Application note 5028: Control of the LV-servoTEC S2 via CANopen

Brief Description	A LV-servoTEC S2 is to be controlled via the CAN bus (CANopen) by a master, a PLC or a PC. The following is described in this manual: ■ Wiring with EMERGENCY OFF and safety door monitoring ■ Configuration of the LV-servoTEC S2 with bus mapping ■ Monitoring with heartbeat or node guarding ■ Examples of the PDO communication

We are always grateful for suggestions for improvements and information about errors.

Content

1 History of Changes

Changes of document

Code of document	Date	Release and Changes
APP5028_EN_1117818_Control_of_the_servoTEC_S2_via_CANopen_R1a.doc	November 2014	First release of this (English) document
APP5028_EN_1117818_Control_of_the_servoTEC_S2_via_CANopen_R1b.doc	December 2015	New chapter: Move relatively to position 10 mm (see chapter 6.6, page 26 New chapter: Move absolute to position 10 mm with cancellation of move (teaching, setting up, ...) 6.7, page 27.

2 General

A LV-servoTEC S2 is equipped with a fieldbus CANopen in the basic device.

This fieldbus can be used to control the drive.

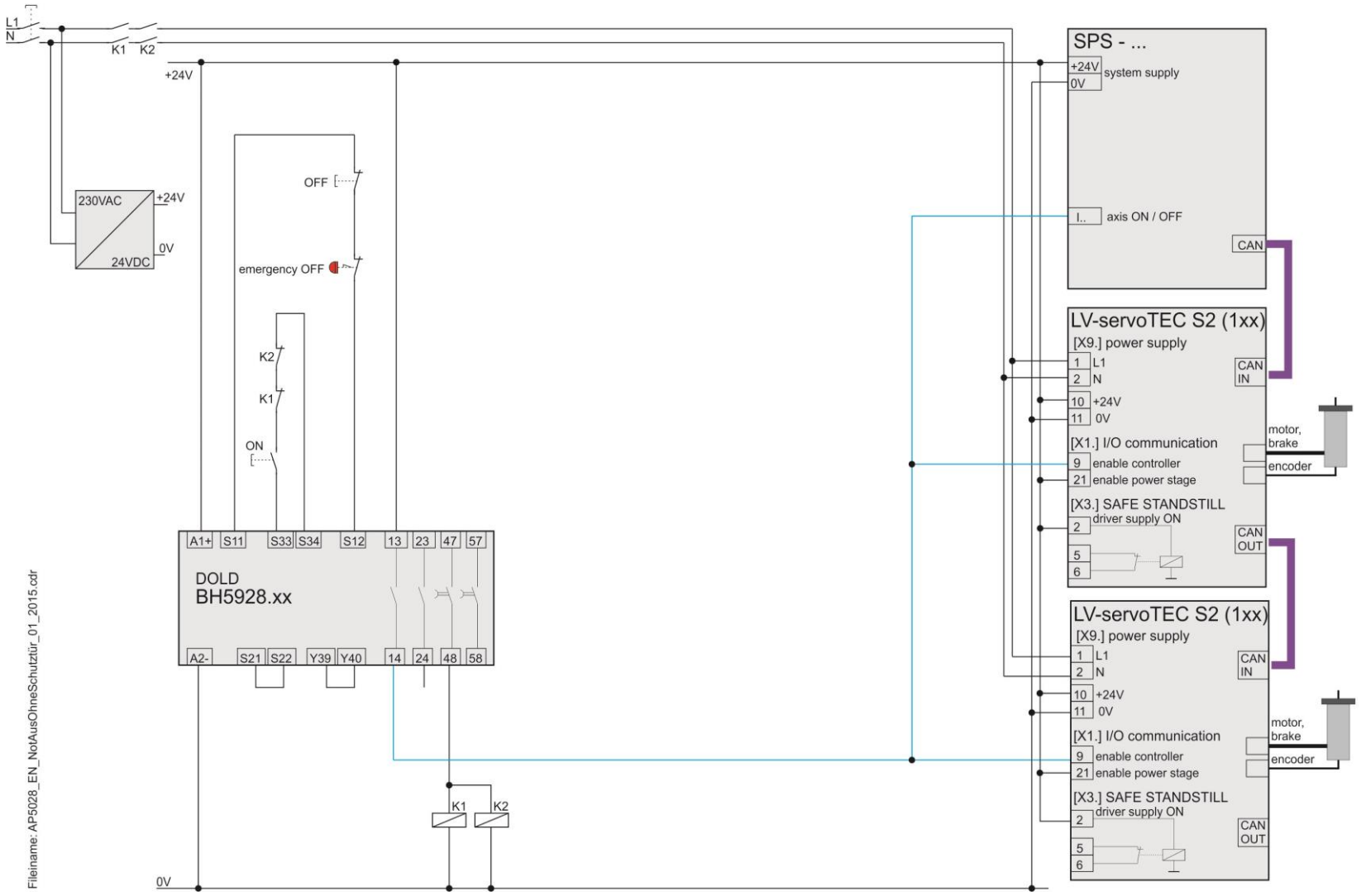
Communication takes place according to the
CANopen standard in the DSP402.

2.1 Documents

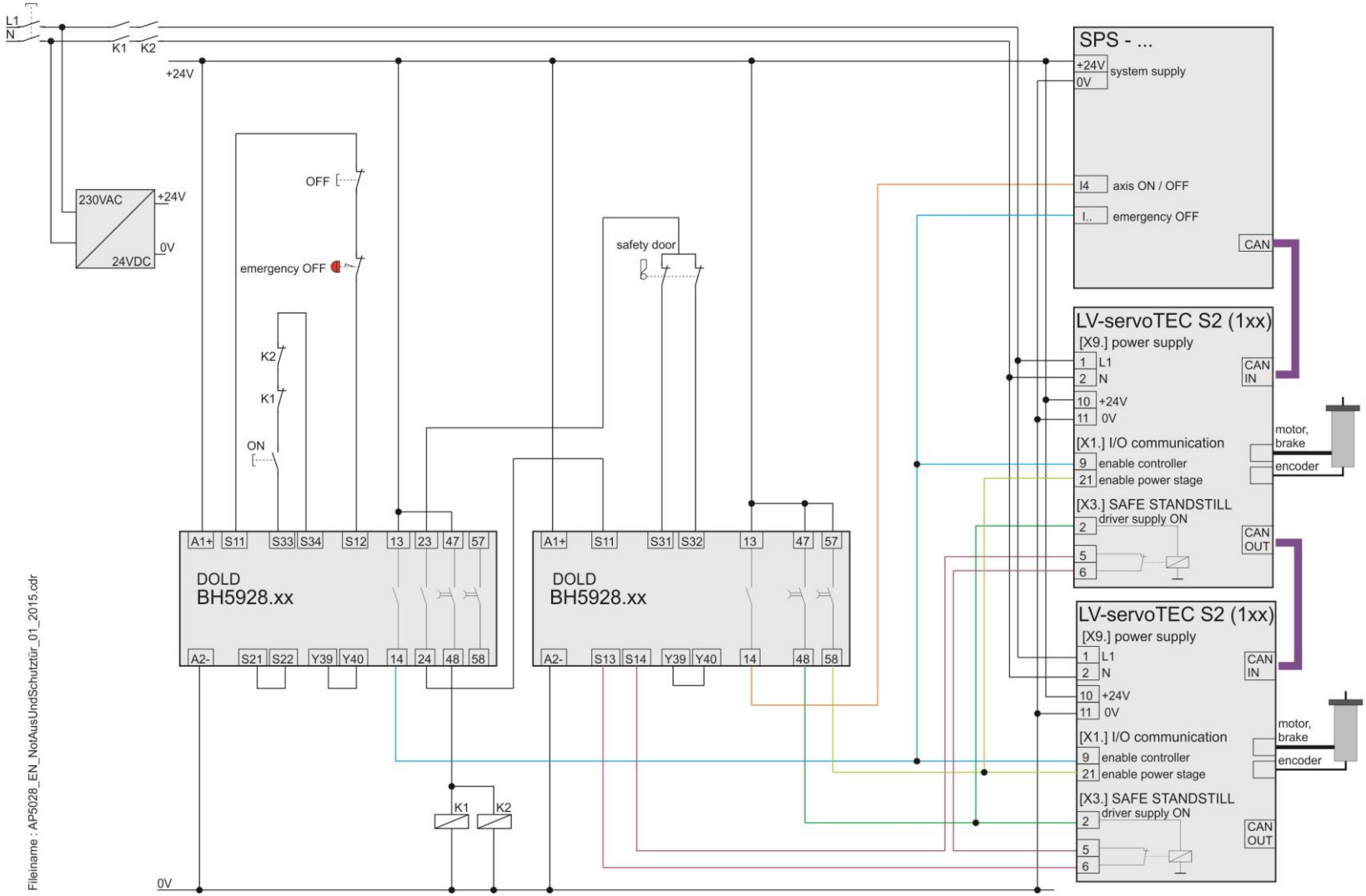
CiA Draft Standard 301 (DS301V402_org.pdf):	In this document, the general setup of the object directory of a CANopen device and access to this are described. The statements of DS201...207 are also detailed. The elements of the object directory required for the controller families LV-servoTEC S2 and the associated access methods are described in this manual MAN_DE_1086954_CANopen_Handbuch_servoTEC_S2). The acquisition of the DS301 is advisable but not absolutely necessary.
CiA Draft Standard 402 (DSP402V20.pdf):	This document deals with the specific implementation of CANopen in the drive controller. Although all implemented objects are also briefly documented and described in this CANopen handbook (MAN_DE_1086954_CANopen_Handbuch_servoTEC_S2), the user should have this document.
MAN_DE_1086954_CANopen_Handbuch_servoTEC_S2:	This manual describes all implemented objects of the LV-servoTEC S2.

3 Wiring Principle "EMERGENCY OFF" and "Protective Door"

3.1 EMERGENCY OFF Without Safety Door Monitoring



3.2 EMERGENCY OFF with Safety Door Monitoring



4 Configuration LV-servoTEC S2

This chapter describes the configuration of the drive as well as the LV-servoTEC S2. The settings are performed once by IEF-Werner GmbH with the S2 Commander and saved in the LV-servoTEC S2 and in a parameter file (*.DCO).

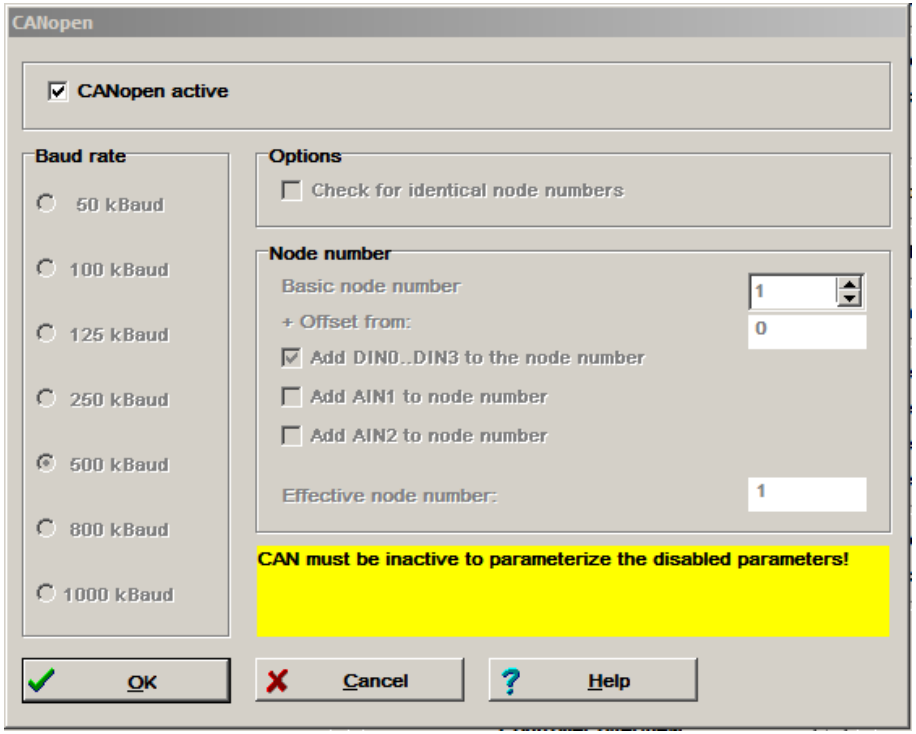
This parameter file can then be loaded with the S2 Commander in the corresponding LV-servoTEC S2 in further projects.

Configuration	Comment
Settings of the basic configuration of the drive	see application document: APP5009...
Settings for the motor (current, return system Resolver/EnDat/,...)	see application document: APP5009...
Settings of the digital and analogue in- and outputs	see application document: APP5009...
Settings for CANopen	see description in this application document
Settings for monitoring the axis	see description in this application document
Settings for referencing the axis	see description in this application document
Settings for positioning the axis	see description in this application document

4.1 CANopen

4.1.1 Address and Baud Rate

The baud rate and the node address are set in this window.

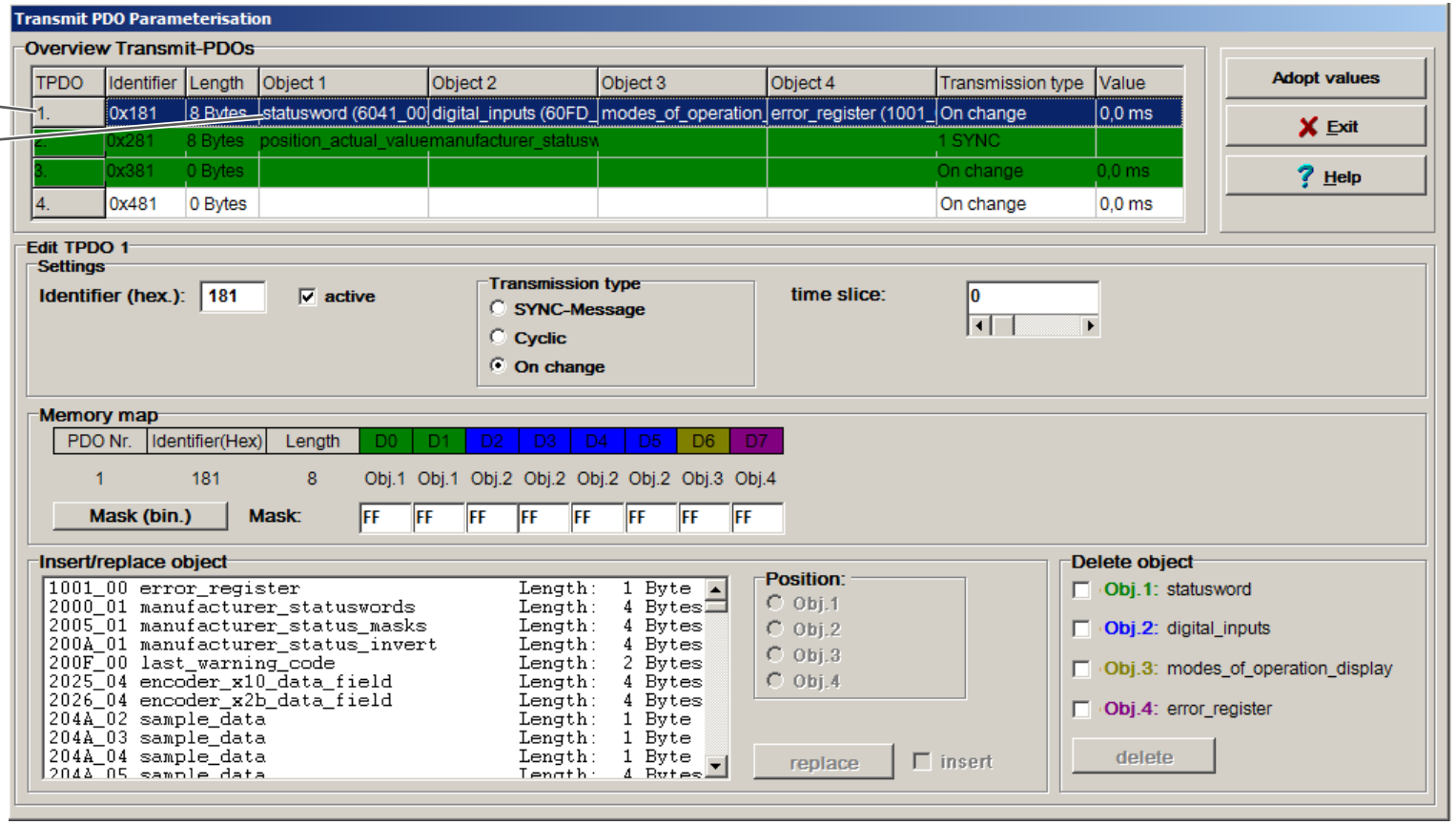


4.1.2 BUS Mapping

4.1.2.1 Transmit PDO 1 (servoTEC S2 to PLC)

TPDO1:

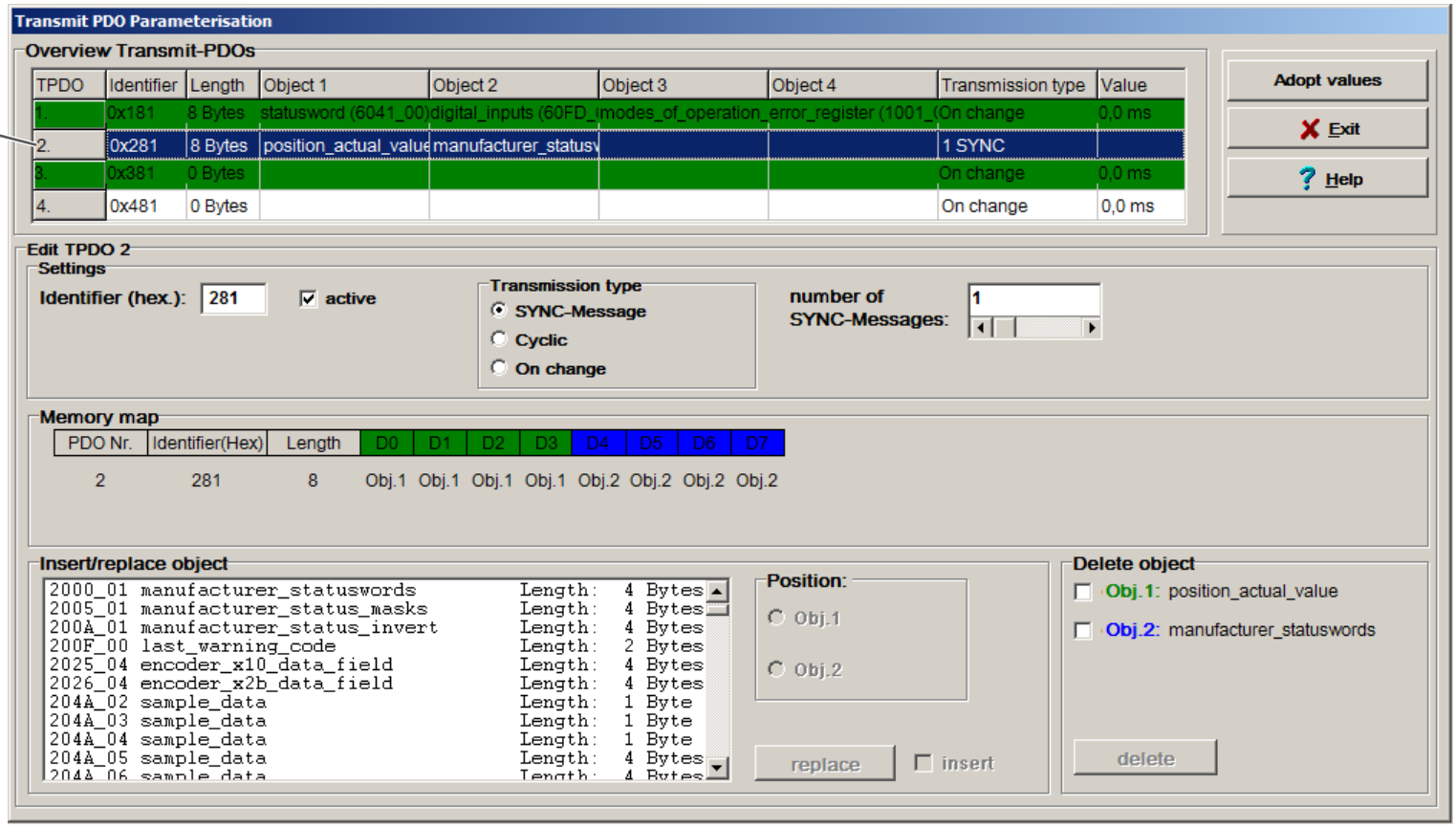
- Status word
- Digital Inputs
- Modes of Operation Display
- Error Register



4.1.2.2 Transmit PDO 2 (LV-servoTEC S2 to PLC)

TPDO2:

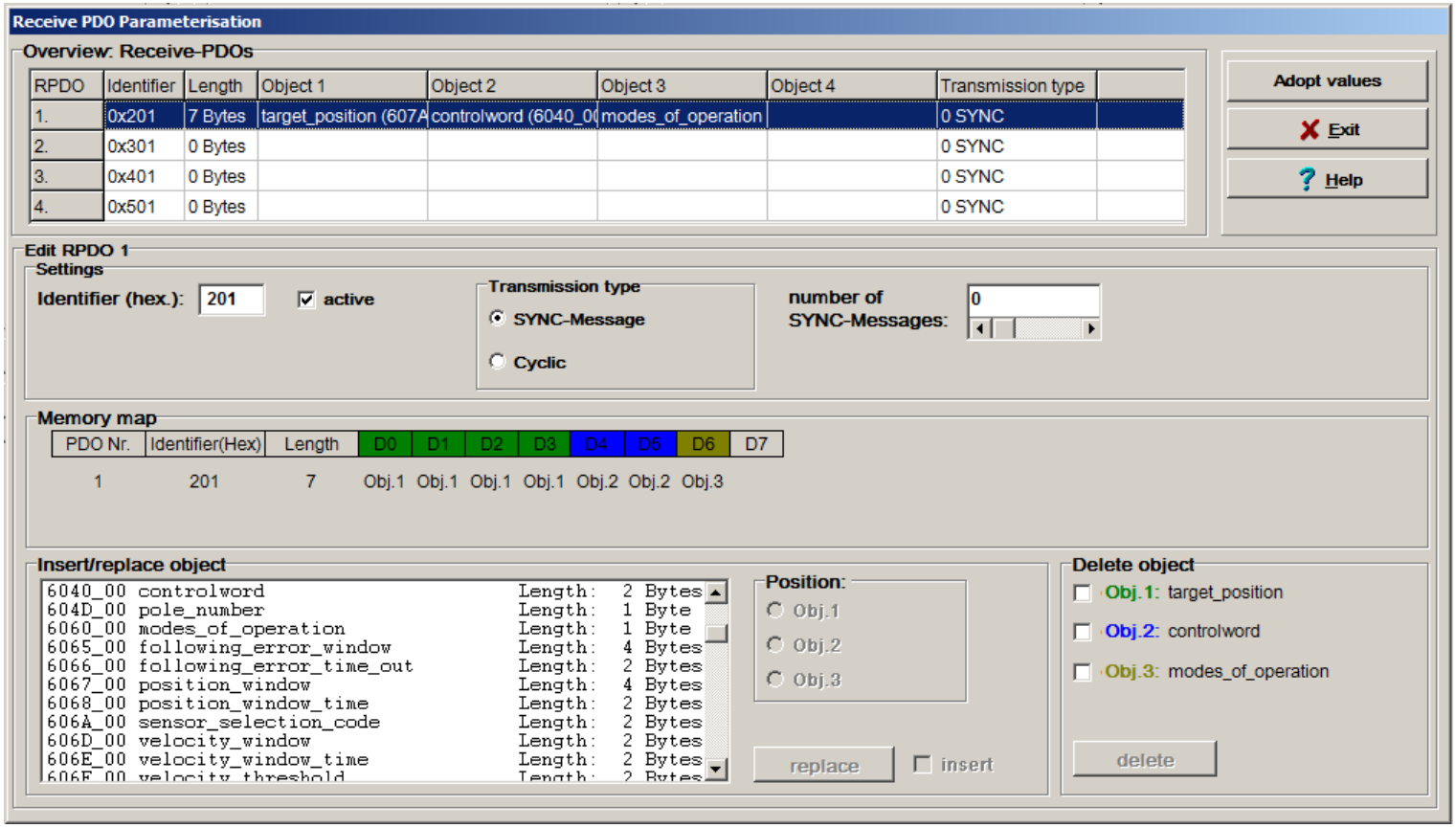
- Position current value (current position)
- Manufacturer status word
- - Reference flag
  - …



4.1.2.3 Receive PDO 1 (SPS to LV-servoTEC S2)

RPDO1:

- Target Position
- Control word
- Modes of Operation

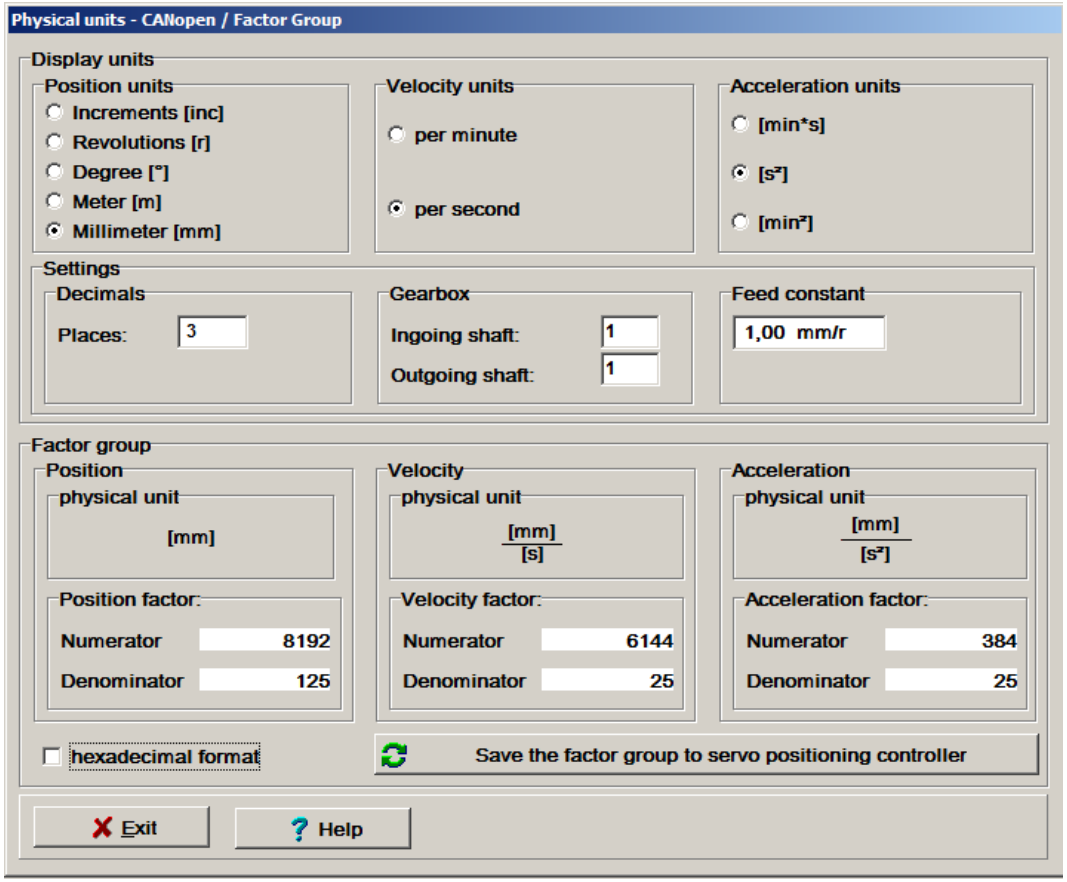


4.1.3 Display Units

Depending on axis type (rotary axis, linear axis ...) the settings for the physical units are controlled in this window.

In a linear axis, the settings can be as follows:

- Position units mm
- Speed units: mm/s
- Acceleration units: mm/s²
- Decimal digits: 3
  The position is specified in µm at 3 decimal digits. If the axis is to move by 12.345 mm, the value submitted will be 12345.
- Gear: 1 / 1
- Infeed constant; 10mm/U
  If the path of the axis per motor turn is 10 mm, 10.00 is set.



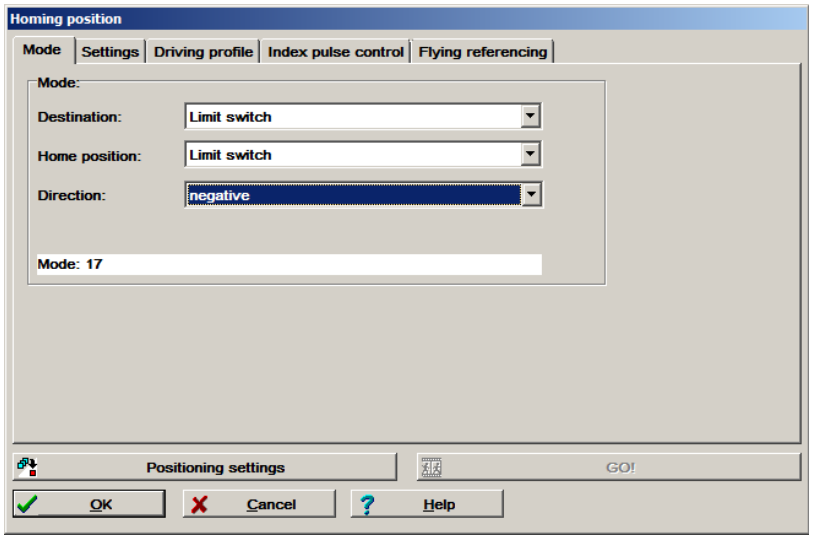
4.1.4 Pre-Settings for the Reference Run

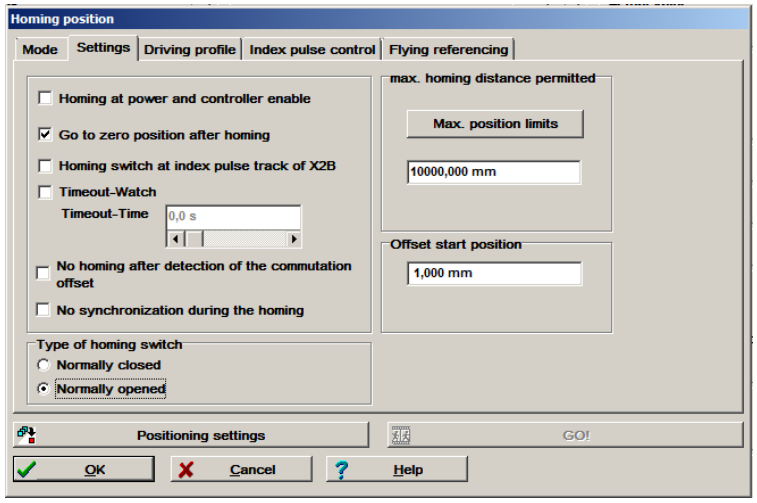
In the simplest case, the reference run can be performed with the set values by activating and starting the operating mode "Referencing" via the CAN bus.

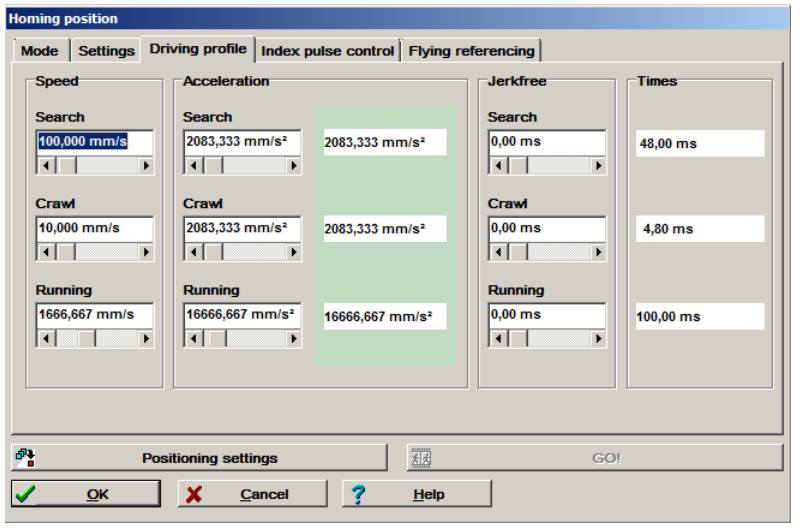
On demand, the values can also be changed via the CAN bus first.

For example:

- Reference run
- Speed
- Reference offset
- ...







4.1.5 Pre-Settings for a Positioning Process

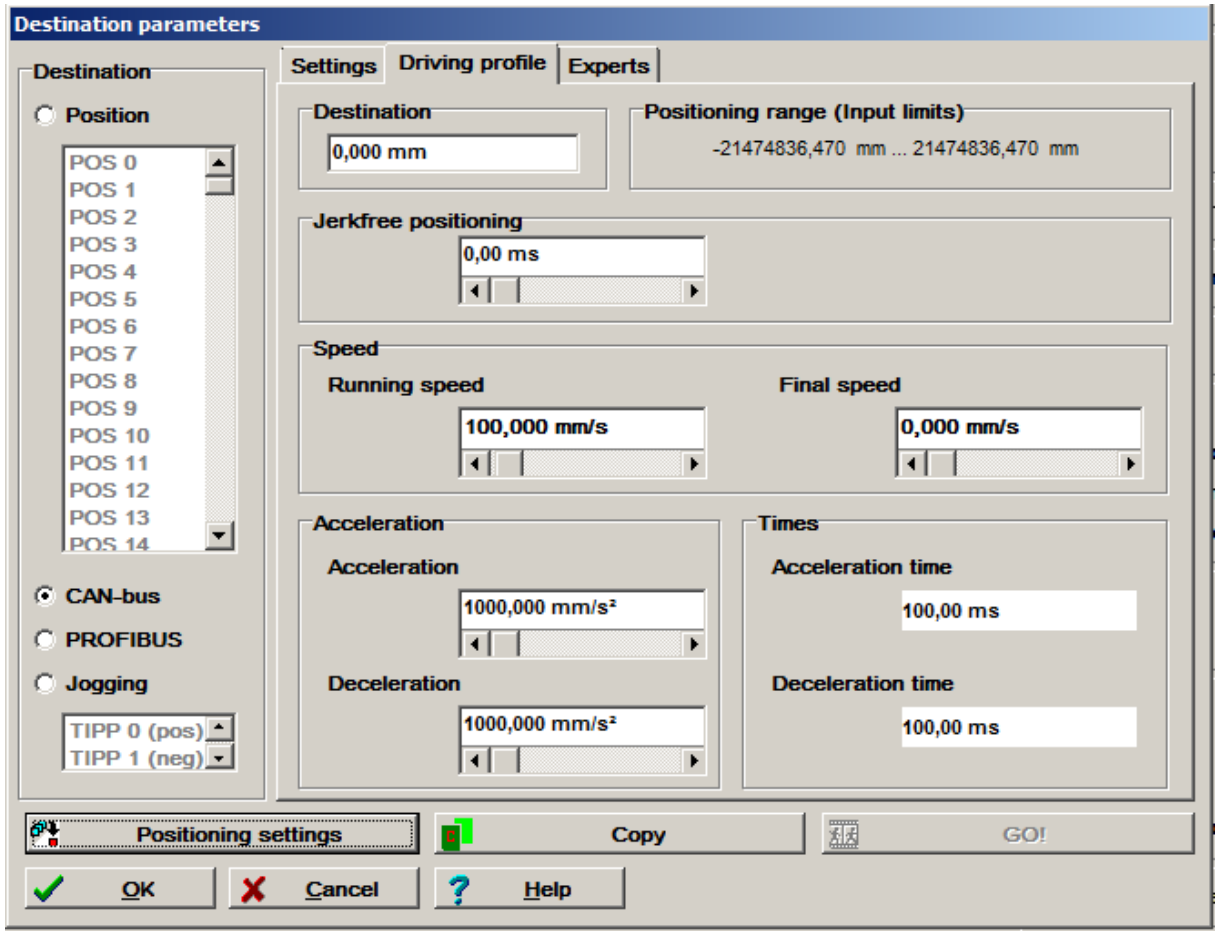
If a run is started via the CAN bus in the operating mode "Positioning", the data from the movement set ”CAN-Bus” are used.

While you want to move with the same speed and acceleration at all times only the target position and the setting for relative or absolute are transferred via the CAN bus before the run starts.

On demand, all settings for positioning can be made via the CAN bus.

For example:

- Target position
- Relative / Absolute
- Speed
- Acceleration
- Ramp type (linear, …)



4.1.6 Monitoring the Drive with "GUARDING"

For monitoring, both heartbeat and node guarding telegrams can be sent with the identifier **700h + node number**
(see MAN_DE_1086954_CANopen_Handbuch_servoTEC_S2.pdf, Section heartbeat and node guarding).

4.1.6.1 Heartbeat (Error Control Protocol)

To monitor the communication between the slave (drive) and master, the heartbeat protocol can be activated.

The drive cyclically sends messages to the master. The master may review the cyclic appearance of this message and initiate the corresponding measures when they do not occur.

4.1.6.2 Node Guarding (Error Control Protocol)

To monitor the communication between slave (drive) and master, the node guarding protocol can be used.

In contrast to the heartbeat protocol, master and slave monitor each other here. The master asks the drive for its NMT status cyclically. A specific bit is inverted (toggled) in each answer of the controller. If these answers are not given or if the controller always reacts with the same toggle bit, the master can react accordingly. The drive also reviews the regular arrival of the node guarding requests of the master: If there are no messages for a certain period of time, the controller will trip error 12-4 (the controller is switched off).

5 Communication

5.1 CAN-PDO Objects

5.1.1 Receive PDO 1 (SPS to LV-servoTEC S2)

RPDO 1							
0	1	2	3	4	5	6	7
607A - "target position"				6040 - "Control word“		6060 - Modes of Operation	Free

5.1.2 Transmit PDO 1 (LV-servoTEC S2 to PLC)

TPDO 1							
0	1	2	3	4	5	6	7
6041 - Status word		60FD - Digital Inputs				6061 - Modes of Operation Display	1001 Error Register

5.1.3 Transmit PDO 2 (LV-servoTEC S2 to PLC)

TPDO 2							
0	1	2	3	4	5	6	7
6064 - Position Current Value				2000 - Manufacturer Status Word			

6 Examples of Control

6.1 General

After activation, the CANopen participant is in the "PRE_OPERATIONAL-MODE".

In this condition, the CANBus can be used for different initialisations. Since these settings are all stored and saved with the S2 Commander in LV-servoTEC S2, this part is dispensed with.

Now the CANopen participant must be switched to "OPERATIONAL-MODE". This is the task of the "CAN-Master" with the NMT command "Start Node".

Then the communication takes place except for changing of speed and acceleration via the PDOs (see examples).

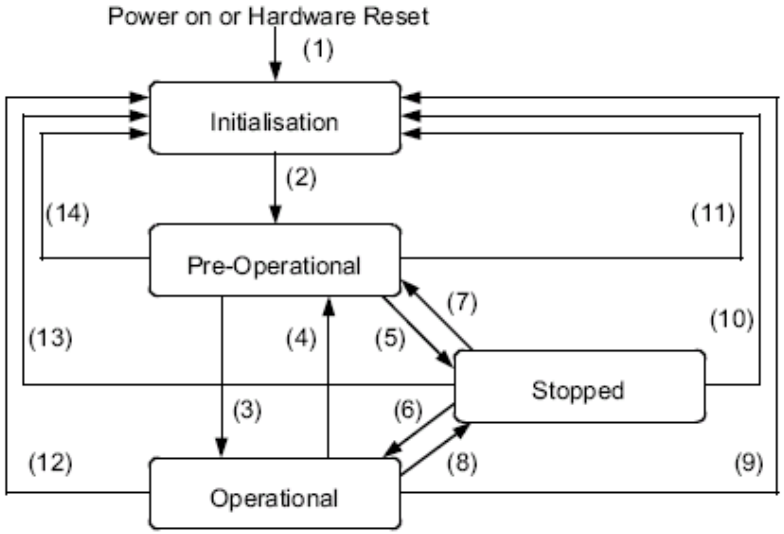


Table 31: Trigger for State Transition

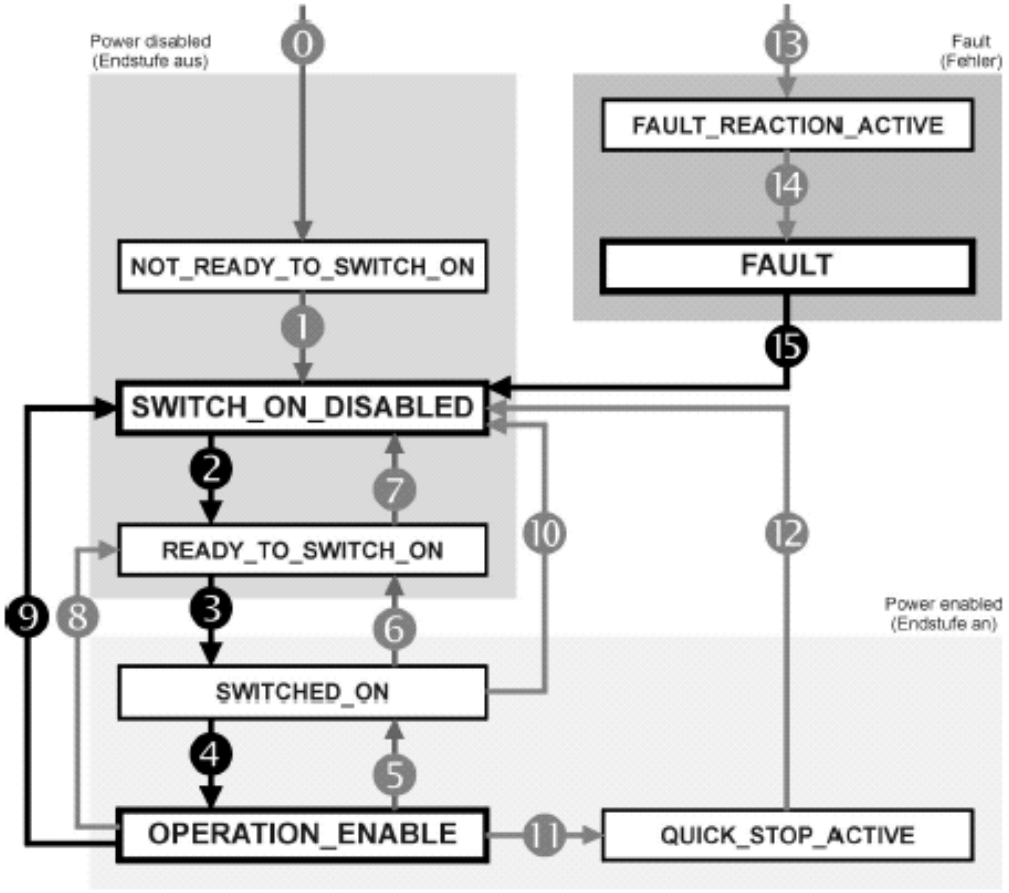
(1)	At Power on the initialisation state is entered autonomously
(2)	Initialisation finished - enter PRE-OPERATIONAL automatically
(3),(6)	Start_Remote_Node indication
(4),(7)	Enter_PRE-OPERATIONAL_State indication
(5),(8)	Stop_Remote_Node indication
(9),(10),(11)	Reset_Node indication
(12),(13),(14)	Reset_Communication indication

See "DS301V402_org.pdf", chapter "NMT State Machine" (page 75).

The drive as such has different conditions.

After a defect-free self-test and reception of the “NMT-START-command", the amplifier switches to the condition "SWITCH_ON_DISABLED".

These conditions are influenced via the "control word" (RPDO1.Byte[4...5]) and controlled via the "status word" (TPDO1.Byte[0...1]).



See: MAN_DE_1086954_CANopen_Handbuch_servoTEC_S2.pdf
Chapter device control (page 150 et seqq.).

6.2 Activating Motor

RPDO1	TPDO1	TPDO2	Comment
	50 02 00 00 00 00 01 00	XX XX XX XX 03 (07) 00 00 00	Amplifier switched on, "SWITCH_ON_DISABLED"
00 00 00 00 **06** **00** 01 -			Command "SHUT_DOWN"
	31 **02** 00 00 00 00 01 00		Is in "READY_TO_SWITCH_ON"
00 00 00 00 **07** **00** 01 -			Command "SWITCH_ON"
	33 **02** 00 00 00 00 01 00		Is in "SWITCHED_ON"
00 00 00 00 **0F** **00** 01 -			Command "ENABLE_OPERATION
	33 **06** 00 00 00 00 01 00		
	27 **06** 00 00 00 00 01 00		Is in "OPERATIONAL_ENABLE"

6.3 Deactivating Motor

RPDO1	TPDO1	TPDO2	Comment
	27 **06** 00 00 00 00 01 00		Is in "OPERATIONAL_ENABLE"
00 00 00 00 **07** 00 00 -			Command "SWITCH_ON"
	27 **02** 00 00 00 00 01 00		
	33 **02** 00 00 00 00 01 00		Is in "SWITCHED_ON"
00 00 00 00 06 00 00 -			Command "SHUT_DOWN"
	31 **02** 00 00 00 00 01 00		Is in "READY_TO_SWITCH_ON"

6.4 Axis Referencing

RPDO1								TPDO1								TPDO2								Comment
								27	06	00	00	00	00	01	00	XX	XX	XX	XX	07	00	00	00	Motor is activated
00	00	00	00	0F	00	**06**	-																	Activate **Homing Mode,** (reference run)
								27	02	00	00	00	00	**FF**	00									Operating mode is changed
								27	02	00	00	00	00	**06**	00									Operating mode is **Homing Mode**
00	00	00	00	7F	00	06	-																	Start reference run
								27	03	00	00	00	00	06	00	XX	XX	XX	XX	**06**	00	00	00	Reference run running
								27	03	**01**	00	00	00	06	00									Limit switch is moved to.
								27	**02**	01	00	00	00	06	00									Axis standing **is not checked.**
								27	**03**	01	00	00	00	06	00									Clear limit switch, **not tested**
								27	**02**	00	00	00	00	06	00									Limit switch is clear, **not tested**
								27	**16**	00	00	00	00	06	00	XX	00	00	00	**07**	00	00	00	Reference run is finished, axis is referenced, position approx. "0", since run to zero after reference run **TPDO1 status word and TPDO2 reference flag are reviewed**

OR								27	12	00	00	00	00	06	00	XX	XX	XX	XX	07	00	00	00	Reference run is done, axis is referenced, position "???"
00	00	00	00	0F	00	06	-																	Deactivate Start reference run
								27	02	00	00	00	00	06	00									
00	00	00	00	0F	00	01	-																	Activate **"Profile-Position-Mode"**
								27	00	00	00	00	00	FF	00									Operating mode is changed
								27	06	00	00	00	00	01	00									Operating mode **"Profile-Position-Mode"**

6.5 Move Absolute to Position 10 mm

RPDO1								TPDO1								TPDO2								Comment
								27	06	00	00	00	00	01	00	12	00	00	00	07	00	00	00	Motor is activated, Axis position 0.018 mm
10	**27**	00	00	**3F**	00	01	-																	Start running order, absolute, Position = 10.0 mm (10000 µm)
								27	**12**	00	00	00	00	01	00									Running order recognised “set_point_acknowledge“
								27	**13**	00	00	00	00	01	00									Axis running
								27	**16**	00	00	00	00	01	00	10	27	00	00	07	00	00	00	Target reached, axis standing “target_reached“
10	27	00	00	**0F**	00	01																		Deactivate start running order
								27	**06**	00	00	00	00	01	00	1X	27	00	00	07	00	00	00	Deactivate start running order recognised

6.6 Run Relatively by 10 mm

RPDO1								TPDO1								TPDO2								Comment
								27	06	00	00	00	00	01	00	12	00	00	00	07	00	00	00	Motor is activated, Axis position 0.018 mm
10	**27**	00	00	7F	00	01	-																	Start running order, relative, Position = 10.0 mm (10000 µm)
								27	**12**	00	00	00	00	01	00									Running order recognised “set_point_acknowledge“
								27	**13**	00	00	00	00	01	00									Axis running
								27	**16**	00	00	00	00	01	00	xx	xx	xx	xx	07	00	00	00	Target reached, axis standing “target_reached“
10	27	00	00	**0F**	**00**	01																		Deactivate start running order
								27	**06**	00	00	00	00	01	00	3D	09	00	00	07	00	00	00	Deactivate start running order recognised

6.7 Move Absolute to Position 10 mm with Cancellation of Move (teaching, setting up, ...)

RPDO1								TPDO1								TPDO2								Comment
								27	06	00	00	00	00	01	00	12	00	00	00	07	00	00	00	Motor is activated, Axis position 0.018 mm
10	**27**	00	00	3F	00	01	-																	Start running order, absolute, Position = 10.0 mm (10000 µm)
								27	**12**	00	00	00	00	01	00									Running order recognised “set_point_acknowledge“
								27	**13**	00	00	00	00	01	00									Axis running
Cancellation of move																								
10	27	00	**01**	3F	00	01	-																	Set flag HALT
								27	**16**	00	00	00	00	01	00	xx	xx	xx	xx	07	00	00	00	Target reached, axis standing “target_reached“
10	27	00	**00**	**0F**	00	01																		Deactivate start running order
								27	**06**	00	00	00	00	01	00	xx	xx	xx	xx	07	00	00	00	Deactivate start running order recognised
00	**00**	00	00	**7F**	00	01																		Start running order, relative, Position = 0 mm
								27	**16**	00	00	00	00	01	00	xx	xx	xx	xx	07	00	00	00	Target reached, axis standing “target_reached“
00	00	00	00	**0F**	00	01																		Deactivate start running order
								27	**06**	00	00	00	00	01	00	xx	xx	xx	xx	07	00	00	00	Deactivate start running order recognised