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Industrial communications subsystem based on ISO 11898 (CAN) for controller-device interfaces - Part 2: DeviceNet

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Industrial communications subsystem based on ISO 11898 (CAN) for controller-device interfaces Part 2: DeviceNet

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CENELEC
European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 65CX, Fieldbus.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 50325-1 on 2000-01-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2001-05-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2003-01-01

This European standard is divided into three parts:

Part 1 General requirements
Part 2 DeviceNet specification
Part 3 Smart Distributed System (SDS) specification

NOTE This European Standard exists only in English.

The specifications for DeviceNet and SDS are based on ISO 11898, a broadcast-oriented communications protocol. However, ISO 11898 specifies only part of a complete communication system, and additional specifications are needed for other layers to ensure precise data exchange functionality and support of inter-operating devices. The DeviceNet and SDS specifications build on ISO 11898 to describe a complete industrial communication system.

General information on licensing

CENELEC calls attention to the fact that patent rights are linked to Part 3 of this 50325[1)]. The patent holder, Honeywell Inc., has assured to CENELEC that it is willing to grant a licence under these patents on reasonable and non discriminatory terms and conditions to anyone wishing to obtain such a license, applying the rules of CEN/CENELEC Memorandum 8.

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The license details may be obtained from

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(Industrial Marketing and Applied Technology Sensing and Controls Europe)
Honeywell Control Systems Ltd.
Newhouse Industrial Estate,
Motherwell,
Lanarkshire
Scotland ML1 5SB
GB

[1)] in preparation.

Contents

Introduction

DeviceNet is intended for use in, but is not limited to, industrial automation applications. These applications may include devices such as limit switches, proximity sensors, electro-pneumatic valves, relays, motor starters, operator interface panels, analogue inputs, analogue outputs, and controllers.

1 Scope

This Part 2 of EN 50325 contains the following particular requirements for DeviceNet:

- requirements for interfaces between controllers and switching elements;
- normal service conditions for devices;
- constructional and performance requirements;
- tests to verify conformance to requirements.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

EN 50081-2	1993	Electromagnetic compatibility (EMC) - Generic emission standard Part 2: Industrial environment
EN 50082-2	1995	Electromagnetic compatibility - Generic immunity standard Part 2: Industrial environment
EN 55011	1998	Industrial, scientific and medical (ISM) radio-frequency equipment – Radio disturbance characteristics - Limits and methods of measurement (CISPR 11:1997, modified)
EN 60529	1991	Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)
EN 60947-5-2	1998	Low-voltage switchgear and controlgear -- Part 5: Control circuit devices and switching elements --Section 2: Proximity switches (IEC 60947-5-2:1997, modified)
EN 61000-4-2	1995	Electromagnetic compatibility (EMC) -- Part 4: Testing and measuring techniques -- Section 2: Electrostatic discharge immunity test (IEC 61000-4-2:1995)
EN 61000-4-3	1996	Electromagnetic compatibility (EMC) -- Part 4: Testing and measuring techniques --Section 3: Radiated, radio-frequency, electromagnetic field immunity test (IEC 61000-4-3:1995, modified)
EN 61000-4-4	1995	Electromagnetic compatibility (EMC) -- Part 4: Testing and measuring techniques --Section 4: Electrical fast transient / burst immunity test (IEC 61000-4-4:1995)
EN 61000-4-5	1995	Electromagnetic compatibility (EMC) -- Part 4: Testing and measuring techniques --Section 5: Surge immunity test (IEC 61000-4-5:1995)
EN 61000-4-6	1996	Electromagnetic compatibility (EMC) --Part 4: Testing and measuring techniques -- Section 6: Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6:1996)
EN 61131-3	1993	Programmable controllers -- Part 3: Programming languages (IEC 61131-3:1993)
ISO/IEC 7498-1	1994	Information technology - Open Systems Interconnection - Basic Reference Model : The Basic Model
ISO 11898	1993	Road vehicles - Interchange of digital information - Controller area network (CAN) for high-speed communication

3 Definitions and abbreviations

For the purposes of this Part 2 of the European Standard, the following definitions and abbreviations apply:

3.1
acknowledged fragmentation
fragmentation performed on an explicit message, in which the transmission of a fragment from the transmitting object is followed by the transmission of an acknowledgement by the receiving object. The reception of each fragment is acknowledged by the receiving object

3.2
ack status
field within an acknowledgement/response message format that indicates whether or not an error has been encountered by the receiver of a fragmented message. This applies specifically to the DeviceNet fragmentation protocol

3.3
application objects
set of object classes and their object instances that are available within the node. These objects manage and provide the exchange of data and messages across a DeviceNet network and within the DeviceNet compliant node

3.4
attribute
description of an externally accessible characteristic or feature of an object. Attributes typically provide status information or govern the operation of an object

3.5
bit-strobe
communication using strobing

3.6
broadcast
communication from one node to all other nodes

3.7
CAN_H
positive half of the differential physical CAN signal

3.8
CAN_L
negative half of the differential physical CAN signal

3.9
change of state
process of data exchange which occurs only when a device's or controller's data changes state according to specific change criteria

3.10
client
1) object which uses the services of another (server) object to perform a task. See server (0)

2) initiator of a message to which a server reacts

3.11
common service
service used by DeviceNet objects. See Annex A.

3.12
communication objects
objects that manage and provide run-time exchange of messages across DeviceNet

3.13
connection
logical binding between two or more application objects. These application objects may be located at the same node or at different nodes

3.14
connection ID (CID)
connection identifier assigned to all transmissions that are associated with a particular connection between multiple nodes

3.15
connection object
manages the communication-specific aspects associated with connections between nodes

3.16
consumer
end point of a connection that is responsible for receiving data

3.17
destination MAC ID
MAC ID of a node that is to receive a message

3.18
device tap
physical point of attachment from a DeviceNet device to a trunk cable or a drop cable

3.19
device type
identification of a collection of device-dependent information describing a viable combination of options selected for all layers in the communication stack

3.20
dominant
one of two complementary logic levels on the physical signal. The dominant level is a logical '0'

3.21
duplicate MAC ID detection
DeviceNet-defined protocol that ensures no two nodes on the same network are assigned the same MAC ID

3.22
explicit messaging
each explicit message commands the performance of a particular task and the return of the results of the task performance to the requester

3.23
fragmentation
DeviceNet protocol provided by the connection object that defines a method by which data greater than eight (8) bytes in length may be transmitted

3.24
group 2 client
UCMM capable device that has gained ownership of the predefined master/slave connection set within a server such that it may act as the client on those connections

3.25
group 2 only client
device that is acting as a Group 2 client to a Group 2 only server. The Group 2 only client provides the UCMM functionality for Group 2 only servers that it has allocated

3.26
group 2 server
unconnected message manager (UCMM) capable device that has been configured to act as the server for the predefined master/slave identifier connections

3.27
group 2 only server
slave device that is UCMM incapable and uses the predefined master/slave connection set to establish communications. A Group 2 only device can transmit and receive only those identifiers defined by the predefined master/slave connection set

3.28
I/O connection
connection between a producer and one or more consumers for the purpose of exchanging application-specific, time-critical I/O data

3.29
I/O data
information which is transferred between I/O points and the controllers which use and set the values

3.30
I/O messaging
exchange of data in a previously defined format

3.31
isolated device
device in which some of its components are not referenced to the V- of the network physical layer. See non-isolated device (0)

3.32
master
node which gathers and distributes I/O using the Predefined Connection Set

3.33
medium access control (MAC) ID
network address of a DeviceNet node

3.34
multicast connection
logical connection from one object to multiple other objects. A multicast connection allows data to be transferred in a single transaction from a producer to multiple consumers sharing the same connection

3.35
node
DeviceNet entity which is identified at the data link level by a unique MAC ID

NOTE Multiple DeviceNet nodes may be implemented in one device but they appear as logically distinct nodes on the DeviceNet network.

3.36
non-isolated device
device in which all components are referenced to the V- of the network physical layer. See isolated device (0)

3.37
object
1) abstract representation of a device's capabilities. Objects may be composed of any or all of the following components: a) Data (information which changes with time); b) Configuration (parameters for behaviour); c) Procedures(actions that may be performed using data and configuration)
2) collection of related data (in the form of variables) and procedures for operating on that data

3.38
point-to-point connection
connection that exists between two objects only. Explicit messaging connections are always point-to-point. I/O connections may be either point-to-point or multicast. See multicast connection (0)

3.39
predefined master/slave connection set
utilisation of an explicit messaging connection to create and configure connection objects within each connection end-point. Uses the general rules as a basis for the definition of a set of connections which facilitate communications typically seen in a master/slave relationship

3.40
producer
end point of a connection that is responsible for sending data

3.41
recessive
one of two complementary logic levels on the physical signal. The recessive level is a logical '1'

3.42
serial number
unique 32-bit integer assigned by each manufacturer to every DeviceNet device. The number is stored within the device as an attribute of the identity object and is unique with respect to the manufacturer

3.43
server
object which provides services to another (client) object. See client (0)

3.44
service
operation or function that an object performs upon request from another object

3.45
slave
a DeviceNet slave returns data to its master using the Predefined Connection Set. The communication method used is set by the master

3.46
source MAC ID
MAC ID of a node that is transmitting a message

3.47
strobing
process of data exchange which occurs when a device, e.g. a controller, sends a single request for data from one or more devices

NOTE Each device receiving the message then responds with its requested data in a predetermined sequence.

3.48
trigger
service used by an application to initiate the production of data

3.49
UCMM capable device
device that supports the UCMM

3.50
UCMM incapable device
device that does not support the UCMM

3.51
unconnected explicit message
explicit message between nodes that have not yet established a connection between each other

3.52
Unconnected Message Manager (UCMM)
function within a node that receives and processes unconnected explicit messages

3.53
unsigned short integer (USINT)
8-bit integer

3.54
unsigned integer (UINT)
16-bit integer

4 Classification

4.1 General

DeviceNet interfaces controlling devices to control circuit devices or switching elements. DeviceNet uses two twisted shielded conductor pairs within one cable - one of these pairs provides a differential communication medium, and the other pair provides power to the devices. The maximum current supported is 8 A at DC 24 V. Data is transmitted at bit rates of 125 kBit/s, 250 kBit/s or 500 kBit/s with maximum cable lengths of 500 m, 250 m, and 100 m respectively. A maximum of 8 bytes of data may be transmitted without fragmentation. A maximum of 64 nodes may be connected using a linear network topology with a trunk line and drop lines (see Figure 1). DeviceNet supports the transmission of I/O data, diagnostics, messaging and programming/configuration. Data exchange may be event driven (change of state), cyclic, polled, or multicast.

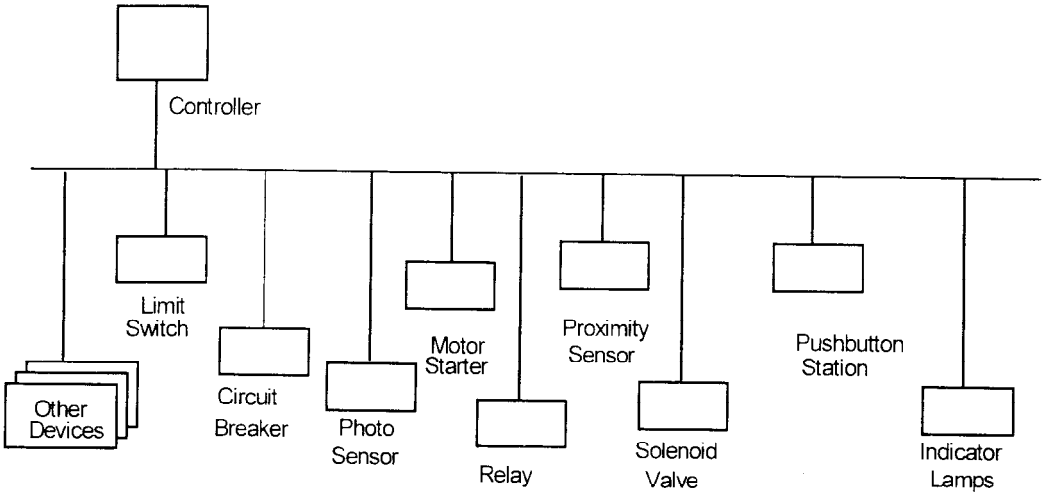

Figure 1 - Typical DeviceNet network

This Part 2 of EN 50325 defines a connection based scheme to facilitate all application communications. A DeviceNet connection provides a communication path between multiple end-points. The end-points of a connection are applications that need to share data. Transmissions associated with a particular connection are assigned an identification value when a connection is established. This identification value is called the Connection ID (CID).

Connection objects model the communication characteristics of a particular application-to-application(s) relationship.

DeviceNet's connection based scheme defines a dynamic means by which the following two types of connections may be established:

— **I/O connections:** Provide dedicated, special purpose communication paths between a producing application and one or more consuming applications. Application specific I/O data moves through these paths.

  I/O messages are exchanged across I/O connections. An I/O message consists of a CID and associated I/O data. The connection end-points shall have knowledge of the intended use or meaning of the I/O message.

  This Part 2 of EN 50325 does not define any particular use for I/O messaging. There are a wide variety of functions that may be accomplished using I/O messaging. The meaning and/or intended use of all I/O messages shall be made known to the system either by the particular type of product transmitting an I/O message, or based upon configuration performed using explicit messaging.

— **Explicit messaging connections:** Provide generic, multi-purpose communication paths between two devices. Explicit messages provide the typical request/response oriented network communications.

  Explicit messages are exchanged across explicit messaging connections. Explicit messages are used to command the performance of a particular task and to report the results of performing the task.

  DeviceNet defines an explicit messaging protocol that states the meaning of the message. An explicit message consists of a CID and associated messaging protocol information.

The rules that govern the dynamic establishment of these connections are used as a foundation upon which a predefined set of connections is defined.

4.2 DeviceNet communication model

The abstract object oriented communication model of a DeviceNet node includes the following:

- **Unconnected Message Manager (UCMM):** processes DeviceNet unconnected explicit messages;
- **Identity object:** identifies and provides general information about the device;
- **Connection class:** allocates and manages internal resources associated with both I/O and explicit messaging connections;
- **Connection object:** manages the communication specific aspects associated with a particular application-to-application network relationship;
- **DeviceNet object:** provides the configuration and status of a physical DeviceNet network connection;
- **Message router:** forwards an explicit request messages to the appropriate object;
- **Application objects:** implement the intended purpose of the product.

4.3 DeviceNet and CAN

DeviceNet is based on ISO 11898 and uses the Controller Area Network (CAN) technology.

NOTE See CAN Specification - Version 2.0, Part A : Sept. 1991, Robert Bosch GmbH.

The relationships between DeviceNet, CAN and the OSI reference model (ISO/IEC 7498-1) are shown in Figure 2.

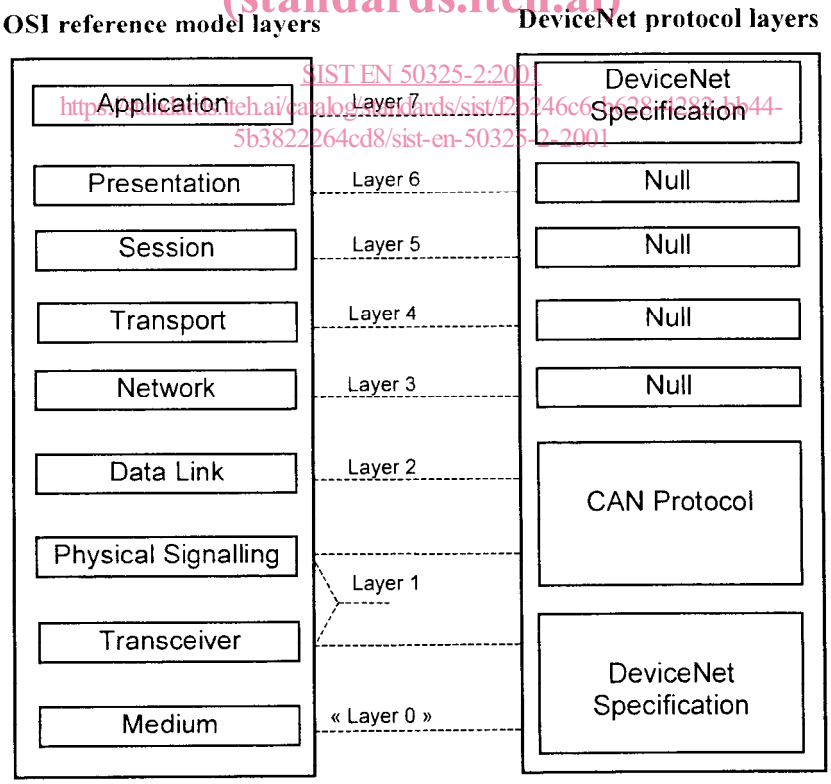

Figure 2 – DeviceNet protocol architecture compared with the OSI reference model