SEMI E54.10-0600 (Reapproved 1111)
SPECIFICATION FOR SENSOR/ACTUATOR NETWORK SPECIFIC DEVICE MODEL FOR AN IN SITU PARTICLE MONITOR DEVICE

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NOTICE: This Document is no longer published with the SEMI E54 suite of Standards. It is published and sold separately.

NOTICE: This Document was reapproved with minor editorial changes.

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1 Purpose

1.1 This Specification is part of a suite of Standards that specify the implementation of SEMI Standards for the Sensor/Actuator Network. The specific purpose of this Specification is to describe a network independent application model comprised of device objects that are common to all in situ particle monitor devices on a semiconductor equipment sensor/actuator communications network.

2 Scope

2.1 An in situ particle monitor (ISPM) is a device that measures and counts particles. These devices classify by size and count, particles in the environment (gaseous, liquid, or vacuum) utilizing a technique such as detecting light from a sample region of the environment's space. These counts are accumulated in bins and then reported. The number of bins varies by vendor and model.

2.2 This Specification specifically addresses the minimum attributes, services, and behavior an ISPM device must support to be interoperable on the Sensor/Actuator Network.

2.3 This Specification is intended to ensure a high-degree of device interoperability on the Sensor/Actuator Network, while still allowing flexibility for product differentiation and technology evolution.

2.4 The model specified in this specification is used in conjunction with SEMI E54.1, Standard for Sensor/Actuator Network Common Device Model (CDM), to completely describe the ISPM as it appears from the network interface.

2.5 This Specification, together with SEMI E54, SEMI E54.1, and one of the Sensor/Actuator Network Communication Specifications, form a complete interoperability specification for the ISPM.

2.6 To comply with this Specification, a device must implement and support, at a minimum, the required attributes, services, and behavior identified in these Documents. Support for optional attributes, services, and behavior is not required to be compliant to this Specification. Optional attributes, services, and behavior are specified in these Documents to promote further device interoperability as features evolve and are adopted by more manufacturers. If optional attributes, services, and behavior are implemented for this device they must be implemented as identified in this Document.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 This Specification is a companion to a suite of specifications that together make up the Sensor/Actuator Network Communication Standard. Therefore, using portions of this Specification that relate to network communications necessarily requires an understanding of the associated network specification.

3.2 As this Document is a specification for the IPSM device model, it does not contain any definition of objects, attributes, services, or behavioral descriptions that are already defined in SEMI E54.1. Additional attributes, attribute assignments, services, and/or service parameters that are ISPM device specific and/or implementation specific are contained in this Specification.

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3.3 While this Specification is sufficient to completely describe the ISPM as it appears from the network, it does not fully describe behavior of the ISPM which is not visible from the network. This allows flexibility in implementation techniques and product differentiation between manufacturers. Manufacturer specific objects may be defined by the manufacturer but are, by definition, outside the scope of this Standard.

3.4 This Specification is compatible, but not compliant with SEMI E39. This means that although this specification does not require compliance with SEMI E39, it is extensible such that implementations may be developed that are fully compliant with both Standards. Note that the concepts and terminology of this Specification are compatible with those of SEMI E39. However, SEMI E39 has specific requirements that are intended for higher level applications and thus are not applied to the ISPM device model.

3.5 Operation over the entire range specified for an attribute within a specific object is not a requisite for compliance with this Specification.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI E39 — Object Services Standard: Concepts, Behavior, and Services

SEMI E54 — Sensor/Actuator Network Standard

SEMI E54.1 — Standard for Sensor/Actuator Network Common Device Model

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

5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *ISPM* — in situ particle monitor

5.1.2 *LCS* — laser current sensor

5.1.3 *MNS* — median noise sensor

5.1.4 *SLS* — stray light sensor

5.2 *Terminology Defined in This Document*

5.2.1 *in situ particle monitor (ISPM)* — a self-contained device, consisting of a laser that generates light, a light detector, counters, diagnostics and control and signal-processing electronics, commonly used in the semiconductor industry to measure and count particles in a specific area.

5.3 This Document inherits the terminology defined by SEMI E54.1:

5.3.1 *attribute*

5.3.2 *behavior*

5.3.3 *Boolean*

5.3.4 *byte*

5.3.5 *character*

5.3.6 *Common Device Model (CDM)*

5.3.7 *data type*

5.3.8 *data units*

5.3.9 *device*

5.3.10 *device manager (DM) object*

5.3.11 *device model*

5.3.12 *double integer (DINT)*

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5.3.13 *enumerated byte*

5.3.14 *full scale range*

5.3.15 *instance*

5.3.16 *last valid value (LVV)*

5.3.17 *long integer (LINT)*

5.3.18 *long real (LREAL)*

5.3.19 *manufacturer*

5.3.20 *nibble*

5.3.21 *null character*

5.3.22 *object*

5.3.23 *real (REAL)*

5.3.24 *S, A, and C objects*

5.3.25 *sensor actuator controller (SAC) object*

5.3.26 *service*

5.3.27 *short integer (SINT)*

5.3.28 *signed integer (INT)*

5.3.29 *state diagram*

5.3.30 *test string*

5.3.31 *unsigned double integer (UDINT)*

5.3.32 *unsigned double long integer (UDLINT)*

5.3.33 *unsigned integer (UINT)*

5.3.34 *unsigned long integer (ULINT)*

5.3.35 *unsigned short integer (USINT)*

6 Requirements and Specifications

6.1 In order to implement this Standard in an ISPM device, it is necessary to also implement SEMI E54.1 and one of the Sensor/Actuator Network Communication Standards. See § 1.1 for more information on a complete interoperability Standard.

6.2 This Specification also requires the implementation of a Date_And_Time data structure used to represent the current device date and time. Table 1 defines the format of the Date_And_Time data type.

Table 1 Date_And_Time Format

Data Item	*Description*	*Range*
1	Number of milli-seconds since midnight	Unsigned Double Integer (UDINT)
2	Number of days since 1/1/72	Unsigned Integer (UINT)

7 Conventions

7.1 This Document embraces the conventions and notations stated in § 6 of SEMI E54.1.

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8 Device High Level Structure

8.1 *General Description*

8.1.1 The high-level object view of an ISPM device is shown in Figure 1.

8.1.2 Note that the 'ISPM' device object is depicted in Figure 1 only for the purposes of illustrating a high level view of the device and its component objects. In the context of this Document, this object is not addressable, does not have addressable attributes, does not have accessible services, and does not exhibit any defined behavior.

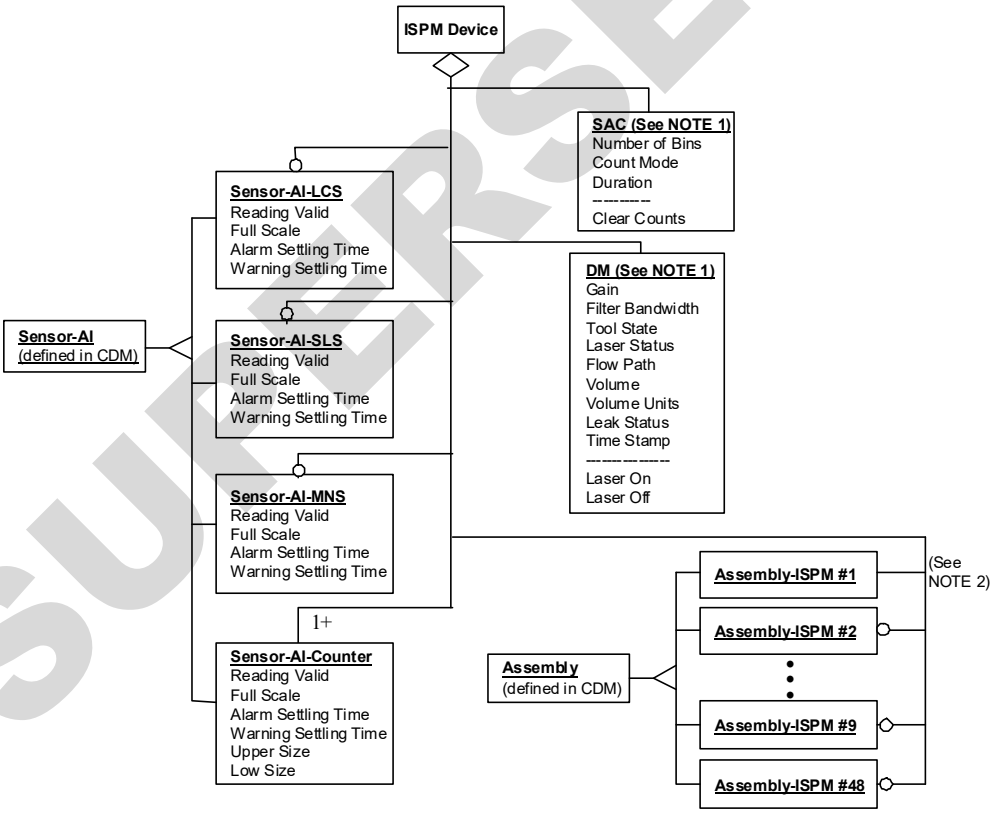
8.1.3 In the remainder of this section, this Document defines in detail all of the component objects unique to the ISPM device. References, rather than definitions, are included for the DM, the SAC, and other objects defined in SEMI E54.1.

8.1.4 Many of the objects defined in this Document inherit properties from other objects. The properties inherited include attribute, services, and behavior definitions. These other objects are specified here or in SEMI E54.1.

8.1.5 This Document provides for future extensions as well as manufacturer specific enhancements by reserving object attribute identifiers and object service identifiers. Specifically, all object definitions in this Document specify or reserve the first 64 attribute identifiers (A1 to A64) and the first 64 service identifiers (S1 to S64) allowing manufacturers to specify identifiers beyond these ranges. Additionally, byte enumerated attributes are specified or reserved from 0 to 63 allowing manufacturers to specify an enumeration beyond this range (64 to 255).

8.1.6 *ISPM Device Description*

8.1.6.1 An ISPM device profile is composed of the component objects and object relationships shown in Figure 1.



#1 The DM and SAC are taken from the CDM. Additional attributes and services are added to support the ISPM device.

#2 Assembly-ISPM #1 and Assembly-ISPM #6 objects are required. Other Assembly-ISPM objects are optional.

Figure 1
ISPM Device High Level Structure

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8.1.7 *General Requirements*

8.1.7.1 *Device Objects* — All objects are defined in terms of their object name and class/object identifier. Identifiers for all objects described in this document are summarized in Table 2.

Table 2 ISPM Device Objects

Referenced Document Section	*Object Name*	*Class/Object Identifier*	*Minimum #*	*Maximum #*
8.2	Device Manager (DM)	ISPMD1	1	1
8.3	Sensor Actuator Controller (SAC)	ISPMD2	1	1
8.5	Sensor-AI-LCS	ISPMD3	0	1
8.6	Sensor-AI-SLS	ISPMD4	0	1
8.7	Sensor-AI-MNS	ISPMD5	0	1
8.8	Sensor-AI-Counter	ISPMD16	1	1024
8.9	Assembly-ISPM#1	ISPMD17	1	1
8.9	Assembly-ISPM#2	ISPMD18	0	1
8.9	Assembly-ISPM#3	ISPMD19	0	1
8.9	Assembly-ISPM#4	ISPMD20	0	1
8.9	Assembly-ISPM#5	ISPMD21	0	1
8.9	Assembly-ISPM#6	ISPMD22	1	1
8.9	Assembly-ISPM#7	ISPMD23	0	1
8.9	Assembly-ISPM#8	ISPMD24	0	1
8.9	Assembly-ISPM#9	ISPMD25	0	1
8.9	Assembly-ISPM#48	ISPMD64	0	1
-	Reserved	ISPM26–ISPM63	-	-
-	Manufacturer Specified	>ISPM64	-	-

8.1.7.2 *Object Services* — Not all object services listed in this document can necessarily be requested over the network. They are included in this document because their behavior may generate network activity.

8.1.7.3 *Object Behavior* — For all service requests received over the network that are not supported by the object, or contain a parameter value which is beyond the supported range, or which is otherwise invalid, a network specific service error response is generated.

8.2 *Device Manager (DM) Object* — The DM object is the device component responsible for managing and consolidating the device operation as specified in SEMI E54.1. The following sections specify the components of the DM object that are not specified in SEMI E54.1 or require further definition than specified in SEMI E54.1.

8.2.1 *DM Object Attributes* — Required and optional DM object attributes are listed in Table 3.

Table 3 DM Object Attributes

Attribute Name	*Attribute Identifier*	*Access Network*	*Required*	*Form*
Device Type	A1	R	Yes	refer to CDM [1]
Exception Detail Alarm	A13	R	No	refer to CDM [1]
Exception Detail Warning	A14	R	No	refer to CDM [1]
Gain	A33	RW *#1	No	REAL
Filter Bandwidth	A34	RW *#1	No	REAL
Tool State	A35	R	No	USINT, enumerated
Laser Status	A36	R	Yes	USINT, enumerated

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Attribute Name	*Attribute Identifier*	*Access Network*	*Required*	*Form*
Flow Path	A37	RW	No	USINT
Volume	A38	R	No	REAL
Volume Units	A39	R	No	Byte, enumerated
Leak Status	A40	R	No	Byte, enumerated
Time Stamp	A41	RW	No	Date_And_Time
Reserved	A42–A64	-	-	Reserved for SDM future expansion
Manufacturer Specified	>A64	-	-	Manufacturer Specific attributes

#1 '*' Indicates that the specific attribute is nonvolatile. Nonvolatile requires that the current attribute value be maintained through a component power cycle.

8.2.1.1 *Device Type* — An attribute that uniquely identifies the type of the device on the network. The device type attribute is assigned as follows:

In Situ Particle Monitor Device = 'ISPM'

8.2.1.2 *Exception Detail Alarm (Optional)* — An attribute which identifies the detailed alarm status of the device. Table 4 defines the bit assignments associated with the alarm exception detail.

Table 4 Exception Detail Alarm Bit Assignments

Bit	*Device Specific Alarm[0]*
0	Reserved
1	Interlock
2	Sensor Not Detected
3	Leak Detected
4	Reserved
5	Sensor Type Changed
6	Reserved
7	Reserved
Bit	*Device Specific Alarm[1]*
0	High Laser Current
1	High Stray Light
2	High Median Noise
3	High Calibration
4	High Fill Rate
5	High Flow Rate
6	Reserved
7	Reserved
Bit	*Device Specific Alarm[2]*
0	Low Laser Current
1	Low Stray Light
2	Low Median Noise
3	Low Calibration
4	Low Fill Rate
5	Low Flow Rate

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Bit	Device Specific Alarm[2]
6	Reserved
7	Reserved

8.2.1.3 *Exception Detail Warning (Optional)* — An attribute which identifies the detailed warning status of the device. Table 5 defines the bit assignments associated with the warning exception detail.

Table 5 Exception Detail Warning Bit Assignments

Bit	Device Specific Warning[0]
0	Reserved
1	0
2	0
3	0
4	Reserved
5	0
6	Reserved
7	Reserved
Bit	Device Specific Warning[1]
0	High Laser Current
1	High Stray Light
2	High Median Noise
3	High Calibration
4	High Fill Rate
5	High Flow Rate
6	Reserved
7	Reserved
Bit	Device Specific Warning[2]
0	Low Laser Current
1	Low Stray Light
2	Low Median Noise
3	Low Calibration
4	Low Fill Rate
5	Low Flow Rate
6	Reserved
7	Reserved

8.2.1.4 *Manufacturer Exception Detail Size (Optional)* — An attribute that specifies the number of exception detail bytes included in the alarm or warning details.

8.2.1.5 *Gain (Optional)* — An attribute that specifies the Gain value of the amplifier for the photodiode signal. The factory configured out-of-box value is determined by the manufacturer based on the sensor type.

8.2.1.6 *Filter Bandwidth (Optional)* — An attribute that determines the bandwidth in kilohertz of the amplifier for the photodiode signal. The factory configured out-of-box value is determined by the manufacturer based on the sensor type.

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8.2.1.7 *Tool State (Optional)* — An attribute that identifies the current state of the tool that is utilizing the counter. In many cases, the ISPM device can detect and report the tool state; this variable is utilized for this type of reporting. This attribute is enumerated and is specified by the manufacturer.

8.2.1.8 *Laser Status* — An attribute that records the current status of the laser. This attribute is enumerated. The possible enumeration and the requirement for support are as follows:

- 0 = LASER OFF (required)
- 1 = LASER TURNING ON (optional)
- 2 = LASER ON BUT NOT STABLE (optional)
- 3 = LASER ON AND STABLE (required)
- 4 = LASER INTERLOCKED (optional)
- 5 = SENSOR MISSING (required)
- 6 to 63 = Reserved
- 64 to 255 = Manufacturer Specified (optional)

8.2.1.9 *Flow Path (Optional)* — An attribute that identifies the current flow path (from multiple sources) being utilized. The source may be modified by a Host at any time. Changing the 'flow path' attribute connects the ISPM device to a different source. When changing sources, data is not valid for a time interval whose length is a function of the distance to the source.

8.2.1.10 *Volume (Optional)* — An attribute that maintains the sample volume. This attribute is used primarily by liquid particle counters utilizing a sampling technique in a small container to extrapolate the particle count in the volume of interest. The value of this attribute is the size of the small container.

8.2.1.11 *Volume Units (Optional)* — An attribute that specifies the unit for the 'volume' attribute. This attribute is enumerated and can take on one of the following values: milliliters or gallons (see Appendix 1 of SEMI E54.1 for assigned values).

8.2.1.12 *Leak Status (Optional)* — An attribute that indicates which one of the potential leak locations is actually leaking. This attribute is enumerated and is specified by the manufacturer. The enumerated value corresponds to a specific leak location.

8.2.1.13 *Time Stamp (Optional)* — An attribute that records the time when the last counting event completed.

8.2.1.14 *Duration (Optional)* — An attribute that defines the interval of time during which the particle counts are collected and put into the bin assemblies.

8.2.1.15 *Initial and Default Values*

Table 6 DM Object Attribute Initial and Default Values

Attribute	*Initial Value*	*Default Value*	*Comment*
Device Type	ISPM	ISPM	ISPM = In Situ Particle Monitor Device
Exception Detail Alarm	0	0	
Exception Detail Warning	0	0	
Laser Status	0	0	Laser Off

8.2.2 *DM Object Services* — The services provided by the DM object are defined in SEMI E54.1 [1]. The DM object supports the additional services listed below.

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