

CANopen
J7



Manual

1 Scope 1

2 Abbreviations and Terms..... 1

3 Plausibility Test..... 1

4 CAN 2

5 CANopen Features Summary 2

6 Network Management (NMT) 2

7 Baud Rate / Node-ID 2

8 Parameter Settings..... 2

9 Restore Default Parameters (Factory Settings)..... 2

10 CAN Message Bit Order (CANopen Definition)..... 3

11 Heartbeat..... 3

12 Error Handling 3

13 SDO Communication..... 4

14 PDO Communication..... 4

15 Function Description..... 5

16 Annex A: Object Dictionary..... 7

17 Annex B: Joystick Axis Definition 13

1 Scope

This document represents the elobau CANopen definitions for joysticks.

2 Abbreviations and Terms

Abbreviation/ Term	Definition and Meaning
ADC	Analogue Digital Converter
COB	Communication object
COB-ID	COB identifier
EMCY	Emergency Message
LSS	Layer Setting Services and Protocol
LSS-PARA	Storable LSS Parameter
NA	Not available
NMT	Network Management
Node-ID	Node Identifier
PARA	Storable Parameter
PDO	Process Data Object
SDO	Service Data Object
TPDO	Transmit-PDO

Tab. 1: Abbreviations and terms

3 Plausibility Test

3.1 General

Signal (on channel) 2 has the opposite direction of signal (on channel) 1.

Signal 1 + Signal 2 = 5,000 mV +/- « Signal Plausibility Limit »

The plausibility parameter “Signal Plausibility Limit” is defined in the object dictionary 0x2000.5.

3.2 J7 specific

Due to hardware restrictions (non-programmable Hall sensor) it is only possible to have an opposite (crossed) direction of signals.

4 CAN

4.1 Bus Off

If a bus off state occurred, a counter is incremented. After this, the device attempts to go on bus again. If the bus off counter is greater than a given value, the device stops communication, goes off bus and does not attempt to send data again.

The number of bus counts can be altered in the object 0x5001.

4.2 Zero Position after Power On or Bus Off

After power on or bus off, the axis signals must be in zero position, otherwise the zero position is sent permanently on the non-zero position until this axis position reaches the zero position.

This function can be switched on/off in the object 0x2000.1D.

5 CANopen Features Summary

- Implemented CiA DS-301 Application Layer and Communication Profile V4.2.0 and CiA DSP-305 Layer Setting Services and Protocol V1.1.1
- Configurable Baud rate 50...1,000 Kbit/s (default 250 Kbit/s) and Node-ID 1...127 (default 0x11 (17)) via LSS and SDO
- NMT Slave (Minimum Boot Up)
- Heartbeat Producer
- EMCY Producer
- SDO Server
- 1 Transmit PDO
- PDO transmission type: Asynchronous event driven, cyclic (default 100 ms)
- Analogue values scanning and coding cycle fixed to 5 ms
- Parameter configuration and LSS configuration cannot be saved in ROM memory more than 1,000 times due to a finite number of write cycles of the flash memory.

6 Network Management (NMT)

The device supports CANopen network management functionality NMT Slave (Minimum Boot Up).

6.1 NMT Services

6.1.1 Start Remote Node

With this service, the NMT Master sets the state of the selected NMT slaves to OPERATIONAL.

6.1.2 Stop Remote Node

With this service, the NMT Master sets the state of the selected NMT slaves to STOPPED.

6.1.3 Enter Pre-Operational

With this service, the NMT Master sets the state of the selected NMT slaves to PRE-OPERATIONAL.

6.1.4 Reset Node

This service causes a CANopen stack reset with parameter re-initialisation.

6.1.5 Reset Communication

This service causes a CANopen stack reset.

7 Baud Rate / Node-ID

Baud rate (object 0x5999.01) and Node-ID (object 0x5999.02) are configurable via Layer Setting Services and Protocol (LSS) and via SDO communication. To save all parameters including LSS parameters use object 0x5999.03 in a manner like by 0x1010.1.

Attention: Please use this service with care. Make sure before saving Baud rate or Node-ID that only desired parameters are changed. Changing these parameters can disturb the network. Use this service only if one device is connected to the network.

The default Baud rate is 250 kbit/s and the default Node-ID 0x11 (17).

8 Parameter Settings

All object dictionary parameters (objects marked PARA) are configurable via SDO communication.

To save all parameters (objects marked PARA) except LSS parameters, write "save" (0x65766173) into the object 0x1010.1. Restart the joystick after the saving procedure.

Attention: Please use this service with care. Make sure before saving parameters that only desired parameters are changed.

9 Restore Default Parameters (Factory Settings)

To restore all parameters to factory settings, write "load" (0x64616F6C) into the object 0x1011.1. Restart the joystick after the saving procedure.

10 CAN Message Bit Order (CANopen Definition)

Byte	0	1	2	3
U16	Bit 7 ... Bit 0	Bit 15 ... Bit 8		
U32	Bit 7 ... Bit 0	Bit 15 ... Bit 8	Bit 23 ... Bit 16	Bit 31 ... Bit 24

Tab. 2: CAN message Bit order example

11 Heartbeat

The heartbeat mechanism for this device is established through cyclic transmission of the heartbeat message by the heartbeat producer. One or more devices in the network are aware of this heartbeat message. If the heartbeat cycle fails from the heartbeat producer, the local application on the heartbeat consumer is informed of this event. The implementation of either guarding or heartbeat is mandatory.

The device shall support **Heartbeat Producer** functionality. The producer heartbeat time is defined in object 0x1017.

11.1 Heartbeat Message

COB-ID	Byte	0
0x700 + Node-ID	Content	NMT state

Tab. 3: Heartbeat message

12 Error Handling

12.1 Principle

Emergency messages (EMCY) shall be triggered by internal errors on the device and they are assigned the highest possible priority to ensure that they obtain access to the bus without delay (**EMCY Producer**). By default, the EMCY shall contain the error field with pre-defined error numbers and additional information. Emergency messages (EMCY) are not sent in network management (NMT) state STOPPED.

12.2 Error Behaviour (object 0x4000)

If a serious device failure is detected, the object 0x4000 specifies to which state the module shall be set:

0: pre-operational

1: no state change (default)*

2: stopped

* In this case, the corresponding error value will be sent:
Axis: Object 0x2000.1B

12.3 EMCY Message

The EMCY COB-ID is defined in object 0x1014. The EMCY message consists of 8 bytes. It contains an emergency error code, the contents of object 0x1001 and 5 bytes of manufacturer specific error code. This device uses only the 1st byte as manufacturer specific error code.

Byte	0	1	2	3	4
Content	Emergency Error Code	Error Register (object 0x1001*)	Manufacturer specific error code (object 0x4001)		
5	6	7			
Manufacturer specific error code - Not used (default value 0xFF)!	Manufacturer specific error code - Not used (default value 0xFF)!	Manufacturer specific error code - Not used (default value 0xFF)!			

Tab. 4: EMCY message

* Always 0

12.4 Emergency Error Code

0x0000: Error Reset or No Error

0x1000: Generic Error = Manufacturer Specific Error

0x81xx: Communication

0x8110: CAN Overrun (object lost) - not supported

0x8120: CAN in Error Passive Mode

0x8140: Recovered from Bus Off (in this case the Manufacturer Specific Error Code contains the amount of Bus Offs)

12.5 Supported Manufacturer Specific Error Codes (object 0x4001)

Manufacturer Specific Error Code	Error name	Description
0x0000	No Manufacturer Specific Error Code	
0x0001	Not used	

Manufacturer Specific Error Code	Error name	Description
0x0002	Parameter Checksum Error	Joystick remains in NMT state Preoperational
0x0003	Not used.	
0x0004	Not used.	
0x0005	RAM Test Error	Not supported.
0x0010	X/Y Axis*, Signal 1, Out Of Range	
0x0011	X/Y Axis*, Signal 2, Out Of Range	
0x0012	X/Y Axis*, Signal Plausibility Error	Error if Signal Plausibility Limit is out of Range. Refer to object 0x2000.5.

Tab. 5: Supported Manufacturer Specific Error Codes



It is recommended that Transmit PDOs cycle rate should not be less than 5 ms as the ADC scanning and coding time is fixed to 5 ms. Sending Transmit PDOs faster than 5 ms will only repeat the last message sent until the end of the next coding cycle.



*The axis designation (X Axis/Y Axis) of the single-axis joystick depends on its respective installation position.

13 SDO Communication

The device fulfils the **SDO Server** functionality.

14 PDO Communication

14.1 Transmit PDO #0

This PDO transmits asynchronously the axis and thumb wheel values (channel 1) and the buttons status. The Tx PDO #0 is transmitted cyclically when the cyclic timer (object 0x1800.5) is programmed > 0. Values between 1 ms and 65535 ms are selectable by parameter settings. The Tx PDO #0 is transmitted after entering the "Operational" state.

Byte	0
Content	X/Y Axis* Signal 1 (object 2000.20)

Tab. 6: TPDO #0 with the default mapping



*The axis designation (X Axis/Y Axis) of the single-axis joystick depends on its respective installation position.

15 Function Description

15.1 Axis

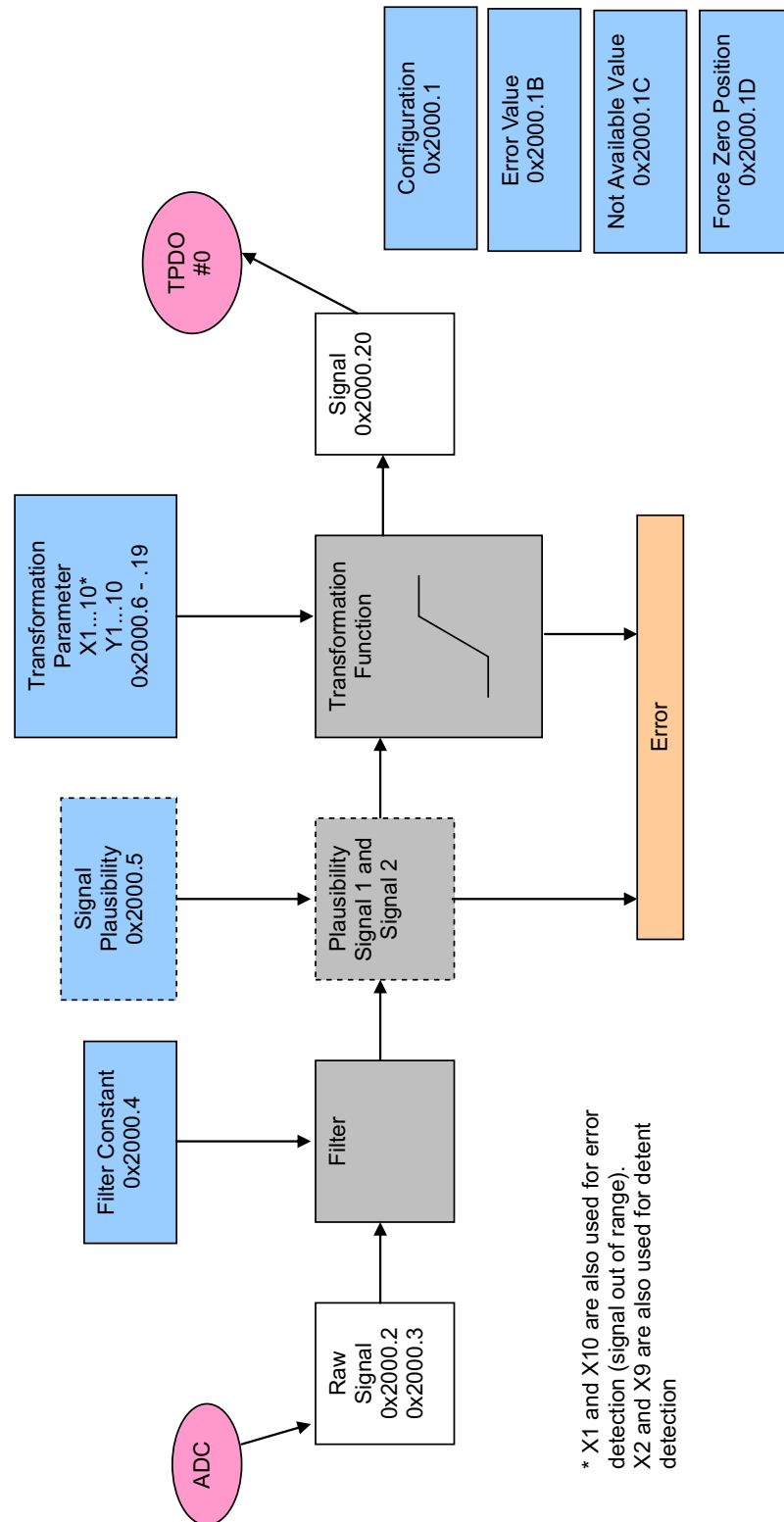


Fig. 1: Axis Overview

This function reads the analogue input value, transforms it according to transformation function and transmits this value cyclic via CAN bus. Error detection and filter functions are also included.

Input value range (X): 0...5V

Transformed signal maximal possible range (Y): -128 ... 127 %

15.1.1 Teach Parameters

The Joystick J7 is designed with non programmable Hall ICs. Therefore it is necessary to teach the analogue values to the microcontroller. This is done by the Eol-Tester by deflecting the shaft and readout of the analogue values. Afterwards the analogue values are written to the corresponding object code $\Rightarrow$ teach parameters.

Signal 1 is used for teaching.

The deflection angles have to be determined according to the sliding gate.

An example for the teach parameters is shown in the following chapters Axis without Detent [► 6] and Axis with Detent [► 6].

15.1.2 Axis without Detent

The following table shows a typical transformation function from -100% to 100%:

X1*	X2	X3	X4	X5
0.2 V	0.2 V	0.6 V	0.6 V	2.3 V
Y1	Y2	Y3	Y4	Y5
-100 %	-100 %	-100 %	-100 %	0 %

X6	X7	X8	X9	X10*
2.7 V	4.4 V	4.4 V	4.8 V	4.8 V
Y6	Y7	Y8	Y9	Y10
0 %	100 %	100 %	100 %	100 %

Tab. 7: Transformation function example with detent

* X1 and X10 are also used for error detection (signal out of range).

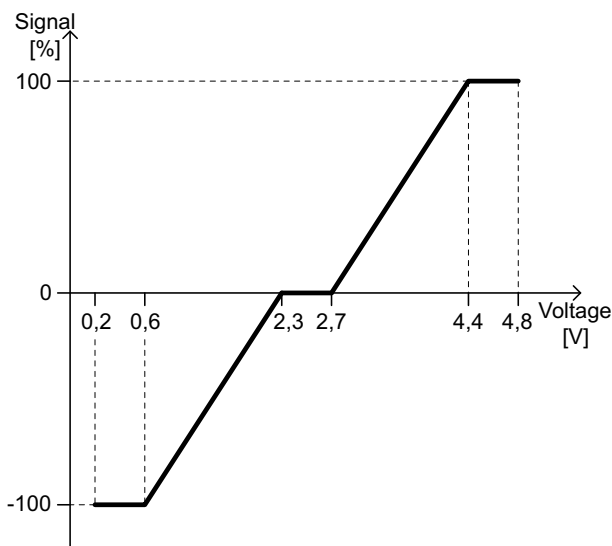


Fig. 2: Example for J7 without detent

In this example the teach parameters are: X3, X4, X5, X6, X7 and X8.

15.1.3 Axis with Detent

The following table shows a typical transformation function with detent on both sides. A detent is indicated with a selectable value (Default: 110% and -110%). The detent function is a jump from 100% to the defined value, see also the following example.

X1*	X2**	X3	X4	X5
0.2 V	1.0 V	1.001 V	1.3 V	2.3 V
Y1	Y2	Y3	Y4	Y5
-110 %	-110 %	-100 %	-100 %	0 %

X6	X7	X8	X9**	X10*
2.7 V	3.7 V	3.999 V	4.0 V	4.8 V
Y6	Y7	Y8	Y9	Y10
0 %	100 %	100 %	110 %	110 %

Tab. 8: Transformation function example with detent

* X1 and X10 are also used for error detection (signal out of range).

** X2 and X9 are used for detent detection.

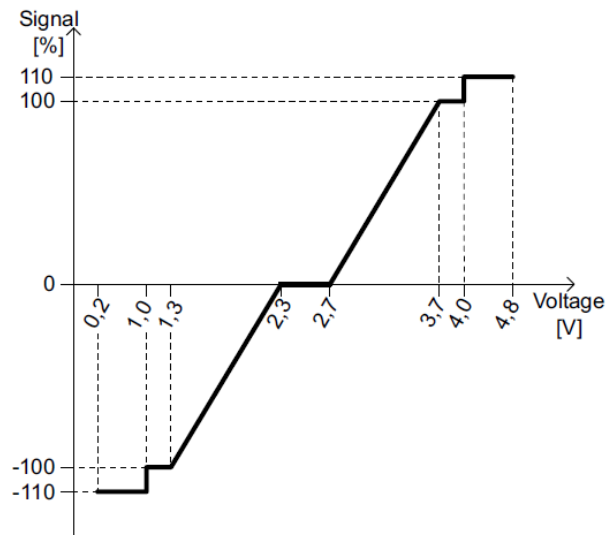


Fig. 3: Example for J7 with detent

In this example the teach parameters are: X2, X3, X4, X5, X6, X7, X8 and X9.

16 Annex A: Object Dictionary

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
Communication Profile Area (0x1000...0x1FFF)									
0x1000		Device Type	U32	ro			0x00000000		No standardised device profile used.
0x1001		Error Register	U8	ro			0x00		Always 0.
0x1008		Manufacturer Device Name	String	Const.			"JST"		"JST": Joystick.
0x1009		Manufacturer Hardware Version	String	Const.			"x.xx"		"Maj.MinMin" Read in via analogue input. Range from 1.00 to B.00.
0x100A		Manufacturer Software Version	String	Const.			"x.xx"		"Maj.MinMin"
0x1010		Store Parameters							Attention: Please use this service with care. Make sure before saving parameters that only desired parameters are changed.
	0x0	Number of Entries	U8	Const.			1		
	0x1	Save all Parameters	U32	rw					"save" (0x65766173) to save all parameters (objects with marked PARA except LSS parameter).
0x1011		Restore Default Parameters							
	0x0	Number of Entries	U8	Const.			1		
	0x1	Restore all Default Parameters	U32	rw					"load" (0x64616F6C) to restore all parameters (objects with marked PARA) to factory settings.
0x1014		COB-ID EMCY	U32	Const.			0x80 + Node-ID		

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
0x1017		Producer Heartbeat Time - PARA	U16	rw			0	1 ms	0: not used
0x1018		Identity Object							
	0x0	Number of Entries	U8	Const.	4	4	4		
	0x1	Vendor ID	U32	ro			0x000000B4		elobau Vendor ID: 0x000000B4
	0x2	Product Code	U32	ro			0x00000104		
	0x3	Revision Number	U32	ro			0x00000000		Major Revision Number: Bit 16...31 Minor Revision Number: Bit 0...15
	0x4	Serial Number	U32	ro					
0x1200		SDO #0 Server Parameter							
	0x0	Number of Entries	U8	Const.	2	2	2		
	0x1	COB-ID Client->Server (Rx)	U32	Const.			0x600 + Node-ID		
	0x2	COB-ID Server->Client (Tx)	U32	ro			0x580 + Node-ID		
0x1800		Tx PDO #0 Communication Parameter							
	0x0	Number of Entries	U8	Const.	2	5	5		
	0x1	COB-ID	U32	Const.			0x180 + Node-ID		
	0x2	Transmission Type	U8	Const.			254		Asynchronous transmission, transmission event is manufacturer specific, i.e. event timer.
	0x3	Inhibit Time	U16	rw			0	100 us	Not supported

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
	0x4	Reserved	U8	rw			0		Not supported
	0x5	Event Timer - PARA	U16	rw			100	1 ms	
0x1A00		Tx PDO #0 Mapping Parameter							
	0x0	Number of Entries	U8	Const.		64	1		
	0x1	Mapping Parameter 1	U32	Const.			0x20002008		object 0x2000.20
Manufacturer Specific Profile Area (0x2000...0x5FFF)									
0x2000		X/Y Axis							
	0x0	Number of Entries	U8	ro			32		
	0x1	Configuration - PARA	U8	rw	0	3	3		(0: no signal available) 1: only signal 1 available (2: only signal 2 available) 3: signal 1 + 2 available
	0x2	Raw Signal 1	U16	ro	0	5000	0	Digit	
	0x3	Raw Signal 2	U16	ro	0	5000	0	Digit	
	0x4	Analogue Signal Filter Constant - PARA	U8	rw	0	255	0		0: disabled, 1: average filter (8 values) enabled
	0x5	Signal Plausibility Limit - PARA	U16	rw	0	5000	300	1 mV	0: no monitoring activated Defines the signal plausibility limit
	0x6	Transformation Function X1 - PARA	U16	rw	0	5000	200	1 mV	This parameter is used for error detection (signal out of range).
	0x7	Transformation Function Y1 - PARA	S8	rw	-128	127	-100	%	

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
	0x8	Transformation Function X2 - PARA	U16	rw	0	5000	200	1mV	Teach parameter – used for detent detection
	0x9	Transformation Function Y2 - PARA	S8	rw	-128	127	-100	%	
	0xA	Transformation Function X3 - PARA	U16	rw	0	5000	600	1 mV	Teach parameter
	0xB	Transformation Function Y3 - PARA	S8	rw	-128	127	-100	%	
	0xC	Transformation Function X4 - PARA	U16	rw	0	5000	600	1mV	Teach parameter
	0xD	Transformation Function Y4 - PARA	S8	rw	-128	127	-100	%	
	0xE	Transformation Function X5 - PARA	U16	rw	0	5000	2300	1 mV	Teach parameter
	0xF	Transformation Function Y5 - PARA	S8	rw	-128	127	0	%	
	0x10	Transformation Function X6 - PARA	U16	rw	0	5000	2700	1 mV	Teach parameter
	0x11	Transformation Function Y6 - PARA	S8	rw	-128	127	0	%	
	0x12	Transformation Function X7 - PARA	U16	rw	0	5000	4400	1 mV	Teach parameter

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
	0x13	Transformation Function Y7 - PARA	S8	rw	-128	127	100	%	
	0x14	Transformation Function X8 - PARA	U16	rw	0	5000	4400	1 mV	Teach parameter
	0x15	Transformation Function Y8 - PARA	S8	rw	-128	127	100	%	
	0x16	Transformation Function X9 - PARA	U16	rw	0	5000	4800	1 mV	Teach parameter – used for detent detection
	0x17	Transformation Function Y9 - PARA	S8	rw	-128	127	100	%	
	0x18	Transformation Function X10 - PARA	U16	rw	0	5000	4800	1 mV	This parameter is used for error detection (signal out of range).
	0x19	Transformation Function Y10 - PARA	S8	rw	-128	127	100	%	
	0x1A	Spare	U8	ro					
	0x1B	Error Value - PARA	S8	rw	-128	127	126	%	This value is sent via CAN bus in case of an error.
	0x1C	Not Available Value - PARA	S8	rw	-128	127	127	%	This value is sent via CAN bus in case of not available.
	0x1D	Force Zero Position after Power On or Bus Off	U8	rw	0	255	1		0: Off, 1: On
	0x1E - 0x1F	Spare	U8	ro					
	0x20	Transformed Signal	S8	ro	-128	127	0	%	

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
0x4000		Error Behavior - PARA	U8	rw	0	2	1		
0x4001		Error Code	U16	ro			0		0: no error
0x4002		Error Field	U8	ro			0xFF		Used as default value for Tx PDOs.
0x5000		Auto NMT Start - PARA	U8	rw	0	1	0		0: not activated 1: activated (starts the PDO transmission automatically after power on – no CANopen standard)
0x5001		Bus-Off Counter Limit - PARA	U16	rw	0	10000	20		0: no limit >0: if Bus-Off counter exceeds this limit, the device will be set in off-line mode (no broadcast/no receive)
0x5999		LSS							Attention: Changing this parameter can disturb the network! Use this service only if one device is connected to the network!
	0x0	Number of Entries	U8	ro			3		
	0x1	Baud rate - PARA	U16	rw	20	1000	250	Kbit/s	Possible values: 20, 50, 125, 250, 500, 800, 1,000 kbit/s.
	0x2	Node-ID - PARA	U8	rw	1	127	0x11 (17)		
	0x3	Save all Parameters (incl. LSS)	U32	rw					"save" (0x65766173) to save all parameters (objects with marked PARA including LSS parameters).
0x599A		SNaFS – INTERNAL							For internal use only.
Standardised Device Profile Area (0x6000...0x9FFF)									

Tab. 9: Object dictionary

17 Annex B: Joystick Axis Definition

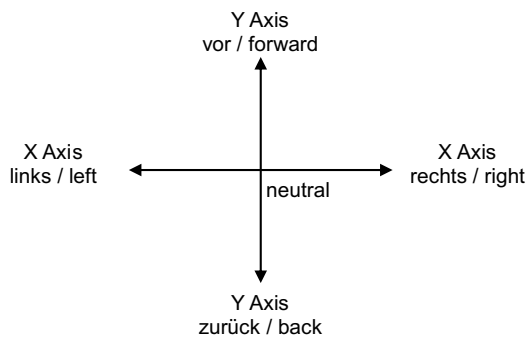


Fig. 4: Joystick Axis Definition



The axis designation (X Axis/Y Axis) of the single-axis joystick depends on its respective installation position.