

SEMI E54.8-0999

STANDARD FOR SENSOR/ACTUATOR NETWORK COMMUNICATIONS FOR PROFIBUS-DP

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1 Purpose

1.1 This specification is part of the SEMI Sensor/Actuator Network (SAN) suite of standards and defines a specific communications protocol based on the PROFIBUS-DP standard. This Network Communication Standard (NCS) taken together with the SEMI Sensor/Actuator Network standard suite and the PROFIBUS standard completely and unambiguously defines an open standard providing an industry specific solution to off-the-shelf interoperability of networked devices in semiconductor manufacturing equipment.

1.2 PROFIBUS is a vendor independent, open fieldbus standard for a wide range of applications in manufacturing, process and building automation. Vendor independence and openness are guaranteed by the European standard for PROFIBUS, EN 50 170. PROFIBUS-DP is one version of PROFIBUS which is optimized for high speed and inexpensive connectivity between automation control systems and distributed I/O at the device level.

2 Scope

2.1 This document specifies a SAN communications standard based on the PROFIBUS-DP specification that is in compliance with SEMI E54.1. As such, it specifies the protocol, services, and behavior that compliant intelligent devices must support in order to interchange information over this SAN in a method compatible with SEMI E39.

2.2 In conjunction with a SEMI standard SAN Common Device Model (CDM) specification and one or more SEMI standard Specific Device Model (SDM) specifications (e.g., for a mass flow controller), this Network Communication Standard (NCS) with the related PROFIBUS-DP standard describe the data structures, interactions, and behavior that are characteristic of the various devices on the network. This composite model forms a complete interoperability standard for communications among intelligent sensors, actuators, and controllers in semiconductor manufacturing equipment.

2.3 This standard does not purport to address all of the safety issues 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 limitations prior to use.

3 Limitations

3.1 This document specifies a semiconductor equipment SAN based solely on PROFIBUS-DP and is a companion document to the PROFIBUS-DP specification, including, by reference, the PROFIBUS-DPV1 standard; thus, a complete specification of this standard necessarily includes the PROFIBUS-DP specifications. There are other semiconductor equipment SAN communications options. The specifications for these options are not included here.

3.2 The specifications within are strictly enhancements that provide additional capabilities over and above those currently required by PROFIBUS-DP. Included throughout this document, primarily in Section 6, is information paraphrased from the PROFIBUS-DP specifications such as: protocol structure, capabilities, options, and limitations. This information is provided here for reference only and is not intended to provide specification definitions. In all such areas, refer to the PROFIBUS-DP specification documents for information. This document is limited to describing enhancements or limitations to the PROFIBUS-DP specification that are imposed by this standard.

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

4 Referenced Standards

4.1 SEMI Standards

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

4.2 ISO Standard¹

ISO 7498 OSI — Basic Reference Model for Open Systems Interconnection

4.3 Other Standard

EN 50 170 Volume 2 — DIN 19245 Part 1 to 4 — PROFIBUS Standard²³

NOTE 1: As listed or revised, all documents cited shall be the latest publications of adopted standards.

5 Terminology

5.1 Acronyms

CDM — Common Device Model

CSRD — Cyclic Send and Request Data

DDL — Direct Data Link Mapper

DP — Decentralized Periphery

DPM1 — DP-Master Class 1

DPM2 — DP-Master Class 2

DPV1 — DP Extensions Version 1

DSAP — Destination SAP

FDL — Fieldbus Data Link

FMA1/2 — Fieldbus Management for Layers 1 and 2

NCS — Network Communication Standard

OSI — Basic Reference Model for Open Systems Interconnection (ISO 7498)

PDU — Protocol Data Unit

PHY — Physical Layer

SAN — Sensor/Actuator Network

SAP — Service Access Point

SDA — Send Data with Acknowledge

SDM — Specific Device Model

SDN — Send Data with No acknowledge

SRD — Send and Request Data with reply

SSAP — Source SAP

UI — User Interface

5.2 Terminology Defined in Sensor/Actuator Network Common Device Model (SEMI E54.1)

attribute

behavior

byte

common device model

device

Device Manager (DM) Object

device model

instance

network communication standard

object

Sensor, Actuator and Controller (SAC) Object

service

specific device model

state diagram

5.3 Terminology Defined in PROFIBUS

Device Data Base — an electronic file that provides a clear and comprehensive description of the characteristics of a device type in a precisely defined format. Also called a GSD File.

Device Profile — a Device Data Base Sheet, which specifies the characteristic features of a device, and a GSD File.

Direct Data Link Mapper — a protocol layer that provides an interface to the User Interface Layer by translating service requests and responses between the User Interface Layer and the Fieldbus Data Link.

DP-Master Class 1 (DPM1) — a device that polls its assigned DP-Slave devices and handles user data exchange.

DP-Master Class 2 (DPM2) — a device that interacts as a configuration or diagnostic tool; usually a programming device.

DP-Slave — a device that is configured, managed, and polled by Master devices; a DP-Slave initiates no unsolicited communications.

Fieldbus Data Link — the PROFIBUS-DP model for the OSI Layer 2 definition.

GSD File — see Device Data Base

Service Access Point — an addressable location in a device for the directing of service requests.

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² Deutsches Institut für Normung e.V., Beuth Verlag GmbH, Burggrafenstrasse 4-10, D-10787 Berlin, Germany, PROFIBUS Trade Organization, 5010 East Shea Blvd., Scottsdale, AZ 85254, USA

³ The original Profibus standard was the DIN standard listed, in March 1996, the DIN standard became the EN standard listed.

Send Data with No acknowledge — a service request that sends data with no reply.

Send and Request Data with reply — a service request that sends data followed by a reply by the receiving device.

Slave Diagnostics — a method of retrieving a specifically formatted Data Structure that represents the diagnostic status of a DP-Slave.

5.4 Terminology Defined in This Document

DP Service Protocol — a messaging specification for the request of, and response to, services for the PROFIBUS-DP NCS using the PROFIBUS-DP standard.

DPV1 Service Protocol — a messaging specification for the request of, and response to, services for the PROFIBUS-DP NCS using the PROFIBUS-DPV1 standard.

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 lower speed applications, multi-master architectures are also possible. PROFIBUS-DP uses the polling principle for communication (Master-Slave method).

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 PROFIBUS-DP protocol as it relates to the ISO 7498 OSI model follows in the sections below. For protocol efficiency, PROFIBUS-DP does not define layers 3 to 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 PROFIBUS-DP standard at this level. These include: the Direct Data Link Mapper, the User Interface, the Service Access Point, the Device Profile, and the Device Data Base.

NOTE 2: The information contained in this section is for reference only. It in no way represents specifications for PROFIBUS-DP. See related documentation for these specifications.

6.2 Physical Layer — Layer 1

6.2.1 There are currently two options specified for the Physical Layer (PHY): RS-485 and Optical. See the

PROFIBUS-DP standard for more information about these options.

6.3 Data Link Layer — Layer 2

6.3.1 Data Transfer

6.3.1.1 The Data Link Layer or Fieldbus Data Link (FDL) provides the functions for sending and receiving data over the network. Protocol Data Units (PDU) 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).

6.3.1.2 A PDU is restricted to 246 bytes. Preferably, the PDU size should not exceed 32 bytes for optimum performance. In addition to the PDU, a transmission frame of variable length will contain 8 bytes of overhead; one of fixed length (8 bytes) will contain 6 bytes of overhead. Various acknowledgement and response frames are also defined.

6.3.1.3 To better understand the FDL, a summary of FDL data transfer services is given by the following list:

- Send Data with Acknowledge (SDA),
- Send Data with No Acknowledge (SDN),
- Send and Request Data with Reply (SRD), and
- Cyclic Send and Request Data with Reply (CSR).

6.3.2 Bus Management

6.3.2.1 The Fieldbus Management for Layers 1 and 2 is provided by the FMA1/2 component. The FMA1/2 acts as a mediator between the local FMA1/2 user and layers 1 and 2. Requests from the FMA1/2 user, modified as required, are transferred to the FDL and PHY control, and acknowledged with a confirmation to the local FMA1/2 user. The FMA1/2 immediately receives indications from the FDL and PHY if status changes have occurred within the layers, which then leads to an FMA1/2 user indication.

6.4 Application Layer — Layer 7

6.4.1 As stated above, PROFIBUS-DP does not define Layer 7. The following components may be considered part of, or above, Layer 7.

6.4.2 Direct Data Link Mapper (DDL)

6.4.2.1 The DDL performs the interpretation of service requests from, and responses to, the User Interface (UI). The DDL offers a well defined, easy interface between the UI and the FDL. Table 1 is included to demonstrate the basic structure of the

PROFIBUS-DP DDLM. For speed and efficiency, the PROFIBUS-DP protocol defines the Service Access Point (SAP). These are included in the transmission protocol to direct messages within the device for fast dedicated processing. Defined are Destination SAP (DSAP) and Source SAP (SSAP).

6.4.3 User Interface (UI)

6.4.3.1 The UI provides the user with access to functionality of the PROFIBUS-DP protocol. There is one UI definition for DPM1 devices and one for DPM2 devices. To better understand the UI, a summary of application functions follows:

6.4.3.2 DPM1 and DPM2 UI — Master-Slave Application Functions

- Read Diagnostic Information of DP-Slaves
- Cyclic User Data Exchange
- Parameterization and Configuration Checking
- Submit Control Commands

6.4.3.3 DPM2 UI — Master-Slave Application Functions

- Read Configuration of a DP-Slave
- Read Input/Output Values
- Address Assignment to DP-Slaves

Table 1 DDLM Primitive Functions

DDL Function	Description	SSAP	DSAP	FDL SRV
Master-Slave				
DDL Data_Exchange	Exchanges I/O Data	NIL	NIL	SRD
DDL Check_Cfg	Sends Configuration to DP-Slave for verification.	62	62	SRD
DDL Set_Prm	Sends Parametric Data to DP-Slave.	62	61	SRD
DDL Slave_Diag	Retrieves the Diagnostic Data Structure from a DP-Slave.	62	60	SRD
DDL Get_Cfg	Retrieves the Configuration Data Structure from a DP-Slave.	62	59	SRD
DDL Global_Control	Controls the Operational and Synchronization Modes of DP-Slaves.	62	58	SDN
DPM2-Slave				
DDL RD_Outp	Retrieves the Status of the Outputs of the DP-Slave.	62	57	SRD
DDL RD_Inp	Retrieves the Values of the Inputs of the DP-Slave.	62	56	SRD
DDL Set_Slave_Add	Sets the Node Address of a DP-Slave.	62	55	SRD
Master-Master				
DDL xxx	Various Services for Master-Master Communications	54	54	SRD
DDL Act_Para_Brct	Accept and Activate the most recent Download of Parameters.	54	54	SDN
Master-Slave — Extended Communications				
DDL Read	Acyclic Read of DP-Slave Data	62	51	SRD
DDL Write	Acyclic Write of DP-Slave Data	62	51	SRD
DPM2-Slave — Connection Configuration				
DDL xxx	Various Services for Control and Management of the MSAC_C2 Connection	50	40–48	