KANN–CANopen protocol

V3.2 – 29.3.2023
For firmware Revisions >= V3.02.000
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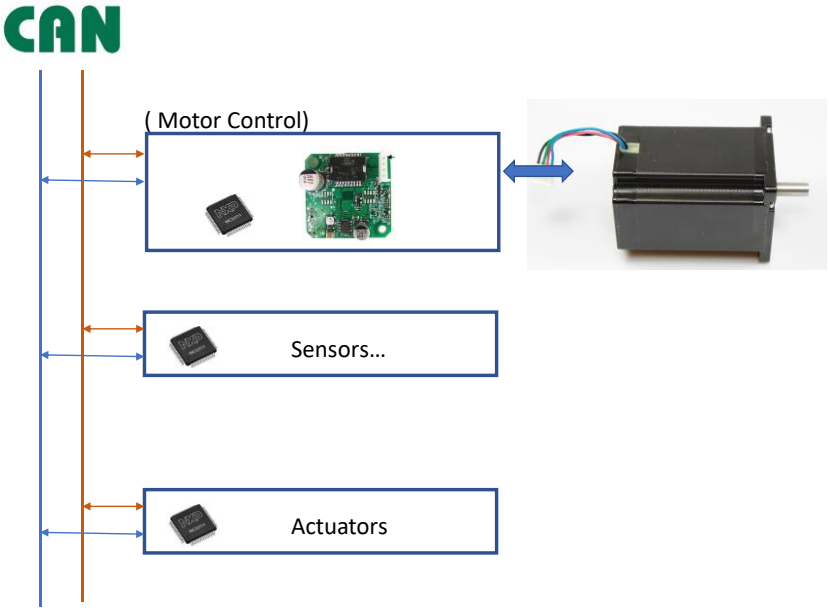
This document is part of the software documentation. It explains special aspects of the CAN-CANopen topic including how to update by a bootloader.

System overview



Contents

1. History

Version	Datum	Description
V2.0	6.11.2020 New Features coming with FW V2.0-002	***KannMotion gets closer with CANopen CiA301 / CiA402*** ***New:*** - SDO 0x1010 New, added - SDO 0x1400-1403 New, added - SDO 0x1600-1603 New, added - SDO 0x1800-1803 New, added - SDO 0x2014 'Save Marked Position as Home' added - SDO 0x2018-2019 New, added - SDO 0x603F New, added - SDO 0x6040 New, added - SDO 0x6041 New, added - SDO 0x6044 New, added - SDO 0x6081 New, added - NMT-Management chapter added ***Changes:*** - SDO 0x2015 changed to USER c-code Info - SDO 0x2020 changed, less parameters - SDO 0x2020:3 .. Control bit for NMT Startup Behave (PreOperatinal or Operational) - SDO error messages: error codes changed - PDO- Mapping - PDO-SYNC integrated
V2.1	23.2.2021 11.8.2021	SDO2014 Information extended SDO6067/6068 Defaults in Table corrected
V2.2	17.11.2021 08.03.2022 22.03.2022	SDO2017 extended SDO2033 Extended specification of 2010-11 and 2011-6 Sample of PDO activation included
V2.3	7.06.2022	SDO 1008, 1009, 100A added
V2.4	9.1.2023	SDO 2033 details added
V3.2	29.3.2023	PDO Mapping changed. Emergency Message added. SDO 6060/6061 Details added. Getting started with CANopen Test-Tool added. Appendix added with packed values list SDO 2021 CANopen Tx-PDO Control added SDO 607E Polarity added

2. Introduction into CANopen communication

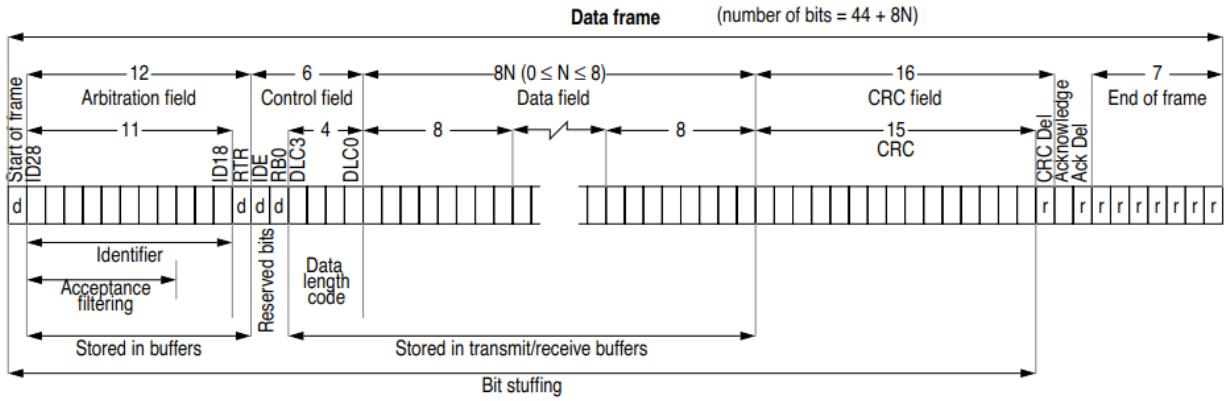
Bit rate

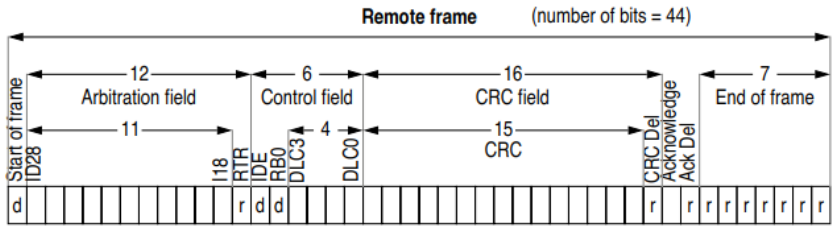
The bit rate can be adjusted to 10k/20k/50k / **125k /250k/500k**.

Table: usual bit rates CANopen:

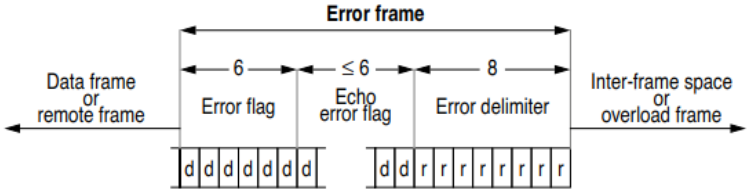
Bit Rate	Max Bus Length (m)	Max Drop Length (m)	Max Cumulative Drop Length (m)
1M	25*	2	10
800k	50*	3	15
500k	100	6	30
250k	250	12	60
125k	500	24	120
50k	1000	60	300
20k	2500	150	750
10k	5000	300	1500

CAN Frame types

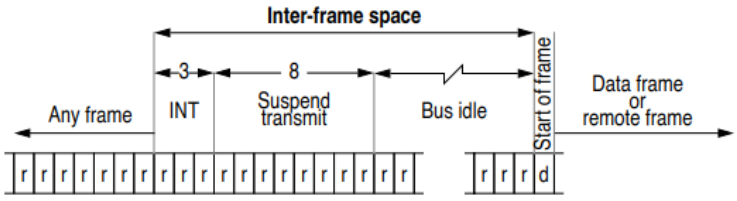




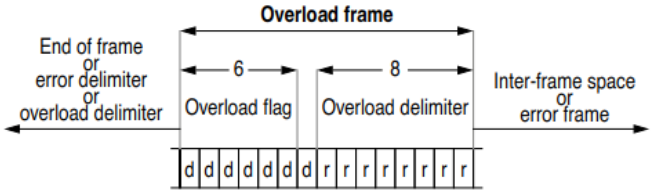
Note: A remote frame is identical to a data frame, except that the RTR bit is recessive, and there is no data field.



Note: An error frame can start anywhere in the middle of a frame.

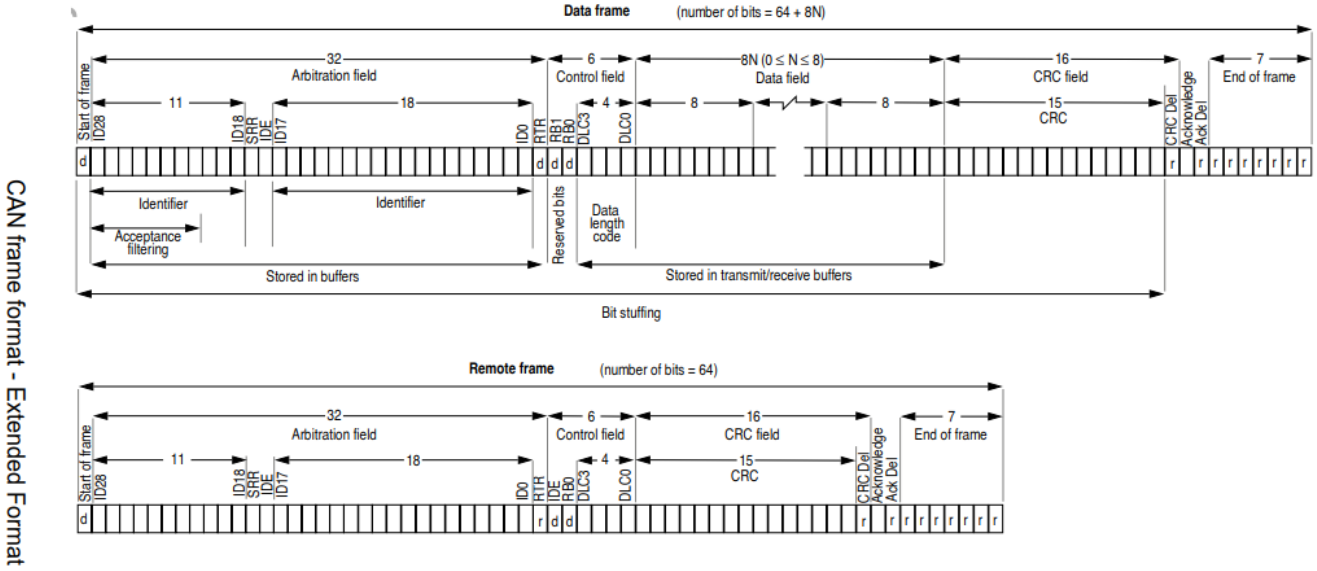


Note: INT = Intermission
Suspend transmission is only for error passive nodes.



Note: An overload frame can only start at the end of a frame.
Maximum echo of overload flag is one bit.

Extended Format



Note: A remote frame is identical to a data frame, except that the RTR bit is recessive, and there is no data field.

Applied Frame types

data frames

Addressing (ID's)

CANopen Default Identifier Distribution

A default indentifier distribuciton saves configuration expenses. Thereby the node number is embedded in the identifier. The default indentifier distribuciton is defined as follows:

Identifier 11-Bit (binär)	Identifier (dezimal)	Identifier (hexadezimal)	Funktion
00000000000	0	0	Netzwerkmanagement
00010000000	128	80h	Synchronisation
0001xxxxxxx	129 - 255	81h - FFh	Emergency
0011xxxxxxx	385 - 511	181h - 1FFh	PDO1 (tx)
0100xxxxxxx	513 - 639	201h - 27Fh	PDO1 (rx)
0101xxxxxxx	641 - 767	281h - 2FFh	PDO2 (tx)
0110xxxxxxx	769 - 895	301h - 37Fh	PDO2 (rx)
0111xxxxxxx	897 - 1023	381h - 3FFh	PDO3 (tx)
1000xxxxxxx	1025 - 1151	401h - 47Fh	PDO3 (rx)
1001xxxxxxx	1153 - 1279	481h - 4FFh	PDO4 (tx)
1010xxxxxxx	1281 - 1407	501h - 57Fh	PDO4 (rx)
1011xxxxxxx	1409 - 1535	581h - 5FFh	SDO senden
1100xxxxxxx	1537 - 1663	601h - 67Fh	SDO empfangen
1110xxxxxxx	1793 - 1919	701h - 77Fh	NMT Error Controll
xxxxxxx = Knotennummer 1 - 127			

Tabelle 2.5: Default-Identifier

CANopen allows a completely free identifier configuration.

Within the pre-defined connection set, the following identifiers are not used:

COB-ID (Identifier values)
001_h - $07F_h$
101_h - 180_h
200_h / 280_h / 300_h / 380_h / 400_h / 480_h / 500_h / 580_h
600_h / 680_h
780_h - $7E3_h$
$7E6_h$ - $7FF_h$

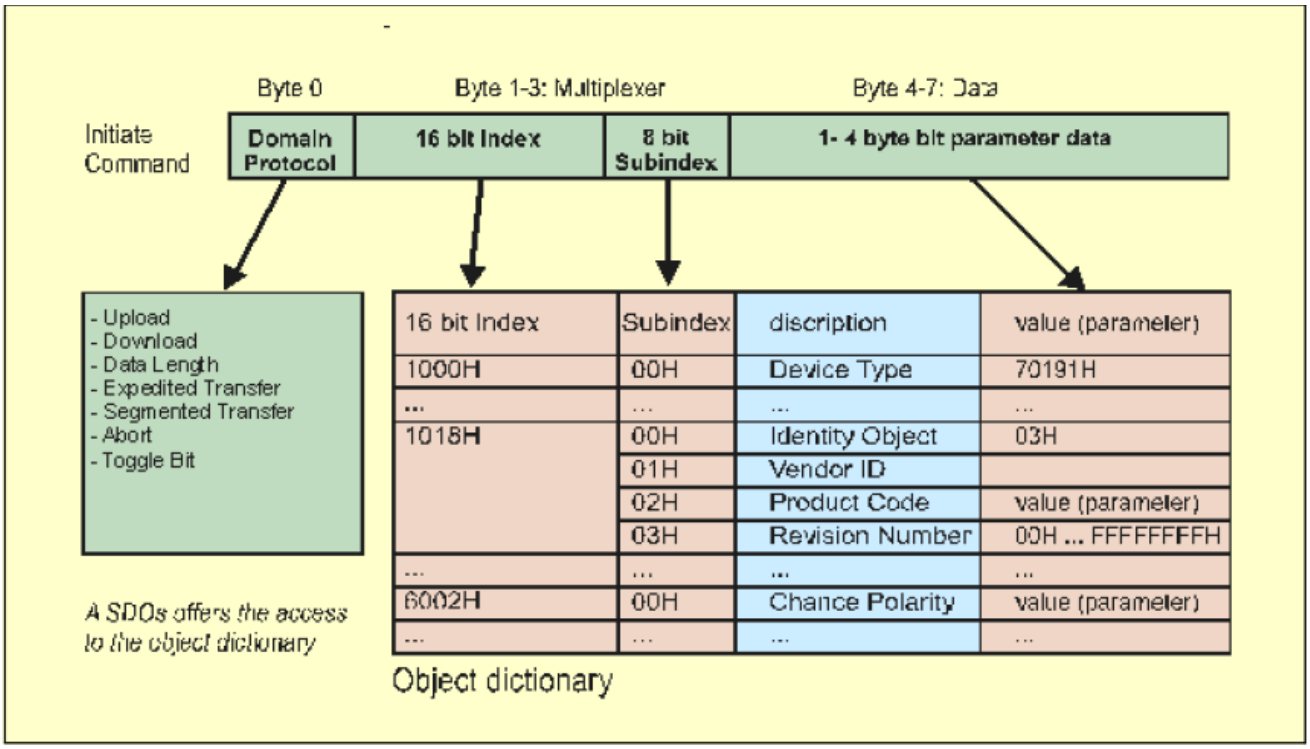
Table 2: Unused identifiers in the Pre-defined Connection Set

Byte ordering: In multibyte variables, the bytes are ordered by significance – lowest significant byte comes first.

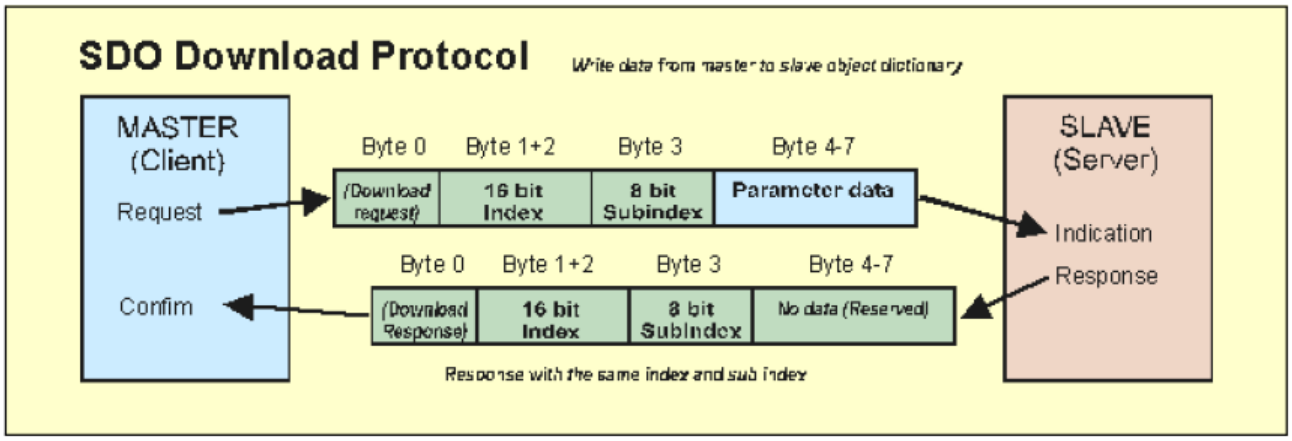
CANopen objects

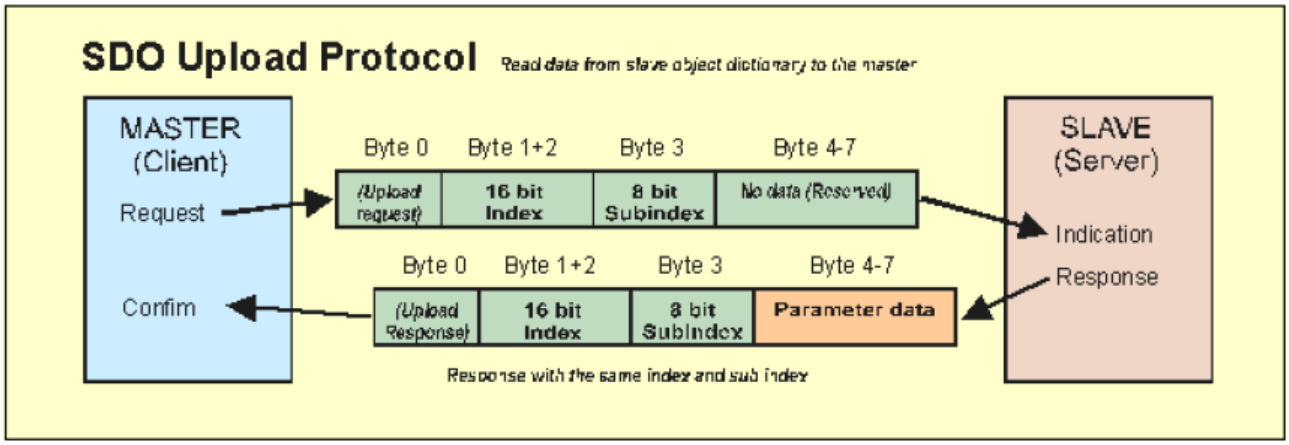
SDO objects (service data object)

A service data object contains a „Domain protocol (8-Bit)“, the „Index (16-Bit)“, the „Sub-Index (8-Bit)“, and up to 4 databytes. The domain protocol contains the action, that follows the parameter, to which refer the index and the sub-index. Are the parameters supposed to get new values, these values can be transmitted in the data bytes.



The 8 bytes of the SDO (as illustrated here) are hosted in the data area of the CAN-Message. The adressing of the node conists of two telegrams at least.





Command	Access to Data 1 - Data 4			Block
	4 byte data (5th - 8th byte)	2 byte data (5th + 6th byte)	1 byte data (5th byte)	
	hex	hex	hex	hex
Write request (Send parameters to drive)	23	2B	2F	Writing not possible
Write Response (Controller response to the write request (acknowledgement))	60	60	60	
Read Request (Request to read a parameter from the drive)	40	40	40	40
Read Response (Response to the read request with an actual value)	43	4B	4F	41
Error response (The controller indicates a communication error)	80	80	80	80

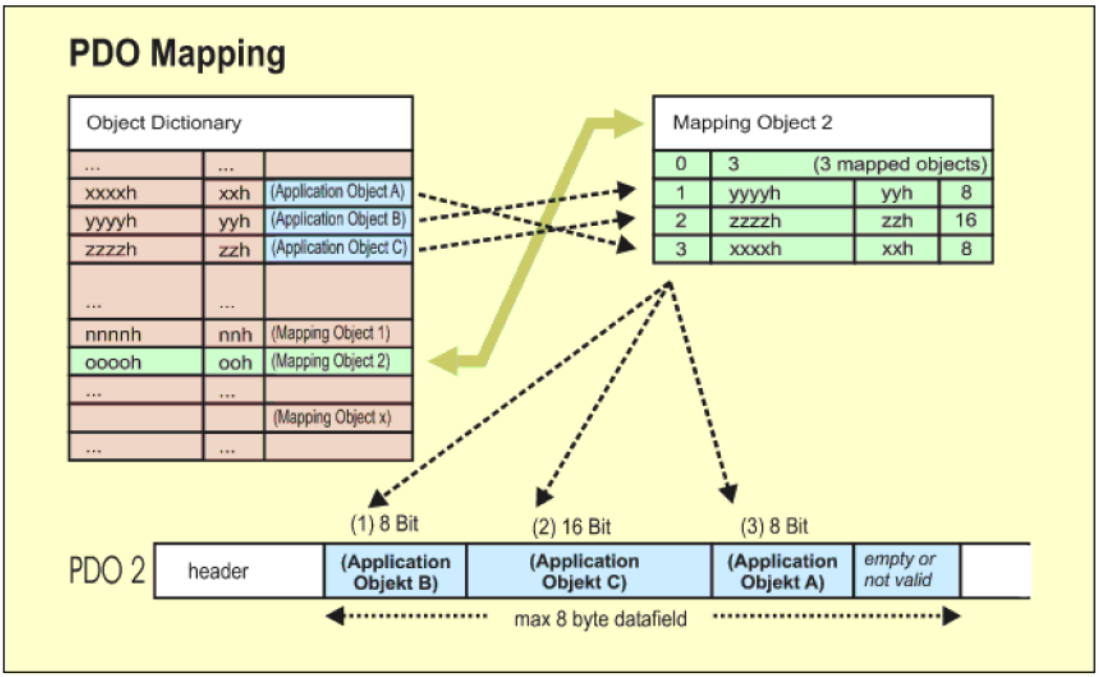
General assignment of the object-index-numbers

Object Index (hex)	Object
0000	Not used
0001 - 001F	Static Data Types
0020 - 003F	Complex Data Types
0040 - 005F	Manufacturer Specific Complex Data Types
0060 - 007F	Device Profile Specific Static Data Types
0080 - 009F	Device Profile Specific Complex Data Types
00A0 - 0FFF	Reserved for further use
1000 - 1FFF	Communication Profile Area
2000 - 5FFF	Manufacturer Specific Profile Area
6000 - 9FFF	Standardized Device Profile Area
A000 - FFFF	Reserved for further use

PDO objects (prozess data objects)

The exchange of process data with CANopen is effected via the CAN-bus, meaning without protocol-overhead. The broadcast-characteristic of the CAN-bus remains completely. A message therefore can be received by all nodes and can be evaluated (producer-consumer-model).
Because the protocol structure in the telegram is missing, the participant of the bus (for whom the data is intended) must know how the information is embedded in the data area of the PDO (which bit/byte is which value). This declaration therefore is affected in advance during the initialization of the net by the so-called PDO-mapping. This allows to place the required information at a certain point in the data area of a PDO.

In order to enable a variable configuration of the PDO data, the mapping itself is effected at a special mapping object. This mapping is in principle a table, in which the objects, that shall be mapped, can be entered.



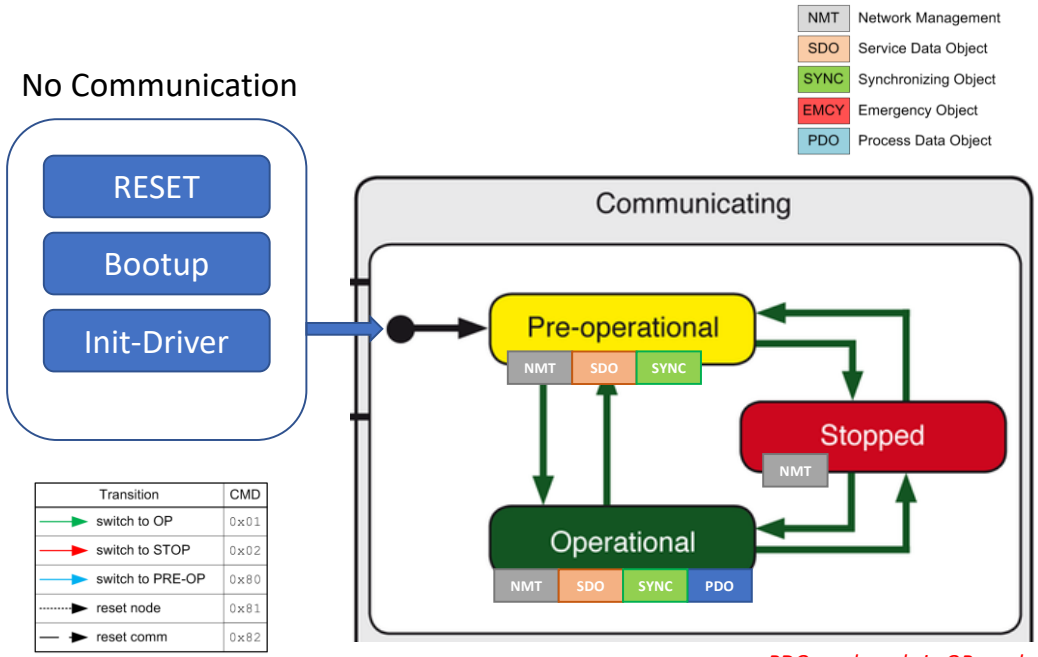
3. implementation of CANopen

The KannMOTION comes with included of CiA301 and CiA402 Standard, extended by some proprietary objects. PDO mapping is shown by SDO and is fix mapped. MPDOs and dynamic SDO-PDO mapping is dispended.
As a Highlight, PDO4 are forwarded to the User specific code section of KannMOTION, so this enables lot of customized wishes to be realized.

Factory Default

A new KannMOTION Drive will have following Preset:
Bitrate: ***250k***
Node Address: ***3 or 0x7F (127)***
Heartbeat: ***2400ms / ON***

Network Management



PDO works only in OP-mode

Network Message, Data length 2-Bytes

CAN ID	Data	
	Byte 0	Byte 1
000	<CMD>	<NodeID>

Byte1: <NodeID> 0x00 -> Broadcast
else -> Message only for device with NodeID

Byte0: <CMD>

CMD	Description
0x01	Switch to Operational
0x02	Switch to Stop
0x80	Switch to Pre-Operational
0x81	Reset-Node (Restart Device)
0x82	Reset Communication (Restart of CAN Module)

NMT State is reportet by Heartbeat

Heartbeat producer

The Heartbeat is showing the actual NMT State

Heartbeat Value	Description
0	Boot-up
1	Off bus
4	Stopped
5	Operational
0x7F	Pre-operational

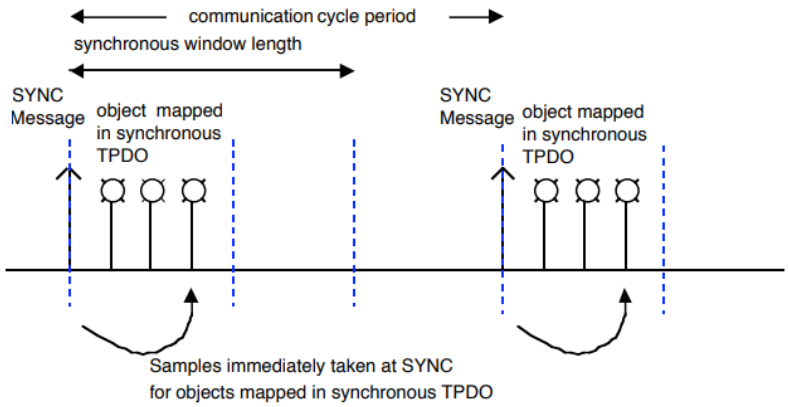
Example, Heartbeat of Node=3

Msg.-Type	Id	DLC	Data (Hex)	Data (ASCII)
STD	703	1	00	.
STD	703	1	05	.
STD	703	1	05	.
STD	703	1	05	.

Sync protocol

CAN-ID	Data		Description
0x80	No data	*(DLC=0)*	Standard sync, see also SDO 1800..1803
0x80	SYNC counter	*(DLC=1)*	Sync Groups

Sync producer might send SYNC message with DLC=0 or DLC=1, in case of DLC=1, only objects are synchronized where SYNC_counter = Content of 0x1800:06.



Emergency protocol

When KannMOTION Enters Error-State, it, sends an Emergency Message.

CAN-ID	Data							
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x80+NodeID	EMCY Error Code		1001	0	603F		0	0

EMCY Error Code:

4. SDO's Object List (Service Data Object)

SDO-accesses (read and write) to the object list are executed by SDO-telegram. The 8 data bytes are split in 4 bytes for the addressing and 4 bytes for user data. SDO-accesses are always responded. At data sizes > 1-Byte <Liddle Endian> is applied in accordance with its specifications. That is to say, the lowest byte is transmitted first.

SDO-object-list

Index (hex)	Sub-Index	Name	Size (bit)	Default Value	Access	Non volatile	Description	PDO-Mapping
1000	0	**Device Type**	u32		ro		Device Type / Stepper 0x00040192	
1001	0	**Error Register**	u8	0	ro		**Bit Meaning** 0: generic error (app not in RUN) 1: current 2: voltage 3: temperature 4: communication error 5: device profile specific 6: Reserved (always 0) 7: Encoder Error	TPDO-2
1005		**COB-ID SYNC message**	u32	0x80	ro		SYNC COB-ID, only consumer	
1008 [5]		**manufacturer device name**	vstr		ro		Device Name	
1009 [5]		**manufacturer hardware version**	vstr		ro		Hardware (as Text)	
100A [5]		**manufacturer software version**	vstr		ro		Firmware (as Text)	
1010	0	**Store parameters** No. of subentries	u8	4	ro			
	1	Save all parameters	u32	0x0001	rw		Write Data = 'Save' = 0x65766173	
	2	Save communication parameters	u32	0x0001	rw			
	3	Save application parameters	u32	0x0001	rw			
	4	Save KannMotion Drive Params	u32	0x0001	rw			
1011	0	Restore default parameters No. of subentries	u8	3	ro			
1017	0	**Heartbeat Time**	u16	2500	rw	YES[4]	**Heartbeat Time in ms** 0: off 20…15000	
1018	0	**Identify Object** / No. of subentries	u8	**6**	ro			
	1	Vendor ID	u32		ro	YES		
	2	Hardware ID Number	u32		ro	YES	ArtNbr: PCB-Board / including Index	
	3	System ID-Number	u32		ro	YES	ArtNbr: Motor complete	
	4	Serial number	u32		ro	YES		
	5	Firmware Revision	u16		ro	YES		
	6	Firmware ID Number	u32		ro	YES		
1400-1403		**Receive PDO Communication Parameter**		**2**	ro	YES[4]	See CiA 301 or *SDO 0x1400…0x1403, Receive PDO-Communication* Parameter	
1600-1603		**Receive PDO Mapping Parameter**		0..3	ro		We use Fixed predefined mapping See CiA 301 or *Activation Example (Step by Step)*	
1800-1803		**Transmit PDO Communication Parameter**		**5**	ro	YES[4]	See CiA 301 or *SDO 0x1800…0x1803, Transmit PDO- Communication* Parameter	
1A00-1A03		**Transmit PDO Mapping Parameter**		0..3	ro		We use Fixed predefined mapping See CiA 301 or *Activation Example (Step by Step)*	

.[4] value might be packed, means there might be a loss in density especially at 16-Bit values, after restart/read, see Appendix
. [5] available depending on firmware revision

Index (hex)	Sub-Index	Name	Size (bit)	Default Value	Access	Non volatile	Description	PDO-Mapping
2010	00	**Motor Drive setup Object** No. of subentries	u8	19	ro		Motor settings 'Driver-Side'	
	01	Driver Factory Setting	u8	0	ro	YES	Factory Settings	
	02	MotStepType	u8	0	ro	YES	12:[15°];24:[7.5°];100:[1.8°];200:[0.9°]	
	03	OutConfig[1)]	u8	0	ro			
	04	Driving Current max.	u16		ro	YES	Default current 100% in [mA] [0..2700]	
	05	Acceleration max	u16		ro	YES	Maximum acceleration [r/s2] [0..0xFF.FF] FixPoint8	
	06	Din Low Threshold[1)]	u16	5000	rw	YES	Input Threshold for digital Inputs [mV]	
	07	Din High Threshold[1)]	u16	15000	rw	YES	Input Threshold for digital Inputs [mV]	
	08	Gear Ratio	u32	1.0 [16777216]	rw	YES	Gear Ratio [0..0xFF.FFFFFF] FixPoint24 in **[mm/Round]** or in **[AxisRound/MotorRound]**	
	09	Gear backlash	s16	0	rw	YES	Back lash from gear box [+/- 32767] in Microsteps	
	0A	Control Mode	u8	0	rw	YES	Control Mode [0..1] [0]: Control in micrometer [um] [1¡: Control in 1/10° [0.1°]	
	0B	Micro steps count	u8	4	rw	YES	Value Range: 0..7 MicroSteps = 2^{Value} -> **4** = 2^4 = **16** Micro steps Available Microsteps: [1,2,4,8,16,32,64,128]	
	0C	Min. speed 0.1 rpm	u16	250	rw	YES	[0.1rpm] e.g. 102 = 10.2 rpm	
	0D	Max. speed 0.1 rpm	u16	1500	rw	YES	[0.1rpm]	
	0E	Torque-HOLD	u8	0	rw	YES	[0.5%], Holding Torque	
	0F	Torque-ACC[2)]	u8	200	rw	YES	[0.5%], ACC Torque	
	10	Torque-RUN	u8	200	rw	YES	[0.5%], RUN Torque	
	11	Torque-DEC[2)]	u8	200	rw	YES	[0.5%], DEC Torque	
	12	Acceleration	u8	200	rw	YES	[0.5%], Acceleration	
	13	Deceleration	u8	100	rw	YES	[0.5%], Deceleration	
	14	Position Regulator Control	u8	0	rw	YES	Position Regulator Control Byte	
	15	Driver Input Filter Control	u8	0	rw	YES	Analog and Digital Input Filter Cntrl	
2011	0	**Motor Control Object** / No. of subentries	u8	**9**	ro		Motor Driver State 'Driver-Side'	
	1	Motor State	u8		ro		**eMS_IDLE = 0,** //!< Motor-Driver is in Standby / Sleep / .. now torque **eMS_HOLD = 1,** //!< Motor-Driver is on, Motor is in stand still **eMS_ROTATE = 0x10,** //!< Start rotation **eMS_GOTOPOS = 0x20,** //!< drive to Position **eMS_DoSTOP = 0x80,** //!< Stop	TPDO-2
	2	Target position	s32	0	rw		Micro-Steps	
	3	Actual position	s32	0	ro		Micro-Steps	
	4	Target speed	s16	0	rw		0.1-rpm	RPDO-2
	5	Encoder position	s32	0	ro		Micro-Steps	
	6	Regulator Bits	u32	0	ro		Info-Bits B0: Closed Loop active B8: Encoder Error B9: Pos Error B10: Homing RUN active B11: Homing shall be Executed (Suggestion) B12: Gear-Calculation Error B13: NewStartNeeded B15: Target Position reached B16: HomingEnd B17: Target Position changed B20: Stall-detected	

	7	Main State	u8		ro			
	8	Temperature	u8		ro		Temp[°C] = (Return Value – 50)	TPDO-2
	9	Errorbits	u8		ro		Lower-8-Bits of 0x603F	
2012	0	Not used	u8		ro			-
2013	0	**Command AND Setting Object** / CMD	u8	**0**	rw		0x00: no CMD 0x01: Goto Home 0x02: Fast-Stop 0x03: Soft-Stop/Rotate 0x04: Store all NV Params into NV .. 0x0F: Clear Error / Retry 0x10: Activate Closed-Loop 0x11: Disable Closed-Loop *While Read: Bit4 shows Closed loop* .. 0x40: Set Actual Pos as Home *see also 0x2014:01* .. 0x51-5F: CAN-Restart Time *0x51 = 32ms (0x52 not accepted)* *0x53 = 96ms (0x54 not accepted)* .. *0x5F = 480ms* *see also 0x2020*	RPDO-2
2014	0	**Homing Control**	u8	3	ro			
	1	Homing Mode	u8	0	rw		Mode see Homing description Set Sub 2 & 3 before Sub 1 will Start Homing Movement	
	2	Homing Timeout [ms]	u16	10000	rw		Timeout in [ms] *0xFFFF = no Timeout*[5)]	
	3	Homing Speed [0.1rpm]	S16	1000	rw		Speed and Direction 0.1rpm/E `[-:CW] /[+:CCW]`	
2015	0	**ADLOS User C-Info**	u8	**8**	ro		ADLOS User C-Info	
	1	UserPrgVersion	u32	0xFFFF	ro		Users specific 'C-Program' Version	
	2	u8_UserPrgTxt Char[1..4]	u32	0xFFFFFFFF	ro		User 'C-Program' Text char [1..4]	
	3	u8_UserPrgTxt Char [5..8]	u32	0xFFFFFFFF	ro		User 'C-Program' Text char [5..8]	
	4..8	u8_UserPrgTxt Char[9..28]	u32	0xFFFFFFFF	ro		User 'C-Program' Text char [9..28]	
2016	0	**ADLOS User VAR, Debug**	u8	**11/20**	ro		ADLOS Access USER RAM	
	01	u16_Timer5ms[0]	u16	0	ro		User Timer	
	02	u16_Timer5ms[1]	u16	0	ro		User Timer	
	03	u16_Timer5ms[2]	u16	0	ro		User Timer	
	04	u16_Timer5ms[3]	u16	0	ro		User Timer	
	05	u8_StepChain[0]	u8	0	ro		User StepChain	
	06	u8_StepChain[1]	u8	0	ro		User StepChain	
	07	u8_StepChain[2]	u8	0	ro		User StepChain	
	08	u8_StepChain[3]	u8	0	ro		User StepChain	
	09	i32_PosVAR_um_01deg[0]	s32	0	ro		User Position Var	
	0A	i32_PosVAR_um_01deg[1]	s32	0	ro		User Position Var	
	0B	i32_PosVAR_um_01deg[2]	s32	0	ro		User Position Var	
2017	0	**Maintainance**	UI_8	**7 / 10**[5)]			ADLOS Maintainance Data	
	1	Total Runtime	u32	0	r	YES *0x0A0*	in [s] 1=1 second	
	2	Critical Temperature Time	u16	0	r	YES	in [s] 1=1 second	
	3	OverTempErrCnt	u16		r	YES	[Events]	
	4	OverCurrErrCnt	u16		r	YES	[Events]	
	5	TimeOutErrCnt	u16		r	YES	[Events]	
5)	6	Stall Error Counter	u16		r	YES	[Events]	
5)	7	U-motor Error Counter	u16		r	YES	[Events]	
5)	8	Driver Chip Error Counter	u16		r	YES	[Events]	
	6 / 9	MinTemperature	UI_8		r	YES	In [°C] w. Offset of 50°C	
	7 / 10	MaxTemperature	UI_8		r	YES	In [°C] w. Offset of 50°C	
2018	0	**DEBUG USER NV-Data**		16			ADLOS Access USER NV	
2019	0	**DEBUG USER DATA**		128			ADLOS Access USER RAM	
2020	0	**CAN Control Object**	u8	4	ro			
	1	Bitrate	u8	1	rw	YES	0:125k/1:250k/2:500k	

	2	NodeAdress	u8	3	rw	YES	1..127	
	3	Control bits	u8	0	rw	YES	B0: NMT-changes automatic into OP-Mode after Reset B4: Closed Loop Position-Control	
	4	ComWatchDogTime [ms]	U16	0	rw	YES[4]	0: off / 50…65535 ms	
2021	0	**CAN Tx PDO Control**	u8	2	ro			
	1	Tx-PDO-1 Control	u8	0x03	rw		Tx PDO Setting when Transmission-Type is 254	
	2	Tx-PDO-2 Control	U8	0x2F	rw			
	3	Tx-PDO-3 Control	U8					
	4	Tx-PDO-4 Control	U8					
2030	0	**Diagnostic EncoderData** Number of subentries	u8	**3**	ro		Encoder Info *.. 12Bit masked*	
	1	Angle	u16		ro		Angle abs	
	2	State	u16		ro		State-Bits	
	3	Temperature	u16		ro		Temperature	
	4	FieldStrength	u16		ro		FieldStrength in Gaus	
	5	Turns	u16		ro		TurnsCounter	
2033	0	**Controller Specific Online Data** Number of subentries	u8	**2..**	ro		Online Data *.. Like Input States* *.. ADC Values* *see specific Controller description*	
	1	Input States	U8		ro		Inputs States-Bit Field *B0: Ain Din0 B1: Din1* *B6: nFault B7: HSE active (crystal Clock)*	
	2	ADC_value-Ain	u16		ro		[8.8644 mV/E]	
	3	ADC_value-Vin	u16		ro		[8.8644 mV/E]	
	4	ADC_value-Vmot[1)2)]	u16		ro		[8.8644 mV/E]	

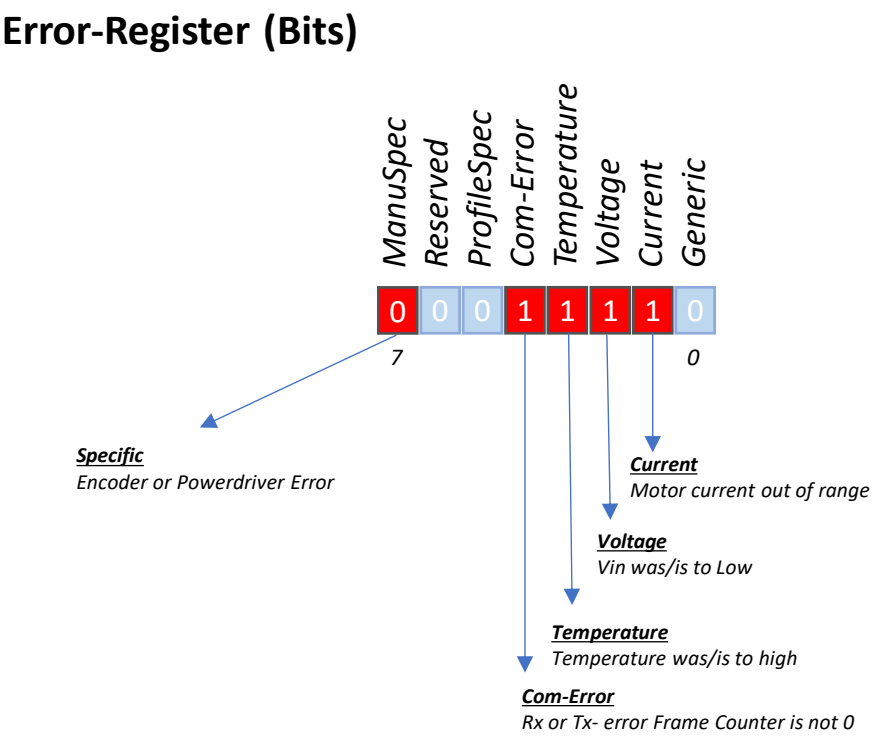
.[1)] onyl effective if IO in hardware exists
.[2)] depending on hardware / firmware not used
. [5)] available depending on firmware revision

Index (hex)	Sub-Index	Name	Size (bit)	Default Value	Access	Non volatile	Description	PDO-Mapping
603F	0	**ErrorCode**	u16		ro	X	Error Code	TPDO-2
6040	0	**Controlword**	u16		rw	?	Drive Control-Bits	
6041	0	**Statusword**	u16		ro		Drive State-Bits	TPDO-1
6042	0	**vl target Velocity**	i16		rw		same as 0x2011:04	
6044	0	**vl Velocity actual value**	i16		ro		Velocity actual value [0.1rpm]	TPDO-1
6046	0	**vl_velocity_min_max_amount**	u8	**2**	ro			
	1	vl_velocity_min_amount	U32		rw		vl_velocity_min_amount same as 0x2010:0C	
	2	vl_velocity_max_amount	U32		rw		vl_velocity_max_amount same as 0x2010:0D	
6060	0	**Modes of operation**	u8		rw		Set operation Mode: 1: Profile Position Mode PP 3: Profile Velocity Mode 6: Homing Mode	
6061	0	**Modes of operation display**	u8		ro		Read Active operation Mode	
6064	0	**actual Position**	i32	0	ro (rw)		Actual position in **[1um]** or **[0.1 °]** *depending on 6041-Bit8*	TPDO-1
6067		**Position Window**	U32	9	rw	YES	Target position tolerance in **[1um]** or **[0.1 °]** *depending on 6041-Bit8* 2…4000	
6068		**Position Window Time**	U16	50	rw	YES	Target position window time in **[ms]** [2] 10…2000	
607A	0	**Target Position**	i32	0	rw		Target position in **[1um]** or **[0.1 °]** *depending on 6041-Bit8*	RPDO-1
607D	0	**Position Limit** No. of subentries	u8	**2**	ro		Limits Object	
	1	Min Position Limit	i32	0	rw	YES	Min Limit in **[1um]** or **[0.1 °]** *depending on 6041-Bit8*	
	2	Max Position Limit	i32	30000	rw	YES	Max Limit in **[1um]** or **[0.1 °]** *depending on 6041-Bit8*	
607E	0	**Polarity**	U8		rw	YES [3)]	0x00: Standard 0xC0: Inverted Axis (CW-> CCW)	
607F	0	**Max Profile Velocity**	U32		rw	YES [3)]	The max profile velocity is the maximum allowed speed coupled with 2010:0D in **[0.1rpm/E]**	
6081	0	**Profile Velocity**	U32		rw		velocity normally attained at the end of the acceleration ramp during a profiled move and is valid for both directions of motion in **[0.1rpm/E]**	RPDO-3
6083	0	**Profile Acceleration**	U32		rw	YES [3)]	Acceleration *same as [0x2010:18]* in **[0.5%]** of [0x2010:5]	
6084	0	**Profile Deceleration**	U32		rw	YES [3)]	Deceleration *same as [0x2010:19]* in **[0.5%]** of [0x2010:5]	

.[1)] only effective if IO in hardware exists
.[2)] depending on hardware / firmware not used
.[3)] store instruction needed
.[4)] value might be packed, means there might be a loss in density especially at 16-Bit values, after restart/read!

SDO-Details

SDO 0x1001 Error Register



SDO 0x1017 Producer Heartbeat Time

The heartbeat is transferred to the according identifier. The slaves report periodically to the master (the period is adjustable, which is helpful especially for debugging). In this way the availability of the system is checked. The heartbeat time can be adjusted or turned off with SDO 0x1017.

Slave Heartbeat

The slave heartbeat has the following characteristics:

- Produced by slave nodes on the network
- Consumed by the CANopen master
- The COB ID range is in the range 0x701 – 0x77F
- The data frame is 1 byte in length and contains a description of the slave node's communication state according to the table below:

Heartbeat Value	Description
0	Boot-up
1	Off bus
4	Stopped
5	Operational
0x7F	Pre-operational

COB ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x701	1	05	-	-	-	-	-	-	-

SDO 0x1400…0x1403, Receive PDO- Communication Parameter

Defines the functionality of a PDO. Due to the fact of fixed PDO Mapping these SDOs are Read only.

Object-ID				Sub-Index			Description
0x1400	0x1401	0x1402	0x1403				
2	2	2	2	**0**	*U8*	*ro*	Largest sub-index supported
0x4000'0200 +Node	*0x4000'0300 +Node*	*0x4000'0400 +Node*	*0x4000'0500 +Node*	**1**	*U32*	*ro*	PDO COB-ID
0xFE	*0xFE*	*0xFE*	*0xFE*	**2**	*U8*	*rw*	Transmission type *[0 or 0xFE]*

Structure of PDO COB-ID entry

UNSIGNED32

	MSB				LSB
bits	*31*	*30*	*29*	*28-11*	*10-0*
11-bit-ID	0/1	0/1	0	00000000000000000	11-bit Identifier
29-bit-ID	0/1	0/1	1	29-bit Identifier	

PDO COB-ID entry, Bit representation

bit number	value	meaning
31 (MSB)	0	PDO exists / is valid
	1	PDO does not exist / is not valid
30	0	RTR allowed on this PDO
	1	no RTR allowed on this PDO
29	0	11-bit ID (CAN 2.0A)
	1	29-bit ID (CAN 2.0B)
28 – 11	0	if bit 29=0
	X	if bit 29=1: bits 28-11 of 29-bit-COB-ID
10-0 (LSB)	X	bits 10-0 of COB-ID

PDO Transmission types

transmission type	PDO transmission				
	cyclic	acyclic	synchronous	asynchronous	RTR only
0		X	X		
1-240	X		X		
241-251	- reserved -				
252			X		X
253				X	X
254				X	
255				X	

Transmission type	Description
0	Data will be copied into PDO while receiving a Sync, PDO is sent/executed afterwards Event occurs
1-240	Data will be copied into PDO while receiving a 1..240 Sync message. '1' means at every Sync frame, 2 at every second…
254 **255**	Data will be copied into PDO when Event occurs and is sent/executed directly

SDO 0x1800…0x1803, Transmit PDO- Communication Parameter

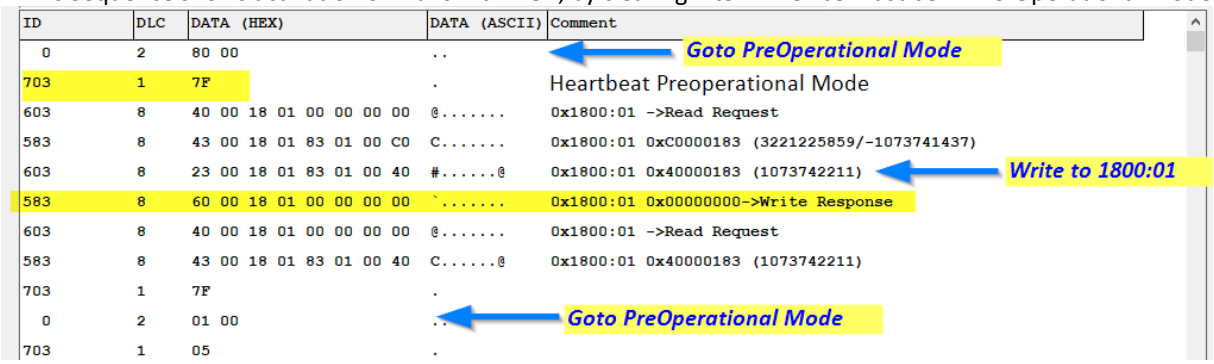
Defines the functionality of a PDO. Due to the fact of fixed PDO Mapping these SDOs are Read only.

Object-ID				Sub-Index			Description
0x1800	**0x1801**	**0x1802**	**0x1803**				
6	6	6	6	**0**	*U8*	*ro*	Largest sub-index supported
0xC000'0180 +Node	*0xC000'0280 +Node*	*0xC000'0380 +Node*	*0xC000'0480 +Node*	**1**	*U32*	*rw*	PDO COB-ID *only Bit31 might be set/cleared to activate PDO*
0xFE	*0xFE*	*0xFE*	*0xFE*	**2**	*U8*	*rw*	Transmission type *Supported values: 0..240; 254, 255*
100	100	-	-	**3**	*U16*	*ro*	Inhibit time [x100us]
-	-	-	-	**4**	*U8*	*ro*	Compatibility entry, not applicable
0 [3)]	0	0	0	**5**	*U16*	*rw*	Event timer [x1ms] *Supported values: 0; 10..65535* *0: Event off*
0	0	0	0	**6**	*U8*	*rw*	Sync start value *(TxPDO is managed when SYNC message with DLC=1 was received, SYNC data(counter) = Sync Start value, this parameter is combined w. transmission type)* *0: off, no group match*

3) this value was in previous versions represented by **SDO 0x2020:05**

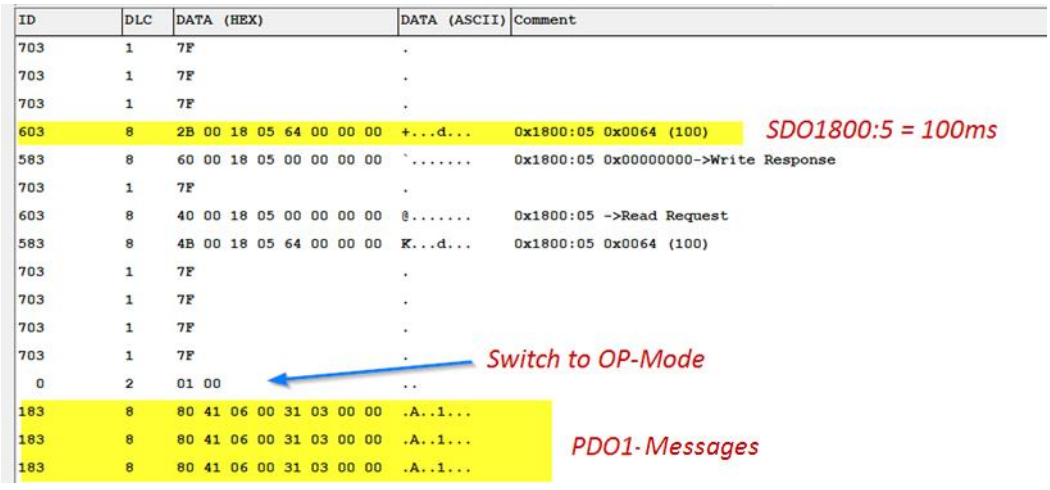
Activation Example (Step by Step)

.. This Sequence shows activation of Transmit-PDO1, by clearing Bit31 .. Device must be in Pre-Operational Mode



ID	DLC	DATA (HEX)	DATA (ASCII)	Comment
0	2	80 00	..	
703	1	7F	.	Heartbeat Preoperational Mode
603	8	40 00 18 01 00 00 00 00	@.....	0x1800:01 ->Read Request
583	8	43 00 18 01 83 01 00 C0	C.....	0x1800:01 0xC0000183 (3221225859/-1073741437)
603	8	23 00 18 01 83 01 00 40	#.....@	0x1800:01 0x40000183 (1073742211)
583	8	60 00 18 01 00 00 00 00	`.....	0x1800:01 0x00000000->Write Response
603	8	40 00 18 01 00 00 00 00	@.....	0x1800:01 ->Read Request
583	8	43 00 18 01 83 01 00 40	C.....@	0x1800:01 0x40000183 (1073742211)
703	1	7F	.	
0	2	01 00	..	
703	1	05	.	

.. Set Transmission Interval to 100ms



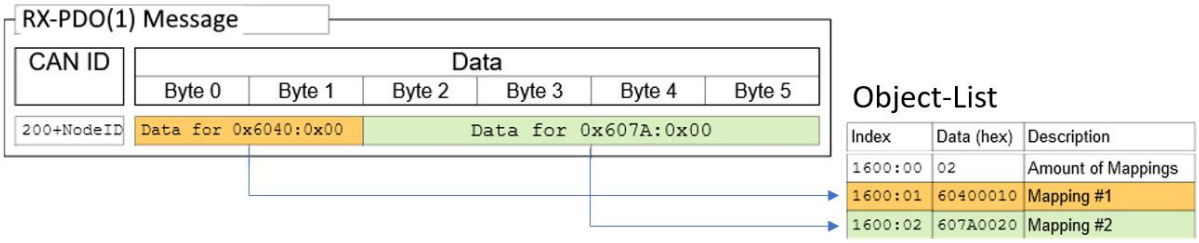
ID	DLC	DATA (HEX)	DATA (ASCII)	Comment
703	1	7F	.	
703	1	7F	.	
703	1	7F	.	
603	8	2B 00 18 05 64 00 00 00	+...d...	0x1800:05 0x0064 (100)
583	8	60 00 18 05 00 00 00 00	`.....	0x1800:05 0x00000000->Write Response
703	1	7F	.	
603	8	40 00 18 05 00 00 00 00	@.....	0x1800:05 ->Read Request
583	8	4B 00 18 05 64 00 00 00	K...d...	0x1800:05 0x0064 (100)
703	1	7F	.	
703	1	7F	.	
703	1	7F	.	
703	1	7F	.	
0	2	01 00	..	
183	8	80 41 06 00 31 03 00 00	.A..1...	
183	8	80 41 06 00 31 03 00 00	.A..1...	
183	8	80 41 06 00 31 03 00 00	.A..1...	

SDO 0x1600…0x1603 / 0x1A00…0x1A03, PDO-Mapping Parameter

Defines the Mapping to the SDO-object List of certain PDO.
Object 0x1600 defines Mapping of RxPDO1 (0x200+Node)
Object 0x1601 defines Mapping of RxPDO2 (0x300+Node)
..
Object 0x1A00 defines Mapping of TxPDO1 (0x180+Node)
Object 0x1A01 defines Mapping of TxPDO2 (0x280+Node)
..

Due to the fact of fixed PDO Mapping, this SDOs are Read-Only, means these objects will give back the static, fixed predefined Mapping information of dedicated PDOs.

Example of a Rx-PDO1 Mapping Parameter (Description)



Mapping Entry: Object-ID (2-Bye), Sub-ID (1-Byte), Number of Bits (1-Byte)

SDO 0x2010, motor drive setup

This object is used to adapt specific drive settings to motor/ gear, like max. motor current, step range etc. Corresponding knowledge is necessary. These parameters are normally preset by Adlos.

0x2010:08: Gear Ratio

Gear Ratio is predefined by ADLOS while drive end test according to drives properties. In some cases it might be useful to change Gear-Ratio by yourself, such cases might be:

- You mount the drive to spindle, and your interest is on final move on the spindle
- You mount your own gear on it

How to proceed:

- Depending on Gear-Type you need to change drive Control mode from 1:[0.1°] to 0:[um] or vice versa
  Object: SDO 0x2010-10, Setting=0 for e.g. spindle, linear moves / 1 for e.g. rotative moves
- Calculate Gear Ratio, write it into 2010-8
- Call Store CMD

Linear [um] Mode:
Slider moves 2mm/round of stepper motor axis

$$GearRatio = \frac{MoveDistance}{Motor{-}round} * 0x100'0000 = \frac{2mm}{1} * 16'777'216 = 0x200'000 = 33'554'432$$

Rotative [0.1°] Mode:
Gear output axis turns ½/round of stepper motor axisl

$$GearRatio = \frac{GearOutrounds}{Motor{-}round} * 0x100'0000 = \frac{0.5}{1} * 16'777'216 = 0x80'000 = 8'388'608$$

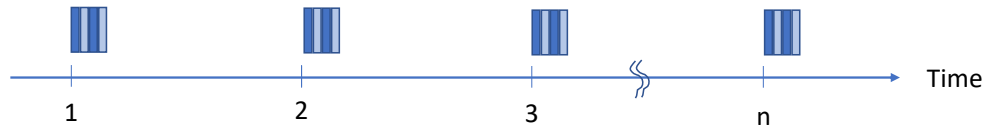
0x2010-21: Filter Control

Configuration Parameter <0x2010:21> Filter Settings Details

Filter Setting parameter enables, filter choice for each digital input, and also for analog input.

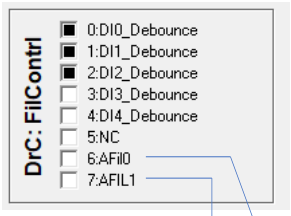
IO-Ain Sampling scheme

Every input is (if possible) sampled as an analogue input, 1 sample is converted for each channel every 1-ms



Without selecting a extra filtering by Parameter 21, every sample is added to a buffer, wich is acting as an low-pass filter of first order. Additionaly you might add a second filter by param 21, as describben below.

Filter Setting / Bit Representation



Digital Input signal Filtering
1-Bit for each Input (Set/Not Set)

Dix_Debounce	
0	Standard low-pass filter, 1. order SR=1ms t=5ms
1	Debounce filter, for mechanical switches SR=1ms t=24ms

analog Input Filter Selection

AFIL1	AFil0	Comment	
0	0	Standard low-pass filter, 1. order	SR=1ms t=5ms
0	1	Mean-Filter (of 8-Values)	SR=5ms t=40ms
1	0	Median-Filter (of 8-Values)	SR=5ms t=40ms
1	1	Reserved	

SR: sample rate

for electromechanical switches, use Debounce filter setting for proper operation.

SDO 0x2011, motor control and state

This object can be seen directly at the motor axis, that is to say these parameters are on Hardware Layer of firmware, so as an example motor axis position parameter are held in Micro-Steps. This object might be used for control or debug purpose.

SDO 0x2013, Command Execution

This object serves to execute specific motor-CMDs.

SDO 0x2014, Homing Control (Sub=1)

```
Return:     Errorcode          see error codes
```

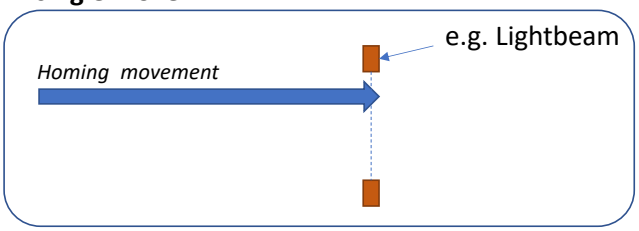
2014:01: will execute Homing Command, if 6060 ist set to AdlosHomingMode (-1)!

Homing modes

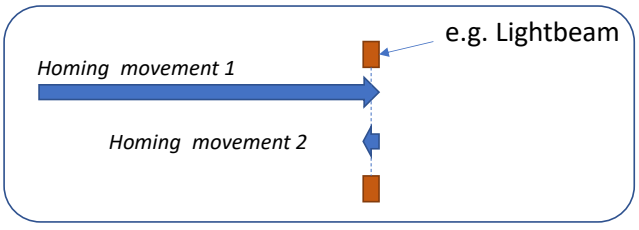
Mode	Type	Description	Timeout	Accuracy
0x00	Store Home	Save actual Position as Home (0)	na	na
0x01	Store 'Stall-Mark' as Home	Saves during Homing generated Mark as 0, this means actual Posiion might be different to Mark.. Use this command after a Homing on Stall, to get better precision	na	na
0x1m	Single move	Move until **stall** <m> is Torque Setting (TorqRunACCDEC * m / 15)	YES	Lo
0x2n	Single move	Move until **Input <n>, signal goes <Lo>**	YES	Med
0x3n	Single move	Move until **Input <n>, signal goes <Hi>**	YES	Med
0x4n	Double move	Move until **Input <n>, signal goes <Lo>** than direction change and 1/10 speed until **signal goes <Hi>**	YES	Hi
0x5n	Double move	Move until **Input <n>, signal goes <Hi>** than direction change and 1/8 of speed until **signal goes <Lo>**	YES	Hi
0xFF	Break/Stop	Stop Homing	na	na

n: defines Digital Input number *m: defines Running Torque (reduction) [0..15]*

single move



Double move



Homing Functionality could be also used for driving to a sensor mark, or to detect the driving boarders. Caused by this, if you would storee reached position as Zero (Homing Mark) it's needed to send a <Store-Home> frame after homing mevements.

Homing movements will take some time, you can check progress by polling the <App-state> or you Enable <PosReach> Event or SDO 2011-6 -B10.
Set 2014:02 and 2014:03 before starting Homing with 2014:01.

SDO 0x2020, CAN Control Object

This object allows you to change Bitrate &, Node address and ComWatchtime. To activate changed parameters, you need to set a restart by NMT management, see Network Management.

Procedure change Bitrate/ Node Address:

- Transmit desired new node address. (0x2020:2)
- Transfer desired new bit rate. (0x2020:1)
- Store it (0x1010:2)
- Send CMD on (0x2013:0) CMD = 0x51..5F depending on OFF-Time

0x2013:0 -0x51 Disables CAN module for 1x32ms, then it Restarts CAN module with new setting
-0x52 means 2x32ms

ComWatchDogTime

With this parameter it is possible to arrange that the movement of a drive is stopped, if no active communication takes place (avoiding running for ever while CAN bus is broken). Setting this time to a longer value than you do cyclic/periodically refresh your driving command. So if you communicate all 100ms w. this device you should set this value to >100ms, e.g. 200ms.

ComWatchDogTime[2)] ms	U16	0	rw	YES	0: off / 50…65535 ms

If you e.g have sent a rotate command, the drive turns at this speed. If contact is broken for some reason (PC off) the drive does not stop. But if you set this parameter to 2000ms, the motors stops 2000ms after the last communication CMD was received.

Control bits

Bit0 NMT change automatically at Startup
Reset: NMT Operation state is changing automatically at startup to <PreOperational State>
Set: NMT Operation state is changing automatically at startup to <Operational State>
Bit4 Closed Loop
Reset motor position is not controlled while passive
Set motor position is controlled to target and 0x6067, position might be corrected automatically.

SDO 0x2021, CANopen Tx PDO Control Object

Defines drive cyclic T_PDO communication in Asynchronous communication mode. This allows definition of Change-Event generation, based on PDO-Data Bytes. This object is only relevant if Transmission Type of PDO is defined to 254 (see SDO 1800:02/1801:02 ..) . Tx-PDO Byte Mapping see *PDO Mapping (Process Data Objects)*

Examples

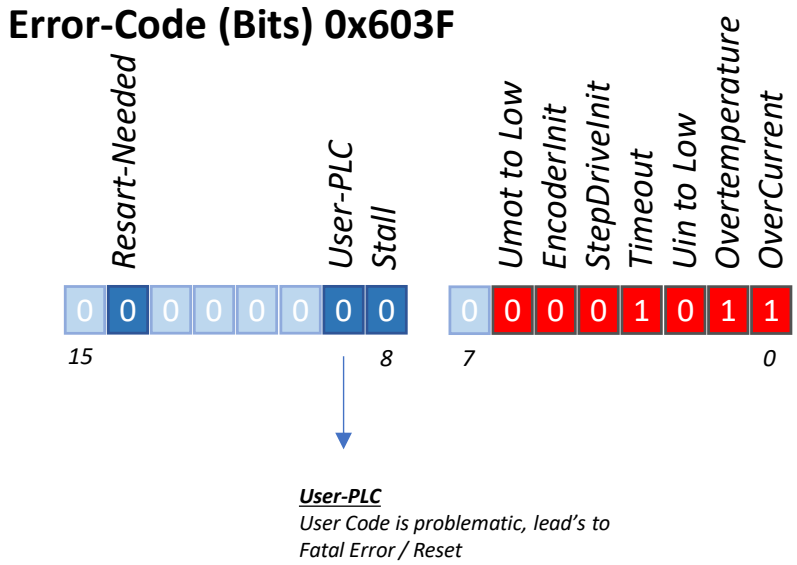
0x1800		**0x2021**	**Description**
Subindex **0x02** Transmission Type	Subindex **0x05** Event Timer	Subindex **0x01**	
0xFE	100	0x00	Cyclic sending T-PDO1 every 100ms
0xFE	100	0x03	Sending T-PDO1 every change of Status-Word (Byte1&2) and latest every 100ms

0x1801		**0x2021**	**Description**
Subindex **0x02** Transmission Type	Subindex **0x05** Event Timer	Subindex **0x02**	
0xFE	10	0x00	Cyclic sending T-PDO2 every 10ms
0xFE	1000	0x02	Sending T-PDO2 every change of Motor State (Byte2) and latest every 1000ms
0xFE	1000	0x22	Sending T-PDO2 every change of Motor State (Byte2) or App-State (Byte6) and latest every 1000ms

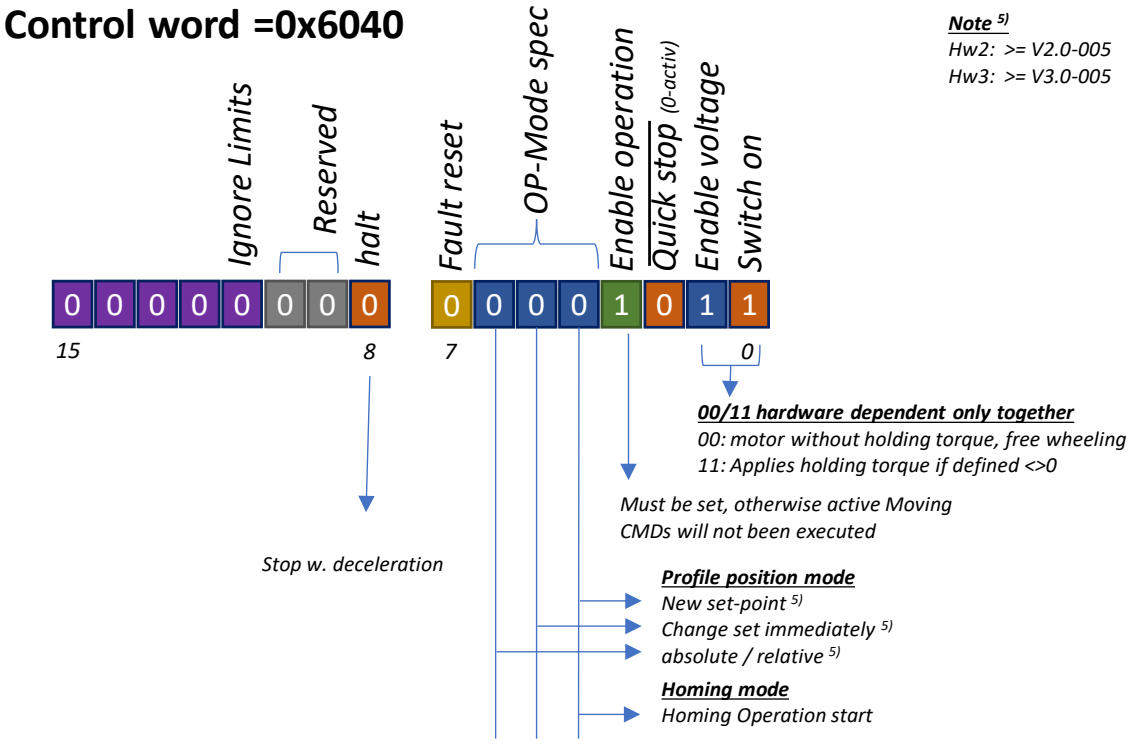
SDO 0x603F, ErrorCode

contrary to the CANopen CiA402-3 standard, we do not represent the official CANopen Error-Codes! The official error codes would be defined in CiA301 Table 25&26 and CiA402-3 Table 24.

Actually, the object 603F is representing an Error-Bit structure, where every bit represents one dedicated Error source. There might be more than one error active.



SDO 0x6040, Controlword



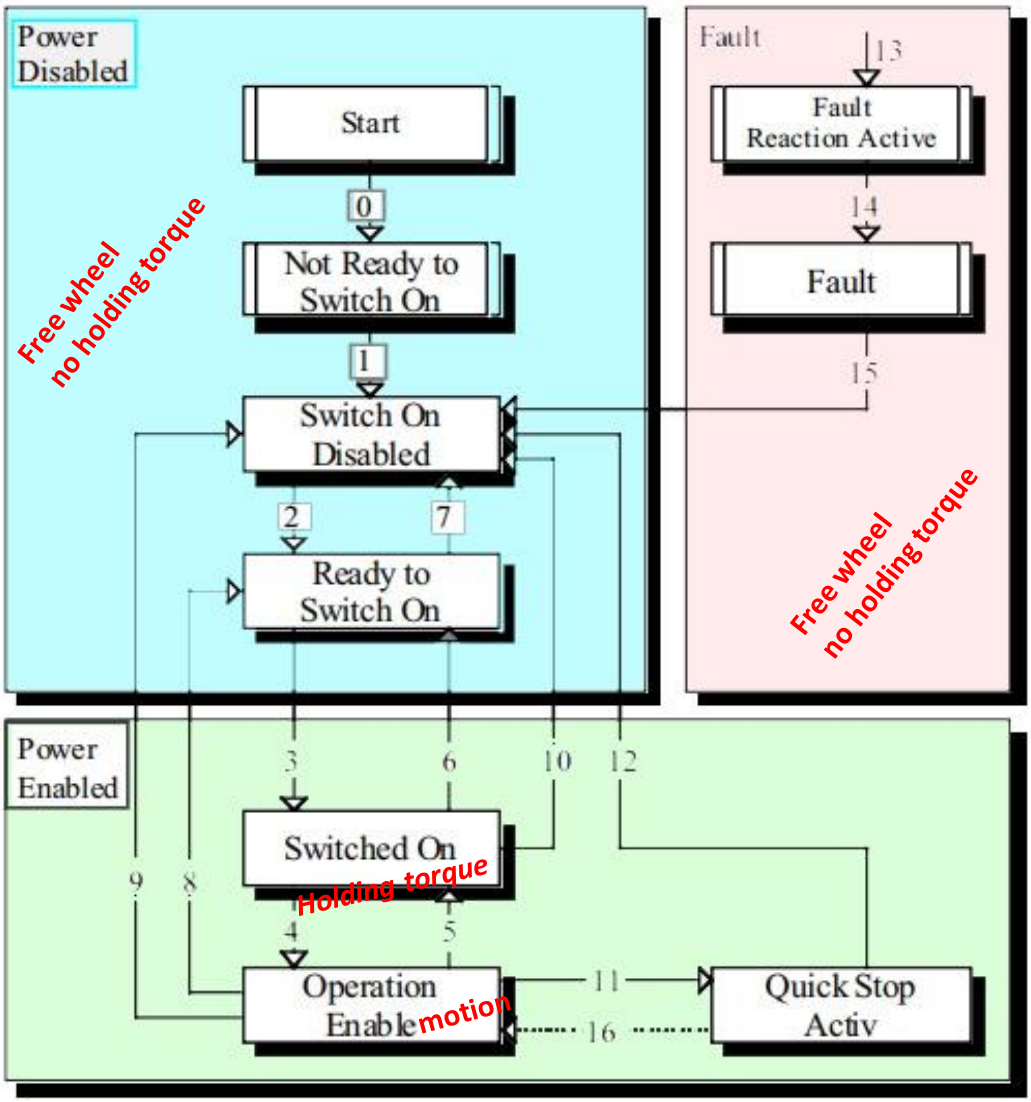
BITS 0 – 3 AND 7:

Device control commands are triggered by the following bit patterns in the *controlword*:

Command	Bit of the *controlword*					Transitions
	Fault reset	Enable operation	Quick stop	Enable voltage	Switch on	
Shutdown	0	X	1	1	0	2,6,8
Switch on	0	0	1	1	1	3*
Switch on	0	1	1	1	1	3**
Disable voltage	0	X	X	0	X	7,9,10,12
Quick stop	0	X	0	1	X	7,10,11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4,16
Fault reset	↑	X	X	X	X	15

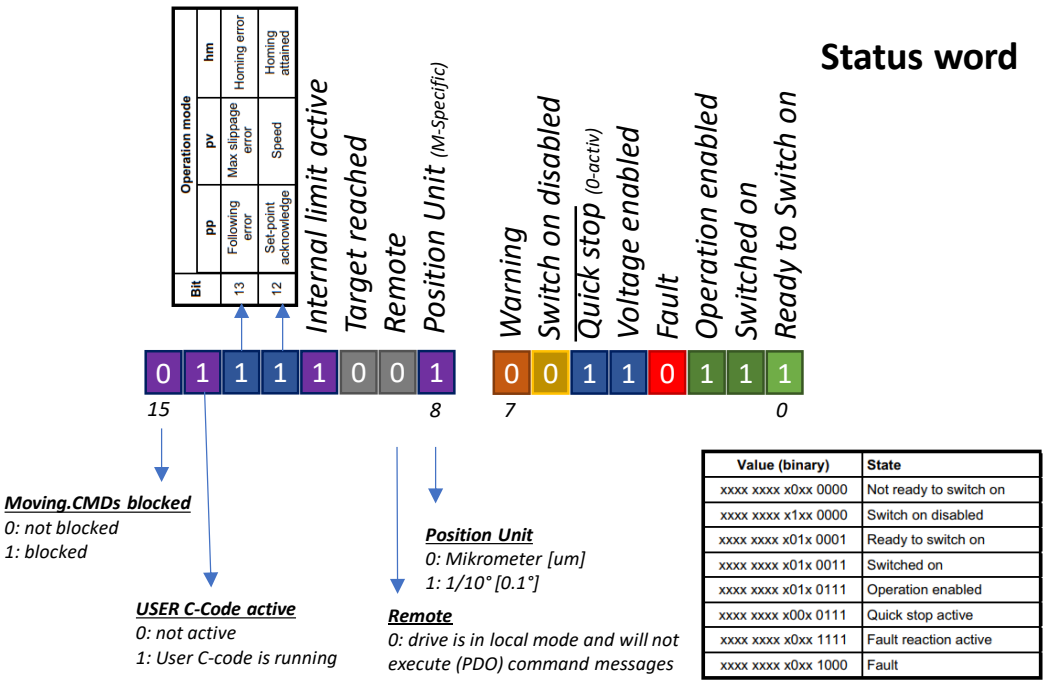
Table 4: Device control commands **(bits marked X are irrelevant, * ... In the state SWITCHED ON the drive executes the functionality of this state., ** ... It exists no functionality in the state SWITCHED ON. The drive does not do any in this state.)**

State-machine according DSP402



- Transitions (0,1,13,14) are done automatically by drive
- Transitions (3,4) might be done automatically by drive (in Position mode)
- Transition (16) is not implemented.
- All other Transitions need to be introduced by Control word 6040

SDO 0x6041, Statusword



Value (binary)	State
xxxx xxxx x0xx 0000	Not ready to switch on
xxxx xxxx x1xx 0000	Switch on disabled
xxxx xxxx x01x 0001	Ready to switch on
xxxx xxxx x01x 0011	Switched on
xxxx xxxx x01x 0111	Operation enabled
xxxx xxxx x00x 0111	Quick stop active
xxxx xxxx x0xx 1111	Fault reaction active
xxxx xxxx x0xx 1000	Fault

Notes:

Moving CMDs blocked

- CAN Moving CMDs, where the drive needs to do some movements are not executed. (like GotoPosition/Rotate/Homing)… this might be as an impact of internally running user c-sequence, this bit might also been set if a drive parameter change needs a Restart for proper Recalculation, see ErrorCode for mor information

SDO 0x6060, 6061 Modes of operation / Modes of operation Display

Value	Definition
-1	KANNmotion Homing mode
0	No mode change/no mode assigned
+1	Profile position mode
+2	Velocity mode
+3	Profile velocity mode
+4	Torque profile mode
+5	Reserved
+6	Homing mode
+7	Interpolated position mode
+8	Cyclic sync position mode
+9	Cyclic sync velocity mode
+10	Cyclic sync torque mode
+11	Cyclic sync torque mode with commutation angle

SDO 0x607D, Limits

- Limits are newly set after the homing run.

SDO 0x607E, Polarity

Might be used to invert Position-Axis (Direction), means CW -> CCW effective motor direction.

607E	**Polarity**	U8	rw	YES [3)]	0x00: Standard 0xC0: Inverted Axis (CW-> CCW)

For effective change the polarity, you need to Store configuration by SDO 0x1010:04 and after storage you need to Restart your drive. (Reset or PowerUp)!
The Direction change is valid for all mode of operations (Positioning, Velocity and Homing -Mode)

SDO error messages

A SDO request always will be responded, that is to say a WR request as well. But the SDO request also could report a error code.

Abort SDO Transfer

CAN ID	Data							
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
600/580 + NodeID	0x80	<IDX>		<SUBIDX>	<ERROR CODE>			

Example:

Verworfene / nicht zuweisbare Datenpackete [0x60 = Write Response] [0x80 = Fehler]

Msg.-Type	ID	DLC	DATA (HEX)	DATA (ASCII)
STD	583	8	60 11 20 02 00 00 00 00	`. .....
STD	583	8	80 10 20 07 FF 00 00 00	.. ..

Illustration 1: not assigned request by the tool

The second answer, which could not be assigned by the tool, concerns a error message.
The error message is coded as follows:

- 1. Byte 0x80
- 2.&3. Byte SDO Object in this case 0x2010 (Liddle Endian coded)
- 4. Byte errror message in this case 0xFF = (-1)

SDO Error codes

Error Code	Description
05030000h	*toggle bit not changed*: Gültig nur bei "normal transfer" oder "block transfer". Das Bit, welches nach jeder Übertragung zu alternieren hat, hat seinen Zustand nicht geändert.
05040001h	*command specifier unknown*: Das Byte 0 des Datenblocks enthielt einen nicht zulässigen Befehl.
06010000h	*unsupported access*: Falls über CAN over EtherCAT (CoE) ein "complete access" angefordert wurde (wird nicht unterstützt.)
06010002h	*read only entry*: Es wurde versucht, auf ein konstantes oder nur lesbares Objekt zu schreiben.
06020000h	*object not existing*: Es wurde versucht, auf ein nicht vorhandenes Objekt zu zugreifen (Index fehlerhaft).
06040041h	*objekt cannot be pdo mapped*: Es wurde versucht, ein Objekt in das PDO zu mappen, für dass das nicht zulässig ist.
06040042h	*mapped pdo exceed pdo*: Würde das gewünschte Objekt in das PDO-Mapping angehängt werden, würden die 8Byte des PDO-Mappings überschritten.
06070012h	*parameter length too long*: Es wurde versucht, auf ein Objekt mit zu vielen Daten zu schreiben; zum Beispiel mit <CMD>=23h (4 Byte) auf ein Objekt des Types Unsigned8, korrekt wäre das <CMD>=2Fh.
06070013h	*parameter length too short*: Es wurde versucht, auf ein Objekt mit zu wenig Daten zu schreiben; zum Beispiel mit <CMD>=2Fh (1 Byte) auf ein Objekt des Types Unsigned32, korrekt wäre das <CMD>=23h.
06090011h	*subindex not existing*: Es wurde versucht, auf ein ungültiges Subindex eines Objektes zu zugreifen, der Index hingegen würde existieren.

Error Code	Description
06090031h	*value too great*: Einige Objekte unterliegen Restriktionen in der Größe des Wertes, in diesem Fall wurde versucht, einen zu hohen Wert in das Objekt zu schreiben. Zum Beispiel darf das Objekt "Pre-defined error field: Number of errors" bei 1003h:00 nur auf den Wert "0" gesetzt werden, alle anderen Zahlenwerte provozieren diesen Fehler.
06090032h	*value too small*: Einige Objekte unterliegen Restriktionen in der Größe des Wertes. In diesem Fall wurde versucht, einen zu niedrigen Wert in das Objekt zu schreiben.
08000000h	*general error*: Allgemeiner Fehler, der in keine andere Kategorie passt.
08000022h	*data cannot be read or stored in this state*: Die Parameter des PDOs dürfen nur im State *Stopped* oder "Pre-Operational" verändert werden. Ein Schreibzugriff auf die Objekte 1400h bis 1407h, 1600h bis 1607h, 1800h bis 1807h und 1A00h bis 1A07h ist im Zustand "Operational" nicht zulässig.

Kannmotion extra Error codes, used only in some cases

```
0:      eMS_OK                          //!< no error Fehler
-1:     eMS_ERR_OUTofRange              //!< error, Parameter are outside the valid range
-2:     eMS_ERR_ParamisWrProtected      //!< error, Parameter can't be written
-3:     eMS_ERR_CMDnotAccepted          //!< error, Command can't be executed, da for example motor is busy
-4:     eMS_ERR_CMDnotKnown             //!< error, Command unknown
-5:     eMS_ERR_ParamisNotKnown         //!< error, Parameter is unknown
```

Translation of the right column:

0: no error
-1: error, parameter outside valid range
-2: error, parameter cannot be written
-3: error, command could not be executed, because e.g. still in progress
-4: error, command unknown
-5: error, parameter unknown

5. PDO Mapping (Process Data Objects)

Process data are transmitted by PDO-telegram. In comparison to the SDO-telegram this is done with a higher priority and the telegram doesn`t require an answer. The 8 data bytes are freely available and can be used as pure user data. Usually, the user data are mapped with objects in the SDO object list.
PDO-communication can be executed cyclical at the request of the master or event based. The event-based variant is used if it has been activated by SDO!

PDO-Mapping

RX-PDO

PDO	ID	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
1	0x200+NodeID	**6040** Control word		**6060** modes of op	**2010:0E** Trq-Hold	**607A** Target-Position			
2	0x300+NodeID	**2013** CMD	**2014:01** Homing Mode	**2014:02** Homing Timeout		**2014:03** Homing Speed		**6042** *(2011:4)* Target Velocity	
3	0x400+NodeID	**6081** Profile velocity							
4	0x500+NodeID	*CUSTOMIZED, mapped into USER specific Code region, see also App-Note 100631*							

TX-PDO

PDO	ID	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
1	0x180+NodeID	**6041** status word		**6044** velocity actual value		**6064** Actual Position			
2	0x280+NodeID	**6061** modes of op D	**2011:1** Motor State	**603F** Error-Code (Error-Bits)		**2011:8** Temperature	**2011:7** App-State	**2033:1** Din-States	
3	0x380+NodeID								
4	0x480+NodeID	*CUSTOMIZED, mapped into USER specific Code region, see also App-Note 100631*							

former Firmware Revisions had a different PDO Mapping. So PDO Mapping changed!
First Test-Version including this Mapping is V03.01.001!

Details PDO4

PDO4 Rx and TX are mapped into User specific App-Code Area. Caused by this you are enabled to customize your drive by using KannMOTION customizing approach. By writing some own ANSI C-code lines you are able to integrate your own behave on PDO4 Rx. With PDO4-Tx you can send your individual data on CANopen.

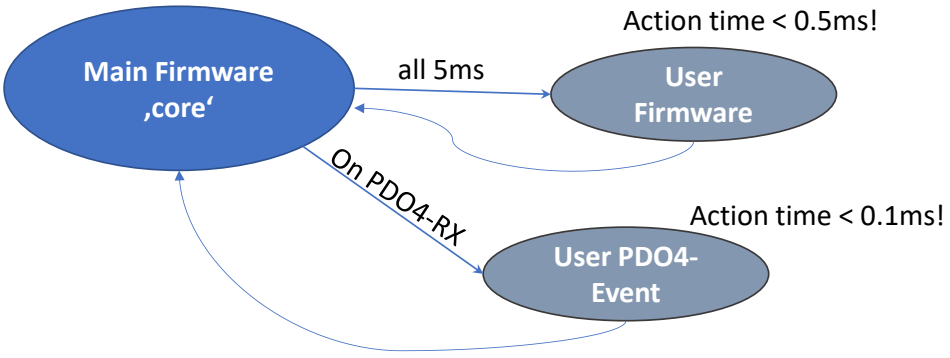


Figure 1: Basic User Section Call

Example code:

Your code interpreter is written into Event-Handler of PDO4-Rx. This example takes first byte from PDO-4 as command information. On Command=0x02 an Answer will be sent through PDO4-Tx.

```
/*****************************************************************************************/
/*!
 *  \brief     SPS-USER Function Event is called at CANopen-PDO4 Rx
 *  \details
*   \param    pRxData, Pointer to Data received
*   \param    Datalength, Data count [0..8]
*   \return
*****************************************************************************************/
void LOCATEUSER AppCSPS_USER_SEQ_CAN_RX_Event(tCANDATA* pRxData, UI_8 Datalength)
{
   // .. My Command interpreter
   switch (pRxData->u08_Data[0])
   {
     // CMD=0: Goto-Pos, Target Position is in
     case 00:
     {
        if (Datalength!=8)
        {
           return;
        }
        // Call Goto Function
        if (stAppCSPS.SPSCallFunctions.GotoFuncP((SI_32)pRxData->i32_Data[1],eGOTO_um_01deg)==eMS_OK)
        {
          stAppCSPS.SPSUserVar.u16_Timer5ms[0]=800;              // 4s -> 5ms x 400
          stAppCSPS.SPSUserVar.u8_StepChain[0]=4;                // next Step = Delay
        }
       break;
     }
     // CMD=2: Query...
     case 02:
     {
       tCANDATA CanTxData;
       CanTxData.u32_Data[0]=0x01234567;
       CanTxData.u32_Data[1]=0x89ABCDEF;
       if (stAppCSPS.SPSCallFunctions.CANopen_PDO4_Send(&CanTxData,8))
       {
       }
       break;
     }
   }
}
```

6. Appendix

Table effective value represented by C44 compression

Market 16-Bit parameters might be compressed to save NV-memory space. The compression leads to a max deviation of +-8% of original value.

In-Value 16bit	C44-8bit	C44-Value 16bit
0	0x00	0
1	0x10	1
2	0x20	2
3	0x30	3
4	0x40	4
5	0x50	5
6	0x60	6
7	0x70	7
8	0x80	8
9	0x90	9
10	0xA0	10
11	0xB0	11
12	0xC0	12
13	0xD0	13
14	0xE0	14
15	0xF0	15
16..17	0x81	16
18..19	0x91	18
20..21	0xA1	20
22..23	0xB1	22
24..25	0xC1	24
26..27	0xD1	26
28..29	0xE1	28
30..31	0xF1	30
32..35	0x82	32
36..39	0x92	36
40..43	0xA2	40
44..47	0xB2	44
48..51	0xC2	48
52..55	0xD2	52
56..59	0xE2	56
60..63	0xF2	60
64..71	0x83	67
72..79	0x93	75
80..87	0xA3	83
88..95	0xB3	91
96..103	0xC3	99
104..111	0xD3	107
112..119	0xE3	115
120..127	0xF3	123
128..143	0x84	134
144..159	0x94	150
160..175	0xA4	166
176..191	0xB4	182
192..207	0xC4	198
208..223	0xD4	214
224..239	0xE4	230
240..255	0xF4	246
256..287	0x85	268
288..319	0x95	300
320..351	0xA5	332
352..383	0xB5	364
384..415	0xC5	396
416..447	0xD5	428
448..479	0xE5	460
480..511	0xF5	492

In-Value 16bit	C44-8bit	C44-Value 16bit
512..575	0x86	536
576..639	0x96	600
640..703	0xA6	664
704..767	0xB6	728
768..831	0xC6	792
832..895	0xD6	856
896..959	0xE6	920
960..1023	0xF6	984
1024..1151	0x87	1072
1152..1279	0x97	1200
1280..1407	0xA7	1328
1408..1535	0xB7	1456
1536..1663	0xC7	1584
1664..1791	0xD7	1712
1792..1919	0xE7	1840
1920..2047	0xF7	1968
2048..2303	0x88	2144
2304..2559	0x98	2400
2560..2815	0xA8	2656
2816..3071	0xB8	2912
3072..3327	0xC8	3168
3328..3583	0xD8	3424
3584..3839	0xE8	3680
3840..4095	0xF8	3936
4096..4607	0x89	4288
4608..5119	0x99	4800
5120..5631	0xA9	5312
5632..6143	0xB9	5824
6144..6655	0xC9	6336
6656..7167	0xD9	6848
7168..7679	0xE9	7360
7680..8191	0xF9	7872
8192..9215	0x8A	8576
9216..10239	0x9A	9600
10240..11263	0xAA	10624
11264..12287	0xBA	11648
12288..13311	0xCA	12672
13312..14335	0xDA	13696
14336..15359	0xEA	14720
15360..16383	0xFA	15744
16384..18431	0x8B	17152
18432..20479	0x9B	19200
20480..22527	0xAB	21248
22528..24575	0xBB	23296
24576..26623	0xCB	25344
26624..28671	0xDB	27392
28672..30719	0xEB	29440
30720..32767	0xFB	31488
32768..36863	0x8C	34304
36864..40959	0x9C	38400
40960..45055	0xAC	42496
45056..49151	0xBC	46592
49152..53247	0xCC	50688
53248..57343	0xDC	54784
57344..61439	0xEC	58880
61440..65535	0xFC	62976

Timing

The transmission time of PDO- or a SDO-package depends on the length of the package and the adjusted baud rate. The structure of a package can be seen in illustration 3: The complete frame including maximally 8 data bytes amounts 108 bit.

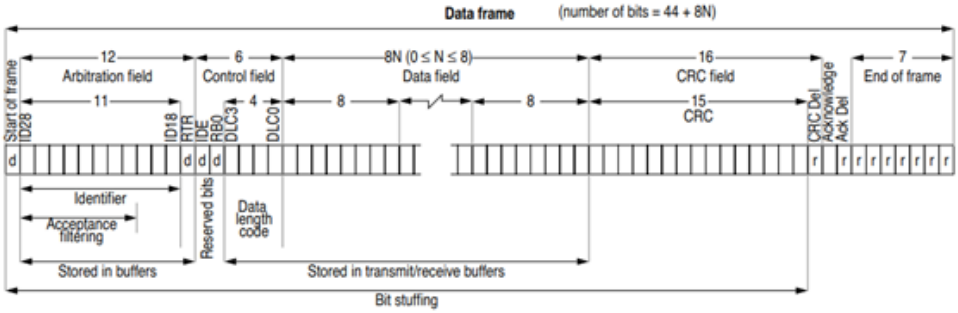


Illustration 2: structure of data frame

The typical transmission time can be calculated from the data frame and the baud rate:

Parameter	Description	Wert
Bitzeit	**250k**	4 us/Bit
Data frame	Complete PDO data frame with 8 data bytes (44+64)	108 Bit
Transmission time frame	108 Bit * 4 us/Bit	432 us
Bus Idle min	3 * 4us	12 us
Maximal frame size	**Incl. min. IDLE time**	**444 us**

Table 1: Transmission time data frame

For the calculation you calculate with the maximal number of 8 data bytes.

Bus usage

For the execution of the main application positioning movement HMI sends the PDO-package. The resulting bus allocation can be seen in the following table:

Pos	Funktion	Richtung	Paket	Dauer [us]
1	Drive comand Motor	HMI -> SmartMotor	PDO1	216
2	Motor Event State change / Moving	SmartMotor ->HMI	PDO1	216
3	Motor Event State change / auf Position	SmartMotor ->HMI	PDO1	216
			Total	**648 us**

Table 2: Timing Standard-Application

Important information:

- By default, selection of the identifiers the PDOs pass always in priority, that is to say SDO-accesses always have a lower priority on the bus.
- The message events (on the PDOs as well) have higher priority as the transmit-PDOs of the HMI.
- Heartbeat has the lowest bus priority.

References and extracts from the standard profiles.

CAN-CANopen sources
The original CAN-specification of Bosch Ltd. (public):
http://www.bosch-semiconductors.de/media/ubk_semiconductors/pdf_1/canliteratur/can2spec.pdf

Further links:
https://www.nxp.com/docs/en/reference-manual/BCANPSV2.pdf
https://en.wikipedia.org/wiki/Unified_Diagnostic_Services

Useful links on the topic of CANopen
(in this document occasionally data from these sources are used):
http://www.leuze.com/media/assets/archive/TD_canopen_guideline_de.pdf
http://www.microcontrol.net/produkte/protokollstacks/canopen/
http://www.microcontrol.net/download/appnotes/canopen_intro.pdf
https://www.can-cia.org/standardization/specifications
http://www.canopensolutions.com/english/about_canopen/about_canopen.shtml
http://www.feldbusse.de/CanOpen/komprofil.shtml

Those wanting a less technical introduction to CAN may want to look at the *CSS Electronics* article and video CAN Bus Explained - A Simple Intro. They also have a good article on CAN with Flexible Data-rate, see CAN FD Explained - A Simple Intro.

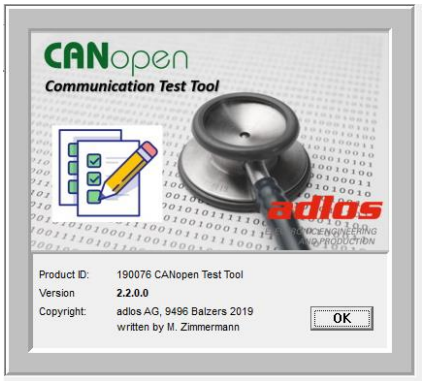
Wiring

In the following I am listing a number of documents referring to wiring CAN Bus (which includes CANopen), DeviceNet and SAE J1939 networks as well as a trouble-shooting guide:

- CANopen Network CAN bus Cabling Guide - Application Note by Copley Controls
- CAN Wiring - Notes on wiring of CAN-Bus Systems and cable selection by esd electronics
- CAN Bus trouble-shooting guide by esd electronics
- SAE J1939 Wiring Requirements
- Practical testing of the CAN physical layer - CiA Newsletter
- DeviceNet trouble-shooting
- ODVA DeviceNet planning and installation manual

Getting started with CANopen Communication Test Tool

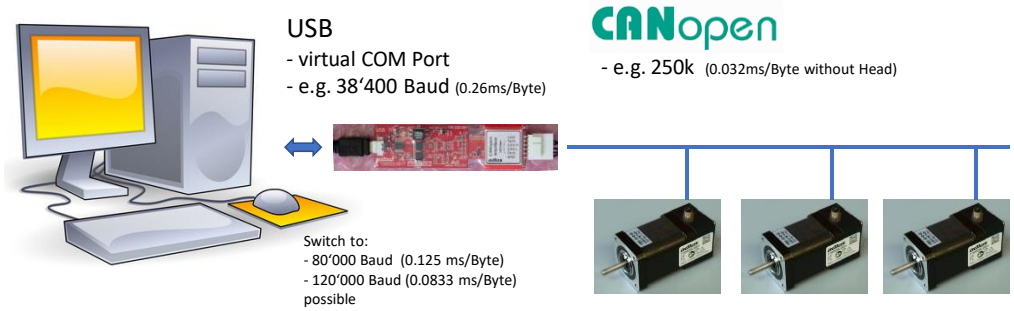
Installation Source



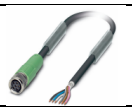
Adlos offers a CANopen Test-Tool to get EDS-Files, Updates and have an Idea about Bus-Communication. This Test Tool comes together with the COM-Watch Test suite installed on your windows computer.
For this Tool you need a **CAN-USB Interface (100732)** from adlos, please contact your sales partner to get more information about this.

Install ComWatch Toolsuite to get this Software:
https://kannmotion.adlos.com/download/comwatchtool/ComWatchSetup.zip

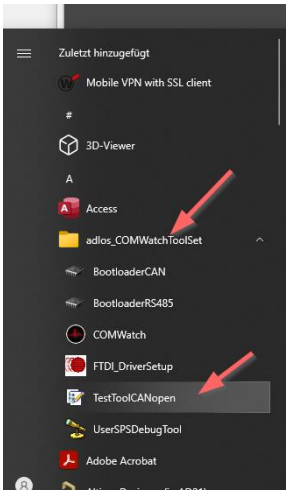
Connect your motor

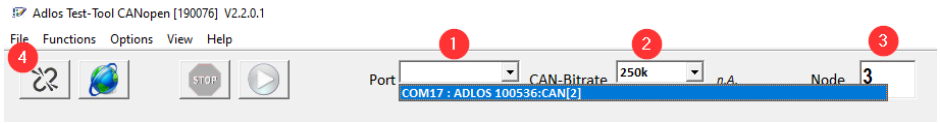


Accessories

Part number	Description	
100 732	USB-CAN converter	
100 767	CIA Adapter cable Molex to D-Sub-9	
100 742	Converter / motor Demo connection cable Molex to M8-motor	
300 201	Cable: M8-6 PUR black 1.5m open wire 6x 0.14 mm²	

Start Application / Choose Port / Node / Bitrate

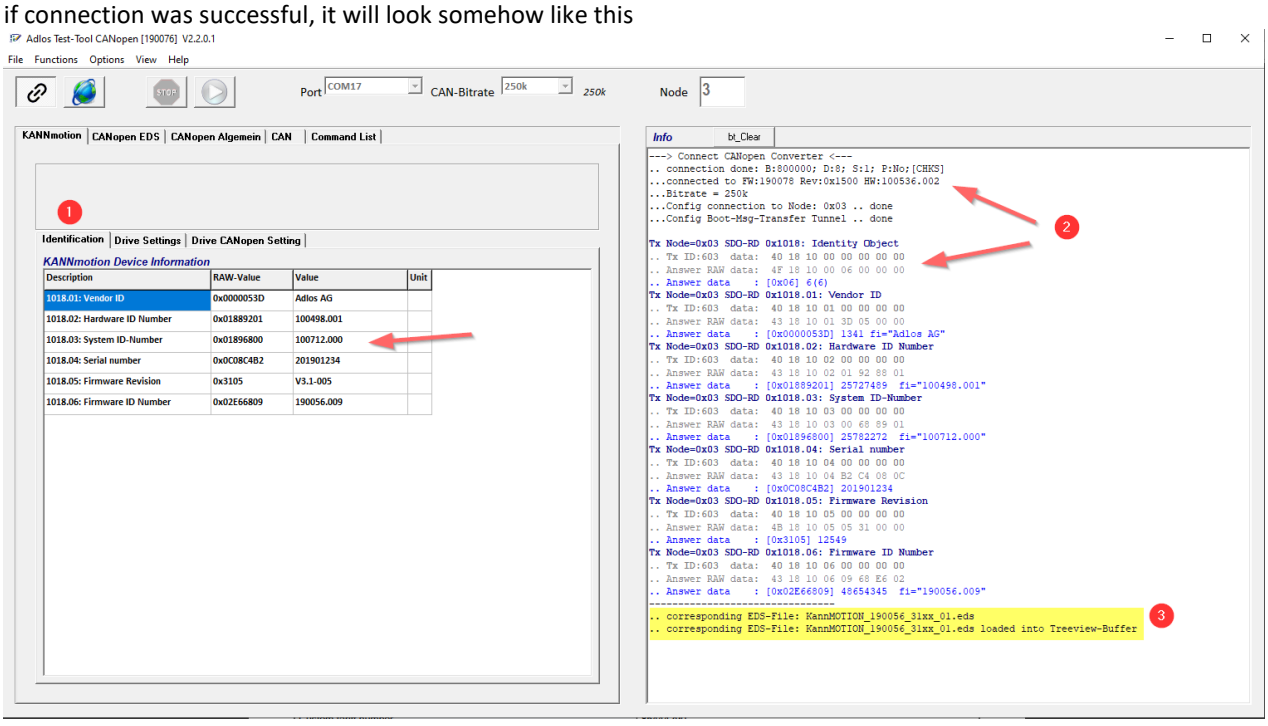




1) Choose your converter.
2) Choose your bitrate. (Standard 250k)
3) Choose your node (Standard 3 or 127 (0x7F))
4) Check if motor is blinking green(powered) and then Press 'connect button'

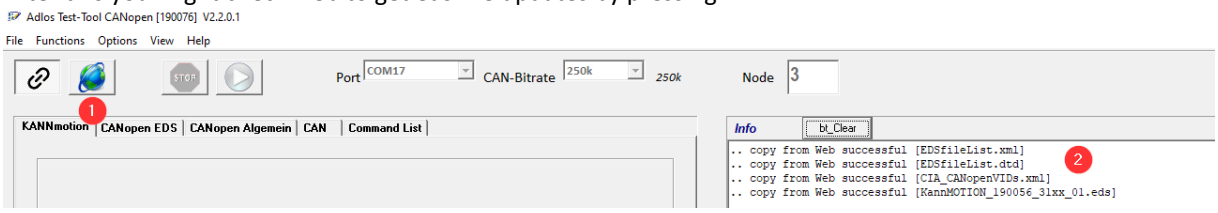
Start View, Main window.

if connection was successful, it will look somehow like this



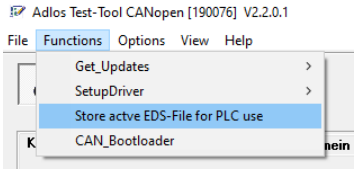
- 1: Drive/motor information
- 2: detail about connection and bus queries
- 3: if it's an adlos drive, it get's and load electronic data sheet from web (eds-file)

After this you might check web to get eds-file updates by pressing 1

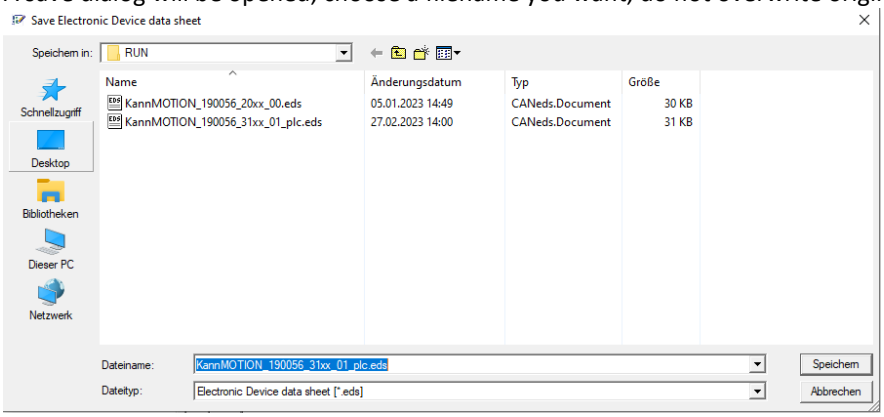


- 1: press this button to get newest versions from web
- 2: information about actions

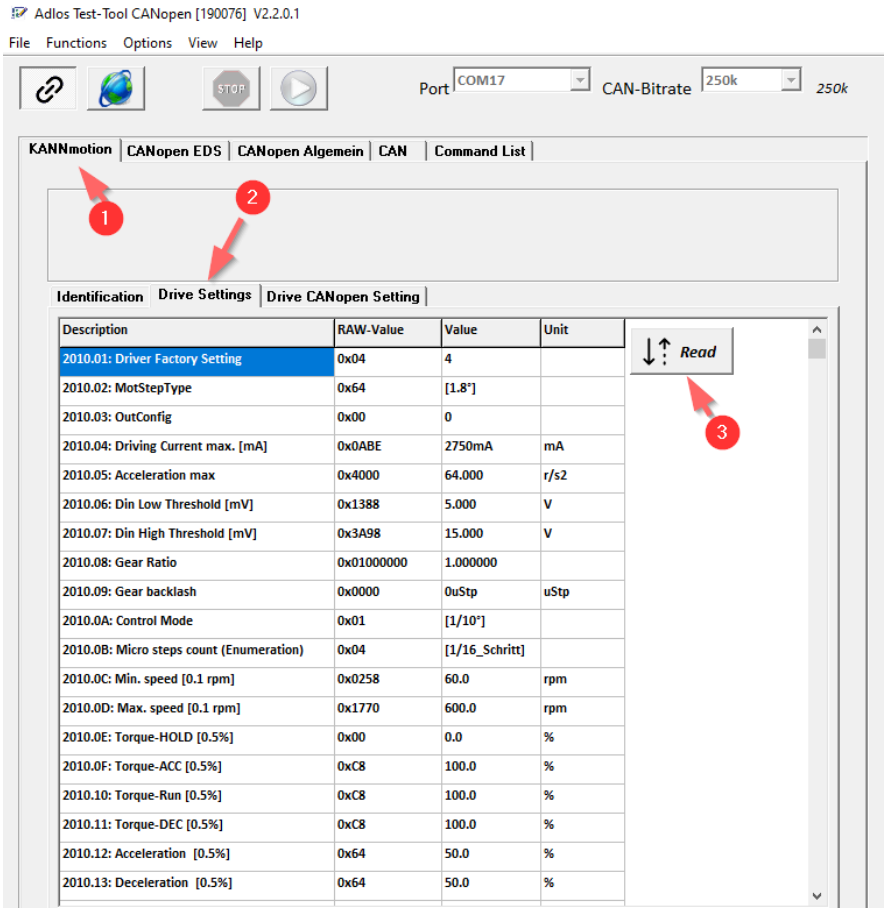
Save dedicated eds-File for using in your PLC environment.



A save dialog will be opened, choose a filename you want, do not overwrite original KannMotion eds-files

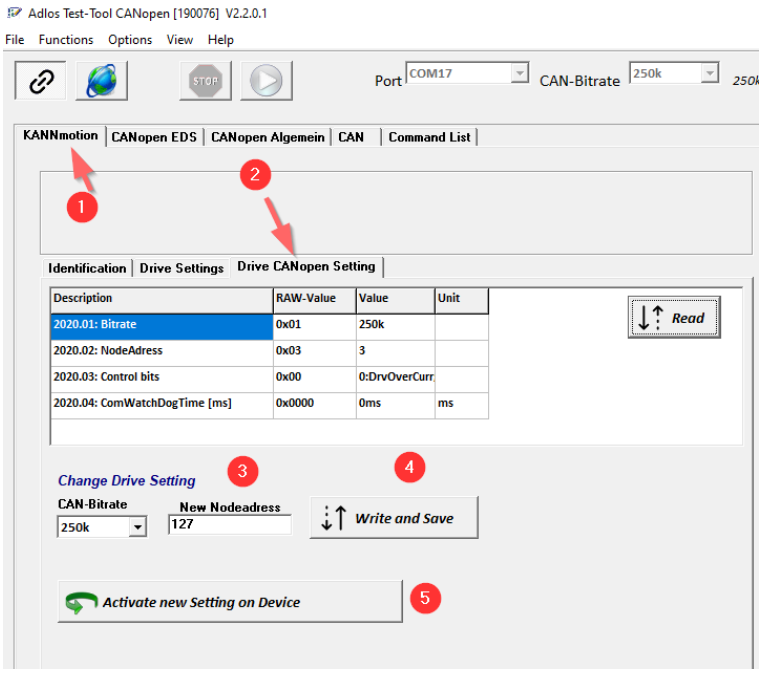


View motor settings.

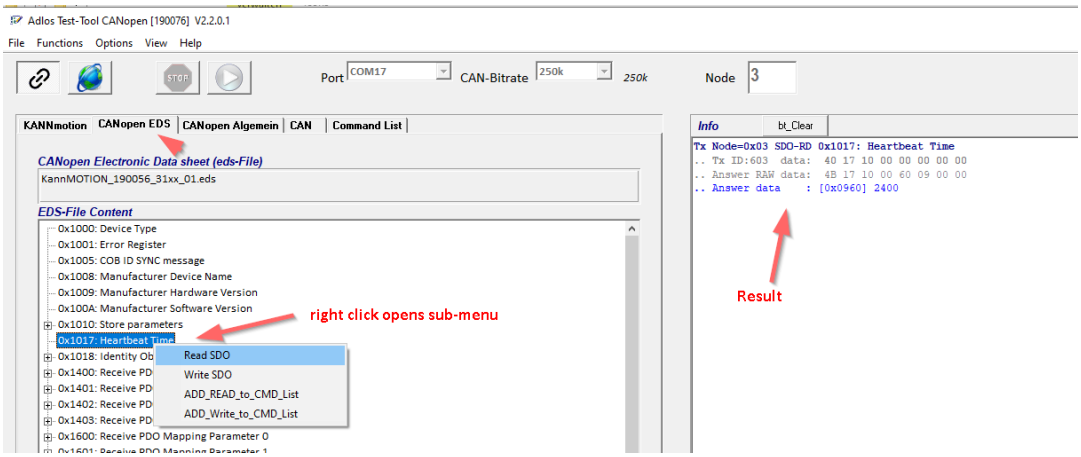


Change motor Node-Adress / bitrate.

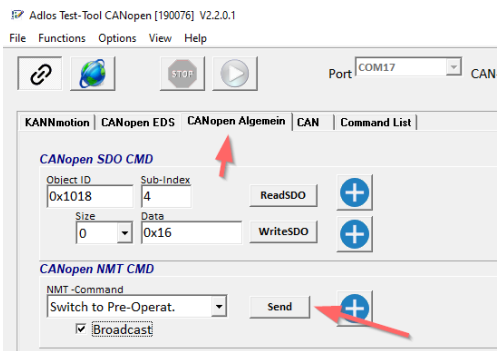
Do not change Bitrate, while other devices are connected to your bus. Otherwise you will lose bus connection due to different bitrates applied.



Use electronic data sheet tree (eds-File Tree) to explore drive.



Change CANopen NMT state of motor/drive

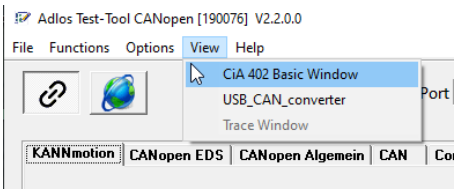


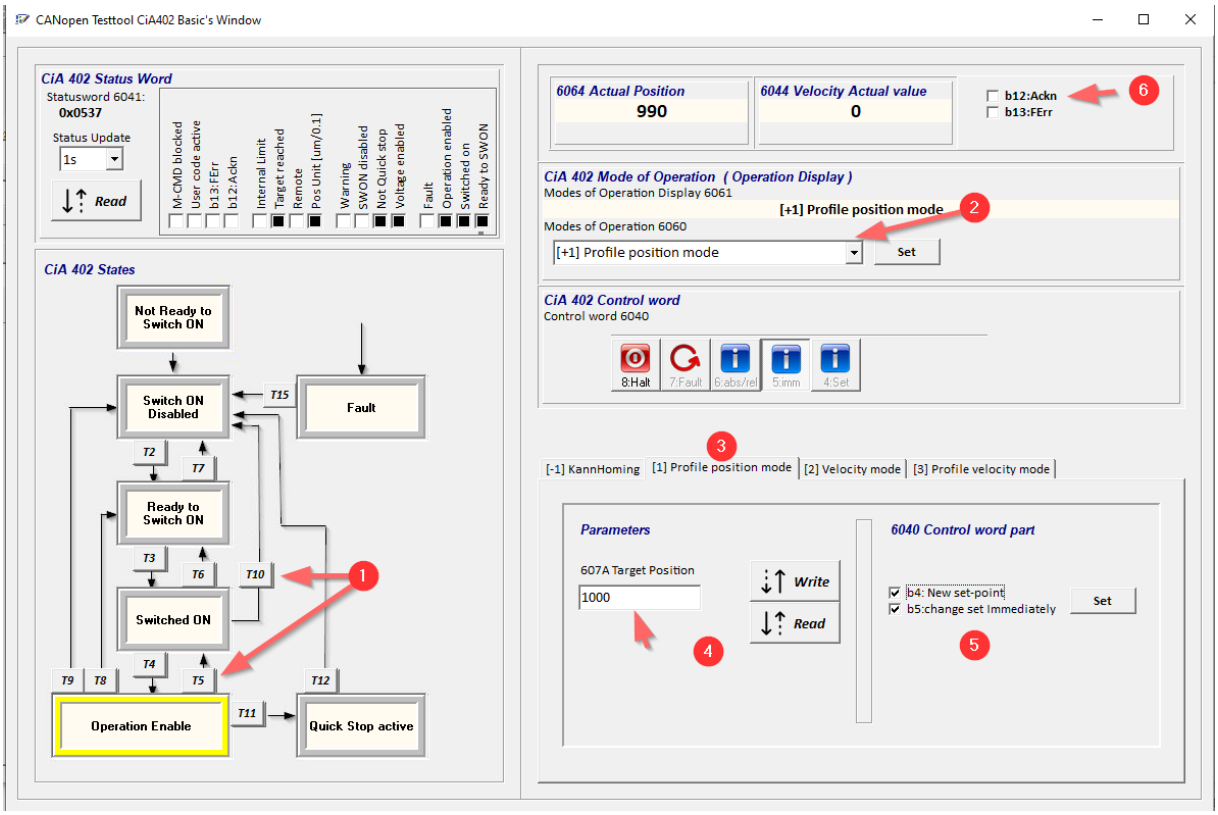
Running motor

The esiest way to get the motor/drive running is to use CiA 402 window.

The CiA 402 window

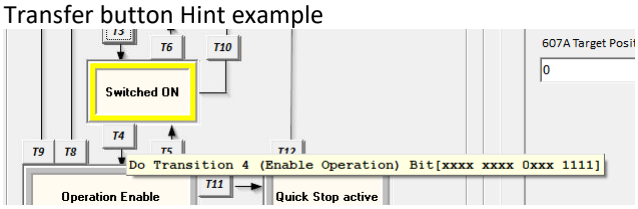
Enable View by Main Menu…





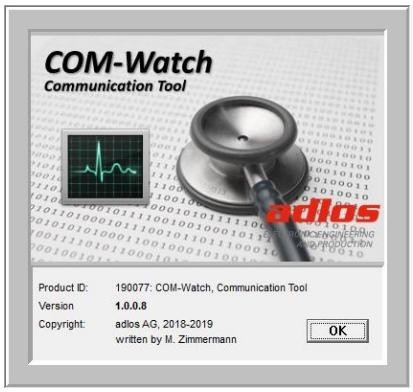
1) *State transfer buttons (Mouse over shows a Hint, means what is changed in Control word)*
2) *Modes of operation Drop-down select.*
3) *Sub objects, depending on modes of operation.*
4) *e.g. Target position (read/write)*
5) *new set-point Control-Word manipulation (new set point must be toggled, pos slope will lead to action)*
6) *Ack-bit is in correlation with the new setpoint bit*

Transfer button Hint example



Other Adlos Win32-APPs

ComWatch Communication Tool (190077)



ComWatch might be used with these drives at very seldom case.
If you Install ComWatch you will also get the CANopen Test tool installed, what might be more interesting to get familiar with CANopen.

https://kannmotion.adlos.com/download/comwatchtool/ComWatchSetup.zip

KannMotion Manager tool (190081), manage your drives

KannMOTION Manager is the general tool for our generation 2 (GEN2) drives. This tool comes with an integrated C-coder and a visual drag and drop user interface for customizing your drive.

https://kannmotion.adlos.com/download/kannmotionmanager/application/SetupKannMOTIONManager.zip