SEMI E54.21-1110 (Reapproved 0517)
SPECIFICATION FOR SENSOR ACTUATOR NETWORK FOR MOTIONNET® COMMUNICATION

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NOTICE: This Document was reapproved with minor editorial changes.

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1 Purpose

1.1 This Document defines a communication specification based on the MOTIONNET® protocol to enable communications between intelligent devices on a Sensor/Actuator Network (SAN) that operate according to SEMI E54 device models on semiconductor manufacturing equipment.

1.2 This Document gives interoperability with SEMI E54 common/specific device model based Sensor/Actuator devices.

2 Scope

2.1 This Document specifies how Sensor/Actuator/Controller devices interoperate on the network specific for the MOTIONNET Public specification referenced in the § 4, as a part of equipment's control system.

2.2 This Document defines relation with main part of SEMI E54 including Common Device Model (CDM) and existing Specific Device Models (SDMs). This Document is to be used with the CDM and one or more SDMs, as well as the MOTIONNET Public Specification.

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 Document specifies a semiconductor equipment SAN based only on MOTIONNET and is a companion Document to the MOTIONNET specification; therefore a complete specification of this Standard includes the MOTIONNET specifications. There are other semiconductor SAN communication options. The specifications for these options are not included here.

3.2 This Standard specifies enhancements that provide additional capability over and above those currently required by MOTIONNET. In order to avoid document inconsistency problem, information in the MOTIONNET specification that relates to this Standard is not repeated in this Document. This Document is limited to describing enhancements or limitations to the MOTIONNET specification that are imposed by this Standard.

3.3 A complete specification of the conformance testing procedure shall include the MOTIONNET protocol conformance testing specification. Conformance testing shall also include enhancements and limitations to the MOTIONNET specification required by this Standard.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI E54 — Specification for Sensor/Actuator Network

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

SEMI E54.3 — Specification for Sensor/Actuator Network Specific Device Model for Mass Flow Device

SEMI E54.10 — Specification for Sensor/Actuator Network Specific Device Model for an In Situ Particle Monitor Device

SEMI E54.11 — Specification for Sensor/Actuator Network Specific Device Model for Endpoint Devices

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SEMI E54.18 — Specification for Sensor/Actuator Specific Device Model for Vacuum Pump Device

4.2 *ISO Standard*[1]

ISO/IEC 7498-1 — Information Technology – Open Systems Interconnection – Basic Reference Model: The Basic Model

4.3 *MOTIONNET Specification*[2]

MOTIONNET Public Specification ver. 1.0

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

5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *CDM* — Common Device Model

5.1.2 *MNMA* — Motionnet Members Association

5.1.3 *NCS* — Network Communication Standard

5.1.4 *OSI* — Open Systems Interconnection [ISO/IEC 7498-1]

5.1.5 *PHY* — physical layer

5.1.6 *SAN* — Sensor/Actuator Network

5.1.7 *SDM* — Specific Device Model

5.1.8 *UI* — user interface

5.2 *Definitions*

5.2.1 Terms used in this Document are defined in SEMI E54.1.

5.3 *Terminology Defined in MOTIONNET*

5.3.1 *communication frame* — the minimum unit of transaction data in communication protocol format of MOTIONNET.

5.3.2 *directive* — a code to identify type of request or response of application.

5.3.3 *interruptive mode* — one of the transmission formats to communicate larger amount of data between master and slave.

5.3.4 *interval frame* — a unit of transaction data between communication frames interruptedly in communication protocol format of MOTIONNET.

5.3.5 *master* — one of nodes on the MOTIONNET, which generates primary frame signal or receives secondary frame for all slave station; Center in another word.

5.3.6 *Motionnet Members Association (MNMA)* — user and vendor group which recommends and improves MOTIONNET communication. This is nonprofitable organization. It shares MOTIONNET applications information, helps solution of MOTIONNET technical problems, and provides MOTIONNET compliance test, etc.

5.3.7 *node* — devices of MOTIONNET master station and slave station.

5.3.8 *primary frame* — a communication frame or interval frame generated before corresponding second frame.

5.3.9 *regular mode* — one of the transmission formats to communicate less overhead time between master and slave.

5.3.10 *secondary frame* — a communication frame or interval frame generated after corresponding primary frame.

[1] International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland; Telephone: +41.22.749.01.11, Fax: +41.22.733.34.30, http://www.iso.org

[2] Motionnet Members Association, No. 16-13, 2-Chome, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan; Telephone: +81.3.3813.8841; Fax: +81.3.3813.3348; http://www.motionnet.jp

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5.3.11 *slave* — one of nodes on the MOTIONNET, which receives primary frame signal or generates secondary frame for master station; Local in another word.

5.3.12 *sub-module* — a logical or physical component to compose a device.

5.3.13 *subset* — a device or composing a device represented by a systematized hardware entity.

5.3.14 *transmission cycle* — a period of cyclic communication on MOTIONNET.

6 Communication Protocol High Level Structure

6.1 *MOTIONNET Communication* — MOTIONNET employs the polling principle with Master and Slave type communication. One Master station can control limited number of the nodes. In the MOTIONNET communication, there are pairs of communication frames on transmission cycle regularly. Each of the pairs consists of primary frame and secondary one. Depending on higher layer of communication interval frame pair may be inserted in the regular pairs. Besides the interval frame pair, all slave node communication is executed in the same manner in regular order of slave node number.

6.2 *Network Model* — A brief description of the MOTIONNET as it relates to the ISO/IEC 7498-1 OSI model follows in the section below. MOTIONNET does not define layers 3 to 6. Layer 7 is the interface between the Application Process and the communication stack.

6.2.1 *Physical Layer — Layer 1*

6.2.1.1 The physical layer is used for the transmission of the physical signal level between nodes through a physical media. The general specifications are as follows.

- Transmission Signaling: Manchester encoding
- Electrical Insulation between Devices and Transmission Lines: Transformers
- Access Control Method: Master/Slave

6.2.1.2 See the MOTIONNET specification for more detail.

6.2.2 *Data Link Layer — Layer 2*

6.2.2.1 The data link layer is responsible for data transmissions between the master and slaves using the service that the physical layer provides. The services provided by the data link layer of this Specification are given below.

- Exchange of data link service data units
- Error notification

6.2.2.2 The data link layer provides connectionless services. Although re-transmission control is provided, establishing data link connection, data sequence control.

6.2.2.3 This layer consists of the media access control (MAC) sub-layer and the logical link control (LLC) sub-layer. The functions of the MAC sub-layer are provided by a transmission LSI, and the functions of the LLC sub-layer are provided by software.

6.2.3 *Network Layer — Layer 3*

6.2.3.1 There is no distinct network layer.

6.2.4 *Transport Layer — Layer 4*

6.2.4.1 There is no distinct network layer.

6.2.5 *Session Layer — Layer 5*

6.2.5.1 There is no distinct network layer.

6.2.6 *Presentation Layer — Layer 6*

6.2.6.1 There is no distinct network layer.

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6.2.7 *Application Layer — Layer 7*

6.2.7.1 The application layer provides the communication and control services between the Master station and Slave stations. The Master station can be one of the controllers, and the Slave stations can be any of various devices. A Slave station may compose a device or it may be shared by more than one devices in equipment as well.

6.2.7.2 Detail of communication specifications for each device is described in the MOTIONNET manuals.

6.2.7.3 The services in the application layer are executed by commands sent from the Master station to the Slave stations.

6.2.7.4 Details of these services are as follows:

- Network and device management
- Controlling a device or Slave stations
- Exchange of data between Master and Slave stations including device data/configuration

6.3 *Protocol Specification*

6.3.1 *Directives*

6.3.1.1 The standard directives that keep MOTIONNET communication transferred in application layer. The slave station supports all the required directives of its device: specific purpose services and general/specific services including device services. Any addition of the function will be indicated in the association public specification or the product specifications.

6.3.2 *Data Frame*

6.3.2.1 There are a couple of types of data size in the MOTIONNET application layer. One of them is fixed to 4 bytes a communication frame pairs and the other is flexible, but limited to 256 bytes maximum an interval frame pair. Each data length here includes directive and its parameter data.

7 Required Object Types

7.1 This section describes a general mapping of the SEMI SAN Object Model to the MOTIONNET environment. Component definitions are clarified and the mapping of Attributes, Services, and Behaviors are specified.

7.2 *Object Model*

7.2.1 The Object Model defined in the CDM is represented in the MOTIONNET NCS. Especially the DM, SAC, and abstract or fundamental application objects are mapped.

7.3 *Component Mapping Summary*

7.3.1 Table 1 provides a summary of the components of the CDM object model as they relate to the components of MOTIONNET.

7.4 *Objects*

7.4.1 The required objects of the CDM are identified here. § 8 specifies additional mapping information for SDM.

7.4.2 Table 1 lists the Object Identifiers specified for use in protocol messages.

Table 1 Object Identifiers

Object Name	*MOTIONNET Class/Object ID*	*CDM Object ID Tag*	*CDM Attribute/Service ID Tag Prefix*
Device Manager	1	DmI0	Dm
SAC	2	SacI0	Sac
Assembly	3	AsmIn[#1]	Asm
Local Link	4	LnkIn[#1]	Lnk
Sensor-AI	9	SenIn[#1]	Sai

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Object Name	*MOTIONNET Class/Object ID*	*CDM Object ID Tag*	*CDM Attribute/Service ID Tag Prefix*
Sensor-EI	10	SenIn#1	Sei
Sensor-BI	11	SenIn#1	Sbi
Sensor-BI-TH	12	SenIn#1	Sbith
Actuator-AO	17	ActIn#1	Aao
Actuator-EO	18	ActIn#1	Aeo
Actuator-BO	19	ActIn#1	Abo
Controller	24	CntIn#1	C
Application Objects	>31	-	-

#1 'In' is used to indicate the instance number of the object; 'n' is non-negative integer.

7.5 *Attribute*

7.5.1 All attributes are accessible via Get_Attribute and Set_Attribute services defined in the sections below. The attributes could be also accessible via different MOTIONNET directives. However this document doesn't specify here and using them is out of scope of the Standard.

Table 2 Service to access Attribute by MOTIONNET

SEMI CDM Service	*MOTIONNET*		*Remarks*
	Command	*ID*	
Get Attribute	LPRD	193	
Set Attribute	LPWR	194	

7.5.2 *MOTIONNET Attribute Mappings for CDM*

7.5.2.1 *Device Manager (DM) Object* — The DM object is the device component responsible for managing and consolidating the device operation as defined in the CDM Standard. Attribute values including DM state are also as same as defined in the CDM Standard. The presentation of object instance attributes to the MOTIONNET network shall be as indicated in Table 3.

Table 3 DM Object Attribute Identifiers for MOTIONNET

SEMI E54.1 CDM		*MOTIONNET*	
SEMI CDM	*Attribute*	*Parameters*	*Remarks*
DmA1	Device Type	1	
DmA2	Standard Revision Level	2	
DmA3	Device Manufacturer Identifier	3	
DmA4	Manufacturer Model Number	4	
DmA5	Software or Firmware Revision Level	5	
DmA6	Hardware Revision Level	6	
DmA7	Serial Number	7	
DmA8	Device Configuration	8	
DmA9	Device Status	9	
DmA10	Reporting Mode	10	

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SEMI E54.1 CDM		MOTIONNET	
SEMI CDM	*Attribute*	*Parameters*	*Remarks*
DmA11	Exception Status Report Interval	11	
DmA12	Exception Status	12	
DmA13	Exception Detail Alarm	13	
DmA14	Exception Detail Warning	14	
DmA15	Visual Indicator	15	
DmA16	Alarm Enable	16	
DmA17	Warning Enable	17	
DmA18	Exception Detail Type	18	
DmA19	Exception Detail Alarm Queue	19	
DmA20	Exception Detail Warning Queue	20	
DmA21	Date and Time	21	
DmA22	Date and Time Type	22	

7.5.2.2 *Sensor, Actuator, Controller (SAC) Object* — The SAC object is the device component responsible for coordinating the interaction of the device with the sensory/actuation/control environment as defined in the CDM Standard. Attribute values including SAC state are also as same as defined in the CDM Standard. The presentation of object instance attributes to the MOTIONNET network shall be as indicated in Table 4.

Table 4 SAC Object Attribute Identifiers for MOTIONNET

SEMI E54.1 CDM		MOTIONNET	
Attribute Identifier	*Attribute*	*Parameters*	*Remarks*
SacA1	Last Calibration Date	1	
SacA2	Next Calibration Date	2	
SacA3	Expiration Timer	3	
SacA4	Expiration Warning Enable	4	
SacA5	Run Hours	5	
SacA7–SacA64	For Reserved		

7.5.2.3 *Assembly Object (Asm)* — The Assembly (Asm) object instances may be used to provide for grouping more than one attribute from one or more object instances as defined in the CDM Standard. Attribute values are also as same as defined in the CDM Standard. The presentation of object instance attributes to the MOTIONNET network shall be as indicated in Table 5.

Table 5 Assembly Object Attribute Identifiers for MOTIONNET

SEMI E54.1 CDM		MOTIONNET	
Attribute Identifier	*Attribute*	*Parameters*	*Remarks*
AsmA1	Data	1	

7.5.2.4 *Local Link Object (Lnk)* — The Local Link (Lnk) object instances may be used to ‘link” an attribute of one object instance to an attribute of another object instance as defined in the CDM Standard. Attribute values are also as

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same as defined in the CDM Standard. The presentation of object instance attributes to the MOTIONNET network shall be as indicated in Table 6.

Table 6 Local Link Object Attribute Identifiers for MOTIONNET

SEMI E54.1 CDM		*MOTIONNET*	
Attribute Identifier	*Attribute*	*Parameters*	*Remarks*
LnkA1	Source Object Class	1	
LnkA2	Source Object Instance	2	
LnkA3	Source Object Attribute	3	
LnkA4	Destination Object Class	4	
LnkA5	Destination Object Instance	5	
LnkA6	Destination Object Attribute	6	
LnkA7	Commit	7	

7.5.2.5 *Active Element (AE) Class* — The AE class is an abstract class generic to any device component as defined in the CDM Standard. Attribute values including AE state are also as same as defined in the CDM Standard. The presentation of object instance attributes to the MOTIONNET network shall be as indicated in Table 7.

Table 7 AE Class Attribute Identifiers for MOTIONNET

SEMI E54.1 CDM		*MOTIONNET*	
Attribute Identifier	*Attribute*	*Parameters*	*Remarks*
nA1	Name	1	
nA2	Status	2	
nA3	Alarm Enable	3	
nA4	Warning Enable	4	

#1 Prefix ‘n’ in the CDM attribute ID represents one of Sai, Sei, Sbi, Sbith, Aao, Aeo, Abo and C.

7.5.2.6 *Sensor (S) Class* — The S class is an abstract class generic to any sensors on device component as defined in the CDM Standard. Attribute values are also as same as defined in the CDM Standard. The presentation of object instance attributes to the MOTIONNET network shall be as indicated in Table 8. These attributes are inherited by any sensor objects as Sensor-AI object. They also inherit AE class attributes. Attribute identifiers on MOTIONNET for such direct and indirect inheritor classes of S class as Sensor-AI are assigned in §§ 7.4.2 and 8.

Table 8 S Class Attribute Identifiers for MOTIONNET

SEMI E54.1 CDM		*MOTIONNET*	
Attribute Identifier	*Attribute*	*Parameters*	*Remarks*
nA16	Value	16	
nA17	ReportInhibitTimer	17	
nA18	EnableReportRate	18	
nA19	ReportRate	19	

#1 Prefix ‘n’ in the CDM attribute ID represents one of Sai, Sei, Sbi or Sbith.

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