# SEMI E54.17-0706 (Reapproved 1211)
# SPECIFICATION OF SENSOR/ACTUATOR NETWORK FOR A-LINK

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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.

## 1 Purpose

1.1 This Document defines a communication specification based on the A-LINK 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 (SAC) devices interoperate on the network specific for the A-LINK 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 A-LINK 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 A-LINK and is a companion document to the A-LINK specification; therefore a complete specification of this Standard includes the A-LINK 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 A-LINK. In order to avoid document inconsistency problem, information in the A-LINK specification that relates to this Standard is not repeated in this Document. This Document is limited to describing enhancements or limitations to the A-LINK specification that are imposed by this Standard.

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

## 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

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

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SEMI E54.11 — Specific Device Model for Endpoint Devices

4.2 *ISO Standard*[1]

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

4.3 *Other Documents*

A-LINK Public Specification Version 1.2 — Basic Reference Model for Open Systems Interconnection[1]

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

## 5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 *AUF* — A-LINK user forum

5.1.2 *CDM* — common device model

5.1.3 *NCS* — network communication standard

5.1.4 *OSI* — open systems interconnection [ISO 7498]

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 This section includes the terms defined in SEMI E54.1, Sensor/Actuator Network Common Device Model.

5.2.1 *attribute*

5.2.2 *behavior*

5.2.3 *byte*

5.2.4 *class*

5.2.5 *common device model (CDM)*

5.2.6 *device*

5.2.7 *device manager (DM) object*

5.2.8 *device model*

5.2.9 *instance*

5.2.10 *network communication standard*

5.2.11 *object*

5.2.12 *sensor, actuator and controller (SAC) object*

5.2.13 *service*

5.2.14 *specific device model (SDM)*

5.2.15 *state diagram*

[1] International Organization for Standardization, ISO Central Secretariat, 1 rue de Varembé, Case postale 56, CH-1211 Geneva 20, Switzerland; Telephone: 41.22.749.01.11, Fax: 41.22.733.34.30, http://www.iso.ch



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5.3 *Terminology Defined in A-LINK*

5.3.1 *A-LINK User Forum (AUF)*[2] — A kind of consortium for A-LINK users to recommend improvement to A-LINK trade organization,[3] share A-LINK applications, provide A-LINK compliance test and etc.

5.3.2 *AN MS* — a station that accesses and exchanges data by polling its assigned networked-slave stations. Even if this may be physically located on the network, this may not be seen logically on the network.

5.3.3 *AN SS* — a station that is managed and accessed by AN MS. Often a device is a kind of AN SS on A-LINK network.

5.3.4 *data exchange* — a capability to communicate such data for a device as raw/processed sensed data and variable settings.

5.3.5 *device profile* — a kind of electric table to provide the characteristic features of a device including configuration and capabilities.

5.3.6 *directive* — a capability to instruct such basic functions to a device as reset or abort.

5.3.7 *DP facility* — a capability to manage diagnostic matters of the device.

5.3.8 *service access element* — an addressable location in a device for the directing of service requests. Even if this may be physically located on the network, this may not be seen logically on the network.

5.3.9 *unite inventory* — a capability to realize and communicate the device profile. This provides property and configuration information of devices on the network.

5.3.10 *unite states* — a capability to communicate state of a device.

## 6 Communication Protocol High Level Structure

6.1 In a typical remote I/O configuration, single master architectures are used to optimize response times. In complicated applications, multi-master architectures are also possible. A-LINK uses the polling principle for communication.

6.1.1 Message transfer is organized in cycles. A message cycle mainly consists of a request-frame followed by a corresponding acknowledge/response-frame of the addressed station. An exception to this is the global-control function for synchronization and coordination of several remote I/O stations.

6.1.2 A brief description of the A-LINK protocol as it relates to the ISO/IEC 7498 OSI model follows in the sections below. For protocol efficiency, A-LINK does not define layers 3–7. However, since the OSI model specifies Layer 7 as the interface between the application process and the communication stack, it is appropriate to discuss several aspects of the A-LINK standard at this level.

NOTE 1: The information contained in this section is for reference only. It in no way represents specifications for A-LINK. See related documentation for these specifications.

6.2 *Physical Layer — Layer 1*

6.2.1 The bottom Physical Layer is established by RS-485. See the A-LINK standard for more information for detail.

6.3 *Data Link Layer — Layer 2*

6.3.1 *Data Transfer*

6.3.1.1 The data link layer provides the functions for sending and receiving data over the network. Data elements are packaged, delivered, and checked. Acknowledgements, responses, retries, and timeouts are used to guard against line protocol errors (e.g., frame, overrun, and parity) and transmission protocol errors (e.g., start and end delimiters, frame check, frame length, and response times).

6.4 *Network Layer — Layer 3*

6.4.1 There is no distinct network layer.

[2] http://www.a-linkuf.com

[3] http://www.algosystem.co.jp



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6.5 *Transport Layer — Layer 4*

6.5.1 There is no distinct transport layer. Such functions as disassembling of message into transport unit and reassembling for transportation are implemented in the application layer.

6.6 *Session Layer — Layer 5*

6.6.1 There is no distinct session layer.

6.7 *Presentation Layer — Layer 6*

6.7.1 There is no distinct presentation layer. Such functions as data representation conformance are implemented in the application layer.

6.8 *Application Layer — Layer 7*

6.8.1 The Device shall comply with A-LINK application layer specification for defining and addressing objects including functions deferred in lower layers as described above.

6.8.2 *User Interface (UI)*

6.8.2.1 The UI provides the user with access to functionality of the A-LINK protocol as a part of application layer.

## 7 Required Object Types

7.1 This section describes a general mapping of the SEMI SAN object model to the A-LINK 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 A-LINK NCS. Especially the DM, SAC, and abstract or fundamental application objects are mapped.

7.2.2 The application objects associated with the SDM standards are mapped in A-LINK user forum public specification documents. § 9 specifies the mapping of SDM Objects in A-LINK.

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 A-LINK.

7.4 *Objects*

7.4.1 The required objects of the CDM are identified here. Additional objects that are contained in the SDM are given identifiers in the device profile. § 9 specifies additional mapping information.

7.4.2 Table 1 lists the object identifiers specified for use in protocol messages.

**Table 1 Object Identifiers**

| *Object Name* | *A-LINK 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 | Asm |
| Local Link | 4 | LnkIn | Lnk |
| Sensor-AI | 9 | SenIn | Sai |
| Sensor-EI | 10 | SenIn | Sei |
| Sensor-BI | 11 | SenIn | Sbi |
| Sensor-BI-TH | 12 | SenIn | Sbith |
| Actuator-AO | 17 | ActIn | Aao |
| Actuator-EO | 18 | ActIn | Aeo |
| Actuator-BO | 19 | ActIn | Abo |

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| *Object Name* | *A-LINK Class/Object ID* | *CDM Object ID Tag* | *CDM Attribute/Service ID Tag Prefix* |
|---|---|---|---|
| Controller | 24 | CntIn | C |
| Application Objects | >31 | - | - |

7.5 *Attributes*

7.5.1 All attributes are accessible via Get_Attribute and Set_Attribute services defined in the sections below. Attributes are also accessible via different A-LINK peculiar instructions which are additionally mapped in this document based on attribute type.

7.5.1.1 The attributes of the DM object consists of distinctive information, states, and setups. Distinctive information attributes are retrieved with the Unite Inventory. Inquiring state attributes are provided by getting status data. Setup attributes are written by setting configuration data.

7.5.1.2 The attributes of application objects are divided into two types: input/output (I/O), settings, status and configuration. I/O attributes are acquired from or given through data exchange capability of A-LINK. Configurable attributes can be retrieved with unite inventory capability.

7.5.1.3 See Table 2 for a list of DM attributes and their related alternative access instructions.

7.5.1.4 *A-LINK Settings*

7.5.1.4.1 Attributes related to general settings are accessed through unite inventory communication.

7.5.1.4.2 Structure of the unite inventory for a given SDM is beyond the scope of this Document. The A-LINK trade organization is responsible for the management of this information.

7.5.1.5 *A-LINK States and Diagnostics*

7.5.1.5.1 Attributes related to device state are categorized and handled as unite state information. For example two attributes of the DM object listed in Table 2 that are identified with an alternative access instruction of unite states are mapped into the A-LINK unite states as specified in this section. See the A-LINK standard for a description of the unite states.

7.5.1.5.2 These two attributes are mapped into the unite state data structure. Additional diagnostic data may be included with DP Facility as specified by A-LINK.

7.5.2 *A-LINK I/O Data Exchange*

7.5.2.1 I/O attributes of the Application objects are communicated using the I/O data exchange instruction of A-LINK. This instruction is described in the A-LINK standard. A list of which attributes are accessible with this instruction is included in the A-LINK device profile for a given device type.

7.5.3 *A-LINK Device Configuration*

7.5.3.1 Configuration attributes of the DM object and application objects are communicated using the unite inventory service of A-LINK. This service is described in the A-LINK standard. A list of which application object attributes are accessible with this instruction is included in the A-LINK device profile for a given device type.

7.5.3.2 *Attribute Identifiers*

7.5.3.2.1 Every class object specified in the CDM uses attribute identifier tags to identify its attributes. The tags are formed with alphabetic part of its object identifier tag, a character 'A' for impressing attribute and a numerical identifier of the attribute. The numerical identifier is assigned to the attribute ID used in the A-LINK NCS for classes DM, SAC, Assembly, Local Link, AE, S, A and C, as described in following tables (i.e., from Tables 2 through 8).

7.5.3.2.2 Except sensor-binary input threshold (SBITH) class, the attribute ID used in the A-LINK for derived classes of sensor and actuator classes is assigned with the same manner as above.

7.5.3.2.3 For SBITH class, the attribute ID used in the A-LINK starts from 128 to prevent duplication with the numerical identifiers in CDM assigned and reserved to is parent class, SBI.

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7.5.3.2.4 The A-LINK attribute ID is used to identify attributes for access via A-LINK message requests, which are explained in later sections.

7.5.4 *A-LINK Attribute Mappings for CDM*

7.5.4.1 *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 A-LINK network shall be as indicated in Table 2.

**Table 2 DM Object Attribute Identifiers for A-LINK**

| *Attribute ID* | | *Attribute Name* | *Alternative Access* |
|---|---|---|---|
| *CDM* | *A-LINK* | | |
| DmA1 | 1 | Device Type | Unite Inventory |
| DmA2 | 2 | Standard Revision Level | Unite Inventory |
| DmA3 | 3 | Device Manufacturer Identifier | Unite Inventory |
| DmA4 | 4 | Manufacturer Model Number | Unite Inventory |
| DmA5 | 5 | Software or Firmware Revision Level | Unite Inventory |
| DmA6 | 6 | Hardware Revision Level | Unite Inventory |
| DmA7 | 7 | Serial Number | Unite Inventory |
| DmA8 | 8 | Device Configuration | Unite Inventory |
| DmA9 | 9 | Device Status | Unite States |
| DmA10 | 10 | Reporting Mode | Unite Inventory |
| DmA11 | 11 | Exception Status Report Interval | Unite Inventory |
| DmA12 | 12 | Exception Status | Unite States |
| DmA13 | 13 | Exception Detail Alarm | Unite Inventory |
| DmA14 | 14 | Exception Detail Warning | Unite Inventory |
| DmA15 | 15 | Visual Indicator | Unite Inventory |
| DmA16 | 16 | Alarm Enable | Unite Inventory |
| DmA17 | 17 | Warning Enable | Unite Inventory |
| DmA18 | 18 | Exception Detail Type | Unite Inventory |
| DmA19 | 19 | Exception Detail Alarm Queue | Unite Inventory |
| DmA20 | 20 | Exception Detail Warning Queue | Unite Inventory |
| DmA21 | 21 | Date and Time | Unite Inventory |
| DmA22 | 22 | Date and Time Type | Unite Inventory |

7.5.4.2 *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 A-LINK network shall be as indicated in Table 3.

**Table 3 SAC Object Attribute Identifiers for A-LINK**

| *Attribute ID* | | *Attribute Name* | *Alternative Access* |
|---|---|---|---|
| *CDM* | *A-LINK* | | |
| SacA1 | 1 | Last Calibration Date | DP Facility |
| SacA2 | 2 | Next Calibration Date | DP Facility |
| SacA3 | 3 | Expiration Timer | DP Facility |

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