SEMI E54.22-0613
SPECIFICATION FOR SENSOR/ACTUATOR NETWORK SPECIFIC DEVICE MODEL FOR VACUUM PRESSURE GAUGES

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1 Purpose

1.1 This Specification is part of a suite of Standards which 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 which are common to all Vacuum Pressure Gauges [1] on a semiconductor equipment Sensor/Actuator communications network.

2 Scope

2.1 This Specification specifically addresses the minimum attributes, services, and behavior a Vacuum Pressure Gauge (VPG) device must support to be interoperable on the Sensor/Actuator Network.

2.2 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.

2.3 The model specified in this Specification is used in conjunction with the Sensor/Actuator Network Common Device Model (CDM) to completely describe the VPG as it appears from the network interface.

2.4 This Specification, together with the Sensor/Actuator Network Standard, the Sensor/Actuator Network Common Device Model, and a Sensor/Actuator Network Communication Specification, form a complete interoperability specification for the VPG.

2.5 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 are 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 which 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 Vacuum Pressure Gauge Model, it does not contain any definition of objects, attributes, services, or behavioral descriptions that are already defined in the Sensor/Actuator Network CDM. Additional attributes, attribute assignments, services, and/or service parameters that are Vacuum Pressure Device-specific and/or implementation-specific are contained in this Specification.

3.3 While this Specification is sufficient to completely describe the VPG as it appears from the network, it does not fully describe behavior of the VPG 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.

[1] Some parts of this Document are defined in a manner similar to the specifications from ODVA; however no portion of any copyright-protected material of ODVA is included herein.

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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 Vacuum Pressure Gauge Device Model.

3.5 Operation over the entire range specified for an attribute within a specific object instance 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 E54.1 — Standard for Sensor/Actuator Network Common Device Model

4.2 *IEEE Standard*[2]

IEEE 754 — Floating Point Definition

4.3 *Other Documents*

ODVA — Common Industrial Protocol (CIP) Specification[3]

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

5 Terminology

5.1 *Terminology Defined in Standard for Sensor/Actuator Network Common Device Model (SEMI E54.1)*

5.1.1 *Attribute*

5.1.2 *Behavior*

5.1.3 *Byte*

5.1.4 *Character*

5.1.5 *Device*

5.1.6 *Device Manager (DM) Object*

5.1.7 *Device Model*

5.1.8 *Instance*

5.1.9 *Nibble*

5.1.10 *Object*

5.1.11 *S, A, and C Objects*

5.1.12 *Sensor Actuator Controller (SAC) Object*

5.1.13 *Service*

5.1.14 *State Diagram*

5.2 *Definitions*

5.2.1 *boolean (BOOL)* — a binary bit representing 0 and 1 corresponding to FALSE and TRUE or DISABLE and ENABLE respectively.

5.2.2 *common device model (CDM)* — refers to Sensor/Actuator Network Common Device Model. [SEMI E54.1]

[2] Institute of Electrical and Electronics Engineers, 3 Park Avenue, 17th Floor, New York, NY 10016-5997, USA; Telephone: 212.419.7900, Fax: 212.752.4929, http://www.ieee.org

[3] ODVA, 1099 Highland Drive, Ann Arbor, Michigan, USA. Telephone: 734.975.8840; Fax: 734.922.0027; http://www.odva.org

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5.2.3 *data type* — an unsigned short integer formatted as an enumerated byte to specify attribute data format. The intended use of this attribute type is in cases where an attribute, or set of attributes, may be defined, allowing for more than one level of support (e.g., INT or REAL). The following values are defined:

- 0 = INT
- 1 = REAL
- 2 = USINT
- 3 = SINT
- 4 = DINT
- 5 = LINT
- 6 = UINT
- 7 = UDINT
- 8 = ULINT
- 9 = LREAL
- 10–99 = Reserved for CDM
- 100–199 = Reserved for SDMs
- 200–255 = Manufacturer-Specified

5.2.4 *data units* — an unsigned integer formatted as an enumerated byte to specify attribute data units. The intended use of this attribute type is in cases where an attribute, or set of attributes, may be defined, allowing for more than one unit's context. The values are defined in an appendix of this Document.

5.2.5 *date* — a data structure of four bytes used to represent a calendar date. Table 1 defines the format of the date data type.

Table 1 Date Format

Data #	*Description*	*Range*
0–1	Year	Unsigned Integer
2	Month	Unsigned Short Integer (range of 1–12)
3	Day	Unsigned Short Integer (range of 1–31)

5.2.6 *double integer (DINT)* — an integer, four bytes long, in the range -2^{31} to $2^{31}-1$.

5.2.7 *enumerated byte* — a byte with assigned meaning to the values 0 through 255. May take on one of a limited set of possible values.

5.2.8 *full scale range* — the defined 100% value of an attribute in its assigned units. This value is not necessarily the maximum value for the attribute. As an example, the *indicated flow* attribute value may attain 120% of the full scale range.

5.2.9 *gas calibration* — a reference to a set of parameters or methods which are used to calibrate or correct the device for a particular gas type, range, and units.

5.2.10 *gas standard number* — a number that references a gas type. The number and its referenced gas type are defined in SEMI E52.

5.2.11 *gas standard symbol* — a text symbol that references a gas type. The symbol and its referenced gas type are defined in SEMI E52.

5.2.12 *last valid value (LVV)* — the most recent value successfully assigned to an attribute.

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5.2.13 *long integer (LINT)* — an integer, eight bytes long, in the range -2^{63} to $2^{63}-1$.

5.2.14 *long real (LREAL)* — a double floating point number, eight bytes long, as defined in IEEE 754.

5.2.15 *manufacturer* — in the context of this document, this refers to the manufacturer of the device.

5.2.16 *null character* — a byte with a value of zero.

5.2.17 *programmed gas calibration* — a reference to a particular gas type, range, and units for which the device is currently calibrated.

5.2.18 *real (REAL)* — a floating point number, four bytes long, as defined by IEEE 754.

5.2.19 *short integer (SINT)* — an integer, one byte long, in the range −128 to 127.

5.2.20 *signed integer (INT)* — an integer, two bytes long, in the range −32768 to 32767.

5.2.21 *text string* — a string of one-byte characters. See ¶ 5.1 for a definition of a character.

5.2.22 *unsigned integer (UINT)* — an integer, two bytes long, in the range 0 to 65535.

5.2.23 *unsigned short integer (USINT)* — an integer, one byte long, in the range 0 to 255.

5.2.24 *vacuum pressure gauge (VPG)* — a self-contained device, consisting of one or more vacuum pressure sensors and signal processing electronics, commonly used in semiconductor industry to measure the pressure of gas.

5.2.25 *vacuum pressure single gauge device (VG)* — a self-contained device, consisting of **one** vacuum pressure sensor and signal-processing electronics, commonly used in semiconductor industry to measure the pressure of gas.

5.2.26 *vacuum pressure gauge/combo device (CG)* — a self-contained device, consisting of **several** vacuum pressure sensors and signal-processing electronics, commonly used in semiconductor industry to measure the pressure of gas. The characteristic of these combo devices is that only one vacuum pressure sensor outputs an actual pressure value at one time. The other sensors are in overrange which means that the pressure is higher than the measurement range of the gauge or underrange condition which means that the pressure is lower than the measurement range of the gauge.

5.2.26.1 Example: A vacuum pressure gauge with two Sensor Analog Input instances

- Pirani measuring instance: measurement range: 1E-3 Torr .. 760 Torr
- Hot Cathode Ion Gauge measurement range: 1E-10 Torr .. 1E-3 Torr

5.2.26.1.1 When working at 1E-5 Torr, the Pirani measuring instance will be in an Underrange condition whereas the Hot Cathode Ion Gauge will output its normal pressure value.

5.2.26.1.2 Working at 100 Torr the Pirani measuring instance will output its normal pressure value whereas the Hot Cathode Ion Gauge will be in an Overrange condition.

5.2.27 *vacuum pressure gauge/multi device (MG)* — a self-contained device, consisting of **several** vacuum pressure sensors and signal-processing electronics, commonly used in semiconductor industry to measure the pressure of gas. The characteristic of these multi devices is that several vacuum pressure sensors output an actual pressure value at the same time. Normally sensors (at a minimum two) are in normal working conditions (no underrange, no overrange).

6 Requirements

6.1 In order to implement this Standard in a VPG, it is necessary to also implement SEMI E54.1 and one of the Sensor/Actuator Network Communication Standards. See § 2 for more information on a complete interoperability standard.

7 Conventions

7.1 This Document embraces the Harel State Chart notation, the transition table definition format, the object attribute representation formats, service message definition formats, and behavior definition formats as specified in SEMI E54.1.

7.2 Figure 1 describes the convention for object representation used throughout this Specification.

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OBJECT NAME

Attributes

Services

Figure 1
Object Representation

8 Device High Level Structure

8.1 *General Description* — The high level object view of a VPG device is shown in Figure 2.

8.1.1 Note that the 'VPG' objects are depicted in Figure 2 only for the purposes of illustrating a high level view of the device and its component objects. In the context of this Document, these objects are not addressable, do not have addressable attributes, do not have accessible services, nor do they exhibit any defined behavior. These objects are only included in the figures to aid in the visualization of the device.

8.1.2 This Document defines in detail all of the component objects unique to the VPG devices. References, rather than definitions, are included for the device manager (DM), the sensor actuator controller (SAC), and other objects defined in SEMI E54.1.

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

8.1.4 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–A64) and the first 64 service identifiers (S1–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 enumerations beyond this range (64 to 255).

8.1.5 *VPG Device Description* — A VPG device profile is composed of the component objects and object relationships shown in Figure 2.

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