

SEMI E54.13-0303

SPECIFICATION FOR SENSOR/ACTUATOR NETWORK COMMUNICATIONS FOR ETHERNET/IP™

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

1 Purpose

1.1 Introduction

1.1.1 This standard defines a communication specification based on the EtherNet/IP¹ (Ethernet/Industrial Protocol) network to enable communications between intelligent devices on a sensor/actuator network (SAN) that operate according to SEMI specified device models (common and device specific) in a semiconductor manufacturing tool.

1.2 Motivation

1.2.1 EtherNet/IP is a communication system suitable for use in industrial environments. EtherNet/IP allows intelligent devices to exchange time-critical application information. These devices include simple I/O devices such as sensors/actuators, as well as complex control devices such as robots, programmable logic controllers, and process controllers.

1.2.2 EtherNet/IP uses CIP (Control and Information Protocol), the common network, transport and application layers also shared by DeviceNet [SEMI E54.4]. EtherNet/IP provides:

- A cost effective solution to bridge factory Ethernet [IEEE 802.3] networks to SEMI E54.4 DeviceNet low-level device networks,
- Access to intelligence present in low-level devices, and
- Producer/Consumer model for Master/Slave and Peer-to-Peer application relationships.

1.3 Background

1.3.1 EtherNet/IP makes use of standard Ethernet and TCP/IP technology to transport CIP communications packets. The result is a common, open application layer on top of open and highly popular Ethernet and TCP/IP protocols.

1.3.2 EtherNet/IP provides a producer/consumer model for the exchange of time-critical control data. The producer/consumer model allows the exchange of application information between a sending device (e.g., the producer) and many receiving devices (e.g., the consumers) without the need to send the data multiple times to multiple destinations. For EtherNet/IP, this is accomplished by making use of the CIP network and transport layers along with IP Multicast technology. Many EtherNet/IP devices can receive the same produced piece of application information from a single producing device.

1.3.3 EtherNet/IP makes use of standard IEEE 802.3 technology; there are no non-standard additions that attempt to improve determinism. Rather, EtherNet/IP recommends the use of commercial switch technology, with 100 Mbps bandwidth and full-duplex operation, to provide for more deterministic performance.

2 Scope

2.1 *Specification* — This document specifies a Sensor/Actuator Network Communications Standard (NCS) based on the EtherNet/IP specification that enables communication with SAN devices configured according to SEMI SAN Common Device Model (CDM) and appropriate Specific Device Model (SDM) specifications.

2.2 *Use* — This document is used in conjunction with a SEMI standard SAN CDM specification and one or more SEMI standard SDM specifications (e.g., for a mass flow controller). Together, they describe the externally visible

¹ EtherNet/IP is a trademark of Open DeviceNet Vendor Association (ODVA)

data structure and behavior of devices utilizing the EtherNet/IP networking capability in a SEMI compliant SAN system. The general sensor/actuator network document architecture is described in the SEMI E54 Sensor/Actuator Network Standard (the root SAN document).

2.3 Document Structure — The EtherNet/IP network communication standard complies with the SEMI SAN NCS template document structure, as described in SEMI E54. The standard document is composed of two main parts. The first part (§§ 1 through 8) specifies the SAN enabling protocol as well as the presentation (i.e., mapping) of CDM object structure and behavior onto the network (referred to as the “CDM mapping”). The second part (§ 9) specifies the presentation (i.e., mapping) of SDM object structure and behavior onto the network for each SEMI specified SDM (referred to as the “SDM mapping”).

2.4 Adding SDM Mappings — SDM mappings added to part two of this document are considered document additions and are balloted as such. An SDM mapping may only be balloted for addition to this document if the corresponding SEMI SDM has been standardized.

NOTICE: 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 or other limitations prior to use.

3 Limitations

3.1 This document specifies a semiconductor equipment SAN based solely on EtherNet/IP and is a companion document to the EtherNet/IP specification; thus a complete specification of this standard necessarily includes the EtherNet/IP specifications. There are other semiconductor equipment SAN communications options. The specifications for these options are not included here.

3.2 This standard specifies enhancements that provide additional capabilities over and above those currently required by EtherNet/IP. In order to avoid document consistency problems, information in the EtherNet/IP specification that relates to this standard is not repeated in this document. This document is limited to describing enhancements or limitations to the EtherNet/IP specification that are imposed by this standard.

3.3 A complete specification of the conformance testing procedure shall include the EtherNet/IP conformance testing specification. Conformance testing shall also include enhancements and limitations to the EtherNet/IP specification required by this standard.

4 Referenced Standards and Documents

4.1 SEMI Standards

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

SEMI E39 — Object Services Standard: Concepts, Behavior, and Services (OSS)

SEMI E54 — Sensor/Actuator Network Standard

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

SEMI E54.2 — Guide for Writing Sensor/Actuator Network (SAN) Standard Ballots

4.2 ISO Standards²

ISO 7498 — Basic Reference Model for Open Systems Interconnection.

ISO/IEC 8802-3 — Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications (Ethernet IEEE 802.3).

4.3 Other Documents

ODVA³ EtherNet/IP Specification — Volume I and Volume II, Release 1.0.

² International Organization for Standardization, ISO Central Secretariat, 1 rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland. Telephone: 41.22.749.01.11; Fax: 41.22.733.34.30; <http://www.iso.ch>

³ Open DeviceNet Vendor Association, 20423 State Road 7 #F6, Boca Raton, FL 33498-6797. Telephone: (1) 561-477-7966; <http://www.odva.org>

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

5 Terminology

5.1 Terminology that is common to all of the documents in this SAN standard may also be defined in SEMI E54. Terminology may be reproduced here which is defined in other SEMI documents.

5.2 Abbreviations and Acronyms

- 5.2.1 *CDM* — Common Device Model
- 5.2.2 *CIP* — Control and Information Protocol
- 5.2.3 *CM* — Connection Manager object
- 5.2.4 *DM* — Device Management object
- 5.2.5 *EIP* — EtherNet/IP
- 5.2.6 *EL* — Ethernet Link object
- 5.2.7 *IP* — Internet Protocol
- 5.2.8 *MR* — Message Router object
- 5.2.9 *NCS* — Network Communication Standard
- 5.2.10 *OSI* — Open Systems Interconnect
- 5.2.11 *OSS* — Object Services Standard
- 5.2.12 *PDU* — Protocol Data Unit
- 5.2.13 *SAC* — Sensor, Actuator, Controller object
- 5.2.14 *SAN* — Sensor/Actuator Network
- 5.2.15 *SDM* — Specific Device Model
- 5.2.16 *S-DS* — S-Device Supervisor object
- 5.2.17 *TCP* — Transport Control Protocol

5.3 Device Component Definitions

5.3.1 As this standard defines the presentation or mapping of CDM data structure and behavior over a network, it makes use of many of the terms in the CDM document. Table 1 provides a mapping of fundamental terminology of the CDM document into this document and the EtherNet/IP specification. Note that Column 2 contains an equal sign “=” if the definition is used exactly as specified in the CDM specification.

Table 1 Mapping of CDM to NCS Terminology

<i>CDM Term</i>	<i>NCS Equivalent</i>	<i>EtherNet/IP Equivalent</i>
Device	=	=
Device Model	=	Device Profile
Object	=, Class	=, Class
Instance	=	=
Attribute	=	=
Behavior	=	=
Service	=	=
Behavior State Diagram	=	State Transition Diagram
State Transition Matrix	=	State Event Matrix