

# CANopen Protocol for Multi Functional Grip 34xG and 36xG

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## Revision History

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		Golubovic	Review.	
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01.21	2016-04-07	Prinz	correction of default value in object 0x1A01	

Revisions will be documented with font color blue.

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## 1 Scope

This document represents the elobau CANopen definitions for joysticks.

## 2 Abbreviations and Terms

Abbreviation / Term	Definition and Meaning
PDO	Process Data Object
SDO	Service Data Object
EMCY	Emergency Message
NMT	Network Management
LSS	Layer Setting Services and Protocol
PARA	Storable Parameter
LSS-PARA	Storable LSS Parameter

Table 1: Abbreviations and terms

## 3 Reference Documents

Index []	Document (in valid version)
1	elobau Product Overview CANopen
2	EDS for Joysticks
3	CiA DS-301 Application Layer and Communication Profile V4.02
4	CiA DSP-305 Layer Setting Services and Protocol V1.1.1
5	elobau CANopen Serial Number Saving V01.00
6	Software Specification for Joysticks
7	Hardware Specification
8	Definition Nummerierung 36xG und 34xG

Table 2: Reference documents

## 4 Zero Position after Power On + Bus Off

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

## 5 CANopen Features Summary

- Implemented CiA DS-301 Application Layer and Communication Profile V4.02 and CiA DSP-305 Layer Setting Services and Protocol V1.1.1
- Configurable Baud rate 50...1000Kbit/s (default 250Kbit/s) and Node-ID 1...127 (default 0x11 (17)) via LSS and SDO
- NMT Slave (Minimum Boot Up)
- Heartbeat Producer
- EMCY Producer
- SDO Server
- 2 Transmit PDOs

- 1 Receive PDO
- PDO transmission types: Asynchronous event driven, cyclic (default 100ms)
- Analogue values scanning and coding cycle fixed to 5 ms

## 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

Through this service the NMT Master sets the state of the selected NMT Slaves to OPERATIONAL.

#### 6.1.2 Stop Remote Node

Through this service the NMT Master sets the state of the selected NMT Slaves to STOPPED.

#### 6.1.3 Enter Pre-Operational

Through 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-initialization.

#### 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 parameter 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 volitional 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 250kbit/s and the default Node-ID 0x11 (17).

## 8 Parameter Settings

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

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

**Attention: Please use this service with care. Make sure before saving parameters, that only volitional 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 saving procedure.

## 10 CAN Message Bit Order (CANopen Definition)

Byte	0	1	2	3	4	5	6	7
U16	Bit7 ... Bit0	Bit15 ... Bit8						
U32	Bit7 ... Bit0	Bit15 ... Bit8	Bit23 ... Bit16	Bit31 ... Bit24				

Table 3: CAN message Bit order example

## 11 Heartbeat

The heartbeat mechanism for this device is established through cyclic transmission of the heartbeat message done 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 will be informed about that 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

Table 4: Heartbeat message

## 12 Error Handling

### 12.1 Principle

Emergency messages (EMCY) shall be triggered by internal errors on device and they are assigned the highest possible priority to ensure that they get 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 Behavior (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 and Thumb Wheel: Object 0x\*\*\*\*.1B

Button: Object 0x2100.9

### 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 byte of manufacturer specific error code. This device uses only the 1st byte as manufacturer specific error code.

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

Table 5: 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
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0x0000	No Manufacturer Specific Error Code	
0x0001	Application Program Checksum Error	CRC32
0x0002	Parameter Checksum Error	CRC32 This error is also set until first parameter saving process.
0x0003	Not used.	
0x0004	Not used.	
0x0005	RAM Test Error	Not supported.
0x0010	X Axis, Signal 1, Out Of Range	
0x0011	X Axis, Signal 2, Out Of Range	
0x0012	X Axis, Signal Difference Too High	Value difference between Signal 1 and Signal 2. Refer to object 0x2000.5. <b>Function not implemented.</b>
0x0020	Y Axis, Signal 1, Out Of Range	
0x0021	Y Axis, Signal 2, Out Of Range	
0x0022	Y Axis, Signal Difference Too High	Value difference between Signal 1 and Signal 2. Refer to object 0x2001.5. <b>Function not implemented.</b>
0x0030	Thumb Wheel A, Signal 1, Out Of Range	
0x0031	Thumb Wheel A, Signal 2, Out Of Range	
0x0032	Thumb Wheel A, Signal Difference Too High	Value difference between signal 1 and signal 2. Refer to object 0x2002.5. <b>Function not implemented.</b>
0x0040	Thumb Wheel B, Signal 1, Out Of Range	
0x0041	Thumb Wheel B, Signal 2, Out Of Range	
0x0042	Thumb Wheel B, Signal Difference Too High	Value difference between signal 1 and signal 2. Refer to object 0x2003.5. <b>Function not implemented.</b>
0x0050	Thumb Wheel C, Signal 1, Out Of Range	
0x0051	Thumb Wheel C, Signal 2, Out Of Range	
0x0052	Thumb Wheel C, Signal Difference Too High	Value difference between signal 1 and signal 2. Refer to object 0x2004.5. <b>Function not implemented.</b>
0x0061	Button 1 Timeout	Refer to object 0x2100.8
0x0062	Button 2 Timeout	Refer to object 0x2100.8
0x0063	Button 3 Timeout	Refer to object 0x2100.8
0x0064	Button 4 Timeout	Refer to object 0x2100.8
0x0065	Button 5 Timeout	Refer to object 0x2100.8
0x0066	Button 6 Timeout	Refer to object 0x2100.8
0x0067	Button 7 Timeout	Refer to object 0x2100.8
0x0068	Button 8 Timeout	Refer to object 0x2100.8
0x0069	Button 9 Timeout	Refer to object 0x2100.8
0x006A	Button 10 Timeout	Refer to object 0x2100.8
0x006B	Button 11 Timeout	Refer to object 0x2100.8

0x0070	LED Message Timeout	Refer to object 0x2200.9 <b>Function not implemented.</b>
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Table 6: Supported Manufacturer Specific Error Codes

## 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 cyclic, when the cyclic timer (object 0x1800.5) is programmed > 0. Values between 1ms and 65535ms are selectable by parameter settings. The Tx PDO #0 is transmitted after entering the "Operational" state.

Byte	0	1	2	3	4	5	6	7
Content	X Axis Signal 1 (object 2000.20)	Y Axis Signal 1 (object 2001.20)	Thumb Wheel A Signal 1 (object 2002.20)	Thumb Wheel B Signal 1 (object 2003.20)	Thumb Wheel C Signal 1 (object 2004.20)	Buttons 1...8 (object 2100.10)	Buttons 9...16 (object 2100.11)	0xFF

Table 7: TPDO #0 with the default mapping

### 14.2 Transmit PDO #1

This PDO transmits asynchronously the axis and thumb wheel values (channel 2). The Tx PDO #1 is transmitted cyclic, when the cyclic timer (object 0x1801.5) is programmed > 0. Values between 1ms and 65535ms are selectable by parameter settings. The Tx PDO #1 is transmitted after entering the "Operational" state.

Byte	0	1	2	3	4	5	6	7
Content	X Axis Signal 2 (object 2000.21)	Y Axis Signal 2 (object 2001.21)	Thumb Wheel A Signal 2 (object 2002.21)	Thumb Wheel B Signal 2 (object 2003.21)	Thumb Wheel C Signal 2 (object 2004.21)	0xFF	0xFF	0xFF

Table 8: TPDO #1 with the default mapping

### Notice:

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

### 14.3 Receive PDO #0

Receive PDO, described in the following table, receives an LED commands. LED commands are described in chapter 15.3 LED Commands.

**Notice:**

While Receive PDO has priority over Transmit PDOs and because LED refresh reaction time is not less than 100ms, Receive PDO transmit rate should not be less than **100ms**, when cyclic transmit is necessary **200ms** cycle rate is suggested. Sending RxPDO faster than 100ms makes only greater busload and have no additional affect on LED functionality self. Please notice that LEDs are always triggered with the last received LED command therefore cyclic update is not necessary.

Byte	Content
0	Bit 0,1: Button 1, LED 1 (object 0x2200.1) Bit 2,3: Button 1, LED 2 Bit 4,5: Button 2, LED 1 Bit 6,7: Button 2, LED 2
1	Bit 0,1: Button 3, LED 1 (object 0x2200.2) Bit 2,3: Button 3, LED 2 Bit 4,5: Button 4, LED 1 Bit 6,7: Button 4, LED 2
2	Bit 0,1: Button 5, LED 1 (object 0x2200.3) Bit 2,3: Button 5, LED 2 Bit 4,5: spare Bit 6,7: spare
3	Bit 0,1: spare (object 0x2200.4) Bit 2,3: spare Bit 4,5: spare Bit 6,7: spare
4	Bit 0,1: spare (object 0x2200.5) Bit 2,3: spare Bit 4,5: spare Bit 6,7: spare
5	Bit 0,1: Thumb Wheel A, LED 2-2 (object 0x2200.6) Alternative: Button 8, LED 1 Bit 2,3: Thumb Wheel A, LED 2-1 Alternative: Button 8, LED 2 Bit 4,5: Thumb Wheel A, LED 1+3 or LED 1+2+3 (if LED 2 not separated) or LED 2-3 (if only LED available) Alternative: Button 10, LED 1 Bit 6,7: spare
6	Bit 0,1: Thumb Wheel B, LED 2-2 (object 0x2200.7) Alternative: Button 9, LED 1 Bit 2,3: Thumb Wheel B, LED 2-1 Alternative: Button 9, LED 2 Bit 4,5: Thumb Wheel B, LED 1+3 or LED 1+2+3 (if LED 2 not separated) or LED 2-3 (if only LED available) Alternative: Button 10, LED 2 Bit 6,7: spare
7	spare (object 0x2200.8)

Table 9: RPDO #0

## 15 Function Description

### 15.1 Axis and Thumb Wheels

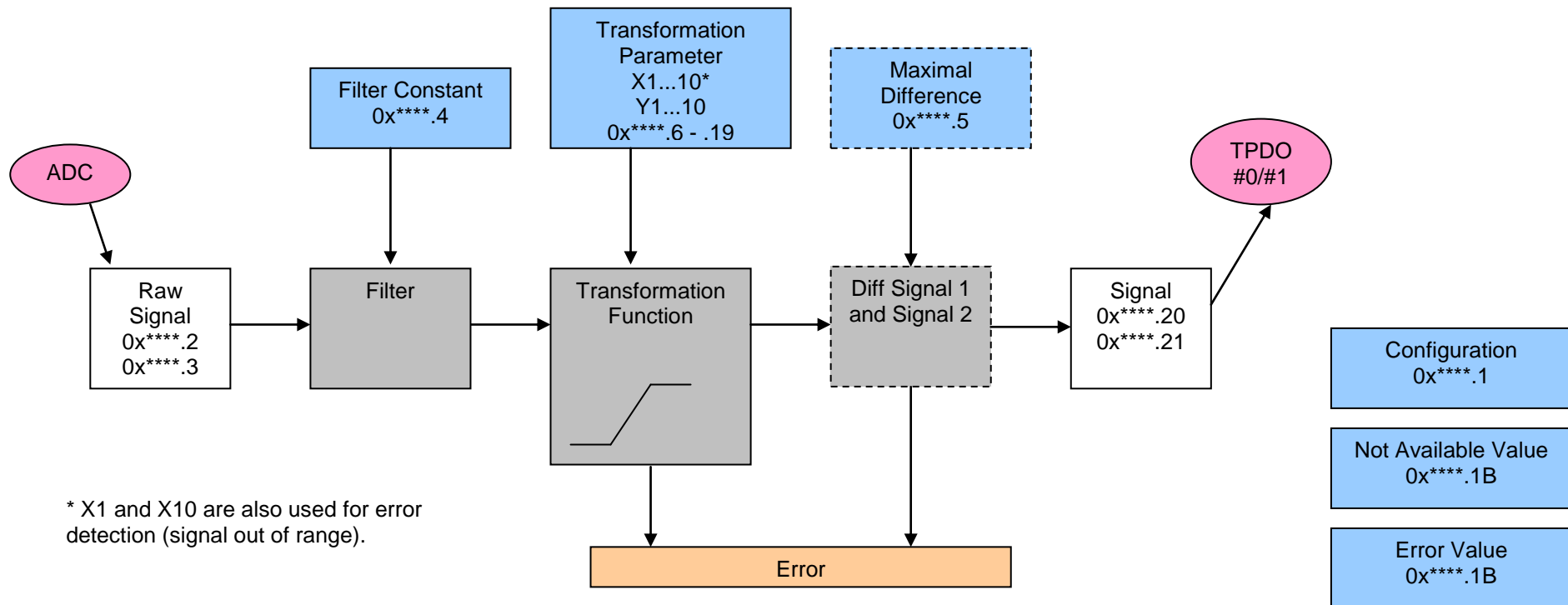


Figure 1: Axis and Thumb Wheel Overview

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 Axis without detent

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

X1*	X2	X3	X4	X5	X6	X7	X8	X9	X10*
0,2V	0,6V	2,3V	2,7V	4,4V	4,8V	4,8V	4,8V	4,8V	4,8V
Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
-100%	-100%	0%	0%	100%	100%	100%	100%	100%	100%

Table 10: Transformation function example without detent

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

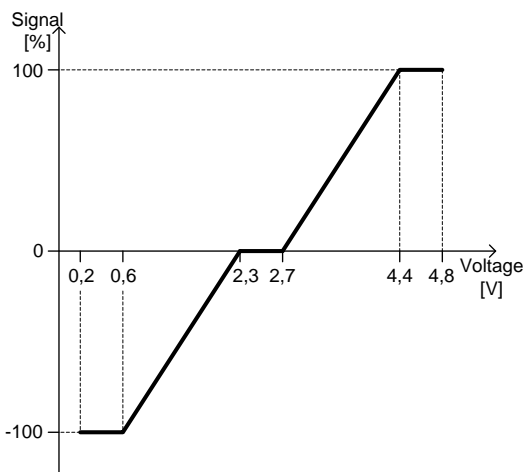


Figure 2: Example for axis without detent

### 15.1.2 Axis with detent

The following table shows a typical transformation function with detent on both sides. A detent is indicated with either 110% or -110%. The detent function is a jump from 100% to 110%.

X1*	X2**	X3	X4	X5	X6	X7	X8	X9**	X10*
0,2V	1,0V	1,3V	1,3V	2,3V	2,7V	3,7V	3,7V	4,0V	4,8V
Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
-110%	-110%	-100%	-100%	0%	0%	100%	100%	110%	110%

Table 11: 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

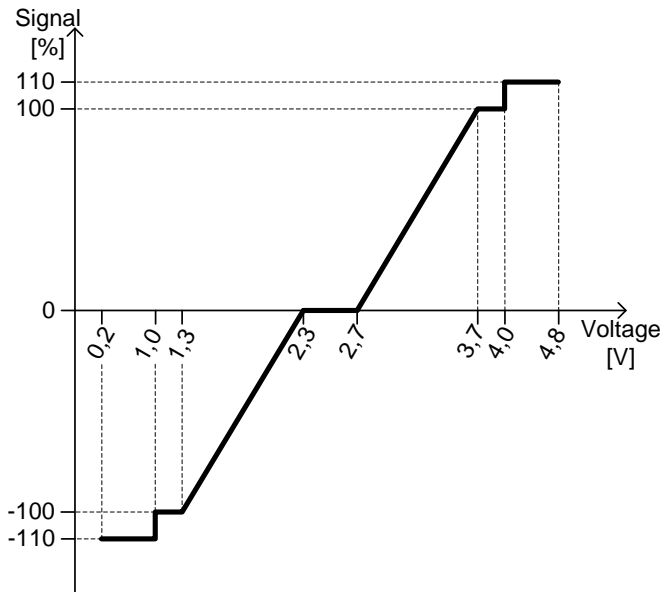


Figure 3: Example for axis with detent

## 15.2 Buttons

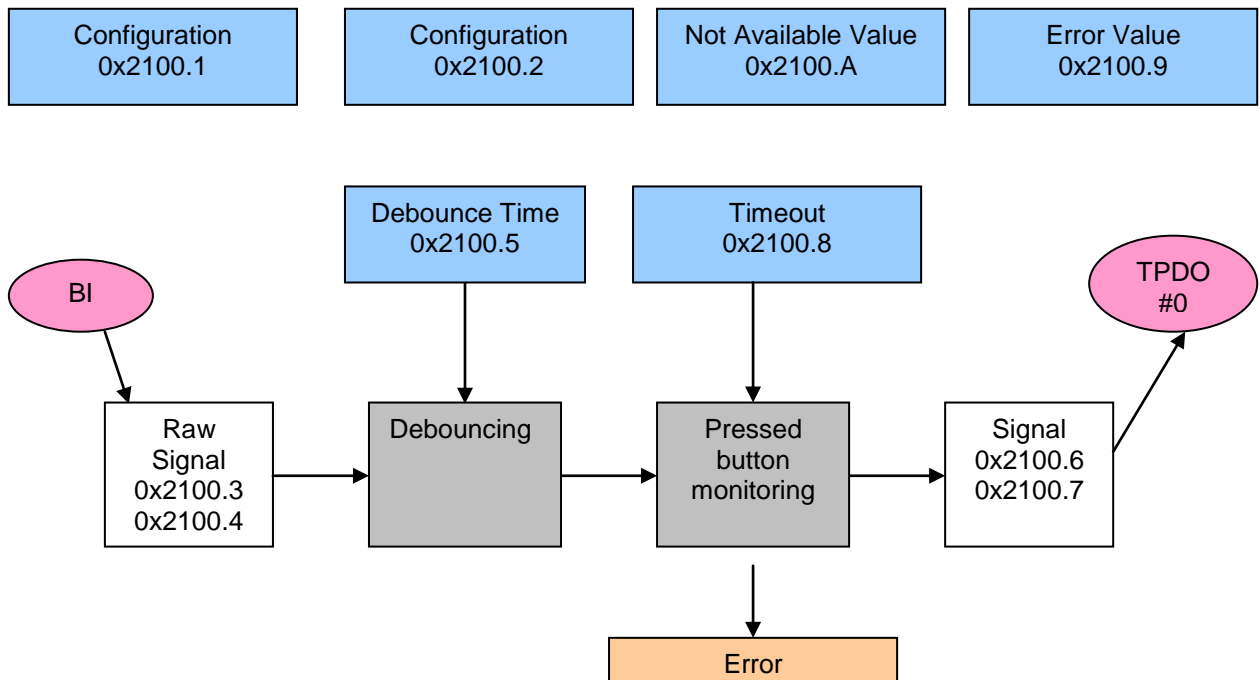


Figure 4: Button Function Overview

This function reads the button status and transmits it cyclic via CAN bus. Also debouncing is included.

Button coding:

Coding (bitwise)	Function
0	Button not pressed
1	Button pressed

Table 12: Button coding

### 15.2.1 Presence Sensor

The presence sensor is also handled like a button and transmitted via CAN bus as button 12. The only difference to the other buttons is that no pressed button monitoring (timeout monitoring) is implemented.

### 15.3 LED Commands

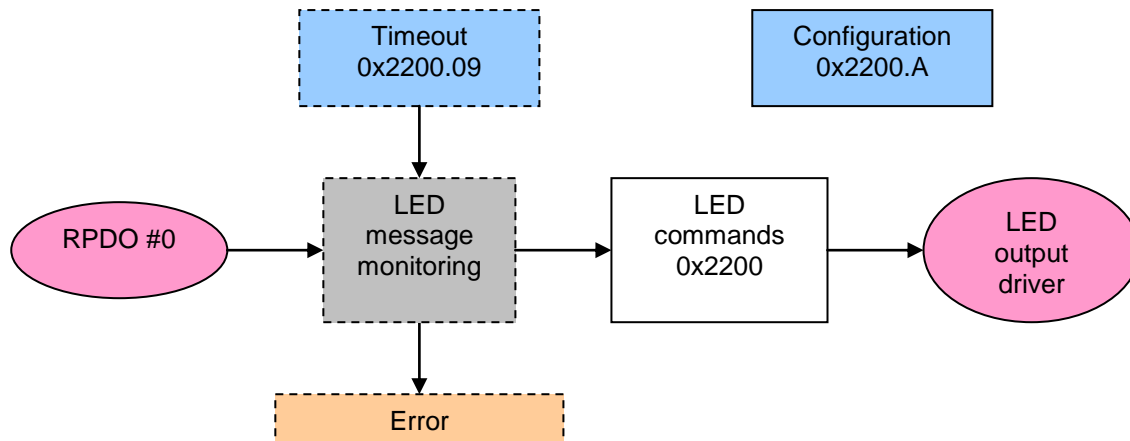


Figure 5: LED Commands Overview

The button and thumb wheel LEDs are controlled with CAN command.

The LED coding follows this rule:

Coding (bit1bit0)	Function
00	LED off
01	LED on
10	LED blink (periodically off/on)
11	No change on previously LED function

Table 13: LED coding

Only LEDs that are allowed by LED configuration (object 0x2200.A) will be displayed regardless to command that was issued.

## 16 Annex A: Object Dictionary

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
		<b>Communication Profile Area (0x1000...0x1FFF)</b>							
0x1000		Device Type	U32	ro			0x00000000		No standardized device profile used.
0x1001		Error Register	U8	ro			0x00		Always 0.
0x1008		Manufacturer Device Name	String	const			"JST"		Refer to "elobau Product Overview CANopen". "JST": Joystick
0x1009		Manufacturer Hardware Version	String	const			"0.00"		"Maj.MinMin" Read in via analogue input. Refer to "Hardware Specification".
0x100A		Manufacturer Software Version	String	const			"0.00"		"Maj.MinMin"
0x1010		Store Parameters							<b>Attention: Please use this service with care. Make sure before saving parameters, that only volitional parameters are changed.</b>
	0x0	Number of Entries	U8	ro			1		
	0x1	Save all Parameters	U32	rw					"save" (0x65766173) to save all parameters (objects with marking PARA except LSS parameter).
0x1011		Restore Default Parameters							Not supported.
	0x0	Number of Entries	U8	ro			1		
	0x1	Restore all Default Parameters	U32	rw					"load" (0x64616F6C) to restore all parameters (objects with marking PARA) to factory settings.
0x1014		COB-ID EMCY	U32	ro			0x80 + Node-ID		
0x1017		Producer Heartbeat Time - PARA	U16	rw			0	1ms	0: not used
0x1018		Identity Object							
	0x0	Number of Entries	U8	ro	4	4	4		



Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
	0x1	Vendor ID	U32	ro			0x000000B4		Refer to "elobau Product Overview CANopen". elobau Vendor ID: 0x000000B4
	0x2	Product Code	U32	ro			0x00010003		Refer to "elobau Product Overview CANopen".
	0x3	Revision Number	U32	ro			0x00000000		Major Revision Number: Bit16...31 Minor Revision Number: Bit0...15
	0x4	Serial Number	U32	ro			0x00000000		
0x1200		SDO #0 Server Parameter							
	0x0	Number of Entries	U8	ro	2	2	2		
	0x1	COB-ID Client->Server (Rx)	U32	ro			0x600 + Node-ID		
	0x2	COB-ID Server->Client (Tx)	U32	ro			0x580 + Node-ID		
0x1400		Rx PDO #0 Communication Parameter							
	0x0	Number of Entries	U8	ro	2	5	2		
	0x1	COB-ID	U32	ro			0x200 + Node-ID		
	0x2	Transmission Type	U8	ro			254		Asynchronous transmission, transmission event is manufacturer specific, i.e. event timer.
0x1600		Rx PDO #0 Mapping Parameter							
	0x0	Number of Entries	U8	ro		64	8		
	0x1	Mapping Parameter 1	U32	ro			0x22000108		object 0x2200.1
	0x2	Mapping Parameter 2	U32	ro			0x22000208		object 0x2200.2
	0x3	Mapping Parameter 3	U32	ro			0x22000308		object 0x2200.3
	0x4	Mapping Parameter 4	U32	ro			0x22000408		object 0x2200.4
	0x5	Mapping Parameter 5	U32	ro			0x22000508		object 0x2200.5
	0x6	Mapping Parameter 6	U32	ro			0x22000608		object 0x2200.6
	0x7	Mapping Parameter 7	U32	ro			0x22000708		object 0x2200.7
	0x8	Mapping Parameter 8	U32	ro			0x22000808		object 0x2200.8
0x1800		Tx PDO #0 Communication Parameter							
	0x0	Number of Entries	U8	ro	2	5	5		

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
	0x1	COB-ID	U32	ro			0x180 + Node-ID		
	0x2	Transmission Type	U8	ro			254		Asynchronous transmission, transmission event is manufacturer specific, i.e. event timer.
	0x3	Inhibit Time	U16	ro			20	100us	Minimum interval time for PDO transmission. Not used
	0x4	Reserved	U8	rw			0		Not supported.
	0x5	Event Timer - PARA	U16	rw			100	1ms	
0x1801		Tx PDO #1 Communication Parameter							
	0x0	Number of Entries	U8	ro	2	5	5		
	0x1	COB-ID	U32	ro			0x280 + Node-ID		
	0x2	Transmission Type	U8	ro			254		Asynchronous transmission, transmission event is manufacturer specific, i.e. event timer.
	0x3	Inhibit Time	U16	ro			20	100us	Minimum interval time for PDO transmission. Not used
	0x4	Reserved	U8	rw			0		Not supported.
	0x5	Event Timer - PARA	U16	rw			100	1ms	
0x1A00		Tx PDO #0 Mapping Parameter							
	0x0	Number of Entries	U8	ro		64	8		
	0x1	Mapping Parameter 1	U32	ro			0x20002008		object 0x2000.20
	0x2	Mapping Parameter 2	U32	ro			0x20012008		object 0x2001.20
	0x3	Mapping Parameter 3	U32	ro			0x20022008		object 0x2002.20
	0x4	Mapping Parameter 4	U32	ro			0x20032008		object 0x2003.20
	0x5	Mapping Parameter 5	U32	ro			0x20042008		object 0x2004.20
	0x6	Mapping Parameter 6	U32	ro			0x21001008		object 0x2100.10
	0x7	Mapping Parameter 7	U32	ro			0x21001108		object 0x2100.11
	0x8	Mapping Parameter 8	U32	ro			0x40020008		object 0x4002.00 (not used: 0xFF)
0x1A01		Tx PDO #1 Mapping Parameter							
	0x0	Number of Entries	U8	ro		64	8		

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
	0x1	Mapping Parameter 1	U32	ro			0x20002108		object 0x2000.21
	0x2	Mapping Parameter 2	U32	ro			0x20012108		object 0x2001.21
	0x3	Mapping Parameter 3	U32	ro			0x20022108		object 0x2002.21
	0x4	Mapping Parameter 4	U32	ro			0x20032108		object 0x2003.21
	0x5	Mapping Parameter 5	U32	ro			0x20042108		object 0x2004.21
	0x6	Mapping Parameter 6	U32	ro			0x40020008		object 0x4002.00 (not used: 0xFF)
	0x7	Mapping Parameter 7	U32	ro			0x40020008		object 0x4002.00 (not used: 0xFF)
	0x8	Mapping Parameter 8	U32	ro			0x40020008		object 0x4002.00 (not used: 0xFF)
		<b>Manufacturer Specific Profile Area (0x2000...0x5FFF)</b>							
0x2000		X Axis							
	0x0	Number of Entries	U8	ro					
	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: not used
	0x5	Maximal Difference Signal 1_2 - PARA	U16	rw	0	5000	0	1mV	0: no monitoring activated Function not implemented.
	0x6	Transformation Function X1 - PARA	U16	rw	0	5000	200	1mV	This parameter is used for error detection (signal out of range).
	0x7	Transformation Function Y1 - PARA	S8	rw	-128	127	-100	%	
	0x8	Transformation Function X2 - PARA	U16	rw	0	5000	600	1mV	
	0x9	Transformation Function Y2 - PARA	S8	rw	-128	127	-100	%	
	0xA	Transformation Function X3 - PARA	U16	rw	0	5000	2300	1mV	
	0xB	Transformation Function Y3 - PARA	S8	rw	-128	127	0	%	
	0xC	Transformation Function X4 - PARA	U16	rw	0	5000	2700	1mV	
	0xD	Transformation Function Y4 - PARA	S8	rw	-128	127	0	%	

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
	0xE	Transformation Function X5 - PARA	U16	rw	0	5000	4400	1mV	
	0xF	Transformation Function Y5 - PARA	S8	rw	-128	127	100	%	
	0x10	Transformation Function X6 - PARA	U16	rw	0	5000	4800	1mV	
	0x11	Transformation Function Y6 - PARA	S8	rw	-128	127	100	%	
	0x12	Transformation Function X7 - PARA	U16	rw	0	5000	4800	1mV	
	0x13	Transformation Function Y7 - PARA	S8	rw	-128	127	100	%	
	0x14	Transformation Function X8 - PARA	U16	rw	0	5000	4800	1mV	
	0x15	Transformation Function Y8 - PARA	S8	rw	-128	127	100	%	
	0x16	Transformation Function X9 - PARA	U16	rw	0	5000	4800	1mV	
	0x17	Transformation Function Y9 - PARA	S8	rw	-128	127	100	%	
	0x18	Transformation Function X10 - PARA	U16	rw	0	5000	4800	1mV	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 - 0x1F	Spare	U8	ro					
	0x20	Transformed Signal 1	S8	ro	-128	127	0	%	
	0x21	Transformed Signal 2	S8	ro	-128	127	0	%	
0x2001		Y Axis							
		dto.							
0x2002		Thumb Wheel A							
		dto.							
0x2003		Thumb Wheel B							
		dto.							
0x2004		Thumb Wheel C							
		dto.							
0x2100		Buttons 1_16							

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
	0x0	Number of Entries	U8	ro					
	0x1	Configuration 8_1 - PARA	U8	rw			63		0: button not available 1: button available
	0x2	Configuration 16_9 - PARA	U8	rw			0		0: button not available 1: button available
	0x3	Raw Signal 8_1	U8	ro			0		
	0x4	Raw Signal 16_9	U8	ro			0		
	0x5	Debounce Time - PARA	U8	rw			0	10ms	
	0x6	Spare	U8	ro					
	0x7	Spare	U8	ro					
	0x8	Timeout - PARA	U8	rw			0	1s	0: no monitoring activated This parameter is used for error detection (button timeout).
	0x9	Error Value - PARA	U8	rw	0	1	0	%	This value is sent via CAN bus in case of an error.
	0xA	Not Available Value - PARA	U8	rw	0	1	0	%	This value is sent via CAN bus in case of not available.
	0xB - 0xF	Spare	U8	ro					
	0x10	Transformed Signal 8_1	U8	ro			0		
	0x11	Transformed Signal 16_9	U8	ro			0		
0x2200		LED Commands							
	0x0	Number of Entries	U8	ro			9		
	0x1	LED Button 1_2: Bit 0,1: Button 1, LED 1 Bit 2,3: Button 1, LED 2 Bit 4,5: Button 2, LED 1 Bit 6,7: Button 2, LED 2	U8	wo			0		

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
	0x2	LED Button 3_4: Bit 0,1: Button 3, LED 1 Bit 2,3: Button 3, LED 2 Bit 4,5: Button 4, LED 1 Bit 6,7: Button 4, LED 2	U8	wo			0		
	0x3	LED Button 5: Bit 0,1: Button 5, LED 1 Bit 2,3: Button 5, LED 2 Bit 4,5: spare Bit 6,7: spare	U8	wo			0		
	0x4	Bit 0,1: spare Bit 2,3: spare Bit 4,5: spare Bit 6,7: spare	U8	wo			0		
	0x5	Bit 0,1: spare Bit 2,3: spare Bit 4,5: spare Bit 6,7: spare	U8	wo			0		
	0x6	LED Thumb Wheel A / Button 8_10: Bit 0,1: Thumb Wheel A, LED 2-2 Alternative: Button 8, LED 1 Bit 2,3: Thumb Wheel A, LED 2-1 Alternative: Button 8, LED 2 Bit 4,5: Thumb Wheel A, LED 1+3 or LED 1+2+3 (if LED 2 not separated) or LED 2-3 (if only LED available) Alternative: Button 10, LED 1 Bit 6,7: spare	U8	wo			0		

Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
	0x7	LED Thumb Wheel B / Button 9_10: Bit 0,1: Thumb Wheel B, LED 2-2 Alternative: Button 9, LED 1 Bit 2,3: Thumb Wheel B, LED 2-1 Alternative: Button 9, LED 2 Bit 4,5: Thumb Wheel B, LED 1+3 or LED 1+2+3 (if LED 2 not separated) or LED 2-3 (if only LED available) Alternative: Button 10, LED 2 Bit 6,7: spare	U8	wo			0		
	0x8	Spare	U8	ro					
	0x9	Timeout - PARA	U8	rw			0	1s	0: no monitoring activated This parameter is used for error detection (LED message timeout). Function not implemented.
	0xA	LED Mask configuration	U16	rw	0	0xFFFF	0xFFFF		Each bit represents configuration for one LED respectively 0: not used 1: LED in use

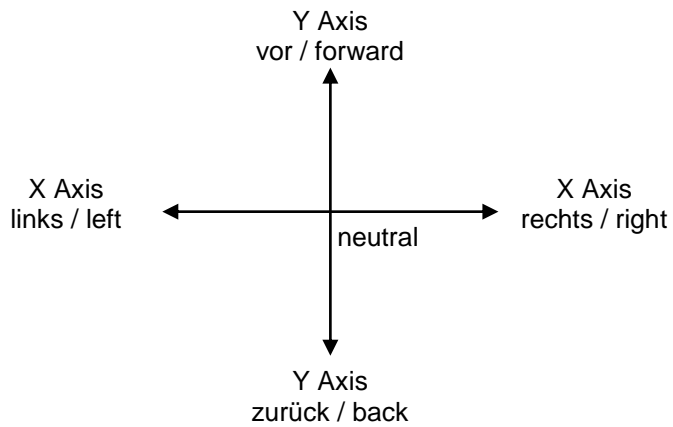
Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
	0xA	Configuration - PARA: Bit 0: Button 1, LED 1 Bit 1: Button 1, LED 2 Bit 2: Button 2, LED 1 Bit 3: Button 2, LED 2 Bit 4: Button 3, LED 1 Bit 5: Button 3, LED 2 Bit 6: Button 4, LED 1 Bit 7: Button 4, LED 2 Bit 8: Button 5, LED 1 Bit 9: Button 5, LED 2 Bit 10: Thumb Wheel A, LED 2-2 Alternative: Button 8, LED 1 Bit 11: Thumb Wheel A, LED 2-1 Alternative: Button 8, LED 2 2-3 (if only LED available) Bit 12: Thumb Wheel B, LED 2-2 Alternative: Button 9, LED 1 Bit 13: Thumb Wheel B, LED 2-1 Alternative: Button 9, LED 2 Bit 14: Thumb Wheel A, LED 1+3 or LED 1+2+3 (if LED 2 not separated) or LED 2-3 (if only LED available) Alternative: Button 10, LED 1 Bit 15: Thumb Wheel B, LED 1+3 or LED 1+2+3 (if LED 2 not separated) or LED 2-3 (if only LED available) Alternative: Button 10, LED 2	U16	rw			0xFFFF		0: LED not available 1: LED available
0x4000		Error Behavior - PARA	U8	rw	0	2	1		0: pre-operational 1: no state change 2: stopped
0x4001		Error Code	U16	ro			0		0: no error
0x4002		Error Field	U8	ro			0xFF		Used as default value for Tx PDOs.



Index	Sub-index	Name	Type	Access	Min	Max	Default	Unit	Comment
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							<b>Attention: Changing this parameter can disturb the network! Use this service only if one device is connected to the network!</b>
	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, 1000kbit/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 marking PARA including LSS parameters).
0x599A		SNaFS - INTERNAL							For internal use only. Refer to additional documentation.
		<b>Standardized Device Profile Area (0x6000...0x9FFF)</b>							

Table 14: Object dictionary

## 17 Annex B: Joystick Axis Definition



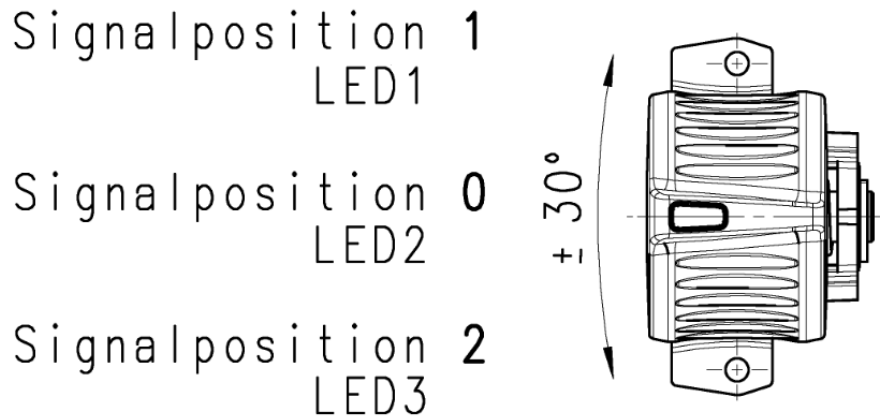
*Figure 6: Joystick Axis Definition*

## **18 Annex C: Multifunctional Grip Definition**

Refer to additional specifications.

## 19 Annex D: Thumb Wheel A/B LED Definition

This figure shows position of LEDs included in thumb wheel.



*Figure 7: Thumb Wheel A/B LED Definition*