

CiA Draft Standard Proposal 413

CANopen

Device Profile for Truck Gateways

Part 1: General definitions and default communication objects

This is a draft standard proposal and shall not be implemented

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HISTORY

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1 Scope

The CANopen device profile for truck gateways consists of several parts:

Part 1 describes general definitions and default communication objects

Part 2 defines application objects for braking and running gear (according to ISO 11992-2)

Part 3 defines application objects for equipment other than brakes and running gear (according to ISO 11992-3)

Part 4 defines application objects for diagnostics (ISO WD 11992-4)

Part 5 defines application objects for specific superstructure

Part 6 defines application objects for J1939 equipment

Part 7 defines application objects for agriculture and forestry equipment (according to ISO 11783)

Part 8 defines application objects for other equipment

These documents represent the CANopen gateway profile for in-vehicle networks. This set of specifications describes CANopen gateways to CAN-based networks using the SAE J1939-71 application profile, ISO 11992-2, -3, and -4 truck/trailer networks as well as specific in-vehicle networks. All these gateways use communication techniques, which conforms to those described in the CANopen communication profile (CiA Draft Standard DS-301). In addition, programmable gateway devices may use communication techniques, which conform to those described in the framework for programmable CANopen Devices (CiA Draft Standard Proposal DSP-302). These specifications should be consulted in parallel to those device profile specifications.

2 Normative references

- /1/ ISO 11898: 1993, Road vehicles – Interchange of digital information – Controller area network (CAN), November 1993.
- /2/ CiA DS-301 V4.01, CANopen application layer and communication profile, June 2000.
- /3/ CiA DSP-302 V3.0, Framework for programmable CANopen devices, June 2000.
- /4/ ISO 11992: 2001, Road vehicles – Interchange of digital information on electrical connections between towing and towed vehicles – Part 2: Application layer for braking and running gear equipment
- /5/ ISO 11992: 2001, Road vehicles – Interchange of digital information on electrical connections between towing and towed vehicles – Part 3: Application layer for equipment other than braking and running gear
- /6/ ISO 11992 (not published), Road vehicles – Interchange of digital information on electrical connections between towing and towed vehicles – Part 4: Diagnostics
- /7/ ISO 16844: 2000, Road vehicles – Tachograph systems – Part 7: Definitions
- /8/ SAE J1939-71, Surface vehicle recommended practice – Vehicle application layer, October 1998

3 Definitions, acronyms and abbreviations

CAN

Controller Area Network. Data link layer protocol for serial communication as specified in ISO 11898-1 (2001).

COB

Communication Object, which is made of one or more CAN frames. Any information transmitted via CANopen has to be mapped into COBs.

COB-ID

COB-Identifier. Identifies a COB uniquely in a CAN network. The identifier determines the priority of that COB in the data link layer, too.

IVN

In-vehicle network. This network represents the other interface of the gateway device, such as truck resp. Trailer internal network.

RPDO

Receive Process Data Object. Communication object of a device, which contains output data.

SDO

Service Data Object. Peer-to-peer communication with access to the Object Dictionary of a CANopen device.

TPDO

Transmit Process Data Object. Communication object of a device, which contains input data.

4 Operating principle

4.1 Introduction

The purpose of gateways compliant to this specification is to connect CANopen networks to in-vehicle networks of trucks, buses, trailers and other vehicles. In operational mode, the gateway provides by default TPDOs (Transmit Process Data Object) with a similar behavior as ISO 11992 compliant interfaces. In addition, it is possible to read objects via SDO (Service Data Object) communication from another module. The gateway is also able to receive via RPDO (Receive Process Data Object) certain function requests to be passed to the in-vehicle networks.

However, the main purpose of SDO communication is to configure the gateway. The gateway can receive via SDO configuration data, parameters for converting data into meaningful measurements and so on. Gateways compliant with this device profile use pre-defined PDOs. If the default PDOs are not suitable for the gateway application, the system designer can delete these PDOs and create new ones with another PDO transmission and mapping behavior. The gateway may provide optionally Sync Producer/Consumer, Time-Stamp Producer/Consumer and Emergency Producer/Consumer functionality. For new designs, it is highly recommended to support Heartbeat functionality.

5 Error handling

5.1 Principle

Emergency Messages shall be triggered by internal errors in the device and they are assigned to the highest possible priority to ensure that they get access to the bus without latency. By default, the Emergency Messages shall contain the error field with pre-defined error numbers and additional information.

5.2 Error behaviour

If a serious device failure is detected the module shall enter by default autonomously the pre-operational state. If object 1029h is implemented, the device can be configured to enter alternatively the stopped state or remain in the current state in case of a device failure. Device failures shall include the following communication errors:

- Bus-off conditions of the CANopen interface
- Life guarding event with the state 'occurred'
- Heartbeat event with state 'occurred'

Severe device errors also can be caused by device internal failures.

5.3 Additional error code meanings

Devices compliant to these gateway profile specifications may use the following error codes:

Error Code	Meaning
FF01h	Time out of IVN ECU with Source Address (SA) 1
to	to
FFFAh	Time out of IVN ECU with Source Address (SA) 251

6 Predefinitions

6.1 Introduction

The gateway shall support the default PDOs. However, the module can support additional manufacturer-specific PDOs. If a gateway does not support a specific function, the related default PDOs shall remain unused. All TPDOs with transmission type 255 shall be transmitted when entering the NMT Operational state.

6.2 Application object definitions

Application objects are represented as ARRAYS. There may be more than one application object in the Array. The application object's dimension may be defined in other standards and specifications. The dimension is given in brackets for convenience and shall be double-checked with the appropriate documents. If `maximum_value_range` and `minimum_value_range` objects are not implemented the default values shall be applied. The default values may be defined in other standards and specifications. These values are given in brackets for convenience; however, they shall be double-checked with the appropriate documents.

All application objects have the same structure:

Sub-Index	Name	Data Type	Entry Category
0h	Number_of_entries	Unsigned8	Mandatory
1h	<application object 1h>	<depends>	Mandatory
2h	<application object 2h>	<depends>	Optional
to			
n-2h	<application object n-2h>	<depends>	Optional
n-1h	Minimum_value_range	<depends>	Optional
nh	Maximum_value_range	<depends>	Optional

Arrays of Boolean data type are formatted as follows:

Bit_1	Bit_2	to	Bit_n
-------	-------	----	-------

If the associated scaling and offset object (ARRAY) is not or only partly implemented the default values shall be applied. The default values of the `resolution_numerator`, `resolution_denominator`, and `offset` objects may be defined in other standards and specifications. These values are given in brackets for convenience; however, they shall be double-checked with the appropriate documents.

All scaling and offset objects have the same structure:

Sub-Index	Name	Data Type	Entry Category
0h	Number_of_entries	Unsigned8	Mandatory
1h	Resolution_numerator	Signed16	Optional
2h	Resolution_denominator	Signed16	Optional
3h	Offset	Signed16	Optional

6.3 Application object value definitions

The value of an application object is valid if the first byte is in the range of 00h to FAh. A value of FBh to FDh is reserved for future indicator bits. The value of FEh in the first byte indicates that there is no valid data available currently. Additional information about the error may be available by an

Emergency message. The value of FFh in the first byte indicates that there is no valid data available; this is because the system has been powered or has been reset recently.
 For digital information a value of all bits set to TRUE means that this data is not yet available or is not installed. A value of TRUE for Bit 1 and FALSE for Bit 2 indicates an error for measured application objects.

6.4 Pre-defined communication objects

Modules compliant with this device profile shall come with default values for some communication objects (1000h to 1FFFh), which are not specified in all details in /2/.

6.1.1 Object 1000h: Device Type

The object at index 1000h describes the type of device and its functionality. For multiple device modules the Additional Information parameter shall contain FFFFh. In this case, the object 67FFh shall be implemented.

Additional Information				General Information			
Specific Functionality		Gateway Functionality		Device Profile Number			
31	24	23	16	15	8	7	0
MSB				LSB			

General Information

Device Profile Number: 413d

Additional Information

1 = function is implemented
 0 = function is not implemented

Gateway Functionality:

Bit	Function	Reference
0	reserved	-
1	Brake and running gear	ISO 11992-2
2	Non brake and running gear equipment	ISO 11992-3
3	Diagnostic function	ISO 11992-4
4	Superstructure function	CiA DSP-413-5
5	J1939 function	SAE J1939-71
6	Agriculture and forestry function	ISO 11783
7	Other equipment	e.g. CiA DSP-407

Any combination is allowed.

Specific Functionality:

Bit	Function
0	Information from IVN
1	Information to IVN
2	GPS/GSM link
3	Software up-/download via external interface
4 .. 7	reserved

Any combination is allowed

6.1.2 Object 1001h: Error Register

The device-specific bits in the status word are reserved for future use.

6.1.3 Object 1029h: Error Behaviour

This object specifies to which state the gateway device shall be set, when a communication error or an in-vehicle network error is detected.

0 = pre-operational (only if current state is operational)

1 = no state change

2 = stopped

Object Description

INDEX	1029h
Name	error_behavior
Object Code	Array
Data Type	Unsigned8
Category	Optional

Entry Description

Sub-Index	0h
Description	number_of_error_classes
Access	ro
Entry Category	Mandatory
PDO Mapping	No
Value Range	1h to 2h
Default Value	No

Sub-Index	1h
Description	communication_error
Access	rw
Entry Category	Mandatory
PDO Mapping	No
Value Range	0h to 2h
Default Value	0h

Sub-Index	2h
Description	in-vehicle_network_error
Access	rw
Entry Category	Mandatory
PDO Mapping	No
Value Range	0h to 2h
Default Value	0h

6.1.4 Object 67FF: Device Type

This objects shall describe the first virtual device in a multiple device module according to /2/.

6.1.5 PDO default mapping

The following PDO default mappings are compliant to some messages as defined in ISO 11992-3. If the truck gateway device does not support a CANopen application object, a dummy object of the very same length shall substitute it. The PDO implementation depends on the truck gateway functionality.

6.1.5.1 1st RPDO mapping

This RPDO is compliant to GPM 22 (see ISO 11992-3). The default transmission type shall be 255. The default values of the mapped objects are described in the Default State objects. *Note:* After power-on and application reset these default values are valid.

Index	Sub-Index	Comment	Default Value
1600h	0h	number of mapped objects	10
	1h	ODD active	6106 01 01h
	2h		6106 02 01h
	3h	Anti theft device	6107 01 01h
	4h		6107 02 01h
	5h	Dummy objects	0001 00 01h
	6h		0001 00 01h
	7h		0001 00 01h
	8h		0001 00 01h
	9h	Dummy object	0005 00 08h
	Ah	Rear obstacle distance	6100 01 08h
	Bh	Thermal body temperature	6102 01 08h
	Ch	Body fluid level	6167 01 10h
	Dh	Body pressure	6169 01 08h
	Eh	Dummy object	0005 00 08h

6.1.5.2 2nd RPDO mapping

This RPDO is compliant to GPM 23 (see ISO 11992-3). The default transmission type shall be 255. The default values of the mapped objects are described in the Default State objects. *Note:* After power-on and application reset these default values are valid.

Index	Sub-Index	Comment	Default Value
1601h	0h	number of mapped objects	5
	1h	Requested engine speed	614A 01 10h
	2h	Requested engine speed upper limit	6140 01 10h
	3h	Requested engine speed lower limit	6142 01 10h
	4h	Requested engine torque limit	6144 01 08h
	5h	Requested vehicle speed limit	6146 01 08h

6.1.5.3 3rd RPDO mapping

This RPDO is compliant to GPM 24 (see ISO 11992-3). The default transmission type shall be 255. The default values of the mapped objects are described in the Default State objects. *Note:* After power-on and application reset these default values are valid.

Index	Sub-Index	Comment	Default Value
1602h	0h	number of mapped objects	23
	1h	Requested percent clutch slip	613B 01 08h
	2h	Starter lockout switch	613D 01 01h
	3h		613D 02 01h
	4h	Engine starter switch	613E 01 01h
	5h		613E 02 01h
	6h	Engine stop switch	613F 01 01h
	7h		613F 02 01h
	8h	Dummy objects	0001 00 01h
	9h		0001 00 01h
	Ah	Refuse packer step switch	6148 01 01h
	Bh		6148 02 01h
	Ch	Operating panel active	6149 01 01h
	Dh		6149 02 01h
	Eh	Dummy objects	0001 00 01h
	Fh		0001 00 01h
	10h	First clutch dependent PTO switch	6136 01 01h
	11h		6136 02 01h
	12h	Second clutch dependent PTO switch	6137 01 01h
	13h		6137 02 01h
	14h	Clutch independent PTO switch	6138 01 01h
	15h		6138 02 01h
	16h	First engine mounted PTO switch	6139 01 01h
	17h		6139 02 01h
	18h	Second engine mounted PTO switch	613A 01 01h
	19h		613A 02 01h

6.1.5.4 1st TPDO mapping

This TPDO is compliant to GPM 12 message (see ISO 11992-3). The default transmission type shall be 255. The PDO shall be transmitted when the GPM 12 message has been received successfully the very first time after power-on or reset or whenever one of the mapped application objects is changing. The event-timer and the inhibit-timer shall be set by default to 0.

Index	Sub-Index	Comment	Default Value
1A00h	0h	number of mapped objects	3
	1h	Engine speed upper limit	611F 01 10h
	2h	Engine speed lower limit	6121 01 10h
	3h	Maximum vehicle speed limit	611D 01 08h
	4h	Dummy object	0016 00 18h

6.1.5.5 2nd TPDO mapping

This TPDO is compliant to GPM 13 message (see ISO 11992-3). The PDO shall be transmitted when the GPM 13 message has been received successfully the very first time after power-on or reset or whenever one of the mapped application objects is changing. The event-timer and the inhibit-timer shall be set by default to 0.

Index	Sub-Index	Comment	Default Value
1A01h	0h	number of mapped objects	No
	1h	Engine torque mode	6135 01 01h
	2h		6135 02 01h
	3h		6135 03 01h
	4h		6135 04 01h
	5h	Engine control allowed	610F 01 01h
	6h		610F 02 01h
	7h	Engine running	6134 01 01h
	8h		6134 02 01h
	9h	Driver's demand engine percent torque	6115 01 08h
	Ah	Actual engine percent torque	6117 01 08h
	Bh	Engine speed	6113 01 10h
	Ch	Percent load at current speed	611B 01 08h
	Dh	Vehicle speed	6111 01 10h

6.1.5.6 3rd TPDO mapping

This TPDO is compliant to GPM 14 message (see ISO 11992-3). The PDO shall be transmitted when the GPM 14 message has been received successfully the very first time after power-on or reset or whenever one of the mapped application objects is changing. The event-timer and the inhibit-timer shall be set by default to 0.

Index	Sub-Index	Comment	Default Value
1A02h	0h	number of mapped objects	No
	1h	Percent clutch slip	610A 01 08h
	2h	Current gear	610C 01 08h
	3h	First clutch dependent PTO	612E 01 01h
	4h	feedback	612E 02 01h
	5h	Second clutch dependent PTO	612F 01 01h
	6h	feedback	612F 02 01h
	7h	Clutch independent PTO	6130 01 01h
	8h	feedback	6130 02 01h
	9h	First engine mounted PTO	6131 01 01h
	Ah	feedback	6131 02 01h
	Bh	Second engine mounted PTO	6132 01 01h
	Ch	feedback	6132 02 01h
	Dh	PTO control allowed	6110 01 01h
	Eh		6110 02 01h
	Fh	Torque converter oil temperature	612B 01 01h
	10h	warning	612B 02 01h
	11h		612B 03 01h
	12h	Dummy object	0001 00 01h
	13h	Torque converter oil temperature	612C 01 10h
	14h	Starter active	6133 01 01h
	15h		6133 02 01h
	16h	Accelerator pedal low idle switch	610E 01 01h
	17h		610E 02 01h
	18h	Dummy object	0001 00 01h
	19h		0001 00 01h
	1Ah		0001 00 01h
	1Bh		0001 00 01h
	1Ch	Accelerator pedal position	614C 01 08h

6.1.5.7 4th TPDO mapping

This TPDO is compliant to GPM 15 message (see ISO 11992-3). The PDO shall be transmitted when the GPM 15 message has been received successfully the very first time after power-on or reset or whenever one of the mapped application objects is changing. The event-timer and the inhibit-timer shall be set by default to 0.

Index	Sub-Index	Comment	Default Value
1A03h	0h	number of mapped objects	No
	1h	Engine oil temperature	6125 01 10h
	2h	Engine coolant temperature	6127 01 08h
	3h	Engine oil pressure	6129 01 08h
	4h	Engine coolant temperature	6123 01 01h
	5h	warning	6123 02 01h
	6h		6123 03 01h
	7h	Engine oil pressure warning	6124 01 01h
	8h		6124 02 01h
	9h	Fuel level warning	6150 01 01h
	Ah		6150 02 01h
	Bh	Dummy object	0001 00 01h
	Ch	Reference engine torque	6119 01 10h
	Dh	Dummy object	0005 00 08h

7 Object dictionary

Each gateway compliant with this device profile shall share the CANopen Object Dictionary entries from 6000h to 67FFh. These entries are common to all gateways. However, each module only implements those objects relevant to its functions. Object Description and Entry Description are specified in /2/.

7.2 Gateway function principles

The gateway device provides automatically time synchronous transmission inside of the in-vehicle network, even when CANopen RPDO timing differs.

7.3 Overview on object dictionary entries

Each physical device compliant with this application profile specification shall share the Object Dictionary entries from 6000h to 67FFh. These entries are common to all modules and each module only implements those objects relevant to its functions.

The application objects are grouped so that index ranges are belonging to function groups. Not all objects have to be implemented in any device to be compliant with this specification.

Index range	Function group
6000h to 60FFh	Brake and running gear equipment
6100h to 61FFh	Other than brake and running gear equipment
To be defined	Diagnostics
To be defined	Superstructure
To be defined	J1939 equipment
To be defined	Agriculture and forestry
To be defined	Other equipment
To be defined	General device profile objects