CiA® 852

Recommended practice

for CiA® 401-based operator environment sub-systems

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HISTORY

Date	Changes
2012-06-21	*Publication of Version 1.0* as recommended practice NOTE: This document has been converted into “docx format”. The conversion caused minor layout differences to the predecessor document in “doc format”. The technical content word-by-word is the very same.

General information on licensing and patents

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CONTENTS

1 Scope

This document specifies the CANopen interface for operator environments with human-machine interface functionality. It is based on the CiA 401 CANopen profile for generic I/O modules. Operator environments are for example simple remote control units, operator seats with integrated joysticks, foot pedals, pushbuttons, indicators, etc., and complete operator cabins. They are dedicated but not limited for construction, mining, agriculture and forestry machines, for harbor cranes, for boats and vessels, for wheelchairs and any other kind of machines on wheels.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

/CiA301/ CiA 301, CANopen application layer and communication profile

/CiA302-2/ CiA 302-2, CANopen additional application layer functions – Part 2: Network management

/CiA302-3/ CiA 302-3, CANopen additional application layer functions – Part 4: Configuration and program download

/CiA302-7/ CiA 302-7, CANopen additional application layer functions – Part 7: Multi-level networking

/CiA305/ CiA 305, CANopen layer setting services (LSS) and protocols

/CiA401-1/ CiA 401-1, CANopen device profile for generic I/O modules

/CiA406/ CiA 406, CANopen device profile for encoder

/CiA801/ CiA 801, CANopen automatic bit-rate detection – Recommended practice and application hints

3 Terms and definitions

For the purpose of this document, the following terms and definitions and those given in /CiA301/, /CiA302-2/, /CiA302-3/, /CiA302-7/, /CiA305/, /CiA401-1/, /CiA406/ and /CiA801/ apply.

4 Symbols and abbreviated terms

For the purpose of this document, the following symbols and abbreviated terms and those given in /CiA301/, /CiA302-2/, /CiA302-3/, /CiA302-7/, /CiA305/, /CiA401-1/, /CiA406/ and /CiA801/ apply.

C conditional
FE functional element
HMI human machine interface
M mandatory
O optional
OE operator environment

5 Operating principles

5.1 General

This clause describes the operating principles of the operator environment sub-system with a CANopen interface compliant to this recommended practice. The OE interface module is based on the CANopen application layer as defined in /CiA301/ and the CANopen device profile for modular I/O devices. The CANopen interface hides the OE-internal networking,

which could be based on CANopen or any other network technology. Figure 1 shows a typical network architecture.

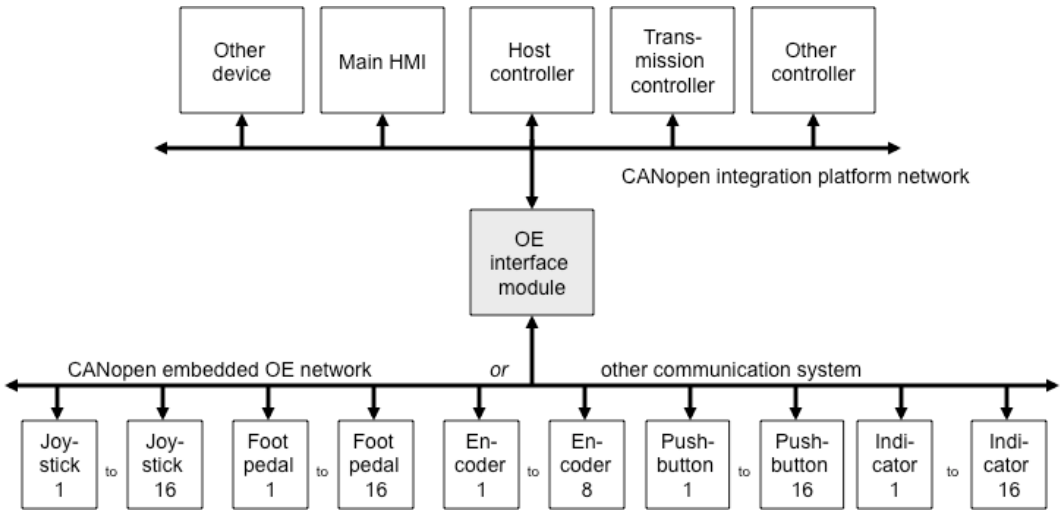

Figure 1 – Typical network architecture for mobile machinery comprising the CANopen integration platform network with the CANopen OE interface module

The main HMI device is normally not part of the operator environment. It is a separate device connected to the CANopen integration platform network or it is part of the CANopen host controller.

NOTE When several operator seats are sharing the same CANopen interface, each set could be implemented as a single logical device as defined in /CiA301/.

The movements of the operator seat or stand or the entire cabin is not controlled via the CANopen OE interface module. This is normally done locally in the sub-layered embedded OE network. In case of moveable cabins, the control of movements performed by a separate controller (often connected to the CANopen integration platform network).

5.2 Configuration of the sub-layered operator devices

The sub-layered operator devices connected via the CANopen OE interface module to the CANopen integration platform network include joysticks, foot-pedals, encoders, handle-twist or thumbwheels, pushbuttons, and indicators. Each kind of device may have several instances. In case of a sub-layered CANopen embedded OE network, the configuration and diagnostic may be performed by means of Remote SDO services and Remote EMCY services from the CANopen host controller as specified in /CiA302-7/.

5.3 Numbering of the OE sub-device/component instances

The numbering of OE sub-devices is shown in Figure 2. The odd numbers are used for OE sub-devices, which the operator handles with the right hand or the right foot; the even numbers are used OE sub-devices handled with the left hand or the left foot. OE indicator devices are numbered in the same way. The numbering starts from the centre line to the left respectively to the right and from the bottom to the sealing.

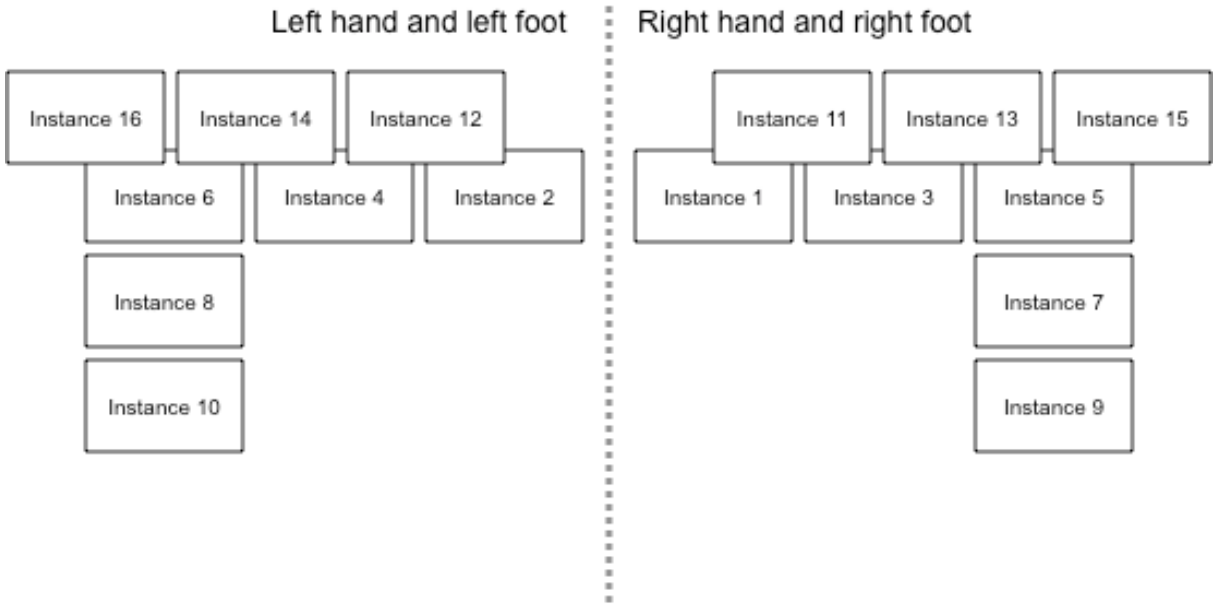

Figure 2: Numbering of OE sub-devices

The numbering of OE sub-device components for example push-button or indicator clusters is shown in Figure 3. The numbering starts from left to right and from the body as shown, and is also used for additional buttons for joysticks. It does not matter, if the device is intended to be used by the right or the lift hand (foot).

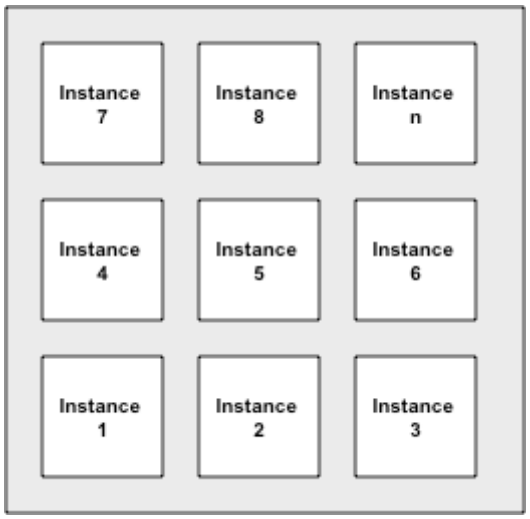

Figure 3: Numbering of sub-device components

The numbering of OE sub-devices and components should be used for all kind of operator environments: simple remote control boards as well as operator seats with integrated joysticks and other units.

6 Physical layer

6.1 General

The general physical layer specification given in /CiA301/ applies to devices compliant to this recommended practice, too.

6.2 Transmission rates

The device compliant to this recommended practice shall support the bit-rates 125 kbit/s, 250 kbit/s, 500 kbit/s and 1000 kbit/s and may support the other bit-rates specified in /CiA301/.

The bit timing as defined in /CiA301/ shall be used. The bit-rates assignment shall be performed by means of LSS (see /CiA305/). Additional bit-rate assignment methods are manufacturer-specific. If several bit-rates are supported, it is recommended to implement automatic bit-rate detection as described in the application note /CiA801/. The bit-rate setting by means of SDO services is not recommended.

NOTE Configuring the bit-rate by means of SDO can lead to serious problems, when using the store and restore functions as defined in /CiA301/.

6.3 Connectors

It is recommended that the pin-assignment of the used connector complies with the recommendations given in /CiA303-1/.

7 Data link layer

The data link layer shall comply with the definitions given in /CiA301/.

8 Application layer

8.1 General

This clause provides an overview on the application layer functionality and specifies generally the communication behavior. All implemented application functions shall comply with /CiA 301/ and /CiA302-2/.

8.2 Node-ID assignment

The node-ID assignment shall be performed by means of LSS (see /CiA305/). Additional node-ID assignment methods are manufacturer-specific. The node-ID assignment via the CANopen object dictionary is not recommended.

NOTE Configuring the node-ID by means of SDO can lead to serious problems, when using the store and restore functions as defined in /CiA301/.

8.3 Network management and Heartbeat functionality

Devices compliant with this recommended practice shall support NMT slave functionality as defined in /CiA301/. Heartbeat producer functionality shall be used, optionally also the Node/Life guarding may be supported, but it is not recommended to use it. Heartbeat consumer functionality shall be supported, if the device provides indicators or other output functions.

8.4 SDO functionality

The OE interface module shall provide the Default-SDO server and may implement additional SDO servers and SDO clients. It is recommended to implement the SDO remote functionality as defined in /CiA302-7/, if the sub-layered embedded OE network is based on CANopen. It is also recommended to support the Normal SDO services, in order to download software updates.

8.5 PDO functionality

The OE interface module shall support the pre-defined PDOs dependent on its provided functionality. It is also recommended to support all PDO transmission types; this includes the reception of the SYNC message. Variable PDO mapping is mandatory.

8.6 EMCY functionality

The OE interface module shall support the production and the reception of EMCY messages. It is recommended to support all Emergency Error Codes defined in /CiA301/ and /CiA401/, if appropriate. For details see clause 14. If the OE interface module transits to NMT operational state and the *analog input global interrupt* object (6423_h) is set to FALSE, it shall transmit an Emergency message with the error code 0080_h. This Emergency message shall not cause a local transition into *NMT pre-operational* or *NMT stopped* state.

8.7 Other CANopen application layer functions

The OE interface module may support optionally other CANopen application layer functions. It is recommended to support Remote EMCY services, if the sub-layered embedded OE network is based on CANopen.

9 Device functionality and application parameter overview

9.1 General

This clause describes the OE interface module functionality and provides an overview of the application parameter. The OE interface module does not provide configuration parameters for the sub-layered functional elements (FE). The FEs for example a joystick and a thumbwheel may be combined and connected as one sub-device to the sub-layered embedded OE network.

The following FEs are supported by this document:

- Up to 16 joysticks instances
- Up to 16 foot-pedals
- Up to 8 encoders
- Up to 8 wheels
- Up to 8 push-button clusters
- Up to 8 indicator clusters
- Up to 8 displays (matrix displays, bar graphs, round meters)

9.2 Joystick

A joystick has 1, 2 or 3-axes of movement. The joystick with 3-axes may provide a rotational movement around one axis, additionally, to the movements along each of two axes as for example forward to backward and left to right movements. The joystick integrates optionally up to 8 buttons with simple switch-on and switch-off function. Figure 4 specifies the structure of the additional button parameter. The value of 0_b shall indicate that the button is switched-off; the value of 1_b shall indicate that the button is switched-on.

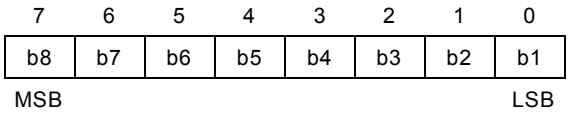

Figure 4 – Value structure for the additional button parameter

Each joystick provides optionally capability for holding current movement direction and keep current movement position. Therefore, a memory function is integrated optionally to provide storing of the current position in the corresponding direction. Figure 5 shows the structure of the memory function parameter as specified in /CiA401/. The value of 0_b shall indicate that the memory function is off; the value of 1_b shall indicate that the memory function is on. In case of 2-axes joystick, the bit 2 is not used and has a value of 0_b.

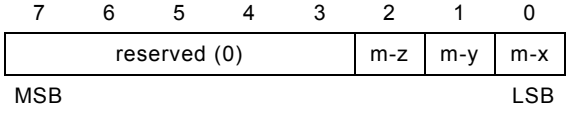

Figure 5 – Value structure for the memory function parameter

NOTE It is also possible that a joystick unit implements two independent joystick functions: A base joystick operated by the hand and a second one on top of the other operated by the thumb. In this case, two joystick instances need to be implemented.

Table 1 specifies the joystick process data mapping to the parameters specified in /CiA401/.

Table 1 — Joystick process data mapping

Index	Sub-index	Default value	Description
6000_h	01_h	No	Joystick 1: Memory function as defined in /CiA401/
	02_h	No	Joystick 1: Up to 8 additional buttons
	to		
	$1F_h$	No	Joystick 16: Memory function as defined in /CiA401/
	20_h	No	Joystick 16: Up to 8 additional buttons
6401_h	01_h *to* 03_h	No	Joystick 1: x- (01_h), y- (02_h), and z-dimension (03_h)
	to		
	$2E_h$ *to* 30_h	No	Joystick 16: x- ($2E_h$), y- ($2F_h$), and z-dimension (30_h)
6423_h	00_h	FALSE	Analogue input global interrupt enable

9.3 Foot pedal

Foot pedals are interpreted as a joystick with 1-axis of movement, which provides button functionality as well as position values for movements along one axis. Figure 6 specifies the structure of the memory function parameter. The value of 0_b shall indicate that the memory function is off; the value of 1_b shall indicate that the memory function is on. Table 2 specifies the foot pedal process data mapping to the parameters specified in /CiA401/.

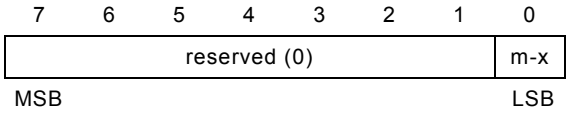

Figure 6 – Value structure for the memory function parameter

Table 2 — Foot pedal process data mapping

Index	Sub-index	Default value	Description
6000_h	21_h	No	Foot pedal 1: Memory function
	to		
	30_h	No	Foot pedal 16: Memory function
6401_h	31_h	0	Foot pedal 1: Position
	to		
	40_h	No	Foot pedal 16: Position
6423_h	00_h	FALSE	Analogue input global interrupt enable

9.4 Encoder

An encoder provides the position as an unsigned 32-bit value. The encoder unit provides a single-turn or a multiple-turn function. Table 3 specifies the encoder process data mapping to the parameters specified in /CiA401/.

Table 3 — Encoder process data mapping

Index	Sub-index	Default value	Description
6120_h	81_h	No	Encoder 1: Position
	to		
	88_h	No	Encoder 8: Position

9.5 Wheel

A wheel unit (handle-twist or thumbwheel) is interpreted as a joystick with 1-axis of movement. Table 4 specifies the wheel process data mapping to the parameters specified in /CiA401/.

Table 4 — Wheel process data mapping

Index	Sub-index	Default value	Description
6401_h	41_h	No	Wheel 1: Position
	to		
	48_h	No	Wheel 8: Position
6423_h	00_h	FALSE	Analogue input global interrupt enable

9.6 Push-button clusters

Each push-button is represented as a single digital value mapped to an 8-bit parameter. Each push-button cluster comprises in maximum 64 push-buttons (switches). The other switch parameters shall be structured in the same way. The value of 0_b shall indicate that the push-button is switched-off; the value of 1_b shall indicate that the push-button is switched-on. Figure 7 specifies the structure of the switch 1-to-8 parameter. Table 5 specifies the push-button cluster process data mapping to the parameters specified in /CiA401/.

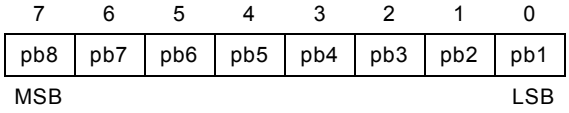

Figure 7 – Value structure for the switch 1-to-8 parameter

Table 5 — Push-button cluster process data mapping

Index	Sub-index	Default value	Description
6000_h	31_h *to* 38_h	No	Push-button cluster 1: Switch 1-to-8 *to* Switch 57-to-64
	to		
	61_h *to* 70_h	No	Push-button cluster 8: Switch 1-to-8 *to* Switch 57-to-64

9.7 Indicator clusters

Each indicator is represented as a single digital value mapped to an 16-bit parameter. Each indicator cluster comprises in maximum 64 digital indicators. Figure 8 specifies the structure of the indicator 1-to-8 parameter. The other indicator parameters shall be structured in the same way. The value of 0_b shall indicate that the indicator shall be switched-off; the value of 1_b shall indicate that the indicator shall be switched-on. Table 6 specifies the indicator cluster process data mapping to the parameters specified in /CiA401/.

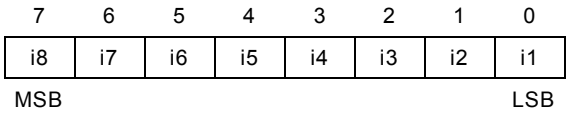

Figure 8 – Value structure for the indicator 1-to-8 parameter

Table 6 — Indicator cluster process data mapping

Index	Sub-index	Default value	Description
6200_h	01_h *to* 08_h	No	Indicator cluster 1: Switch 1-to-8 *to* Switch 57-to-64
	to		
	31_h *to* 40_h	No	Indicator cluster 8: Switch 1-to-8 *to* Switch 57-to-64
6206_h	01_h *to* 08_h	01_h	Indicator cluster 1: Error mode 1-to-8 *to* Error mode 57-to-64
	to		
	31_h *to* 40_h	01_h	Indicator cluster 8: Error mode 1-to-8 *to* Error mode 57-to-64
6207_h	01_h *to* 08_h	0	Indicator cluster 1: Error value 1-to-8 *to* Error value 57-to-64
	to		
	31_h *to* 40_h	0	Indicator cluster 8: Error value 1-to-8 *to* Error value 57-to-64

9.8 Displays

Each matrix display, bar graph or round meter parameter is represented as a single analogue value mapped to a 16-bit parameter. Table 7 specifies the process data (integer values) for display mapping to the parameters specified in /CiA401/.

Table 7 — Display process data (integer values) mapping

Index	Sub-index	Default value	Description
6411_h	01_h	0	Display 1: parameter 1
	to		
	$0C_h$	0	Display 1: parameter 12
	to		
	AB_h	0	Display 8: parameter 1
	to		
	$C0_h$	0	Display 8: parameter 12
6443_h	01_h	01_h	Error mode display 1: parameter 1
	to		
	18_h	01_h	Error mode display 1: parameter 12
	to		
	AB_h	01_h	Error mode display 8: parameter 1
	to		
	$C0_h$	01_h	Error mode display 8: parameter 12
6444_h	01_h	0	Error value display 1: parameter 1
	to		
	18_h	0	Error value display 1: parameter 12
	to		
	AB_h	0	Error value display 8: parameter 1
	to		
	$C0_h$	0	Error value display 8: parameter 12

10 Device classes

There are no device classes specified.

11 General communication parameter

11.1 General

The general communication parameter are specified in /CiA301/. This clause provides additional value specifications or specifies some optional parameters as mandatory.

11.2 Object 1000_h: Device type

This object indicates the type and functionality of the device. The structure as well as the object and entry descriptions are defined in /CiA301/; the *device profile number* field as well as the *I/O functionality* and *M* field are specified in /CiA401/. Table 8 specifies the values to be used for OE interface modules.

Table 8 — Value definitions

Additional information			Device profile number	Description
Specific functionality	M	I/O functionality		
1XXX XXX1$_b$	1$_b$	X1X0$_b$	0191$_h$	Joystick
1XXX XXX1$_b$	1$_b$	X1X1$_b$	0191$_h$	Joystick with buttons
1XXX XX1X$_b$	1$_b$	X1XX$_b$	0191$_h$	Foot-pedal
1XXX X1XX$_b$	1$_b$	X1XX$_b$	0191$_h$	Encoder
1XXX 1XXX$_b$	1$_b$	X1XX$_b$	0191$_h$	Wheel
1XX1 XXXX$_b$	1$_b$	XXX1$_b$	0191$_h$	Push-button cluster
1X1X XXXX$_b$	1$_b$	XX1X$_b$	0191$_h$	Indicator cluster
11XX XXXX$_b$	1$_b$	1X1X$_b$	0191$_h$	Display
X = don't care				

The OE interface module may implement different functions in any combination. The device type parameter shall provide information of the entire implemented functions.

EXAMPLE When the OE interface module provides joystick with additional buttons as well as memory capability, wheel, and push-button functions, the *specific functionality* field value is 1001 1001$_b$, and the *I/O functionality* field value is 0101$_h$.

11.3 Object 1001_h: Error register

It is recommended to support not just the generic error bit, but also the other bits. The profile-specific error bit is reserved and shall not be used.

11.4 Object 1018_h: Identity

All four sub-indexes of this parameter shall be implemented. The device manufacturer shall assign uniquely the product code, the revision number, and serial number.

NOTE The vendor-ID is assigned by CAN in Automation.

11.5 Object 1029_h: Error behavior

If this object is not implemented, the OE interface module shall behave as defined by the default values specified in /CiA301/.

11.6 Other general communication parameters

In addition to the mandatory general communication parameters (1000_h, 1001_h, and 1018_h) as specified by /CiA301/, it is recommended to implement the communication parameters listed in Table A 1 (See Annex A). Some are specified as mandatory to be compliant with this recommended practice.

11.7 Additional communication parameters

For more sophisticated OE interface modules it is recommended to support some of the additional communication parameters as specified in /CiA302-3/, in particular, the program download data ($1F50_h$).

12 PDO parameter sets

12.1 General

All TPDOs and RPDOs are disabled by default. All TPDOs and RPDOs use by default the transmission type 0xFF. This means all TPDOs shall be transmitted after the device transits into NMT Operational state, and when one of the mapped parameters changes. The RPDO shall be processed immediately after reception.

12.2 TPDO specification

12.2.1 TPDO 1 parameter sets

The TPDO 1 transmits process data from joystick 1. Table 9 specifies the object description and Table 10 specifies the entry description of the TPDO 1 communication parameter.

Table 9 – Object description

Attribute	Value
Index	1800_h
Name	TPDO 1 communication parameter
Object code	RECORD
Data type	PDO communication parameter record
Category	Conditional: Mandatory, if joystick supported (see values for OE interface modules in object 1000_h)

Table 10 – Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	const
PDO mapping	No
Value range	02_h *to* 06_h
Default value	Manufacturer-specific
Sub-index	01_h
Description	COB-ID
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	(8000 0180_h or C000 0180_h) + node-ID

Attribute	Value
Sub-index	02_h
Description	Transmission type
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	FF_h
Sub-index	03_h
Description	Inhibit time
Entry category	Optional
Access	rw
PDO mapping	No
Value range	See /CiA301/
Default value	0000_h
Sub-index	05_h
Description	Event-timer
Entry category	Optional
Access	rw
PDO mapping	No
Value range	See /CiA301/
Default value	0000_h
Sub-index	06_h
Description	SYNC start value
Entry category	Optional
Access	rw *or* const
PDO mapping	No
Value range	See /CiA301/
Default value	00_h

Table 11 specifies the object description and Table 12 specifies the entry description of the TPDO 1 mapping parameter.

Table 11 – Object description

Attribute	Value
Index	$1A00_h$
Name	TPDO 1 mapping parameter
Object code	RECORD
Data type	PDO mapping parameter record
Category	Conditional: Mandatory, if 1800_h is implemented

Table 12 – Entry description

Attribute	Value
Sub-index	00_h
Description	Number of mapped application objects in PDO
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	Manufacturer-specific
Sub-index	01_h
Description	1st application parameter
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6401 01 10_h
Sub-index	02_h
Description	2nd application parameter
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6401 02 10_h
Sub-index	03_h
Description	3rd application parameter
Entry category	Conditional: Mandatory, if 3-axis joystick supported
Access	rw or const
PDO mapping	No
Value range	See /CiA301/, if 3-axis joystick not supported, then the value shall be $FFFF_h$
Default value	6401 03 10_h
Sub-index	04_h
Description	4th application parameter
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6000 01 08_h

Attribute	Value
Sub-index	05_h
Description	5th application parameter
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6000 02 08_h

12.2.2 TPDO 5 to 19 parameter sets

The TPDO 5 to 19 transmit process data from joysticks 2 to 16 respectively. The communication parameter of the TPDO 5 to 19 are the same as used for TPDO 1, except the attribute "default value" of sub-index 01_h of TPDO 5 to 19 communication parameters, which may have the value 8000 0000_h or C000 0000_h (see /CiA301/). The corresponding mapping entries for TPDO 5 to 19 are provided in the Table 1.

12.2.3 TPDO 20 parameter sets

The TPDO 20 transmits process data from foot pedal 1. Table 13 specifies the object description and Table 14 specifies the entry description of the TPDO 20 communication parameter.

Table 13 – Object description

Attribute	Value
Index	1814_h
Name	TPDO 20 communication parameter
Object code	RECORD
Data type	PDO communication parameter record
Category	Conditional: Mandatory, if foot pedal supported (see values for OE interface modules in object 1000_h)

Table 14 – Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	const
PDO mapping	No
Value range	02_h *to* 06_h
Default value	Manufacturer-specific
Sub-index	01_h
Description	COB-ID
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	8000 0000_h or C000 0000_h

Attribute	Value
Sub-index	02_h
Description	Transmission type
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	FF_h
Sub-index	03_h
Description	Inhibit time
Entry category	Optional
Access	rw
PDO mapping	No
Value range	See /CiA301/
Default value	0000_h
Sub-index	05_h
Description	Event-timer
Entry category	Optional
Access	rw
PDO mapping	No
Value range	See /CiA301/
Default value	0000_h
Sub-index	06_h
Description	SYNC start value
Entry category	Optional
Access	rw *or* const
PDO mapping	No
Value range	See /CiA301/
Default value	00_h

Table 15 specifies the object description and Table 16 specifies the entry description of the TPDO 20 mapping parameter.

Table 15 – Object description

Attribute	Value
Index	$1A14_h$
Name	TPDO 20 mapping parameter
Object code	RECORD
Data type	PDO mapping parameter record
Category	Conditional: Mandatory, if 1814_h is implemented

Table 16 – Entry description

Attribute	Value
Sub-index	00_h
Description	Number of mapped application objects in PDO
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	Manufacturer-specific
Sub-index	01_h
Description	1st application parameter
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6000 21 08_h
Sub-index	02_h
Description	2nd application parameter
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6401 31 10_h
Sub-index	03_h
Description	3rd application parameter
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6000 22 08_h
Sub-index	04_h
Description	4th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6401 32 10_h

12.2.4 TPDO 21 to 27 parameter sets

The TPDO 21 to 27 transmit process data from foot pedals 3 to 16. The communication parameters of the TPDO 21 to 27 are the same as used for TPDO 20. The corresponding mapping entries for the TPDO 21 to 27 are provided in the Table 2.

12.2.5 TPDO 28 parameter sets

The TPDO 28 transmits process data from encoder 1 to 2. Table 17 specifies the object description and Table 18 specifies the entry description of the TPDO 28 communication parameter.

Table 17 – Object description

Attribute	Value
Index	$181C_h$
Name	TPDO 28 communication parameter
Object code	RECORD
Data type	PDO communication parameter record
Category	Conditional: Mandatory, if encoder supported (see values for OE interface modules in object 1000_h)

Table 18 – Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	const
PDO mapping	No
Value range	02_h *to* 06_h
Default value	Manufacturer-specific
Sub-index	01_h
Description	COB-ID
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	8000 0000_h or C000 0000_h
Sub-index	02_h
Description	Transmission type
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	FF_h

Attribute	Value
Sub-index	03_h
Description	Inhibit time
Entry category	Optional
Access	rw
PDO mapping	No
Value range	See /CiA301/
Default value	0000_h
Sub-index	05_h
Description	Event-timer
Entry category	Optional
Access	rw
PDO mapping	No
Value range	See /CiA301/
Default value	0000_h
Sub-index	06_h
Description	SYNC start value
Entry category	Optional
Access	rw *or* const
PDO mapping	No
Value range	See /CiA301/
Default value	00_h

Table 19 specifies the object description and Table 20 specifies the entry description of the TPDO 28 mapping parameter.

Table 19 – Object description

Attribute	Value
Index	$1A1C_h$
Name	TPDO 28 mapping parameter
Object code	RECORD
Data type	PDO mapping parameter record
Category	Conditional: Mandatory, if $181C_h$ is implemented

Table 20 – Entry description

Attribute	Value
Sub-index	00_h
Description	Number of mapped application objects in PDO
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	Manufacturer-specific

Attribute	Value
Sub-index	01_h
Description	1st application parameter
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6120 81_h
Sub-index	02_h
Description	2nd application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6120 82_h

12.2.6 TPDO 29 to 31 parameter sets

The TPDO 29 to 31 transmit process data from encoders 3 to 8. The communication parameters of the TPDO 29 to 31 are the same as used for TPDO 28. The corresponding mapping entries for the TPDO 29 to 31 are provided in the Table 3.

12.2.7 TPDO 32 parameter sets

The TPDO 32 transmits process data from wheel 1 to 4. Table 17 specifies the object description and Table 18 specifies the entry description of the TPDO 32 communication parameter.

Table 21 – Object description

Attribute	Value
Index	1820_h
Name	TPDO 32 communication parameter
Object code	RECORD
Data type	PDO communication parameter record
Category	Conditional: Mandatory, if wheel supported (see values for OE interface modules in object 1000_h)

Table 22 – Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	const
PDO mapping	No
Value range	02_h *to* 06_h
Default value	Manufacturer-specific

Attribute	Value
Sub-index	01_h
Description	COB-ID
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	8000 0000_h or C000 0000_h
Sub-index	02_h
Description	Transmission type
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	FF_h
Sub-index	03_h
Description	Inhibit time
Entry category	Optional
Access	rw
PDO mapping	No
Value range	See /CiA301/
Default value	0000_h
Sub-index	05_h
Description	Event-timer
Entry category	Optional
Access	rw
PDO mapping	No
Value range	See /CiA301/
Default value	0000_h
Sub-index	06_h
Description	SYNC start value
Entry category	Optional
Access	rw *or* const
PDO mapping	No
Value range	See /CiA301/
Default value	00_h

Table 19 specifies the object description and Table 20 specifies the entry description of the TPDO 32 mapping parameter.

Table 23 – Object description

Attribute	Value
Index	$1A20_h$
Name	TPDO 32 mapping parameter
Object code	RECORD
Data type	PDO mapping parameter record
Category	Conditional: Mandatory, if 1820_h is implemented

Table 24 – Entry description

Attribute	Value
Sub-index	00_h
Description	Number of mapped application objects in PDO
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	Manufacturer-specific
Sub-index	01_h
Description	1st application parameter
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6401 41 10_h
Sub-index	02_h
Description	2nd application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6401 42 10_h
Sub-index	03_h
Description	3rd application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6401 43 10_h

Attribute	Value
Sub-index	04_h
Description	4th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6401 44 10_h

12.2.8 TPDO 33 parameter sets

The TPDO 33 transmit process data from wheels 5 to 8. The communication parameters of the TPDO 33 are the same as used for TPDO 32. The corresponding mapping entries for the TPDO 33 are provided in the Table 4.

12.2.9 TPDO 34 parameter sets

The TPDO 34 transmits process data from push-button cluster 1. Table 25 specifies the object description and Table 26 specifies the entry description of the TPDO 1 communication parameter.

Table 25 – Object description

Attribute	Value
Index	1822_h
Name	TPDO 34 communication parameter
Object code	RECORD
Data type	PDO communication parameter record
Category	Conditional: Mandatory, if push-button cluster supported (see values for OE interface modules in object 1000_h)

Table 26 – Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	const
PDO mapping	No
Value range	02_h *to* 06_h
Default value	Manufacturer-specific
Sub-index	01_h
Description	COB-ID
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	8000 0000_h or C000 0000_h

Attribute	Value
Sub-index	02_h
Description	Transmission type
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	FF_h
Sub-index	03_h
Description	Inhibit time
Entry category	Optional
Access	rw
PDO mapping	No
Value range	See /CiA301/
Default value	0000_h
Sub-index	05_h
Description	Event-timer
Entry category	Optional
Access	rw
PDO mapping	No
Value range	See /CiA301/
Default value	0000_h
Sub-index	06_h
Description	SYNC start value
Entry category	Optional
Access	rw *or* const
PDO mapping	No
Value range	See /CiA301/
Default value	00_h

Table 27 specifies the object description and Table 28 specifies the entry description of the TPDO 34 mapping parameter.

Table 27 – Object description

Attribute	Value
Index	$1A22_h$
Name	TPDO 34 mapping parameter
Object code	RECORD
Data type	PDO mapping parameter record
Category	Conditional: Mandatory, if 1822_h is implemented

Table 28 – Entry description

Attribute	Value
Sub-index	00_h
Description	Number of mapped application objects in PDO
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	Manufacturer-specific
Sub-index	01_h
Description	1st application parameter
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6000 31 08_h
Sub-index	02_h
Description	2nd application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6000 32 08_h
Sub-index	03_h
Description	3rd application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6000 33 08_h
Sub-index	04_h
Description	4th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6000 34 08_h

Attribute	Value
Sub-index	05_h
Description	5th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6000 35 08_h
Sub-index	06_h
Description	6th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6000 36 08_h
Sub-index	07_h
Description	7th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6000 37 08_h
Sub-index	08_h
Description	8th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6000 38 08_h

12.2.10 TPDO 35 to 41 parameter sets

The TPDO 35 to 41 transmit process data from push-button clusters 2 to 8. The communication parameters of the TPDO 35 to 41 communication parameter sets are the same as used for TPDO 34. The corresponding mapping entries for the TPDO 35 to 41 are provided in the Table 5.

12.2.11 RPDO 1 parameter sets

The RPDO 1 receives process data for indicator cluster 1. Table 29 specifies the object description and Table 30 specifies the entry description of the RPDO 1 communication parameter.

Table 29 – Object description

Attribute	Value
Index	1400_h
Name	RPDO 1 communication parameter
Object code	RECORD
Data type	PDO communication parameter record
Category	Conditional: Mandatory, if indicator cluster supported (see values for OE interface modules in object 1000_h)

Table 30 – Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	const
PDO mapping	No
Value range	02_h *to* 06_h
Default value	Manufacturer-specific
Sub-index	01_h
Description	COB-ID
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	8000 0000_h or C000 0000_h
Sub-index	02_h
Description	Transmission type
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	FF_h
Sub-index	05_h
Description	Event-timer
Entry category	Optional
Access	rw
PDO mapping	No
Value range	See /CiA301/
Default value	0000_h

Table 31 specifies the object description and Table 32 specifies the entry description of the RPDO 1 mapping parameter.

Table 31 – Object description

Attribute	Value
Index	1600_h
Name	RPDO 1 mapping parameter
Object code	RECORD
Data type	PDO mapping parameter record
Category	Conditional: Mandatory, if 1400_h is implemented

Table 32 – Entry description

Attribute	Value
Sub-index	00_h
Description	Number of mapped application objects in PDO
Entry category	Mandatory
Access	const
PDO mapping	No
Value range	See /CiA301/
Default value	Manufacturer-specific
Sub-index	01_h
Description	1st application parameter
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6200 01 08_h
Sub-index	02_h
Description	2nd application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6200 02 08_h
Sub-index	03_h
Description	3rd application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6200 03 08_h

Attribute	Value
Sub-index	04_h
Description	4th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6200 04 08_h
Sub-index	05_h
Description	5th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6200 05 08_h
Sub-index	06_h
Description	6th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6200 06 08_h
Sub-index	07_h
Description	7th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6200 07 08_h
Sub-index	08_h
Description	8th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6200 08 08_h

12.2.12 RPDO 5 to 11 parameter sets

The RPDO 5 to 11 receive process data for indicator clusters 2 to 8. The communication parameters of the RPDO 5 to 11 are the same as used for RPDO 1. The corresponding mapping entries for the RPDO 5 to 11 are provided in the Table 6.

12.2.13 RPDO 2 parameter sets

The RPDO 2 receives process data for display 1. Table 33 specifies the object description and Table 34 specifies the entry description of the RPDO 2 communication parameter.

Table 33 – Object description

Attribute	Value
Index	1401_h
Name	RPDO 2 communication parameter
Object code	RECORD
Data type	PDO communication parameter record
Category	Conditional: Mandatory, if display supported (see values for OE interface modules in object 1000_h)

Table 34 – Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	const
PDO mapping	No
Value range	02_h *to* 06_h
Default value	Manufacturer-specific
Sub-index	01_h
Description	COB-ID
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	8000 0000_h or C000 0000_h
Sub-index	02_h
Description	Transmission type
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	FF_h

Attribute	Value
Sub-index	05_h
Description	Event-timer
Entry category	Optional
Access	rw
PDO mapping	No
Value range	See /CiA301/
Default value	0000_h

Table 35 specifies the object description and Table 36 specifies the entry description of the RPDO 1 mapping parameter.

Table 35 – Object description

Attribute	Value
Index	1601_h
Name	RPDO 2 mapping parameter
Object code	RECORD
Data type	PDO mapping parameter record
Category	Conditional: Mandatory, if 1401_h is implemented

Table 36 – Entry description

Attribute	Value
Sub-index	00_h
Description	Number of mapped application objects in PDO
Entry category	Mandatory
Access	const
PDO mapping	No
Value range	See /CiA301/
Default value	Manufacturer-specific
Sub-index	01_h
Description	1st application parameter
Entry category	Mandatory
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6411 01 10_h
Sub-index	02_h
Description	2nd application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6411 02 10_h

Attribute	Value
Sub-index	03_h
Description	3rd application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6411 03 10_h
Sub-index	04_h
Description	4th application parameter
Entry category	Optional
Access	rw or const
PDO mapping	No
Value range	See /CiA301/
Default value	6411 04 10_h

12.2.14 RPDO 4 and RPDO 12 to 34 parameter sets

The RPDO 2, 4 and 12 receive process data for display 1. The RPDO 13 to 34 receive process data for displays 2 to 8.The communication parameters of the RPDO 4 and RPDO 12 to 34 are the same as used for RPDO 2. The corresponding mapping entries for the RPDO 4 and RPDO 12 to 34 are provided in Table 7.

12.2.15 TPDO 42 to 64 parameter sets

The TPDO 42 to 64 are not used.

12.2.16 RPDO 35 to 64 parameter sets

The TPDO 35 to 64 are not used.

13 SDO parameter sets

The SDO parameter set for the Default Server SDO may be implemented. SDO parameter sets for additional Server SDOs or Client SDOs may be implemented. For details see /CiA301/.

14 EMCY error codes

The EECs given in Table 37 shall be supported. Other EECs defined in /CiA301/ or /CiA401/ may be supported, too.

Table 37 – Emergency error codes

EEC	Description	Reference
0000_h	Error reset or no error	/CiA301/
0080_h	Warning: Analog inputs disabled	/CiA401/
2000_h	Generic current error	/CiA301/
3000_h	Generic voltage error	/CiA301/
4000_h	Generic temperature error	/CiA301/
5000_h	Generic CANopen device hardware error	/CiA301/
6000_h	Generic CANopen device software error	/CiA301/
7000_h	Generic additional modules error	/CiA301/
8110_h	CAN overrun (objects lost)	/CiA301/

EEC	Description	Reference
8120_h	CAN in error passive mode	/CiA301/
8140_h	Recovered from bus-off	/CiA301/
8150_h	CAN-ID collision	/CiA301/
8200_h	Generic CANopen protocol error	/CiA301/
8240_h	Unexpected SYNC data length	/CiA301/

15 Application parameter

The OE interface module shall implement all necessary application parameters depending on the provided functionality and number of instances of each FE. The indexes to be assigned shall be used as specified in clause 9. Additional digital and analog I/O process data are reserved for future extension of this recommended practice. Additional digital and analog I/O process data may be used for manufacturer-specific functionality. The device manufacturer may implement configuration parameter as defined in /CiA401/.

Annex A Recommended communication and application parameters

The recommended communication parameters are specified in Table A 1.

Table A 1 – Recommended communication parameters

Index	Object name	Category	Reference
1005_h	COB-ID SYNC	M	/CiA301/
1007_h	Synchronous window length	O	/CiA301/
1010_h	Store parameters	O	/CiA301/
1011_h	Restore default parameters	O	/CiA301/
1014_h	COB-ID EMCY	M	/CiA301/
1015_h	Inhibit time EMCY	M	/CiA301/
1016_h	Consumer heartbeat time	C (NOTE)	/CiA301/
1017_h	Producer heartbeat time	M	/CiA301/
1028_h	Emergency consumer	C (NOTE)	/CiA301/
1029_h	Error behavior	M	/CiA301/, /CiA401/
NOTE Mandatory, when digital or and analog output functions are implemented.			

The recommended application parameters for joysticks are specified in Table A 2.

Table A 2 – Recommended application parameters for joysticks

Index	Object name	Category	Reference
6000_h	Read input 8-bit	O	/CiA401/
6401_h	Read analogue input 16-bit	O	/CiA401/
6423_h	Analogue input global interrupt enable	O	/CiA401/
NOTE For detailed information on sub-indexes of these application objects used in joysticks see Table 1.			

The recommended application parameters for foot pedals are specified in Table A 3.

Table A 3 – Recommended application parameters for foot pedals

Index	Object name	Category	Reference
6000_h	Read input 8-bit	O	/CiA401/
6401_h	Read analogue input 16-bit	O	/CiA401/
6423_h	Analogue input global interrupt enable	O	/CiA401/
NOTE For detailed information on sub-indexes of these application objects used in foot pedals see Table 2.			

The recommended application parameters for encoders are specified in Table A 4.

Table A 4 – Recommended application parameters for encoders

Index	Object name	Category	Reference
6120_h	Read input 32-bit	O	/CiA401/
NOTE For detailed information on sub-indexes of this application object used in encoders see Table 3.			

The recommended application parameters for wheels are specified in Table A 5.

Table A 5 – Recommended application parameters for wheels

Index	Object name	Category	Reference
6401_h	Read analogue input 16-bit	O	/CiA401/
6423_h	Analogue input global interrupt enable	O	/CiA401/
NOTE For detailed information on sub-indexes of these application objects used in wheels see Table 4.			

The recommended application parameters for push-button clusters are specified in Table A 6.

Table A 6 – Recommended application parameters for push-button clusters

Index	Object name	Category	Reference
6000_h	Read input 8-bit	O	/CiA401/
NOTE For detailed information on sub-indexes of this application object used in push-button clusters see Table 5.			

The recommended application parameters for indicator clusters are specified in Table A 7.

Table A 7 – Recommended application parameters for indicator clusters

Index	Object name	Category	Reference
6200_h	Write input 8-bit	O	/CiA401/
6206_h	Error mode output 8-bit	O	/CiA401/
6207_h	Error value output 8-bit	C*	/CiA401/
* If the object 6206_h has the value 1 then object 6207_h shall be implemented (see /CiA401/).			
NOTE For detailed information on sub-indexes of these application objects used in indicator clusters see Table 6.			

The recommended application parameters are specified in Table A 8.

Table A 8 – Recommended application parameters for matrix displays, bar graphs and round meters

Index	Object name	Category	Reference
6411_h	Write analogue output 16-bit	O	/CiA401/
6413_h	Write analogue output float	O	/CiA401/
6443_h	Analogue output error mode	O	/CiA401/
6444_h	Analogue output error value integer	C*	/CiA401/
6445_h	Analogue output error value float	C*	/CiA401/
* The object 6444_h shall be implemented if object 6411_h is supported The same is valid for objects 6445_h and 6413_h.			
NOTE For detailed information on sub-indexes of these application objects used in matrix displays, bar graphs and round meters see Table 7.			

