SEMI E91-0600
SPECIFICATION FOR PROBER SPECIFIC EQUIPMENT MODEL (PSEM)

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1 Purpose

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

2 Scope

2.1 The scope of this document is limited to the definition of prober equipment behavior as perceived by a Semiconductor Equipment Communications Standard (SECS-II) (SEMI E5) host that complies with GEM. The document defines the view of the equipment through the SECS communications link, but does not define the internal operation of the equipment. It includes a specific processing state model as the basis for the behavior of all equipment of this class.

2.2 This document requires that the GEM fundamental requirements and applicable additional capabilities have been implemented on the prober equipment. This document expands GEM Standard requirements and capabilities in the areas of the processing state model, collection events, remote commands, data item variables and process program management, and adds Prober Job state model to GEM Standard requirements and capabilities. This document does not include the definition of the treatment of Multiple Stage.

2.3 This document applies to the class of prober equipment in which the wafer is unloaded from the same slot in the same carrier which loaded the wafer after processing.

2.4 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 Referenced Standards

3.1 *SEMI Standards*

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

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

SEMI M20 — Specification for Establishing a Wafer Coordinate System

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

3.2 *Other Documents*

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

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

4 Terminology

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

4.2 *bin* — categorized data of die as a result of measurement.

4.3 *cassette* — a physical object containing one or more substrate locations (see slot). For example, a SEMI standard cassette is a carrier with 25 substrate slot locations.

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

4.5 *execution area* — the area from which a current copy of the process program instructions are executed.

4.6 *inker* — a resource of the prober. The electromechanical units to put ink mark on die.

4.7 *instruction data* — the Result Data to refer on the inspection process.

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

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4.8 *job* — a lot, processed with a single process program on PSEM equipment.

4.9 *load* — move material to the probing or marking location from the cassette.

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

4.11 *map* — a list of coordinate positions of die on a substrate. MAP is defined in accordance with SEMI M21 in this document.

4.12 *map data* — the categorized data of die as a result of measurement associated with coordinates. Map data also have an information that identifies origin die.

4.13 *marking* — the process of the prober that making an ink mark on a die using the inker.

4.14 *material* — 1. The basic unit of process, physically a cassette or some cassettes. 2. A lot.

4.15 *measurement* — making a test, contacting the probe card and the die. The tester sends to the prober a categorized data as a result of test.

4.16 *probe card* — the electromechanical interface necessary to enable temporary electrical contact between the substrate to be tested and the tester resource. May consist of multiple components.

4.17 *re-inspection* — a process where the same substrate is tested again by using the inspected map data.

4.18 *slot* — a physical location within a cassette capable of containing a substrate. (Also referred to as a carrier location).

4.19 *state* — 1. A static set of conditions. If the conditions are met, the state is current (SEMI E30). 2. A state reacts predictably to specific stimuli.

4.20 *substrate* — 1. The basic unit of material, processed by PSEM equipment such as wafers.

4.21 *testing equipment* — an equipment class generally consisting of integrated mechanisms and controls for performing electrical tests of packaged devices and or wafer die during the manufacturing process.

4.22 *unload* — remove materials to the cassette slots from the probing or marking location.

4.23 *wafer end* — the end of measuring process of a wafer.

5 State Model

5.1 The purpose is to define the equipment-specific processing state model and Prober Job state models necessary to portray the expected operational states of the equipment to enable host tracking and control in place of a local operator.

5.1.1 The processing state models in this document are required for implementing an PSEM-compliant prober, in addition to the required state models in SEMI E30. A state model consists of a state model diagram, state definitions, and a state transitions' table. A state model represents the host's view of the prober, but not necessarily the actual prober operations. All PSEM state model transitions shall be mapped sequentially into the actual equipment events that satisfy the requirements of those transitions. In certain implementations, the prober may enter a state and has already satisfied all of the conditions required by the PSEM state model for transition to another state. In this situation, the prober makes the required transition without any additional actions.

5.1.1.1 Various symbols used in a state diagram are described in Figure 1.

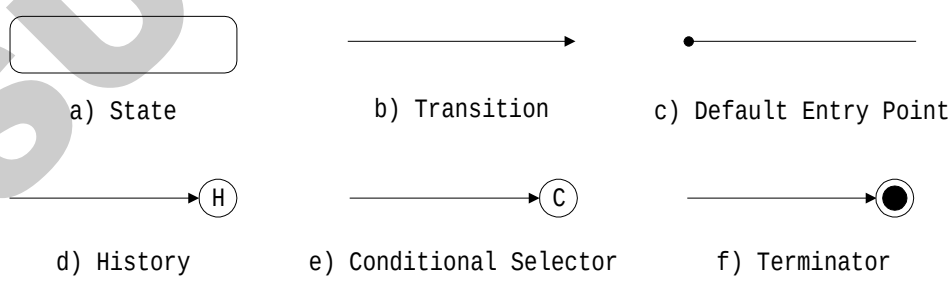

Figure 1
Various Symbols Used in a State Diagram

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

5.2 *PSEM Processing State Model*

5.2.1 *Purpose*

5.2.1.1 The purpose of the PSEM Processing State Model is to make an accurate model for the behavior of the PSEM prober from Processing State Model defined in SEMI E30.

5.2.2 *PSEM Processing State Model Diagram*

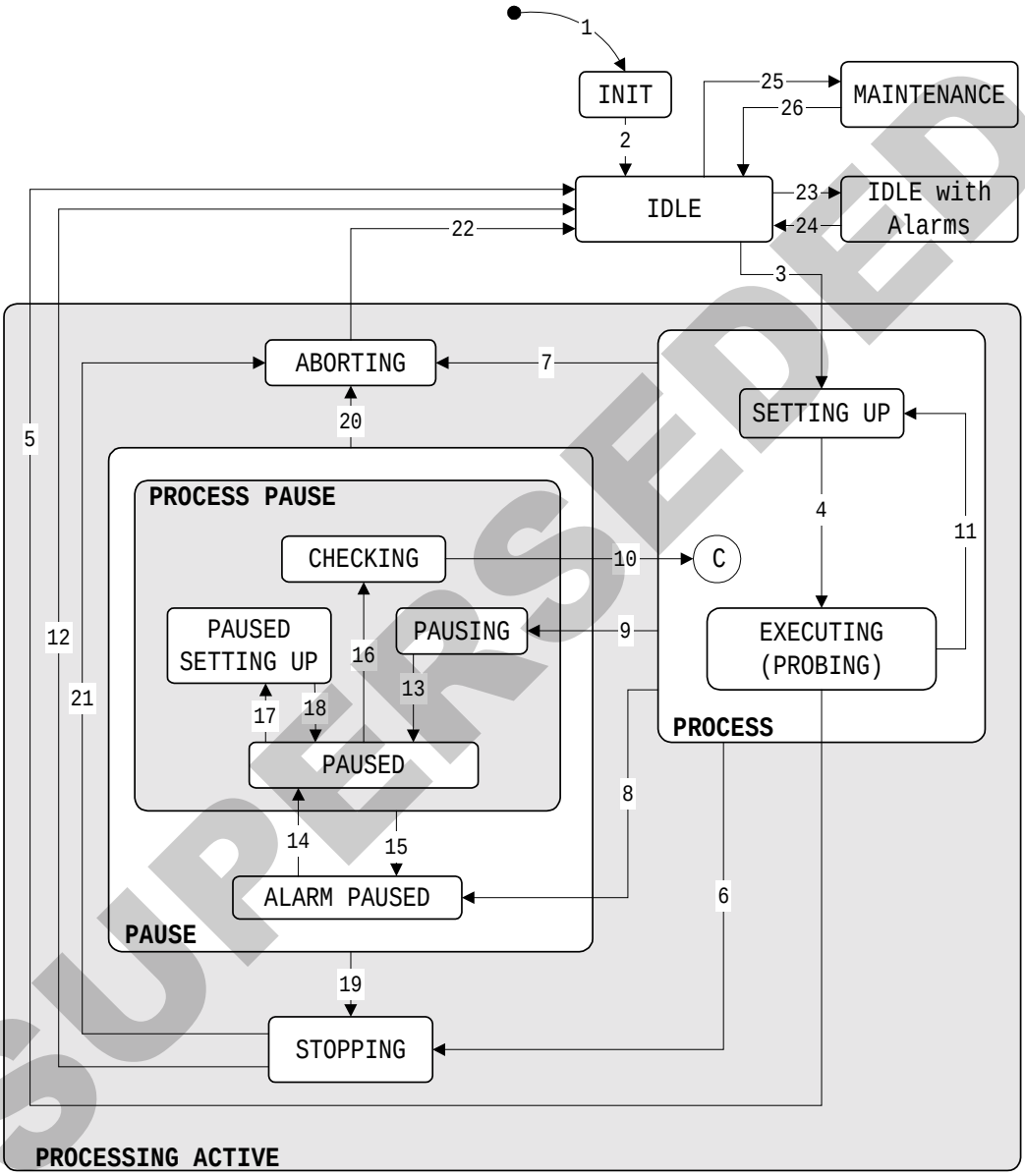

Figure 2
PSEM Processing State Model Diagram

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5.2.3 *Description of Prober Processing States*

5.2.3.1 *ABORTING (PROCESSING ACTIVE Sub-state)* — The prober has received ABORT command. All activities are suspended. The prober is taking an appropriate action to ensure possible safe state for the prober itself and materials. Wafer data or lot data may be unavailable.

5.2.3.2 *ALARM PAUSED (PAUSE Sub-state)* — An alarm has occurred in PROCESS or PROCESS PAUSE state. The prober is waiting for the alarm to be cleared.

5.2.3.3 *CHECKING (PROCESS PAUSE Sub-state)* — The prober verifies that a process program update performed is valid. This is a procedure same with that taken in SETTING UP state before the prober is ready to transit to READY state. Upon completion of verification, an event will be created if the verification is successfully ended. A transition is made to the process state, based on the process model condition table.

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

5.2.3.5 *IDLE* — The prober is waiting for an instruction. IDLE is free of ALARMS and error conditions.

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

5.2.3.7 *INIT* — Prober is in the course of initialization.

5.2.3.8 *MAINTENANCE*

5.2.3.8.1 The operator's instruction has disabled production by the prober.

5.2.3.8.2 Maintenance and inspection of the prober are executed in this state.

5.2.3.9 *PAUSE (PROCESSING ACTIVE Sub-state)* — PROCESS state is interrupted when the processing can be paused. An action to ensure safety of the prober is taken. The prober waits for a command (RESUME, STOP or ABORT) or the alarm to be cleared.

5.2.3.10 *PAUSED (PROCESS PAUSE Sub-state)* — In this state an operator can correct an error as far as the current process program selection is not affected. PROCESS state is suspended and the prober waits for a command (RESUME, STOP or ABORT). In this state, the operator is allowed to correct an error conditions that does not affect the current process program selected. One of such corrective actions that can be taken by the operator is manual alignment of the wafer in process.

5.2.3.11 *PAUSED SETTING UP (PROCESS PAUSE Sub-state)* — When PROCESS state is suspended, the prober is made to perform simple set-up operations. Probe card replacing work and inker replacing work are included in those operations.

5.2.3.12 *PAUSING (PROCESS PAUSE Sub-state)* — PROCESS state is interrupted when the processing can be paused. The prober cannot transit to PAUSED state until safe state is ensured.

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

5.2.3.14 *PROCESS PAUSE (PAUSE Sub-state)* — The prober is free of alarm conditions in the PAUSE state.

5.2.3.15 *PROCESSING ACTIVE* — The state in which the prober is processing materials.

5.2.3.16 *SETTING UP (PROCESS Sub-state)* — The prober is trying to satisfy requirements to be able to start processing. This is the state under which the prober has already received a process program and materials to be processed, then has received START command from the host or the operator and is making preparation for the processing according to the process program.

5.2.3.17 *STOPPING (PROCESSING ACTIVE Sub-state)* — The prober has received STOP command and sets up for the stop. All necessary cleanup is completed within this state with regard to material, data, control system, etc. Data is preserved. Any error condition is cleared before exiting from this state.

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5.2.4 *PSEM Processing State Transition Table*

Table 1 Processing State Transition Table

No.	*Current State*	*Trigger*	*New State*	*Action*	*Comment*
1	Undefined	After turning the power on, the operator has commanded the prober to perform initialization.	INIT	The prober executes initialization.	None
2	INIT	Initialization of all probers completes without an alarm or error.	IDLE	The prober is waiting for a command by the host or the operator.	None
3	IDLE	Prober Job has been created, and the prober has already received a process program and materials, then has received START command from the host or the operator.	SETTING UP	The prober is set up according to the process program.	None
4	SETTING UP	All set-up performance has completed.	EXECUTING	The prober executes wafer transfer and measuring.	None
5	EXECUTING	Material processing completes.	IDLE	None	None
6	PROCESS	The prober received STOP command.	STOPPING	The prober completes the current wafer or the current die under EXECUTING state and unloads it in accordance with the setting of ECV "StopUnit".	The prober starts clearing data. Whether or not unloading is executed after the completion of the current wafer or the current die depends on the specification.
7	PROCESS	The prober received ABORT command from operator, host or self generated.	ABORTING	The prober is placed in a safe state.	Wafer data or lot data may be invalid or not available.
8	PROCESS	An alarm occurs.	ALARM PAUSED	PROCESS activity is suspended, the prober is waiting for all alarms to be cleared, STOP or ABORT command.	ALARM PAUSED is PAUSE sub-state.
9	PROCESS	The prober received PAUSE command from the host or the operator.	PAUSING	PROCESS state is suspended when the processing can be stopped. All operations required to put the prober in safe condition are performed.	PAUSING is PROCESS PAUSE sub-state.
10	CHECKING	Parameter checking ends normally.	Previous PROCESS state.	Processing re-starts from the previously suspended state.	None

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No.	Current State	Trigger	New State	Action	Comment
11	EXECUTING	Processing of the last wafer of a current lot completed. The prober has received START command for next lot.	SETTING UP	None	None
12	STOPPING	The prober completes clearing of data and no alarm remains.	IDLE	None	None
13	PAUSING	The prober stopped the processing of the current wafer which was in EXECUTING state at a possible stop breakpoint and attained a safe state.	PAUSED	The prober is waiting for command (RESUME, STOP or ABORT).	None
14	ALARM PAUSED	Alarm is cleared.	PAUSED	The prober is waiting for command (RESUME, STOP or ABORT).	None
15	PROCESS PAUSE	An alarm occurs in the prober.	ALARM PAUSED	The prober is waiting for all alarms to be cleared, STOP or ABORT command.	None
16	PAUSED	RESUME command was received.	CHECKING	Verification of process program parameters.	Before continuing processing, the host or operator is required to issue RESUME command.
17	PAUSED	The operator instructed a state transition.	PAUSED SETTING UP	Probe card replacement or inker replacement is carried out by operator's instruction.	None
18	PAUSED SETTING UP	The operator instructed a state transition.	PAUSED	None	None
19	PAUSE	The prober received STOP command.	STOPPING	The prober starts clearing data.	Data is saved and valid.
20	PAUSE	The prober received ABORT command.	ABORTING	If possible, unsafe condition is reset.	Wafer data or lot data may be invalid or not available.
21	STOPPING	The prober received ABORT command.	ABORTING	If possible, unsafe condition is reset.	Wafer data or lot data may be invalid or not available.
22	ABORTING	An abort performance has completed.	IDLE	None	Only a state transition to IDLE is permitted.
23	IDLE	An alarm occurs.	IDLE with ALARMS	The prober is waiting for all alarms to be cleared.	None
24	IDLE with ALARMS	All alarms were cleared.	IDLE	None	The IDLE state is free of alarms.
25	IDLE	The operator instructed a state transition.	MAINTEN-ANCE	None	Maintenance and inspection of the prober modules and creation, change and deletion of process programs are possible.
26	MAINTEN-ANCE	The operator instructed a state transition.	IDLE	None	None

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5.2.5 *The Process Model Condition Table*

5.2.5.1 Undermentioned Table 2 is an explanation of the transition condition of transition No. 10 in PSEM Processing State Model diagram.

Table 2 The Process Model Condition Table

Conditions	*Next State*
The check approves that the process program is changed.	SETTING UP
The check approves that the process program is **not** changed.	
The previous state was SETTING UP.	SETTING UP
The previous state was EXECUTING.	EXECUTING

5.3 *Prober Job State Model*

5.3.1 *Purpose*

5.3.1.1 The Prober Job state model is defined for the purpose of keeping track of its processing state of the material to be processed by the prober in every material. The host can give instructions on how to process which material by creating Prober Job to the equipment. Prober Job is created by the JOB CREATE command. Prober Job state exists in each Prober Job. It occurs upon creation of Prober Job and is deleted upon its completion. The host can control progress of material processing which is requested to the equipment according to an event report accompanied by progress of Prober Job.

5.3.2 *Prober Job State Model Diagram*

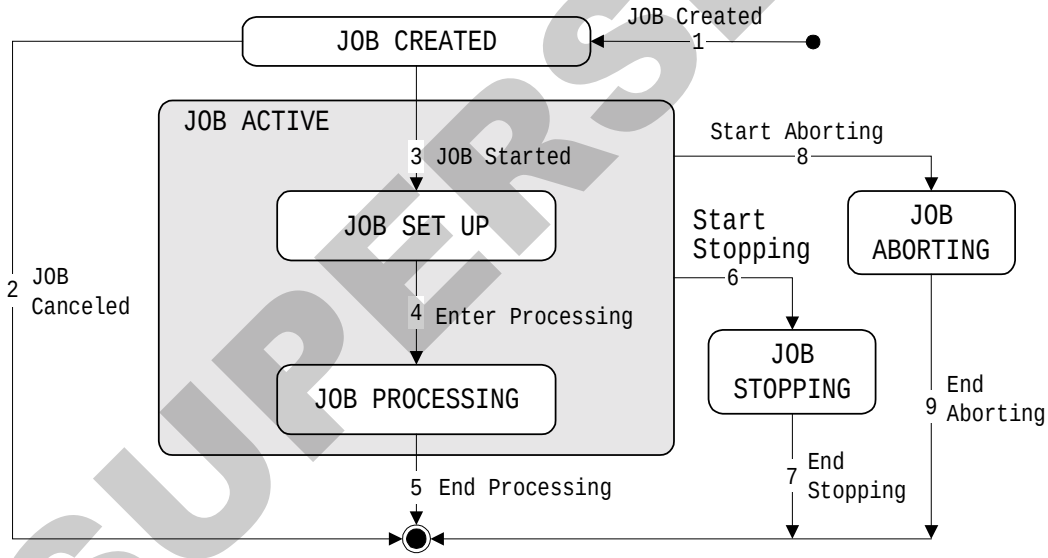

Figure 3
Prober Job State Model Diagram

5.3.3 *Description of Prober Job State*

5.3.3.1 *JOB CREATED* — State where Prober Job is created to the equipment Prober Job has not processed yet. It has nothing to do with whether material reached the equipment or not.

5.3.3.2 *JOB ACTIVE* — State where normal Prober Job processing operation is performed It consists of two sub-states.

5.3.3.3 *JOB SET UP (JOB ACTIVE Sub-state)* — State that waits for condition to be ready for processing such as Equipment preparation.

5.3.3.4 *JOB PROCESSING (JOB ACTIVE Sub-state)* — State where this processing is performed.

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