an ABORT command or an alarm was received while STOPPING.	ABORTING	Any unsafe condition is resolved if possible.	Data may be invalid or not available.
16	ABORTING	Unsafe conditions have been resolved where possible.	ABORTED	The equipment is waiting for alarm and ABORT conditions to be cleared.	The only state change allowed is to IDLE.
17	ABORTED	All alarms and abort conditions have been cleared.	IDLE	Equipment is waiting for a command (PP-SELECT, PP-ASSIGN, or MAP-CARRIER).	If needed, the CLEANUP command clears the abort conditions. IDLE state entry requires that no ISEM job or process program be selected.
18	IDLE	An alarm is set.	IDLE with ALARMS	The equipment waits for all alarms to be cleared.	None
19	IDLE with ALARMS	All alarms have been cleared.	IDLE	None	IDLE is free of alarms.

Transition #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comments*
20	PAUSING	The equipment has achieved a “safe state.”	PAUSED	The equipment is waiting for a command (PP-UPDATE, RESUME, STOP, or ABORT).	None
21	PROCESS PAUSED	An alarm is set.	ALARM PAUSED	The equipment waits for all alarms to be cleared or for a STOP or ABORT command.	None
22	ALARM PAUSED	All alarms are cleared.	PAUSED	The equipment is waiting for a command (RESUME, PP-UPDATE, STOP, or ABORT).	None
23	LOAD	Material transfer to processing location is complete.	WORKING	The substrate is being processed.	None
24	WORKING	The processing of the specific material being processed successfully completed.	UNLOAD	This material is transferred from the processing location.	Normal completion of the substrate.
25	UNLOAD	The material unload is complete.	LOAD	The equipment returns to LOAD and determines if processing is complete, if not, transfers the next substrate to the processing location.	None
26	WORKING	The processing of the specific material being processed abnormally ended.	UNLOAD	This material is transferred from the processing location.	Error exit from WORKING. Data may be invalid.
27	ALIGN	The material alignment is complete, and inspection is required.	INSPECT	The equipment determines if another region needs to be inspected.	This transition is to the INSPECT SETUP Sub-State of INSPECT.
28	INSPECT SETUP	All inspect setup activity is complete, and the inspection is not complete.	INSPECT REGION	The equipment inspects the current alignment region.	None
29	INSPECT REGION	The region inspection has ended.	INSPECT SETUP	The equipment determines if another region needs to be inspected.	None
30	INSPECT SETUP	Inspection of this alignment group is complete.	INSPECT COMPLETE	The equipment determines if (a) additional alignment areas are required to do more inspections, (b) the recipe on this material is complete, or (c) a review of the current alignment area is required.	The next transition is conditional.
31	INSPECT COMPLETE	The inspection of this alignment area ended, and additional inspections may be required.	ALIGN	An inspection group is complete, and additional inspections may be required.	None
32	ALIGN	The material alignment is complete, and review is required.	REVIEW	The material is reviewed.	This transition is to the REVIEW SETUP Sub-State of REVIEW.
33	REVIEW SETUP	Anomaly data is needed to perform the review.	ACQUIRE ANOMALY DATA	Anomaly data is being acquired.	Anomaly data may come from the host or equipment.

Transition #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comments*
34	ACQUIRE ANOMALY DATA	Anomaly data has been acquired for the review, or no more anomaly data is available.	REVIEW SETUP	The equipment determines what to do.	
35	REVIEW SETUP	The equipment has anomaly data, and the review is not complete.	ACQUIRE ANOMALY IMAGE	The equipment acquires the anomaly image at the specified site.	The image may be a stored image or from an imaging device.
36	ACQUIRE ANOMALY IMAGE	The equipment has acquired the anomaly image for the specified site.	CLASSIFY	The operator or equipment classifies the anomaly.	None
37	CLASSIFY	All anomalies have been classified for the site.	REVIEW SETUP	The equipment determines what to do.	None
38	REVIEW SETUP	The review of the align area is complete.	REVIEW COMPLETE	Transition to next state is to be determined.	None
39	REVIEW COMPLETE	The review of this alignment area ended, and additional review is required.	ALIGN	A review group is complete, and additional alignment is required.	None
40	INSPECT	The alignment area inspection is complete, and review is required.	REVIEW	The material is reviewed.	This transition is to the REVIEW SETUP Sub-State of REVIEW.
41	REVIEW COMPLETE	The review is complete, and inspection is required.	INSPECT	The material is inspected.	This transition is to the INSPECT SETUP Sub-State of INSPECT.
42	CHECKING	Validation of requested process program changes failed.	PAUSED	The equipment is waiting for a new command.	No process program parameters have been changed.
43	PAUSED	The equipment receives a PP-UPDATE command.	CHECKING	The equipment begins validating requested changes to the process program.	No process program parameters are updated or changed before “all” requested changes are validated.
44	LOAD	Previous process program has completed, and there are additional process programs assigned to the “CARRIERBLD”. See Section 13.	SETTING UP	The equipment performs setup according to specifications of the next process program.	PROCESS-BLD-GROUP may include an AUTOSTART command within its body. Otherwise, the equipment waits for a START command.

8 Collection Event List

This section identifies data collection events and defines (Stream 6) reporting levels for variable items. The host can use the report definition scenario defined in SEMI E30 to define reports at ISEM-defined levels. The intent of this section is to ensure data is available at specific events and to optimize data reporting to the SECS-II host by allowing data to be grouped at reporting levels.

8.1 *Requirements*

8.1.1 This standard requires all collection events listed in the SEMI E30 standard. This standard requires the ISEM events in Table 2 for data collection (RunDataComplete, SubstrateDataComplete, GroupDataComplete, RegionDataComplete, and AnomalyDataComplete). These events are separate from the processing state transitions. These collection events shall occur before or on the processing state transition specified in Table 1. This was done to ensure that the data and the material remain synchronous. As a result, in some cases material processing may be delayed due to extended data processing time.

8.1.2 The most fundamental level of data defined for ISEM equipment is the anomaly level for review equipment and region level for inspection equipment. For example, review equipment has data available for individual anomalies at the AnomalyDataComplete event. Anomaly data may be grouped for level reporting. For example, data for anomalies found within a region on a substrate would be available at the RegionDataComplete event. This data would be available as a list variable item for Region Anomalies. All anomalies found on a substrate would be available at the SubstrateDataComplete event. This could either be 1) a list of list variable items for Region Anomaly, or 2) a single list variable item of all Substrate Anomalies. In this way, data can be reported with less high-level event reports, rather than as more low-level event reports.

8.1.3 Data produced by ISEM equipment is customarily grouped for reporting by processing, material, and equipment constraints which are called reporting levels (i.e., run, substrate, group, site, and anomaly data). Level data is grouped by these constraints for a reporting level. Data shall be grouped within a reporting level according to other constraints by degree of processing (e.g., raw sensor, basic, or analyzed data), or statistically (e.g., summary, correlation, or comparison).

Table 2 Collection Events for ISEM Data Reporting

Reporting Level	*Data Collection Event*	*Inspection Equipment*	*Review Equipment*
Run	RunDataComplete	STOPPING → IDLE and LOAD → SETTING UP	STOPPING → IDLE and LOAD → SETTING UP
ProcessGroup	ProcessBuildGroup-Complete	LOAD → SETTING UP	LOAD → SETTING UP
Substrate	SubstrateDataComplete	UNLOAD → LOAD	UNLOAD → LOAD
Group	GroupDataComplete	INSPECT COMPLETE → ALIGN *or* WORKING → UNLOAD	REVIEW COMPLETE → ALIGN *or* WORKING → UNLOAD
Region	RegionDataComplete	INSPECT REGION → INSPECT SETUP	*Not Defined*
Anomaly	AnomalyDataComplete	*Not Defined*	CLASSIFY → REVIEW SETUP

NOTE 1: The data collection event shall occur before or on the processing state transition.

9 Variable Items

The purpose of this section is to define the list of variable item requirements for inspection and review equipment. Values of these variables shall be available to the host via collection event reports and host status queries. These variable items are separated into three categories: (a) common to all ISEM equipment; (b) specific to inspection equipment; (c) and specific to review equipment.

If equipment supports the data item functionality defined by ISEM, then it is required and shall be implemented as specified in Table 4 “Variable Item Dictionary”. That is, a variable item is only required if the equipment supports the functionality necessary to support it. For example, if an inspection instrument only has the hardware to count detected anomalies and lacks the hardware to determine their size, then the ISEM requires it to report anomaly count (e.g., as SubstrateAnomalyCount), but reporting anomaly size (as AnomalySize) is not required by the ISEM.

9.1 *Requirements*

- All variable items and data item restrictions defined in SEMI E30 are required on ISEM equipment.
- All variable items in the ISEM Variable Item Dictionary for specific equipment classifications are required for ISEM equipment. The data item restrictions are also required.

9.1.1 Variable items are categorized in the Variable Item Dictionary as follows:

- *Common Variables (CV)* — variables common to all ISEM equipment.
- *Inspection-Specific Variables (ISV)* — variables required only for inspection equipment.
- *Review-Specific Variables (RSV)* — variables required only for review equipment.

9.2 *Variable Items and Reporting Levels* — Table 3 defines reporting levels and associated Data Collection Events for which Variable Items are valid for.

Table 3 Variable Items and Reporting Levels

Level	*Reporting Level*	*Data Collection Event*
R	Run	RunDataComplete
P	ProcessGroup	ProcessGroupComplete
S	Substrate	SubstrateDataComplete
G	Group	GroupDataComplete
X	Region	RegionDataComplete
A	Anomaly	AnomalyDataComplete
ALL	Run, Substrate, Group, Region, and Anomaly	All of the above.

9.2.1 Variable items are documented in the ISEM Variable Item Dictionary using the following format:

Variable Name	*Type*	*Description*	*Level*	*Class*	*Format*	*Comments*

Where:

Variable Name: A unique name for the variable item (this name is for reference only).

Type: Defined as Common (CV), Inspection (ISV), Review (RSV), or Inspection/Review specific variables (IRSV).

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

Level: The report level at which this variable is used <R| S| G| X| A| ALL> as defined in Table 3. It also indicates when the variable item is valid.

Class: The data type of the item.

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

Comments: Any additional information pertinent to the variable name.

9.3 *Variable Item Types*

9.3.1 *Equipment Constants (ECV)* — The value can be changed by the host using S2,F15. The operator may have the ability to change some or all of the values. The value of an equipment constant may be queried at any time by the host using the S2,F13/14 transaction or Stream 6 reports.

9.3.2 *Status Variables (SV)* — The values are valid at all times. A SV may not be changed by the host or operator but may be changed by the equipment. A host or operator command may change an equipment status, thus changing an SV. The value of status variables may be queried by the host at any time using the S1,F3/4 or Stream 6 reports.

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

9.4 *Variable Item Dictionary*

9.4.1 *Data Validity* — The "Level" column in Table 4 defines when the variable item is valid. The entry in this column corresponds to a reporting level defined in Section 9.2 "Variable Items and Reporting Levels". For example, "RunAnomalyCount" is valid at the "RunDataComplete" event, and "AnomalySize" is valid at all reporting level data collection events.

Table 4 Variable Item Dictionary

Variable Name	*Type*	*Description*	*Level*	*Class*	*Format*	*Comment*
ActiveLocation	CV	The current carrier location that has substrates in the executing state of the processing state model.	ALL	SV	U2	Valid in all data collection events as defined in Table 3.
AlignList	CV	A list of alignment sites information being used by the current active process program.	ALL	DVVAL	L,n 1. <AlignName> : n.	The order in which the alignment name appears in the list is important and is equipment-dependent.
AlignName	CV	Alignment name	ALL	DVVAL	A[1..16]	An item in the AlignList variable.
AnomalyArea	CV	The area within the bounds of an anomaly (in units of micron^2).	ALL	DVVAL	F4	
Anomaly-Attributes	CV	Miscellaneous anomaly information that is equipment-dependent and defined by the equipment supplier.	ALL	DVVAL	L,n 1. <attribute$_1$> : n. <attribute$_n$>	Mainly used as part of other anomaly-related data (list) (i.e., AnomalySize).
Anomaly-Comment	RSV	Operator-generated comment associated with the anomaly.	A	DVVAL	A[1..80]	
AnomalyData2D	CV	Coordinate data for an anomaly.	A	DVVAL	L,5 1. <AnomalyID> 2. <CoordSys> 3. <Coord2D> 4. <Anomaly-Attributes>	
AnomalyID	CV	A unique anomaly identifier.	A	DVVAL	A[1..16]	
AnomalySize	CV	The X,Y extent of the anomaly in microns. The dimensions of the smallest rectangle that contains the anomaly whose sides are parallel to the X and Y axis.	A	DVVAL	L,2 1. <XExtent> 2. <YExtent>	XExtent and YExtent are of Format F4.
AnomalyTable-Name	CV	Name identifier of anomaly table.	ALL	SV	A[1..80]	
AnomalyTable-Type	CV	Type of anomaly table. (See Section 11.)	ALL	SV	A[1..20]	"TABLE-AREA-DEF", "TABLE-ALIGN-DEF", "TABLE-ANOMALY-DEF", "TABLE-M21-ANOMALY-DEF"
BatchID	CV	The batch identification of the current material inspected/reviewed.	ALL	DVVAL	A[1..16]	
CarrierBuild	CV	ID of the CARRIERBLD ISEM job that the inspection/review data is associated with.	ALL	SV	A[1..80]	See Section 14.
CarrierID	CV	Physical identification of the current material inspected/reviewed.	ALL	DVVAL	A[1..16]	
CarrierNumber	CV	Used to identify carriers in	ALL	DVVAL	A[1..16]	

Variable Name	*Type*	*Description*	*Level*	*Class*	*Format*	*Comment*
		multi-lot runs (batch).				
Classification	RSV	Classification code of an anomaly.	A	DVVAL	A[1..80]	
Coord2D	CV	The two-dimensional coordinate of an anomaly.	ALL	DVVAL	L,2 1. <CoordX> 2. <CoordY>	
CoordSys	CV	The identification for a coordinate system definition. SEMI M20, M20P, or SEMI M21.	ALL	DVVAL	A[1..16]	“M20” “M21” “M20P”
CoordX	CV	The coordinate in the X direction of a site (anomaly, alignment site, or the lower left-hand of an area or element).	ALL	DVVAL	F4	
CoordY	CV	The coordinate in the Y direction of a site (anomaly, alignment site, or the lower left-hand of an area or element).	ALL	DVVAL	F4	
DefaultPriority	CV	The default priority given a material location if none is assigned.	ALL	EC	U2	
DeltaX	CV	The X-axis translation of M20P coordinate system relative to the SEMI M20 coordinate system.	ALL	DVVAL	F4	
DeltaY	CV	The Y-axis translation of M20P coordinate system relative to the SEMI M20 coordinate system.	ALL	DVVAL	F4	
ElementID	CV	The SEMI M21 address for a specific rectangular element on a substrate.	ALL	DVVAL	I4[2]	May refer to a field or die.
ElementList	CV	A list of SEMI M21 elements where processing can be attempted.	ALL	DVVAL	L,n 1. <ElementID> : n.	
Fiducial	CV	The physical feature used to associate a fiducial line used for orientation (i.e., flat or notch on a substrate).	ALL	DVVAL	A[1..16]	“FLAT” “NOTCH”
GroupAnomaly-Count	CV	Anomaly count for the current or last group (i.e., field or die inspected).	G	DVVAL	U2	
GroupArea	CV	Square Area (microns^2) of the last group inspected.	G	DVVAL	F4	
GroupComment	RSV	Operator-generated comment associated with the group.	G	DVVAL	A[1..80]	
GroupID	CV	Inspection/review group identification for the current inspection/review.	ALL	DVVAL	U2	
InspectionPPID	CV	Process program used on the inspection/review tool	ALL	DVVAL	A[1..80]	

Variable Name	Type	Description	Level	Class	Format	Comment
		for the current inspection/review.				
InspectionRunID	CV	Run identification in the current inspection/review.	ALL	DVVAL	A[1..16]	
LotID	CV	Lot identification of the current material inspected/reviewed.	ALL	DVVAL	A[1..16]	
M20Data	CV	The silicon substrate size, fiducial type, and orientation to use.	ALL	DVVAL	L,3 1. <SubstrateSize 2. <Fiducial> 3. <Orientation>	
M21Data	CV	The data necessary to establish an ISEM SEMI M21 layout on a substrate.	ALL	DVVAL	L,2 1. L,3 1. <M21XSize> 2. <M21YSize> 3. <Tile> 2. L,n 1. L,3 1. <ElementID> 2. <CoordX> 3. <CoordY> : n.	
M21XSize	CV	The value of the SEMI M21 coordinate system in the X-direction.	ALL	DVVAL	F4	
M21YSize	CV	The value of the SEMI M21 coordinate system in the Y-direction.	ALL	DVVAL	F4	
Offset	CV	The distance of the actual or found location of a site relative to its defined or expected location.	ALL	DVVAL	L[2]	Refers to SiteDeltaX, SiteDeltaY which are of Format F4.
OperatorAction	CV	The action taken by the operator on the equipment's operator I/O.	ALL	DVVAL	A[1..80]	
OperatorComment	CV	Operator-generated comment, not associated with any reporting level.	ALL	DVVAL	A[1..80]	(See also Run-Comment, Substrate-Comment, Area-Comment, RegionComment, Site-Comment, and AnomalyComment.)
OperatorID	CV	Identification of the operator of the inspection/review equipment.	ALL	DVVAL	A[1..16]	This information may be added by the host in the ISEM Tables. (See Section 11.)
Orientation	CV	How the wafer is loaded on the equipment.	ALL	EC	F4	"0" degrees indicates that the wafer has the primary fiducial towards the operator.
ProcessBuild-GroupID	CV	Name of the current or last process program executed.	ALL	SV	A[1..80]	See Section 14.
ProcessEquipmentID	CV	Identification of the process equipment used with the	ALL	DVVAL	A[1..16]	This information may be added by the host in

Variable Name	Type	Description	Level	Class	Format	Comment
		current material immediately prior to the inspection/review.				the ISEM Tables. (See Section 11.)
ProcessEquipmentLocation	CV	Location (code) of the process equipment used with the current material immediately prior to the inspection/review.	ALL	DVVAL	A[1..16]	This information may be added by the host in the ISEM Tables. (See Section 11.)
ProcessEquipmentPPID	CV	Identification of the process program used with the process equipment used on the current material immediately prior to the inspection/review.	ALL	DVVAL	A[1..80]	This information may be added by the host in the ISEM Tables. (See Section 11.)
ProcessLevel	CV	Identification of the processing level of the current material.	ALL	DVVAL	A[1..16]	This information may be added by the host in the ISEM Tables. (See Section 11.)
ProcessRunID	CV	Run identification for the process prior to current inspection/review.	ALL	DVVAL	A[1..16]	This information may be added by the host in the ISEM Tables. (See Section 11.)
ProductID	CV	The product identification of the current material inspected/reviewed.	ALL	DVVAL	A[1..16]	This information may be added by the host in the ISEM Tables. (See Section 11.)
RegionComment	CV	Operator-generated comment associated with the region.	X	DVVAL	A[1..80]	
RunAnomaly-Count	ISV	Total number of all anomalies found on all substrates in the last run.	R	DVVAL	U2	
RunComment	CV	Operator-generated comment associated with the run.	ALL	DVVAL	A[1..80]	
RunInspected-AreasCount	ISV	The total number of inspected/reviewed areas on all substrates in the last run.	RS	DVVAL	U2	
RunInspection-PPCount	ISV	The total number of process programs used for the current or last run.	RS	DVVAL	U2	
RunSubstrate-Count	CV	The total number of substrates completed in the current inspection run, which remains valid until the next START command.	ALL	DVVAL	U2	
ScaleFactor	CV	A correction factor applied to the translation of one coordinate system to another.	ALL	DVVAL	F4	In most cases, a scaling of 1 (one) is expected.
SiteID	CV	Inspection/Review group identification for the current site inspection/review.	ALL	DVVAL	U2	
SlotID	CV	Carrier slot number from which the current substrate was taken.	ALL	DVVAL	U2	

Variable Name	*Type*	*Description*	*Level*	*Class*	*Format*	*Comment*
SlotList	CV	The list of carrier slots with substrates to be processed.	ALL	DVVAL	L,n 1. <SlotID> : n.	
SubstrateAnomalyCount	ISV	The total number of anomalies for the current substrate.	S	DVVAL	U2	For the most recent inspection.
Substrate-Comment	CV	Operator-generated comment associated with the substrate.	ALL	DVVAL	A[1..80]	
SubstrateID	CV	Substrate identification for the current inspection/review.	ALL	DVVAL	A[1..16]	
Substrate-InspectedAreas-Count	ISV	The total number of inspected areas on the current substrate.	S	DVVAL	U2	
SubstrateRegion-Count	CV	Total area count for the current or last substrate inspected.	ALL	DVVAL	U2	
SubstrateSize	CV	The nominal diameter (in mm) of the current or last substrate inspected/reviewed.	ALL	DVVAL	U2	
SubstrateTotal-AreaInspected	ISV	Total square area inspected/reviewed (micron^2) of the current substrate.	S	DVVAL	F4	
Theta	CV	The rotational difference in radians between a primary and secondary coordinate system.	ALL	DVVAL	F4	
Tile	CV	The layout of the pattern in the substrate.	ALL	DVVAL	A[1..16]	“NTILE” non-tiled, “CTILE” column-tiled, and “RTILE” row-tiled.
XLateData	CV	Variable for the equipment to report offset of the found or actual pattern-based coordinate system relative to the substrate-based coordinate system on the substrate being tested.	ALL	DVVAL	L,4 1. <DeltaX> 2. <DeltaY> 3. <Theta> 4. <ScaleFactor>	

10 Alarm List

Since each model of equipment differs in configuration, it is not practical to provide an exhaustive list of all possible alarms. Instead, the ISEM is requiring the two tables provided as described in SEMI E30 (document section). Alarm List Table, which is intended to provide for equipment configuration-specific alarms and Alarm ID, Alarm Set/Cleared Event Table.

10.1 *Alarm List Table*

10.1.1 The alarm list table contains examples of alarms that pertain to various configuration aspects of equipment. These examples are intended to illustrate that alarms pertain to situations in which there exists a potential for exceeding physical safety limits associated with people, equipment, and material being processed as per the SEMI E30 definition of an alarm. (See SEMI E30 for further reference.)

10.2 *Alarm ID, Alarm Set/Cleared Event Table*

10.2.1 The Alarm ID, Alarm Set/Cleared Event Table documents the association of each ALID to a set and cleared event as required by SEMI E30. (See SEMI E30 for further reference.)

11 ISEM Tables

A fundamental requirement of ISEM equipment is to transfer anomaly and review data between itself and the host. ISEM equipment may also be required to transfer “Area” and “Alignment Site” data needed for run setup. Anomaly and review data sets (as well as area and alignment site data sets) are commonly handled as lists and tables. ISEM equipment shall use tables when transferring this kind of data between itself and the host. List shall be used to refer to sub-sets of this table data.

11.1 *ISEM Table Data*

11.1.1 ISEM Tables are used to specify area, alignment site, and anomaly coordinate lists for ISEM equipment. ISEM Tables are transferred between the host and the equipment using SECS-II Stream 13 messages (Unformatted Data Set Transfers). For example, an ISEM Table may be used to transfer anomaly data (e.g., “M21” coordinates) generated by inspection equipment to the host, which in turn may then be transferred to review equipment from the host. ISEM Tables also include attributes items that are associated with the table, not with the table data. ISEM Table attributes are used to include information associated with table data, like the number of columns (NumCols), number of rows (NumRows), and table size (DataLength). (See SEMI E58 for additional information.) Product or process-related information may also be included on the attribute section of the ISEM Tables (e.g., LotID, ProductID, OperatorID, ProcessEquipmentID) (see Table 4). The ISEM does not specify additional table attribute variable items that may be associated with the table.

11.2 *TABLE-DEFs*

11.2.1 ISEM Tables are documented using TABLE-DEF structures (Figure 5). Each TABLE-DEF structure has a unique name (TableID) and type (TableType). Each column in the TABLE-DEF has a name (e.g., “AREANAME”, “ALIGNNAME”, OR “ANOMALYID”); row names are specific instances or values that correspond to the column headers in TABLE-DEF. A specific TABLE-DEF row is designated by referring to the TABLE-DEF name and the specific row name. ISEM Tables are transferred using standard (SECS-II message) Stream 13 messages (Figure 6), and each ISEM-defined TABLE-DEF item maps into a Stream 13 message item. Align and area data tables are host-defined, and anomaly tables are equipment-defined.

TableType = <*TableDef*> TableID = <*TableName*>

Row Name	*Column$_1$*	*Column$_2$*	*Column$_3$*	…	*Column$_n$*
Row$_1$ Name					
…					
Row$_m$ Name					

Figure 5
TABLE-DEF Structure

An example of usage of S13,F13 to transfer data sets is shown below:

```
L,7
   1. <DATAID>
   2. <OBJSPEC>
   3. “TableDef”                      <TBLTYP>
   4. “TableName”                     <TBLID>
   5. L,n                             # of table attributes
        1. L,2
                1. “NumRows”          <ATTRID1>
                2. <m>                <ATTRDATA1>
        2. L,2
                1. “NumCols”          <ATTRID2>
                2. <n>                <ATTRDATA2>
        3. L,2
                1. “DataLength”       <ATTRID3>
                2. <table length>     <ATTRDATA3>
        4. L,2
                1. “LotID”            <ATTRID4>
                2. “ABC123”           <ATTRDATA4>
           n. L,2
                1. “ProductID”        <ATTRIDn>
                2. “CPUTYPE”          <ATTRDATAn>
        6. L,n                        # of columns
             1. “AREANAME”            <COLHDR1>(1st column description)
             .
             n. “ATTRIBUTE5”          <COLHDRn>(nth column description)
        7. L,m                        # of rows
             1. L,n                   # of columns
                1. <Item 1,1>         table item in row 1, column 1
                .
                n. <Item 1,n>         table item in row 1, column n
                .
             m. L,n                   # of columns
                1. <Item m,1>         table item in row m, column 1
                .
                n. <Item m,n>         table item in row m, column n
```

Figure 6
S13,F13 with ISEM TABLE-DEF Data

11.3 *Required ISEM Tables* — ISEM equipment shall support all three table types: area, align, and anomaly. SEMI M21 anomaly table type may be supported, but it is optional. The ISEM equipment shall be able to store simultaneously at least 3 (three) defined tables of each type supported to guarantee the validity of any table while that table is being transferred (a table transfer transaction is in process).

ISEM align and area tables are stored by the equipment during the current inspection or review run (i.e., until a new remote command PP-SELECT or PP-ASSIGN is sent, or until they are modified with PP-UPDATE).

Table 5 ISEM Table Types (TABLE-DEFs)

Table Type	*Req/Opt*	*Description*
“TABLE-AREA-DEF”	R	*Area Definition* — A set of areas and their attributes, typically the list of areas to be inspected.
“TABLE-ALIGN-DEF”	R	*Alignment Site Definition* — A set of alignment sites and their attributes.
“TABLE-ANOMALY-DEF”	R	*Anomaly Coordinate Data Definition* — A set of anomalies and their attributes, with coordinates given in the SEMI M20 or M20P coordinate system.
“TABLE-M21-ANOMALY-DEF”	O	*Anomaly SEMI M21 Coordinate Data Definition* — A set of anomalies and their attributes, with coordinates given in the SEMI M21 coordinate system.

As indicated in Table 5, the SEMI M21 anomaly definition table "TABLE-M21-ANOMALY-DEF" is optional. The others are required.

ISEM requires that the following columns be included in the TABLE-DEFs. Table 6 defines the column headers and the allowed formats. Anomaly attributes and attribute headings are defined by the supplier, based on equipment capability.

11.3.1 "TABLE-AREA-DEF"

TableType: "TableAreaDef" TableID: <*AreaTableName*>

Area Name	*Coordx*	*Coordy*	*Coordsys*	*Xtentx*	*Xtenty*	*Attribute (1)*	…	*Attribute*

11.3.2 "TABLE-ALIGN-DEF"

TableType: "TableAlignDef" TableID: <*AlignTableName*>

AlignName	*Coordx*	*Coordy*	*Coordsys*	*Attribute (1)*	…	*Attribute(N)*

11.3.3 "TABLE-ANOMALY-DEF"

TableType: "TableAnomalyDef" TableID: <*AnomalyTableName*>

Anomalyid	*Coordx*	*Coordy*	*Coordsys*	*AnomalyAttribute*	…	*AnomalyAttribute*

11.3.4 "TABLE-M21-ANOMALY-DEF"

TableType = "TableM21AnomalyDef" TableID = <*M21AnomalyTableName*>

Anomalyid	*Coordx*	*Coordy*	*Elementid*	*AnomalyAttribute*	…	*AnomalyAttribute*

Defect data shall be transferred between the host and inspection/review/analysis equipment using SEMI E5, S13,F13. Columns in the table are defined by Table 11.3.5 below.

11.3.5 TABLE-STANDARD-DEFECT-DATA-SET-DEF

NOTE 1: Data for each substrate should be reported in column order shown below. Inspection tools should support relevant columns (see NOTE 6). Review and analysis tools should support all columns. Multiple data entries (list format data items) are allowed for a given attribute on a single defect.

NOTE 2: The inspection equipment must add a table attribute called "Substrate Header" (ATTRID). It must be a list that includes the following items in the given order: LotID (A[1..16]), SubstrateID (A[1..16]), ProcessEquipmentID (A[1..16]), substrate center[1] (L[2], CoordX (F4), CoordY (F4)) and centering method[2] (A[1..16]). Refer to Table 4, Variable Item Dictionary for descriptions of these items.

NOTE 3: See SEMI M21 for (0,0) die location methodology.

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1 Vector from the origin of the substrate coordinate system to nominal substrate center location.
2 CoordSys (e.g., "SEMI M20", "SEMI M21", "M21P", etc).

NOTE 4: Die origin is located at lower left-hand corner (LLHC).

NOTE 5: Data format must comply with the ISEM standard.

NOTE 6: In order to signify tool context, anomaly attributes are labeled as follows:

Column name starts with “insp*_” for inspection data, “rev*_” for defect review data, “and “anal*_” for analysis data, where “*” is a numeric string that ensures each set of columns added is uniquely named (e.g., “rev1_” and “rev2_”).

NOTE 7: Inspection, review and analysis tools must add a table attribute called “insp*_ Header,” “rev*_Header” and “anal*_Header” respectively (ATTRID) each time they add data to the table.[3] It must be a list that includes the following items in the given order: EquipmentID (A[1..16]), EquipmentType (A[1..16]), OperatorID (A[1..16]), and CLOCK[4] (A[16]).

Column #	*Column Name*	*Description*
1	Insp_Anomaly ID	ID # for the defect
2	Insp_Table specifier	Specifies table with other relevant information
3	Insp_Coordinate X	Intra die X Coordinate wrt LLHC of die in um
4	Insp_Coordinate Y	Intra die Y Coordinate wrt LLHC of die in um
5	Insp_X index	X axis die index wrt center of wafer (COW)
6	Insp_Y index	Y axis die index wrt center of wafer (COW)
7	Insp_X size	Defect size along X axis in microns
8	Insp_Y size	Defect size along Y axis in microns
9	Insp_Defect area	Defect area in square microns
10	Insp_Defect size	Linear measure of defect size in microns
11	Insp_Scatter intensity	Anomaly scattering intensity
12	Insp_Defect class number	Previously defined class number assigned to the defect
13	Insp_Test number	Inspection test in which defect was found
14	Insp_# Optical image count	Number of optical images stored for a given defect
15	Insp_Optical image data	Optical image data specifier
16	Insp_Cluster	= 1 if defect is part of a systematic defect cluster
17	Insp_Cluster class	Systematic defect class name
18	Sampled for SEM	= 1 if defect chosen for SEM review
19	Rev_SEM image data	SEM image data specifier
20	Rev_SEM class	SEM defect class name
21	Rev_Defect height	Defect height in microns
22	Sampled for analysis	= 1 if defect chosen for EDX, = 2 if defect chosen for FIB or other analysis
23	Anal_EDX data	EDX data specifier
24	Anal_FIB data	FIB data specifier

3 Where “*” is a numeric string that corresponds to the one in the column names the header refers to.
4 Date and time of the start of inspection, review, or analysis per SEMI E5 CLOCK data item variable.

11.4 TABLE-DEF Column Header Descriptions and Formats

Table 6 Description and Formats for ISEM Table Data

Column Header	*Description*	*Format*	*Comments*
"ALIGNNAME"	The identifier given to an alignment site.	A[1..16]	
ANOMALYATTRIBUTE (n) NOTE: String defined by equipment supplier.	Tool-specific information associated with an ANOMALY for which no specific ISEM data item has been defined.	U2, F4, F8, A[1..16]	Examples: Include information such as magnification, voltage, current, wavelength, brightness, color, height, or chemical spectra. The equipment supplier shall document all attributes that are supported.
"ANOMALYID"	A unique identifier for an anomaly.	A[1..16]	
"AREANAME"	A unique identifier given to an inspection area.	A[1..16]	
ATTRIBUTE(n) NOTE: String defined by equipment supplier.	Tool-specific information associated with an alignment or measurement site for which no specific ISEM data item has been defined.	U2, F4, F8, A[1..16]	Examples: Include information such as magnification, voltage, current, wavelength, number of scans, integration time, or film stack. The equipment supplier shall document all attributes that are supported.
"COORDSYS"	The identification for applicable coordinate system.	A[1..16]	Options are "M20", "M20P", and "M21".
"COORDX"	The x-coordinate for a site.	F4	Units are in microns.
"COORDY"	The y-coordinate for a site.	F4	Units are in microns.
"ELEMENTID"	The SEMI M21 address for a specific rectangular element on a substrate.	I4[2]	
"XTENTX"	The extent in the X-direction of an area to inspect as measured from the lower left-hand corner of the area given by CoordX.	F4	Units in microns.
"XTENTY"	The extent in the Y-direction of an area to inspect measured from the lower left-hand corner of the area given by CoordY.	F4	Units in microns.

12 Process Program Management

12.1 *Definition and Rules for ISEM Process Programs*

12.1.1 A process program contains information and/or instructions required for the Inspection/Review equipment to process a given run of material. The process program shall supply all of the information required for a remotely executed run to be processed without operator intervention.

12.2 *Requirements*

12.2.1 The ISEM requires that the SEMI E30 capability of Process Program Management be fully supported for this class of equipment. ISEM 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. ISEM requires the ability to vary the quantity of substrates processed, the alignment information used, and the number and/or location of the areas/anomalies to be inspected/reviewed through the uses of process program variable parameters. The concepts of process program structure and process program variable parameters are discussed in the following sections.

12.3 *Process Program Structure*

12.3.1 The purpose of this process program structure and the related concepts is to provide flexibility in using process programs to reduce the number of process programs needed. This structure enables the user or host to vary certain parameters of a given process program as needed for any particular run.

12.3.2 Often a process program may be very similar from one run to another and may differ only in a few parameters such as: which substrate slots to run, which areas to inspect, which parameters to run on each substrate, etc. Previously this small variation from run to run would require a large number of process programs to be created and maintained. The flexibility of the method described in this section will reduce the number of process programs.

12.4 *Process Program Variable Parameters* — A process program parameter specifies a value that temporarily modifies the value of a process program variable parameter. A process program variable parameter is formally defined within a process program body and contains (1) a variable parameter name that is unique in the body (CPNAME), and (2) a parameter default value for use when the process program is selected for execution without specification of an override value for this variable parameter (CPVAL/CPEVAL).

12.4.1 *Overriding Process Program Variable Parameters Default Values*

12.4.1.1 Any process-related information that is normally requested from the operator console in manual operation shall have a process program variable parameter identified in the process program and default values assigned in the body of the process program. An equipment would run the process program using the default values unless those values were overridden.

12.4.1.2 These process program variable parameters allow a host to tailor a process program for a specific run of material by temporarily modifying (replacing) the process program default values using a remote command of PP-UPDATE. The modification does not permanently change the process program; the modifications remain in effect only until the next run or until the next PP-UPDATE remote command is received.

12.4.2 *Requirements and Rules*

12.4.2.1 ISEM equipment is required to support variable process program parameters. Additionally, ISEM process programs are required to contain variable process program parameters that specify a name for each of the four previously defined ISEM table types. Specifically, parameters for “TABLE-AREA-DEF”, “TABLE-ALIGN-DEF”, “TABLE-ANOMALY-DEF”, and “TABLE-M21-ANOMALY-DEF” table names are required. Only the names that refer to these TABLE-DEFs are required to be included in the process program body. The actual TABLE-DEF data is external to the process program body. The host may always assume that there are variable process program parameters for these four ISEM tables.

12.4.2.2 Before execution of a CARRIERBLD can begin, the presence of all the ISEM Tables that it references shall be verified by the equipment. If they are not all present, an error shall be reported. The equipment shall support data items that may be linked to the event report that specifies the name of missing ISEM Tables. S7,F27 is used for reporting this error condition.

12.4.2.3 The following table summarizes the variable process program parameters that ISEM equipment shall support and the remote command parameters that the host may use to override their values (as defined in Section 13 and Table 9).

Table 7 Required Variable Process Program Parameters

Variable Process Program Parameter and Host Command Parameter Name (CPNAME)	*Description*
“ALIGNLIST”	A list of location identifiers to be reviewed.
“ANOMALYLIST”	A list of location identifiers to be reviewed.
“AREALIST”	A list of area identifiers to be inspected or reviewed.
“ELEMENTLIST”	A list of array element identifiers to be inspected.
“SLOTLIST”	A list of carrier slot numbers with material to be inspected or to be reviewed.
“SUBSTRATELIST”	A list of substrate IDs with material to be inspected or to be reviewed.
“TABLE-ALIGN-DEF”	A set of alignment site definitions.
“TABLE-ANOMALY-DEF”	A set of (SEMI M20) anomaly location and attribute definitions.
“TABLE-AREA-DEF”	A set of area definitions.
“TABLE-M21-ANOMALY-DEF”	A set of SEMI M21 anomaly location and attribute definitions.