FirmwareTde Macno

User's Manual

Can Open DSP402 attachment n°08

Cod. MW01001E00 V_1.6

INDEX

1. INTRODUCTION 3
1.1 ABOUT THIS MANUAL 3
1.2 COMMON SYMBOLS AND ABBREVIATIONS 3
1.3 INTENDED AUDIENCE 3
1.4 UNIT MEASURING SYSTEM 3
2. CAN OPEN DSP402 PROFILES 4
2.1 CAN OPEN DS402 PROFILES SUPPORTED 4
2.2 DEVICE CONTROL 4
2.2.1 SECOND SENSOR 9
2.2.2 POSITION RESOLUTION 10
2.2.3 CYCLIC TASK 10
2.2.4 LIFE GUARDING ALARM AND MAX SYNCH ALARM 10
2.2.5 sipCONTROL_WORD AND STATUS_WORD2 10
2.2.6 S-RAMPS 12
2.3 EXTRA VIEW 13
2.4 PROFILE VELOCITY MODE 14
2.5 PROFILE POSITION MODE 15
2.6 INTERPOLATE POSITION MODE 17
2.7 HOMING MODE 18
2.7.1 HOMING SWITCHES 20
2.7.2 HOMING WITH TOUCH PROBE 20
2.8 PROFILE SYNC VELOCITY MODE 22
2.9 PROFILE SYNC POSITION MODE 23
2.10 PROFILE TORQUE MODE 24
2.11 CYCLIC SYNC TORQUE MODE 26
2.12 STOP IN POSITION FUNCTION 28
2.12.1 WORKING MODE 30
2.12.2 STOP IN POSITION DOWNSTREAM REDUCTION GEAR 32
2.13 HOLDING BRAKE 35
2.13.1 HOLDING BRAKE PARAMETERS 35
2.13.2 DISABLING BRAKE AT START 36
2.13.3 OTHER CONDITIONS 39
2.13.4 QUICK STOP 40
2.14 OTHER PARAMETERS 41
2.14.1 Torque limit by analogue input and fieldbus 42
2.14.2 Jump from Sensor 1 to sensor 2 function 43
2.15 SECOND BANK PARAMETERS 44
2.16 PWM SYNCHRONIZATION 45
2.17 OTHER MAPPED OBJECTS 47
2.18 APPLICATION DIGITAL INPUTS 48
2.19 APPLICATION DIGITAL OUTPUT 48
2.20 ANALOGUE OUTPUTS AND MONITORS 48
2.21 ALARMS 49
3. APPLICATION REVISION HISTORY 50

VERSION APPLICATION: 8.11

1. INTRODUCTION

1.1 ABOUT THIS MANUAL

This manual is meant as a brief explanation of OPDE CAN OPEN DSP402. The manual contains the following chapters:

- **Revision Table** contains the history revision of the manual;
- **Introduction** provides information background about the manual;
- **CAN OPEN DSP402 Profiles** contains the DSP402 Profiles cabling instruction and general information about EtherCAT connections;

1.2 COMMON SYMBOLS AND ABBREVIATIONS

Abbreviations	Explanations
CAN	Controller Area Network
CiA	CAN in Automation
EMCY	Emergency Object or Service
OPDE	Open Drive Exp or OPDExp
OPD Explorer	OPD Explorer Supervisory Software
SDO	Service Data Object

1.3 INTENDED AUDIENCE

The manual is intended for those persons who are responsible for commissioning and using an OPDE CAN Module. The reader should have some basic knowledge of networking, electrical fundamentals, electrical wiring practices and how to work the OPDE drive and OPD Explorer.

1.4 UNIT MEASURING SYSTEM

The units of measurement used by CAN Open DSP 402 are the following:

- Positions are expressed in “ie” (encoder pulse). One mechanical motor revolution is 65536 ie (or encoder pulses);
- Speed are expressed in “ie/s”. One revolutions-per-second is 65536 ie/s;
- Accelerations are expressed in “ie/s^2”. One revolutions-per-second^2 is 65536 ie/s^2

2. CAN OPEN DSP402 PROFILES

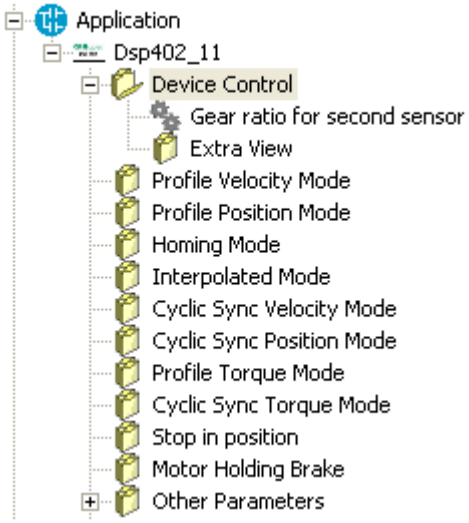
2.1 CAN OPEN DS402 PROFILES SUPPORTED

In OPDE drive are implemented the following CAN Open DSP 402 profiles:

- **Device Control;**
- **Profile Velocity Mode (3);**
- **Profile Position Mode (1);**
- **Interpolation Position Mode (7);**
- **Homing Mode (6);**
- **Cyclic synchronous velocity mode (9);**
- **Cyclic synchronous position mode (8).**
- **Profile Torque Mode (10);**
- **Cyclic synchronous torque mode (4).**

For more information, see CiA Draft Standard Proposal 402 specifications.

2.2 DEVICE CONTROL



Device controls is a profile that define the behaviour of the control device. The master controls like the slave works with the following objects:

- Control Word;
- Status word;
- Modes of operation;
- Modes of operation display;
- Quick stop option code;
- Quick stop deceleration;

The following picture shows the Device Control of Dsp402. The parameter **E101 – Finite State automation** gives the information about Drive's actual state.

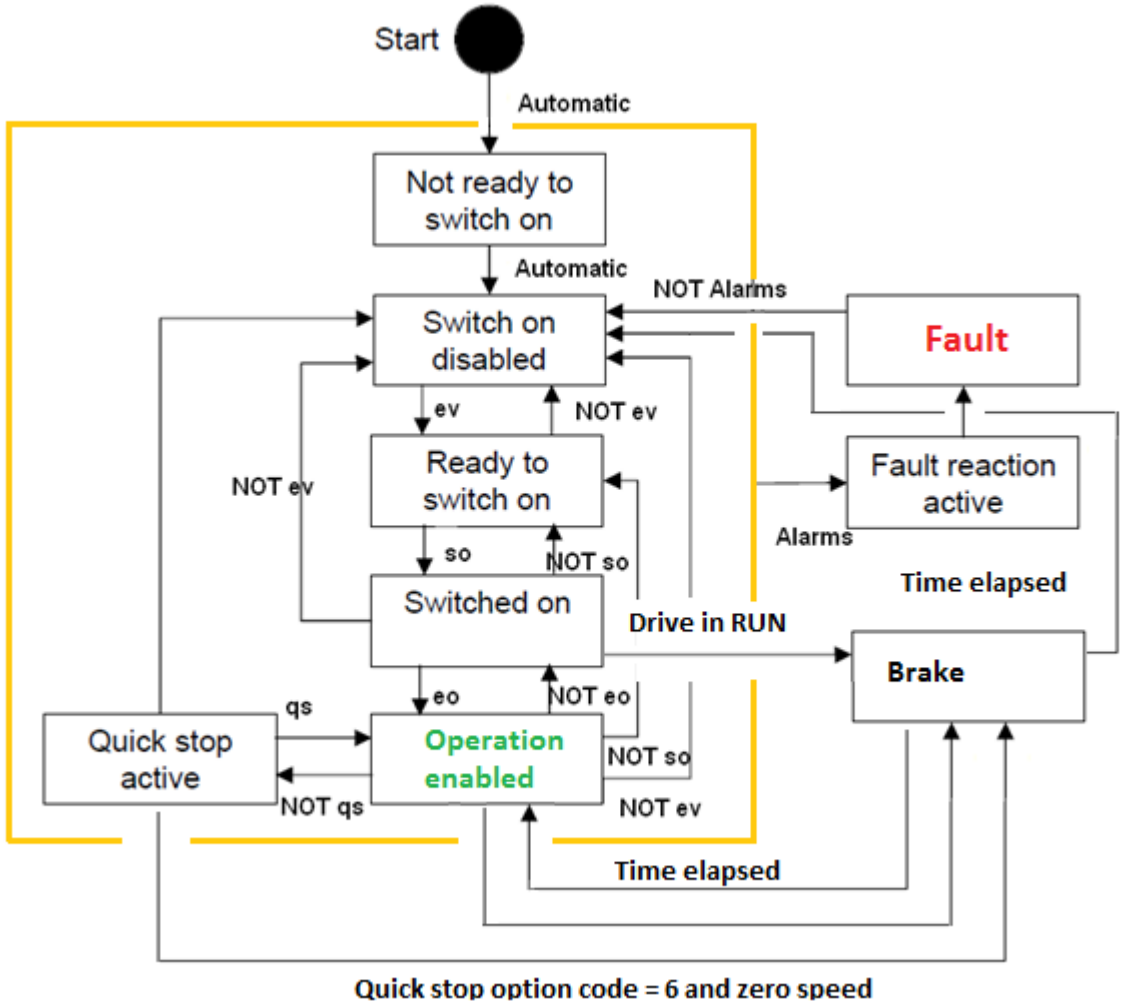


Fig. 1- Drive State Machine

15 b12	14 b14	13 b13	12 b12	11 EnSip	10	9	8 hlt	7 fr	6 b6	5 b5	4 nsp	3 eo	2 qs	1 ev	0 so

Fig. 2-0x6040 Control word

bit	value	definition
0	0	Switch On Disable
	1	Switch On Enable
1	0	Enable Voltage
	1	Disable Voltage
2	0	Quick Stop Enable (Quick stop not active)

	1	Quick Stop Disable (Quick stop active)
3	0	Enable Operation Enable
	1	Enable Operation Disable
4	0	New Set Point enable
	1	New Set Point disable
5	0	b5 enable
	1	b5 disable
6	0	b6 enable
	1	b6 disable
7	0	Fault Reaction Active Enable
	1	Fault Reaction Active Disable
8	0	Halt command Enable
	1	Halt command Disable
11	0	Enable Stop in position Function (Stop in position)
	1	Disable Stop in position Function (Stop in position)
12	0	Enable Stop in position function (Stop in position)
	1	Disable Stop in position function (Stop in position)
13	0	Enable Stop in position movement (Stop in position)
	1	Disable Stop in position movement (Stop in position)
14	0	Enable Stop in position bit 0 (Stop in position)
	1	Disable Stop in position bit 0 (Stop in position)
15	0	Enable Stop in position bit 1 (Stop in position)
	1	Disable Stop in position bit 1 (Stop in position)

Tab. 1- Control word bit

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms_b1	ms_b0	oms_b1	oms_b0	ila	tr	rm	HmC	w	sod	qs	ve	f	oe	so	rtso

Fig. 3-0x6041 Status word

bit	value	definition
0	0	Ready to Switch On State Not Active
	1	Ready to Switch On State Active
1	0	Switched On State Not Active
	1	Switched On State Active
2	0	Operation Enable State Not Active
	1	Operation Enable State Active
3	0	Fault State Not Active
	1	Fault State Active

4	0	Voltage Enabled Not Active
	1	Voltage Enabled Active
5	0	Quick Stop State Not Active
	1	Quick Stop State Active
6	0	Switch On Disabled State Not Active
	1	Switch On Disabled State Active
7	0	Warning Active
	1	Warning Not Active
8	0	Homing Completed
	1	Homing Not Completed
9	0	Remote Active
	1	Remote Not Active
10	0	Target Reached
	1	Target Not Reached
11	0	Internal Limit Active
	1	Internal Limit Not Active
12	0	Op. Mode specific 0 Not Active
	1	Op. Mode specific 0 Active
13	0	Op. Mode specific 1 Not Active
	1	Op. Mode specific 1 Not Active
14	0	Manufacturer specific 0 Active
	1	Manufacturer specific 0 Not Active
15	0	Manufacturer specific 1 Active
	1	Manufacturer specific 1 Not Active

Tab. 2- Status word bit

The picture shows the device control on interface of OPDExplorer. It's possible to see the Internal Operative Mode and the actual device control state.

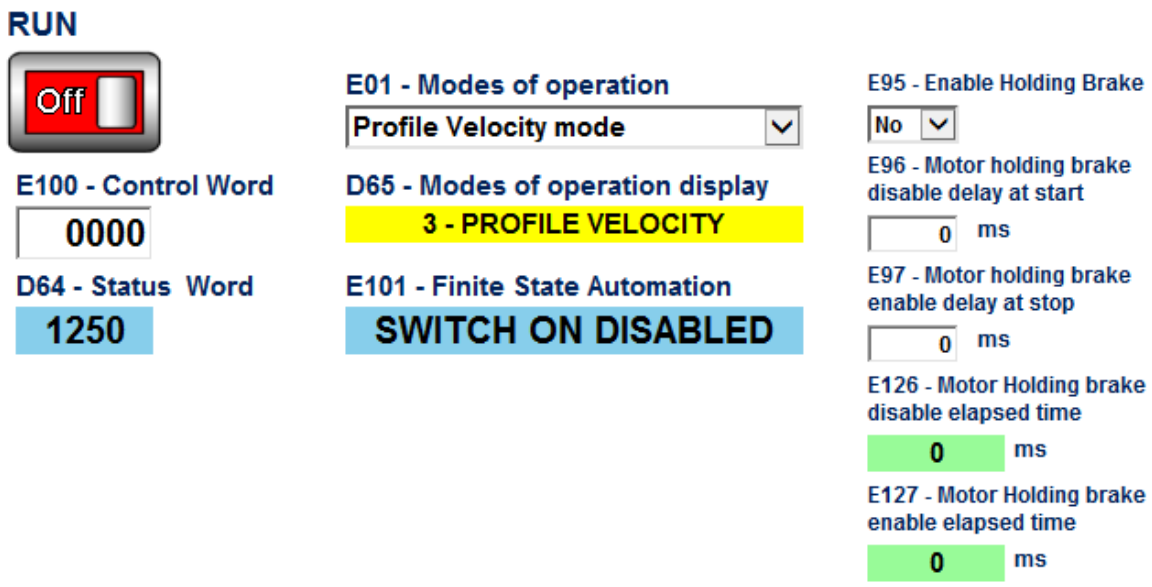


Fig. 4-Device control interface

The object descriptions are in **Tab. 3**:

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
6040	VAR	UNSIGNED16	Control word	This object controls the Finite State Machine of DSP 402. OPD Explorer Parameter: **E100**	Yes	Reading/ writing
6041	VAR	UNSIGNED16	Status word	This object provides the status of Finite State Machine of DSP 402. OPD Explorer Parameter: **D64**	Yes	reading
6060	VAR	INTEGER8	Modes of operation	This object indicates the requested operation modes. OPDE drive supports the following modes: **1. Profile position mode;** **3. Profile velocity mode;** **6. Homing mode;** **7. Interpolation position mode;** **8. Cyclicsync position mode;** **9. Cyclic sync velocity mode.** OPD Explorer Parameter: **E01**	Yes	Reading /writing
6061	VAR	INTEGER8	Modes of operation display	This object provides the actual operation mode OPD Explorer Parameter: **D65**	Yes	reading
605A	VAR	INTEGER16	Quick stop option code	This object indicates what action is performed when the quick stop function is executed. OPDE drive supports the following codes: **Slow down on quick stop ramp and transit into Switch On Disabled;** **Slow down on quick stop ramp and stay in Quick Stop Active;** **Note:** if the inserted code is not expected, the quick stop option code executes the code 1. OPD Explorer Parameter: **E38**	No	Reading
6085	VAR	UNSIGNED32	Quick stop deceleration	This object configures the deceleration used to stop the motor when the quick stop function is activated. OPD Explorer Parameters: **E08-E09**	Yes	Reading

Tab. 3- Device Control Objects

2.2.1 SECOND SENSOR

The parameter **E51**, **pENSECONDSENS = Yes** allows to select the second sensor and close the position loop on this. There is the possibility to set a gear ratio between motor revolution and driving shaft revolution parameters **E60-E61 - pNUM_GEAR_BOX**, and parameters **E62-E63 - pDEN_GEAR_BOX**).
Tab. 4 shows second sensor function parameters.

Name	Value	UM	Default	Min	Max	Description
pENSECONDSENS	No		No			E51 – Enable second sensor
pNUM_GEAR_BOX	1	Rev	1	1	2147483647	E60-E61– Gear box numerator
pDEN_GEAR_BOX	1	Rev	1	1	2147483647	E62-E63 – Gear box numerator
pENMULTICORRECT	No		No			E64 Enable correction for absolute multi-turn sensor

Tab. 4- Second sensor device control

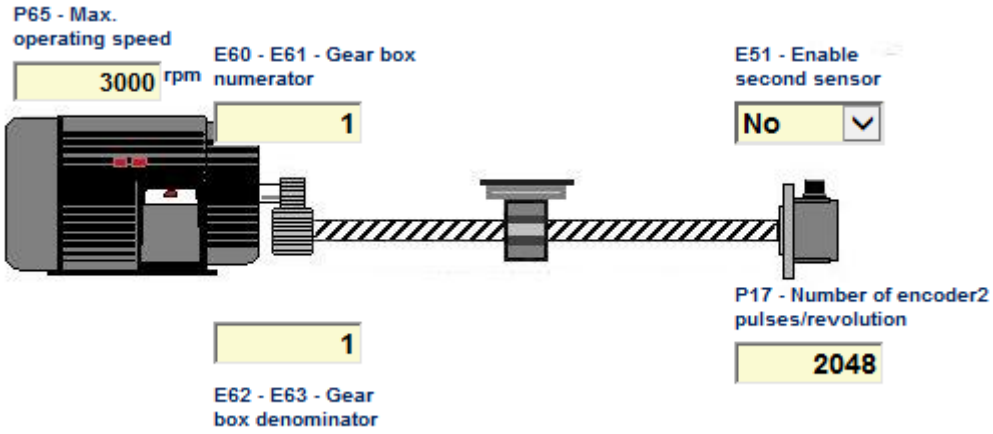


Fig. 5-Second sensor graphic interface

The example shown in **Fig. 3** regards a system with a reduction ratio **10:1** between the motor shaft and the driving shaft, with a revolution of the driving shaft. The second sensor is an encoder with 4096 pulses/revolution set in the parameter **P17-ENC2_PPR**.
This parameter is located in the directory:

All Parameters > Application I/O Parameters > Input > Second Sensor

The internal software realizes a possible "correction" for incremental sensor's which have zero pulse. In these kind of sensor when comes the zero pulse signal the position goes to zero. For the homing method's without index pulses (metods 17---30) take place the correction when the zero pulse comes and the position doesn't go to zero. The "correction" is allowed for both sensors (first or second).

If the second sensor is enabled, the value of position, velocity and acceleration in all the operation mode available al referred to the motor shaft side.
For example if the gear ratio is **10:1** (1 turn of the motor shaft = 10 turns of the driving shaft) and the position target **pTARGETPOS – E10 – E11** is 655360 i.e., the motor turns for 10 revolutions and the driving shaft for 1 revolution.
For each PWM period a pulses difference is calculated (delta pulses), depending on the second sensor mechanical position read. This value is reported to motor side by relationship:

$$\text{motor side delta pulses} = \frac{\textbf{pNUM\_GEAR\_BOX E60-E61}}{\textbf{pDEN\_GEAR\_BOX E62-E63}} \cdot \text{delta pulses sec. Sensor}$$

The parameter **E64- pENMULTICORRECT** (if enabled) consents to correct the overflow for absolute sensor multi-turn when the high mechanical position (number of turns) reaches the maximum number of turn.
For example for ENDAT-BISS 12bit after 4095 turns high position goes to zero value, this could be a problem.

2.2.2 POSITION RESOLUTION

Is possible to choose the resolution of first and second sensor with the parameter **E98 - pPOS_FRAC_SENS1** and **E99 - pPOS_FRAC_SENS2**.

Example:
If the user selects a resolution of 19 bit, the meaning of the 32 bit position's variables is: 19 bit for resolution on single turn and 13 bit is the number of the turns (1 turn = 524288 ie).

Bit [18...31] position on multi-turn	Bit [0...18] position on single turn

The units of measurement used in Stop in position function are the same developed by CAN Open DSP 402:

- Position in "ie" (1 turn = **2** $^{\text{pPOS\_FRAC\_SENS}}$ ie),
- Velocity in "ie/s",
- Acceleration in "ie".

2.2.3 CYCLIC TASK

From firmware version 22.10 and 12.10 the user can chose the duration of cyclic task. The parameter is **E94 – pCYCLICPERIOD** (ms).
The S-Ramp profile generator and the torque limits are calculate cyclically while the position loop is calculated each PWM period.

2.2.4 LIFE GUARDING ALARM AND MAX SYNCH ALARM

The user can choose if set the Life Guarding alarm (**A4.0**) or not when communication with master is lost. The parameter **E46-pENGUARDAL** can choose the different setting: when is set to zero, the drive trips in alarm, otherwise it stops with emergency deceleration ramps without alarm.

The maximum synch delay alarm (**A4.1**) is activated when the difference between two consecutive sync is greather than the value set in the threshold **E65-MAX_SYNC_ERROR** (unit 100 us).

2.2.5 sipCONTROL_WORD AND STATUS_WORD2

The device control of Dsp402 supports also an additional CONTROL_WORD (sipCONTROL_WORD) and additional STATUS_WORD2 for particular functions.

15	14	13	12	11	10 S2Sel	9 S2Abs	8 Sens2	7 TrqFl	6 TrqAl	5 ZeroTopSec	4 ASet	3 ZeroTop	2 GBox	1 Pos Cmd	0 Stop Pos

Fig. 6- E67 – sipCONTROL_WORD

bit	value	definition
0	0	Same direction
	1	Minimum track
1	0	Input I19 OR bit 12 of rCONTROL_WORD
	1	Speed reference
2	0	Disable gearbox
	1	Enable gerbox
3	0	Zero TOP: sensor connector
	1	Zero TOP: fast DI8
4	0	Switch off autoset
	1	Enable autoset
5	0	Zero TOP Second Sensor: sensor connector
	1	Zero TOP Second Sensor: fast DI8
6	0	Enable torque limit by analogue Input
	1	Disable torque limit by analogue Input
7	0	Enable Torque limit by Fieldbus
	1	Disable Torque limit by Fieldbus
8	0	Enable Second Sensor calculation
	1	DisableSecond Sensor calculation
9	0	Enable Second sensor Zero Top Correction
	1	DisableSecond sensor Zero Top Correction
10	0	Enable Jump from First Sensor to Second Sensor
	1	Enable Jump from Second Sensor to First Sensor
11	0	Enable second sensor bank
	1	Disable second sensor bank

Tab. 5- sipCONTROL_WORD bits

15	14	13	12	11	10	9	8	7 Bank2	6 SetSens	5 SwitchPosEn	4 FldTrq	3 AnTrq	2 Toff	1 Ton	0 Brake

Fig. 7- D72 – STATUS_WORD2

bit	value	definition
0	0	System not in the “Brake State”
	1	**System in “Brake State”**
1	0	Disable timer not activated or not end
	1	Disable timer end
2	0	Enable timer not activated or not end
	1	Enable timer end
3	0	Torque limitation from analogue input disabled

	1	Torque limitation from analogue input enabled
4	0	Torque limitation from fielbus disabled
	1	Torque limitation from fielbus enabled
5	0	Switch position function disabled
	1	Switch position function enabled
6	0	Set sensor disabled
	1	Set sensor enabled
7	0	Speed Bank 2 not active
	1	Speed Bank 2 actived

Tab. 6- STATUS_WORD2 bits

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
2100	VAR	INTEGER16	STATUS_WORD2	This object contains the second status word value OPD Explorer Parameter: **D72**	Yes	Reading

Tab. 7- STATUS_WORD2 object

2.2.6 S-RAMPS

S-Ramps can be enabled with the following operative mode: **1-Profile Position mode**, **2-Homing mode**, **3-Profile velocity mode**,
Parameter **E92 - 93 – pPROFJERK** set the value of the jerk and enable the S-Ramps, if this parameters is equal to zero trapezoidal profile generator is automatically enabled.

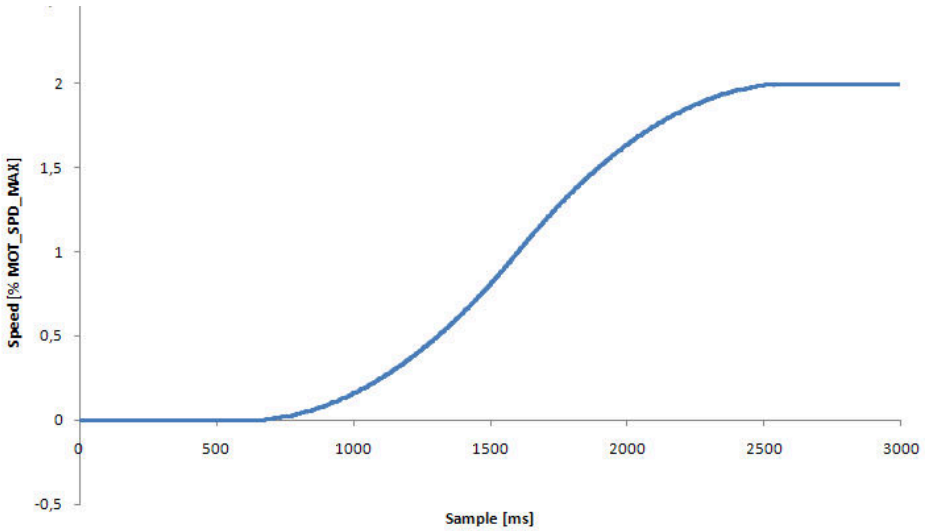
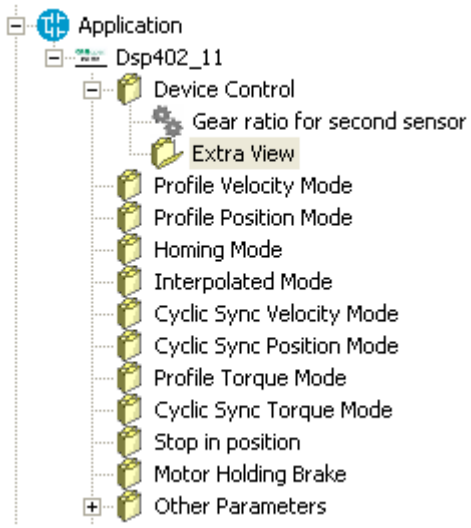


Fig. 8-SRamps

2.3 EXTRA VIEW



Extra View interface contains some objects usefully for check the internal position read from the firmware.

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
2101 sub 0x00	VAR	INTEGER32	Sensor 1 Zero Top	This object contains the position of zero top in i.e. OPD Explorer Parameter: **E114-115**	Yes	Reading
2101 sub 0x01	VAR	INTEGER32	Sensor 2 Zero Top	This object contains the position of zero top in i.e. OPD Explorer Parameter: **E116-117**	Yes	Reading
2101 sub 0x02	VAR	INTEGER32	Di Zero Pos	This object contains the Zero Position for the system OPD Explorer Parameter: **E118-119**	Yes	Reading
2101 sub 0x03	VAR	INTEGER32	Sensor 1 Mechanical position	This object contains the Mechanical position read from sensor 1 (sysMechPosition) OPD Explorer Parameter: **E120-121**	Yes	Reading
2101 sub 0x04	VAR	INTEGER32	Sensor 2 Mechanical position	This object contains the Mechanical position read from sensor 2 (sysSecondSensorMechPosition) OPD Explorer Parameter: **E122-123**	Yes	Reading
2101 sub 0x05	VAR	INTEGER32	Mechanical position	This object contains the final Mechanical position (SensMechPosition) OPD Explorer Parameters: **E124-125**	Yes	Reading

Tab. 8- Position objects

The final position **SensMechPosition** could follow exactly the position read by sensor (example: **sysMechPosition**) for homing methods which uses the index pulse signal or could compensate the zero top like the following picture (**Fig. 7**) for homing methods which doesn't use index pulse signal.

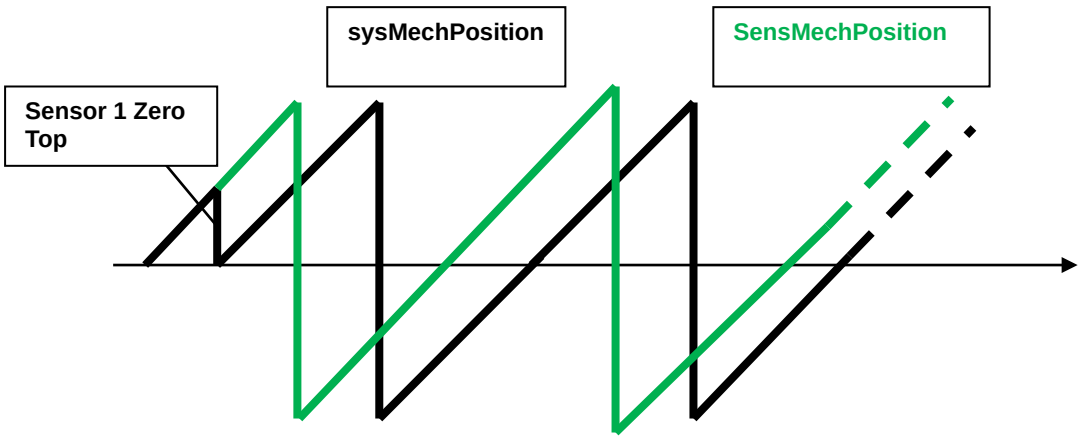
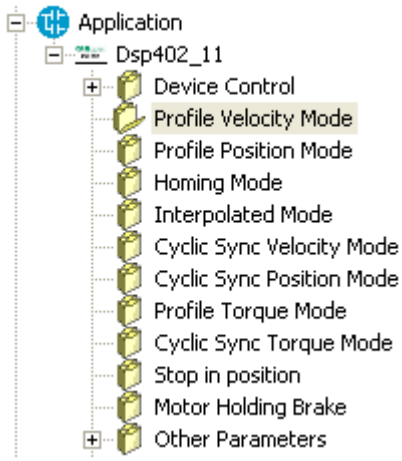


Fig. 9-Position variables

When zero position is found (after homing), the actual position is read in the following way:

ACTUALPOS (0x6064) = SensMechPosition - diZeroPos

2.4 PROFILE VELOCITY MODE



The profile velocity mode covers the following sub-functions:

- Demand value input via trajectory generator;
- Velocity capture using position sensor or velocity sensor;
- Velocity control function with appropriate input and output signals;
- Monitoring of the profile velocity using a window-function;
- Monitoring of velocity actual value using a threshold.

OPDE drive supports the following Profile Velocity Mode objects (**Tab. 9**):

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
606C	VAR	INTEGER32	Velocity actual value	This object provides the actual velocity. OPD Explorer Parameters: **D68-D69**	Yes	Reading

606D	VAR	UNSIGNED16	Velocity window	This object indicates the configured velocity window. OPD Explorer Parameter: **E22 – E23**	Yes	Reading/ writing
606E	VAR	UNSIGNED16	Velocity window time	This object indicates the configured velocity window time. OPD Explorer Parameter: **E24**	Yes	Reading/ writing
606F	VAR	UNSIGNED16	Velocity threshold	This object indicates the configured velocity threshold. OPD Explorer Parameter: **E18**	Yes	Reading/ writing
6070	VAR	UNSIGNED16	Velocity threshold time	This object indicates the configured velocity threshold time. OPD Explorer Parameter: **E20**	Yes	Reading/ writing
6083	VAR	UNSIGNED32	Profile acceleration	This object indicates the configured acceleration. OPD Explorer Parameter: **E04-E05**	Yes	Reading/ writing
6084	VAR	UNSIGNED32	Profile deceleration	This object indicates the configured deceleration OPD Explorer Parameter: **E06-E07**	Yes	Reading/ writing
60FF	VAR	INTEGER32	Target velocity	This object indicates the configured target velocity. OPD Explorer Parameter: **E02-E03**	Yes	Reading/ writing
60A4	VAR	UNSIGNED32	Profile Jerk	This object indicates the configured target jerk. OPD Explorer Parameter: **E92-E93**	Yes	Reading/writing

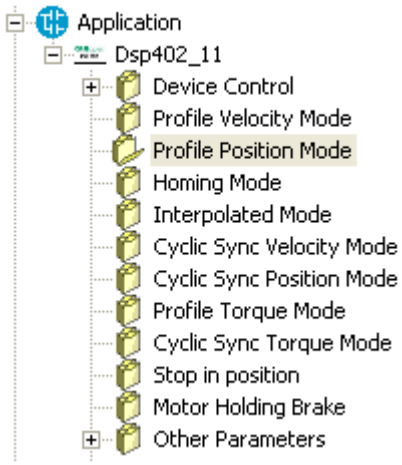
Tab. 9- Profile Velocity Mode Objects

Object 606F Velocity threshold is refrred to 16 bit (0-65535 ie). In case of mechanical position shifted, this object is automatically scaled.

Example: **E98 - pPOS_FRAC_SENS1 =** 18 bits
E18 - pTHRVEL = 10000 ie/s
E128 -129 - pTHRVEL_SHIFTED = 40000 ie/s

The same is for object 606D Velocity window.

2.5 PROFILE POSITION MODE



In profile position mode a target position is applied to the trajectory generator. The trajectory generator produces a position demand value for the position control loop.

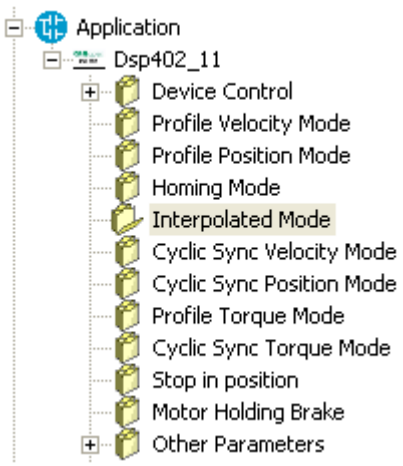
OPDE drive supports the following Profile Position Mode objects (**Tab. 10**):

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
6064	VAR	INTEGER 32	Position actual value	This object provides the actual position. OPD Explorer Parameters: **D66-D67**	Yes	Reading
6065	VAR	UNSIGNED 32	Following error window	This object indicates the configured range of tolerant position values symmetrically to the position demand value. OPD Explorer Parameters: **E16 – E17**	Yes	Reading/writing
6067	VAR	UNSIGNED 32	Position window	This object indicates the configured symmetrical range of accepted positions relative to the target position. OPD Explorer Parameter: **E14-E15**	Yes	Reading/writing
606F	VAR	UNSIGNED 16	Velocity threshold	This object indicates the configured velocity threshold. OPD Explorer Parameter: **E18-E19**	Yes	Reading/writing
607A	VAR	INTEGER32	Target position	This object indicates the commanded position that the drive should move to in position profile mode. OPD Explorer Parameter: **E10-E11**	Yes	Reading/writing
607D	ARRAY	UNSIGNED 8	Highest sub-index supported (Sub-index 0)	Highest sub-index supported	No	Reading
		INTEGER 32	Min position limit (Sub-index 1)	This object indicates the maximal software position limit. OPD Explorer Parameter: **E40–E41**	Yes	Reading/writing
		INTEGER 32	Max position limit (Sub-index 2)	This object indicates the maximal software position limit. OPD Explorer Parameter: **E42-E43**	Yes	Reading/writing
6081	VAR	UNSIGNED 32	Profile velocity	This object indicates the configured velocity normally attained at the end of the acceleration ramp during a profiled motion. OPD Explorer Parameter: **E12-E13**	Yes	Reading/writing

6083	VAR	UNSIGNED 32	Profile acceleration	This object indicates the configured acceleration. OPD Explorer Parameter: **E04-E05**	Yes	Reading/writing
6084	VAR	UNSIGNED 32	Profile deceleration	This object indicates the configured deceleration OPD Explorer Parameter: **E06-E07**	Yes	Reading/writing
60A4	VAR	UNSIGNED32	Profile Jerk	This object indicates the configured target jerk. OPD Explorer Parameter: **E92-E93**	Yes	Reading/writing

Tab. 10 - Profile Position Mode Objects

2.6 INTERPOLATE POSITION MODE



Interpolated position mode is used to control multiple coordinated axes or a single axis with the need for time-interpolation of set-point data. The interpolated position mode normally uses time synchronisation mechanisms for a time coordination of the related drive units (e.g. Distributed Clock in EtherCAT protocol).

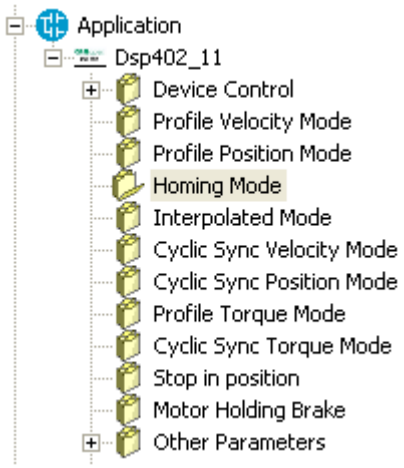
OPDE drive supports the following Interpolated Position Mode objects (**Tab. 11**):

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
6064	VAR	INTEGER 32	Position actual value	This object provides the actual position. OPD Explorer Parameters: **D66-D67**	Yes	Reading
606F	VAR	UNSIGNED 16	Velocity threshold	This object indicates the configured velocity threshold. OPD Explorer Parameter: **E18-E19**	Yes	Reading/writing

60C1	ARRAY	UNSIGNED 8	Highest sub-index supported (Sub-index 0)	Highest sub-index supported	No	Reading
		INTEGER 32	Interpolated data – 1st set-point (Sub-index 1)	This object indicates data words, which are necessary to perform the interpolation algorithm. OPD Explorer Parameter: **E24-E25**	Yes	Reading/writing

Tab. 11 - Interpolated Position Mode Objects

2.7 HOMING MODE



Homing Mode implements the methods which a drive seeks the home position, or initial reference point (also called, the datum or zero point). There are various methods of achieving this using limit switches at the ends of travel or a home switch (zero point switch) in mid-travel, most of the methods also use the index (zero) pulse train from an incremental encoder.

OPDE drive supports the following methods:

1. ***Homing on negative limit switch and index pulse****;*
2. ***Homing on positive limit switch and index pulse****;*
3. ***Homing on positive home switch and index pulse.*** *The home position is at the left of the point where the home switch changes state;*
4. ***Homing on positive home switch and index pulse.*** *The home position is at the right of the point where the home switch changes state;*
5. ***Homing on negative home switch and index pulse.*** *The home position is at the right of the point where the home switch changes state;*
6. ***Homing on negative home switch and index pulse.*** *The home position is at the left of the point where the home switch changes state;*
7. ***Homing on home switch and index pulse with positive limit switch.*** *The home position is at the left of the point where the home switch has falling edge;*
8. ***Homing on home switch and index pulse with positive limit switch.*** *The home position is at the right of the point where the home switch has rising edge;*
9. ***Homing on home switch and index pulse with positive limit switch.*** *The home position is at the left of the point where the home switch has rising edge;*

10. ***Homing on home switch and index pulse with positive limit switch.*** *The home position is at the right of the point where the home switch has falling edge;*
11. ***Homing on home switch and index pulse with negative limit switch.*** *The home position is at the right of the point where the home switch has falling edge;*
12. ***Homing on home switch and index pulse with negative limit switch.*** *The home position is at the left of the point where the home switch has rising edge;*
13. ***Homing on home switch and index pulse with negative limit switch.*** *The home position is at the right of the point where the home switch has rising edge;*
14. ***Homing on home switch and index pulse with negative limit switch.*** *The home position is at the left of the point where the home switch has falling edge;*
17. ***Homing on negative limit switch without index pulse;***
18. ***Homing on positive limit switch without index pulse;***
19. ***Homing on positive home switch without index pulse.*** *The home position is at the left of the point where the home switch changes state;*
21. ***Homing on negative home switch without index pulse.*** *The home position is at the right of the point where the home switch changes state;*
23. ***Homing on home switch and index pulse without positive limit switch.*** *The home position is at the left of the point where the home switch has falling edge;*
26. ***Homing on home switch without index pulse with positive limit switch.*** *The home position is at the right of the point where the home switch has falling edge;*
27. ***Homing on home switch without index pulse with negative limit switch.*** *The home position is at the right of the point where the home switch has falling edge;*
30. ***Homing on home switch without index pulse with negative limit switch.*** *The home position is at the left of the point where the home switch has falling edge;*
33. ***Homing on index pulse.*** *The home position is at first index pulse found on the left;*
34. ***Homing on index pulse.*** *The home position is at first index pulse found on the right;*
35. ***Homing on index pulse.*** *The home position is the current position.*

OPDE drive supports the following Homing Mode objects (**Tab. 10**).

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
606F	VAR	UNSIGNED 16	Velocity threshold	This object indicates the configured velocity threshold. OPD Explorer Parameter: **E18-E19**	Yes	Reading/writing
607C	VAR	INTEGER 32	Home offset	This object indicates the configured difference between the zero position for the application and the machine home position. OPD Explorer Parameters: **E28-E29**	Yes	Reading/writing
6098	VAR	INTEGER 8	Homing method	This object indicates the configured homing method The supported methods are those descripted above. OPD Explorer Parameters: **E26**	Yes	Reading/writing
6099	ARRAY	UNSIGNED 8	Highest sub-index supported (Sub-index 0)	Highest sub-index supported	No	Reading

		UNSIGNED 32	Speed during search for switch (Sub-index 1)	This object indicates the configured speed during search for switch. OPD Explorer Parameter: **E30-E31**	Yes	Reading/writing
		UNSIGNED 32	Speed during search for zero (Sub-index 2)	This object indicates the configured speed during search for zero. OPD Explorer Parameter: **E32-E33**	Yes	Reading/writing
609A	VAR	UNSIGNED 32	Homing acceleration	This object indicates the configured acceleration and deceleration to be used during homing operation. OPD Explorer Parameters: **E34-E35**	Yes	Reading/writing
60A4	VAR	UNSIGNED32	Profile Jerk	This object indicates the configured target jerk. OPD Explorer Parameter: **E92-E93**	Yes	Reading/writing

Tab. 12 - Homing Mode Objects

2.7.1 HOMING SWITCHES

The homing switches are implemented with the following Logic Input Functions:

- **positive limit switch** is the input logic function **I28**;
- **negative limit switch** is the input logic function **I29**;
- **home switch** is the input logic function **I30.**

For more information about input logic functions, see OPDE manual.

2.7.2 HOMING WITH TOUCH PROBE

In this method, the position is not sampled by control device, but by the **drive device** itself. When the switch is triggered, the corresponding actual position together will the switch signal shall be reported.

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
60B8	VAR	UNSIGNED16	Touch probe function	This object indicates the configured function of touch probe. OPD Explorer Parameter: **E104**	Yes	Reading/writing
60B9	VAR	UNSIGNED16	Touch probe status	This object indicates the status of touch probe. OPD Explorer Parameters: **E105**	Yes	Reading
60BA	VAR	INTEGER 32	Touch probe pos1 pos value	This object indicates the position values of touch probe 1 at positive edge. The value shall be given in user-defined position units. OPD Explorer Parameters: **E106-E107**	Yes	Reading
60BB	VAR	INTEGER 32	Touch probe pos1 negative value	This object indicates the position values of touch probe 1 at negative edge. The value shall be given in user-defined position units. OPD Explorer Parameters: **E108-E109**	Yes	Reading

60BC	VAR	INTEGER 32	Touch probe pos2 positive value	This object indicates the position values of touch probe 2 at positive edge. The value shall be given in user-defined position units. OPD Explorer Parameters: **E110-E111**	Yes	Reading
60BD	VAR	INTEGER 32	Touch probe pos2 negative value	This object indicates the position values of touch probe 2 at positive edge. The value shall be given in user-defined position units. OPD Explorer Parameters: **E112-E113**	Yes	Reading

Tab. 13- Touch probe objects

For touch probe function, the setting is:

bit	value	definition
0	0	Switch off touch probe 1
	1	Enable touch probe 1
1	0	Trigger first event
	1	continuous
2	0	Trigger with touch probe 1 input
	1	Trigger with zero impulse signal or position encoder
3	0	Reserved
4	0	Switch off sampling at positive edge of touch probe 1
	1	Enable sampling at positive edge of touch probe 1
5	0	Switch off sampling at negative edge of touch probe 1
	1	Enable sampling at negative edge of touch probe 1
6,7	-	User-defined
8	0	Switch off touch probe 2
	1	Enable touch probe 2
9	0	Trigger first event
	1	continuous
10	0	Trigger with touch probe 2 input
	1	Trigger with zero impulse signal or position encoder
11	0	Reserved
12	0	Switch off sampling at positive edge of touch probe 2
	1	Enable sampling at positive edge of touch probe 2
13	0	Switch off sampling at negative edge of touch probe 2
	1	Enable sampling at negative edge of touch probe 2
14,15	-	User-defined

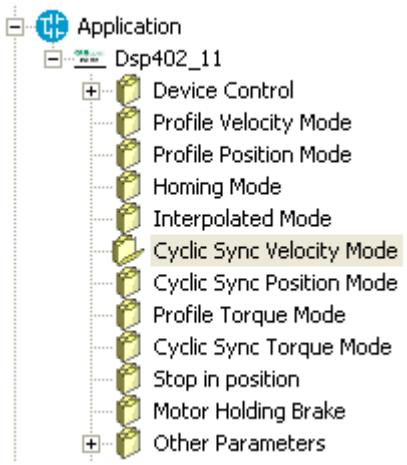
Tab. 14- Touch probe function bits

And for touch probe status:

bit	value	definition
0	0	Touch probe 1 is switched off
	1	Touch probe 1 is enabled
1	0	Touch probe 1 no positive edge value stored
	1	Touch probe 1 positive edge value stored
2	0	Touch probe 1 no negative edge value stored
	1	Touch probe 1 negative edge value stored
3 to 5	0	Reserved
6,7	-	User-defined (e.g. for testing)
8	0	Touch probe 2 is Switched off
	1	Touch probe 2 is Enabled
9	0	Touch probe 2 no positive edge value stored
	1	Touch probe 2 positive edge value stored
10	0	Touch probe 2 no negative edge value stored
	1	Touch probe 2 negative edge value stored
11 to 13	-	Reserved
14, 15	-	User-defined (e.g. for testing)

Tab. 15- Touch probe status bits

2.8 PROFILE SYNC VELOCITY MODE



The cyclic synchronous velocity mode covers the following sub-functions:

- Demand value input
- Velocity capture using position sensor or velocity sensor
- Velocity control function with appropriate input and output signals
- Limitation of torque demand

Various sensors may be used for velocity capture. In particular, the aim is that costs are reduced and the drive power system is simplified by evaluating position and velocity using a common sensor, such as is optional using a resolver or an encoder.

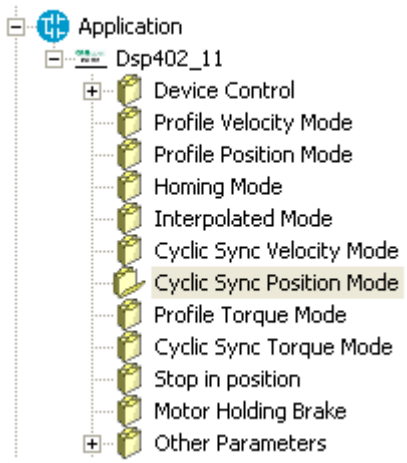
The behavior of the control function is influenced by control parameters such as limit functions, which are externally applicable. The drive internal control function is not specified more precisely in this part of profile specification as it is highly manufacturer-specific, but the format and content of the control parameters are provided. The input (from the

control device point of view) are the target velocity. The drive device may support limitation of motor speed and a quick stop function for emergency reasons. The interpolation time period defines the time period between two updates of the target velocity and shall be used for intercycle interpolation.
The **velocity actual value is** used as mandatory output to the control device.

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
605A	VAR	UNSIGNED 16	Quick stop option code	This object indicates what action is performed when the quick stop function is executed. OPDE drive supports the following codes: **Slow down on quick stop ramp and transit into Switch On Disabled;** **Slow down on quick stop ramp and stay in Quick Stop Active;** **Note:** if the inserted code is not expected, the quick stop option code executes the code 1. OPD Explorer Parameter: **E38**	No	Reading
606C	VAR	SIGNED 32	Velocity actual value	This object provides the actual velocity. OPD Explorer Parameters: **D68-D69**	Yes	Reading
606D	VAR	UNSIGNED 16	Velocity window	This object indicates the configured velocity window. OPD Explorer Parameter: **E22-E23**	Yes	Reading/writing
6085	VAR	UNSIGNED 32	Quick stop deceler ation	This object configures the deceleration used to stop the motor when the quick stop function is activated. OPD Explorer Parameters: **E08-E09**	Yes	Reading
60FF	VAR	SIGNED32	Target Velocity	This object indicates the configured target velocity. OPD Explorer Parameter: **E02-E03**	Yes	Reading/writing

Tab. 16 Profile sync velocity mode

2.9 PROFILE SYNC POSITION MODE



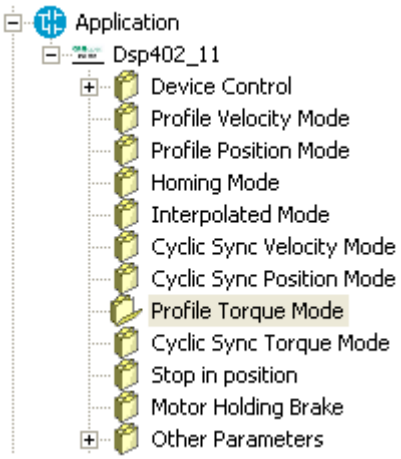
With this mode, the trajectory generator is located in the **control device**, not in the drive device. In cyclic synchronous manner, it provides a target position to the drive device, which performs position control,
velocity control and torque control. Optionally, additive velocity and torque values can be provided by the control system in order to allow for velocity and/or torque feedforward. Measured by sensors, the drive device may provide actual values for position, velocity and torque to the control device.

The behavior of the control function is influenced by control parameters like limit functions, which are externally applicable. The drive internal control function is not specified more precisely in this part of profile specification as it is highly manufacturer-specific, but the format and content of the control parameters are provided.

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
605A	VAR	UNSIGNED 16	Quick stop option code	This object indicates what action is performed when the quick stop function is executed. OPDE drive supports the following codes: **Slow down on quick stop ramp and transit into Switch On Disabled;** **Slow down on quick stop ramp and stay in Quick Stop Active;** **Note:** if the inserted code is not expected, the quick stop option code executes the code 1. OPD Explorer Parameter: **E38**	No	Reading
6064	VAR	INTEGER32	Position actual value	This object provides the actual position. OPD Explorer Parameters: **D66-D67**	Yes	Reading
6065	VAR	UNSIGNED 32	Following error window	This object indicates the configured range of tolerant position values symmetrically to the position demand value. OPD Explorer Parameters: **E16-E17**	Yes	Reading/ writing
607A	VAR	INTEGER32	Target position	This object indicates the commanded position that the drive should move to in position profile mode. OPD Explorer Parameter: **E10-E11**	Yes	Reading/ writing
60F4	VAR	INTEGER32	Following error actual value	This object shall provide the actual value of the following error. The value is given in user-defined position units. OPD Explorer Parameter: **d70-d71**	Yes	Reading

Tab. 17 Profile sync position mode

2.10 PROFILE TORQUE MODE



The profile torque mode allows control device (i.e. closed-loop speed controller, open-loop transmission force controller) to transmit the target torque value, which is processed via the

trajectory generator. The torque slope and torque profile type parameters are required.
If the control device switches the controlword bit 8 (halt) from 0 to 1 or from 1 to 0, than the trajectory generator ramps its control effort output down to zero, respectively up to the target torque. In both cases, the trajectory generator takes the torque slope and torque profile type into consideration.

bit	value	definition
8	0	The motion shall be executed or continued
	1	Axis shall be stopped

Tab. 18 Bit 8 of Control Word for Profile Torque mode

bit	value	definition
10	0	Halt (Bit 8 in controlword) = 0: *Target torque* not reached Halt (Bit 8 in controlword) = 1: Axis decelerates
	1	Halt (Bit 8 in controlword) = 0: *Target torque* reached Halt (Bit 8 in controlword) = 1: Velocity of axis is 0

Tab. 19 Bit 10 of Status Word for Profile Torque mode

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
605A	VAR	UNSIGNED 16	Quick stop option code	This object indicates what action is performed when the quick stop function is executed. OPDE drive supports the following codes: **Slow down on quick stop ramp and transit into Switch On Disabled;** **Slow down on quick stop ramp and stay in Quick Stop Active;** **Note:** if the inserted code is not expected, the quick stop option code executes the code 1. OPD Explorer Parameter: **E38**	No	Reading
6071	VAR	INTEGER16	Target Torque	This object shall indicate the configured input value for the torque controller in profile torque mode. The value shall be given per thousand of rated torque OPD Explorer Parameter: **E47**	Yes	Reading/ writing
6087	VAR	UNSIGNED 32	Torque slope	This object shall indicate the configured rate of change of torque. The value shall be given in units of per thousand of rated torque per second. OPD Explorer Parameter: **E48 - 49**	Yes	reading/writing

Tab. 20 Profile Torque mode objects

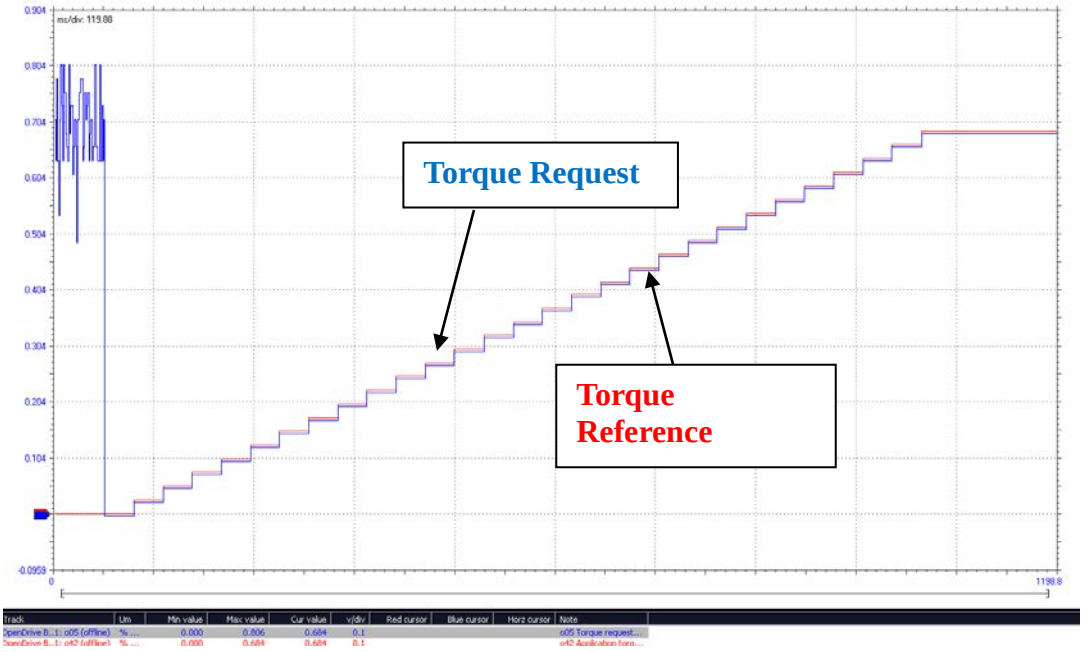
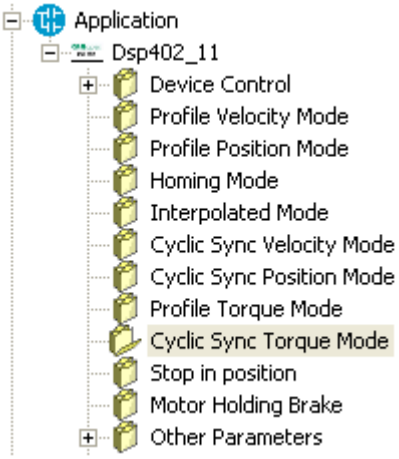


Fig. 10 Profile Torque Mode

2.11 CYCLIC SYNC TORQUE MODE



The trajectory generator is located in the control device, not in the drive device.
In cyclic synchronous manner, it provides a target torque to the drive device, which performs torque control.

bit	value	definition
10	0	reserved
	1	reserved
12	0	Target torque ignored
	1	Target torque shall be used as input to torque control loop
13	0	reserved
	1	reserved

Tab. 21 Bit 12 of Status Word for CST Mode

With parameter **E55 – EN_INTERP** is possible to enable the torque interpolation between two SYNCH torque references.

Object of Torque Reference is the same 0x6071.

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
6071	VAR	INTEGER16	Target Torque	This object shall indicate the configured input value for the torque controller in profile torque mode. The value shall be given per thousand of rated torque OPD Explorer Parameter: **E47**	Yes	Reading/ writing

Tab. 22 CST Mode objects

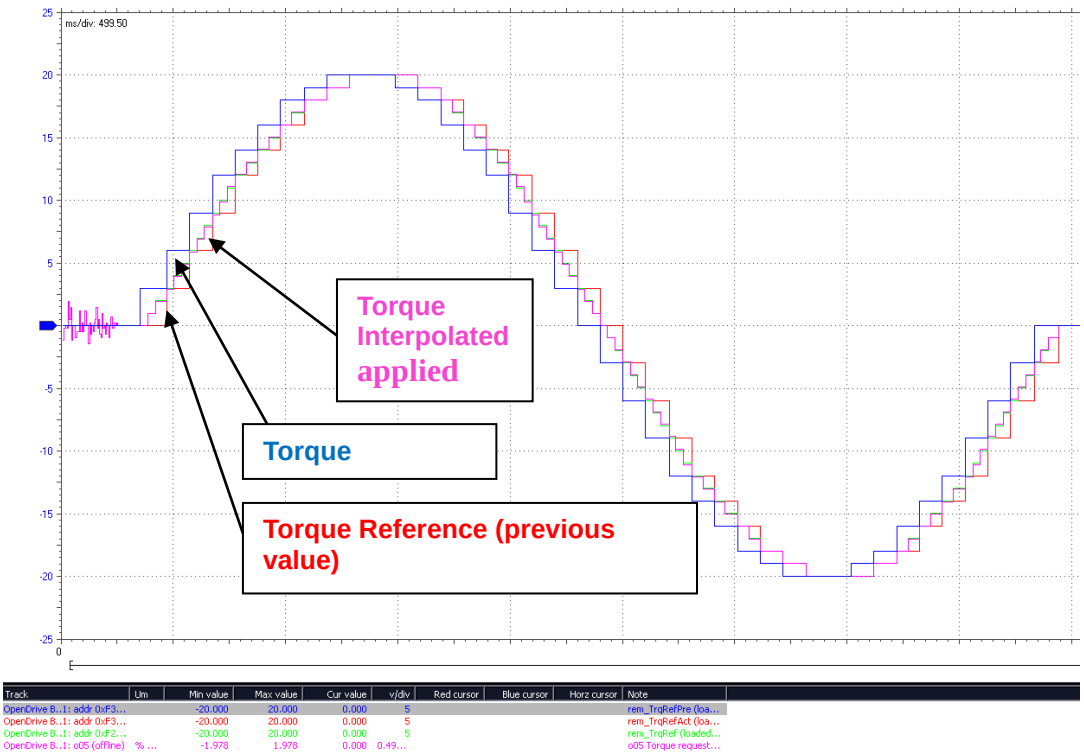
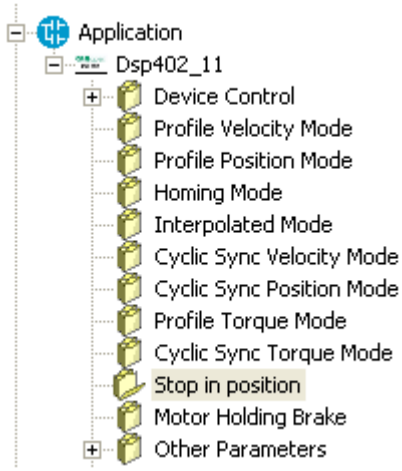


Fig. 11-CST mode Torque Interpolation

2.12 STOP IN POSITION FUNCTION



This function can work only with this operative mode: **3-Profile velocity mode** and **9-Cyclic Sync Velocity mode**, where the profile control loop is not active.
The function is the same developed in the Standard Application. However the units of measurement used in Stop in position function are the same developed by CAN Open DSP 402:

- Position in “ie” (1 turn = 65536 ie),
- Velocity in “ie/s”,
- Acceleration in “ie”,

If the drive is working in speed control, this particular function gives the chance to stop in a specific and absolute position of the rotation revolution (stop target position). Once the stop position has been reached, it is possible to command a relative movement of ±32768 ie (±180°). Moreover there is the chance of choosing the indexing speed and if to stop without inverting the rotation direction or not. The sensor needs to have an absolute indication of the mechanical position, so if it is an Incremental Encoder, zero TOP is necessary (obviously it is essential to run at least a one complete revolution before entering the stop-order). If Resolver feedback is used, this must be a single pole pair one.
The stop in position can optionally be referred to a mechanical turn after a reduction gear using the zero TOP on the load. The typical stop in position application is the indexing for the tool changing system.

Name	Description	Min	Max	Def	UM	Scale
pPOS_REG_KP	E39 - Kvposition	0.0	100.0	4.0		10
pPRC_SPD_INDEX	E68-69 –Indexing speed reference value	0	2147483647	65536	ie/s	1
pSTOP_POS0	E71 - Target 1 Stop in position	0	65535	0	ie	1
pSTOP_POS1	E71 - Target 1 Stop in position	0	65535	0	ie	1
pSTOP_POS2	E72 - Target 2 Stop in position	0	65535	0	ie	1
pSTOP_POS3	E73 - Target 3 Stop in position	0	65535	0	ie	1
pANG_MOV	E74 - Angular movement Stop in position	-32768	32767	0	ie	1
pPOS_WINDOW	E75 - Position Reached window	0	32768	98	ie	1
pTIME_WINDOW	E76 - Time on Position Reached window	0	19999	10	ms	1
pPRC_SPD_MIN_AUTO	E78-79 - Minimum speed for automatic stop	0	2147483647	6554	ie/s	1
pSPD_MIN_HYST	E80-81 - Minimum speed hysteresis	0	2147483647	0	ie/s	1
pNUM_GEAR_BOX	E60-61 - Gearbox NUM	0	2147483647	1		1
pDEN_GEAR_BOX	E62-63 - Gearbox DEN	0	2147483647	1		1

Tab. 23 Stop in position’s parameters

The 5 more significant bits are manufacturer specific and are used in this function. **Bit 11** of **rCONTROL_WORD** is used for enable the stop in position function. When the function is enabled the other **ms bits can** be used for control stop in position function.
For the ms bits, the setting is:

bit	value	definition
11	0	Switch off Stop in position function
	1	**Enable stop in position function**
12	0	Switch off stop in position function (is in OR with I19)
	1	Enable stop in position function (is in OR with I19)
13	0	Switch off stop in position movement (is in OR with I20)
	1	Enable stop in position movement (is in OR with I20)
14	0	Switch off bit 0 target selection (is in OR with I21)
	1	Enable bit 0 target selection (is in OR with I21)
15	0	Switch off bit 1 target selection (is in OR with I22)
	1	Enable bit 1 target selection (is in OR with I22)

Tab. 24 Control word bits 11-15

When the stop in position function is active is possible to set the working mode with the **"Stop in position control word" sipCONTROL_WORD – E67.**
This is the structure of **sipCONTROL_WORD,** for *Stop In Position Function* the 5 lsb are used:

The setting is:

bit	value	definition
0	0	Same direction
	1	Minimum track
1	0	Input I19 OR bit 12 of rCONTROL_WORD
	1	Speed reference
2	0	Disable gearbox
	1	Enable gerbox
3	0	Zero TOP: sensor connector
	1	Zero TOP: fast DI8
4	0	Switch off autoset
	1	Enable autoset

Tab. 25 Stop in position control word

The 2 msb of **STATUS WORD** are manufacturer specific and are used in stop in position function.
The meaning is:

bit	value	definition
14	0	Stop in position function not active
	1	Stop in position function enabled
15	0	Target (stop in position) not reached
	1	Target (stop in position) reached

Tab. 26 Status Word bits 14-15

2.12.1 WORKING MODE

With the drive working in speed control , there is the chance of enabling the function " Stop in position " in two different ways, based on **bit 1** of **sipCONTROL_WORD** : if **bit 1**= 0 the input function I19 (OR bit 12 of **rCONTROL_WORD**) **"Stop in position command "** must be set to high logic level ; if **bit 1** of **sipCONTROL_WORD** = 1 "Stop in position command " is taken when the speed reference goes below of the threshold value preset on **E78-79** (on **E80-81** the hysteresis on the stop activation can be set).

Note: the speed reference that is tested is the one in percent of the max speed ("sysSpeedPercReference") in case the frequency input is used, the timing signal decoding must be enabled.
Once this function has been activated the drive follows a ramp speed reference (automatically activated) to reach the indexing speed. The indexing speed is programmable in **E68-69** in ie/s. At this point it is possible to choose how to stop with E55.
The selectable stop positions are 4, the default value is set on **E70**, the other on **E71, E72** and **E73,** in percent of the revolution, related to the absolute position.
It's possible to select the stop position using the logical function inputs **I21** and **I22** or with bit 14 and 15 of **rCONTROL_WORD**, how it's shown in the following table:

Code I27 & I28 bit 14 & bit 15		Position selected	Description
0	0	E70	Stop target position 0
0	1	E71	Stop target position 1
1	0	E72	Stop target position 2
1	1	E73	Stop target position 3

Tab. 27 Targets position

with **bit 0** of **sipCONTROL_WORD=1**
without changing the motor rotation verse after the stop in position is commanded.

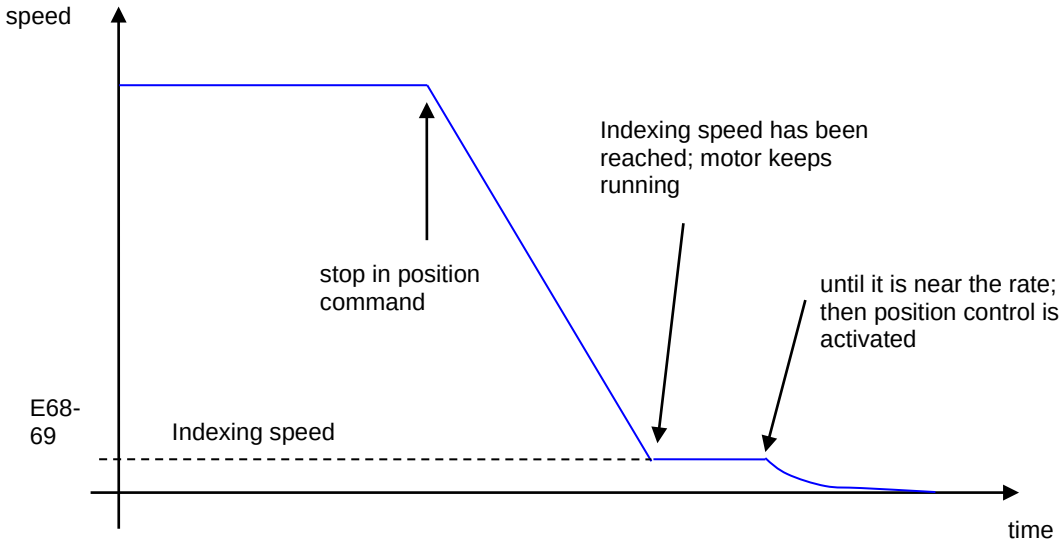


Fig. 12-Stop in position working

NB: in this modality, to activate position control, it is necessary that the max. position error (180°) multiplied by the position loop gain (E38) being greater than the indexing speed (E59), thus:

$$\frac{E68-69}{100} \leq E38 \cdot \frac{30}{P65}$$

E.g : E38 = 4.0
P65 = 1500 ⇨ E68-69 ≤ 8 % maximum speed

If this condition isn't true, appears alarm A4.0

with **bit 0** of **sipCONTROL_WORD=0** always following the minimum track

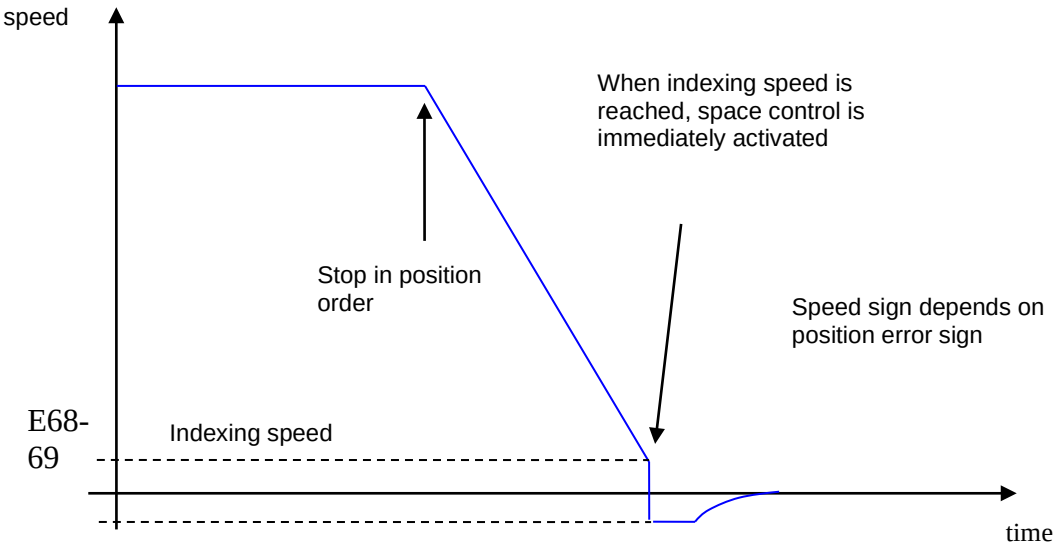


Fig. 13-Stop in position working

Anyway the speed reference generated by the position control can never exceed the indexing speed (in absolute value) set on E68-69.

Once the drive is stopped in position, for a time programmable in **E76**, the **bit 15** of **STATUS WORD**, becomes active. It is possible to set the uncertain area of the logic output on parameter **E75**, in half of a revolution in ie, as max distance (+ or -) from the correct position.
At this point it is possible to command another movement by activating the input function **I20** (or **bit 13** of **rCONTROL_WORD**) “execute the angular movement”.
The amplitude of the movement can be set in **E74** in percent of the revolution.
In any case the motor will move on the minimum path to reach the reference position and the speed will never go over the indexing one.(**E68-69**).
.

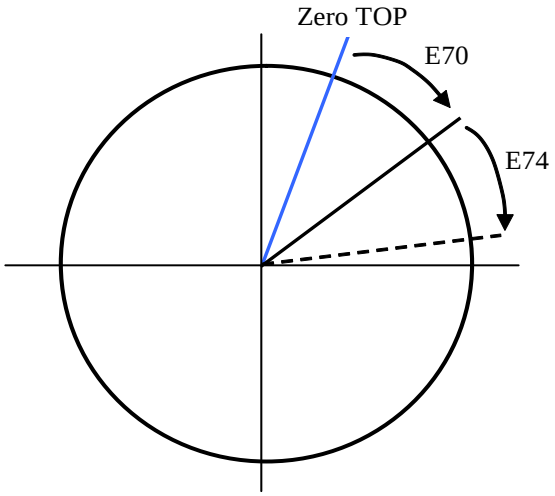


Fig. 14-Target positions

2.12.2 STOP IN POSITION DOWNSTREAM REDUCTION GEAR

This function is enabled setting **bit 2** of **sipCONTROL_WORD=1** and it’s very important to set correctly the reduction ratio
into parameters **E60-61** and **E62-63** corresponding to numerator and denominator (with E60-61 ≥ E62-63).
When this particular control is enabled, the stop position and angular movement (**E70** e **E74**) are referred to the absolute position downstream reduction gear.
There are two different working mode for the zero TOP management downstream reduction gear, selectable with **bit 3** of **sipCONTROL_WORD** connection:

with **bit 3=0** and only with Incremental Encoder (with or without Hall sensors) the zero TOP have to be connected to **PC1** and **/PC1** channels motor sensor connector.

with **bit 3=1** the zero TOP have to be connected to the eighth logic input on **M3** connector. It’s necessary to de-configure the logic function related to eighth logic input **C08=-1**. If the speed (*filtered*) is positive, the zero position will be stored on rising edge (0 → 1), if is negative the zero position will be stored on falling edge (1 → 0). The situation is explained in the following scheme.

In both cases, the zero pulse width have to be at least 26us.

Bit3 of sipCONTROL_WORD =1

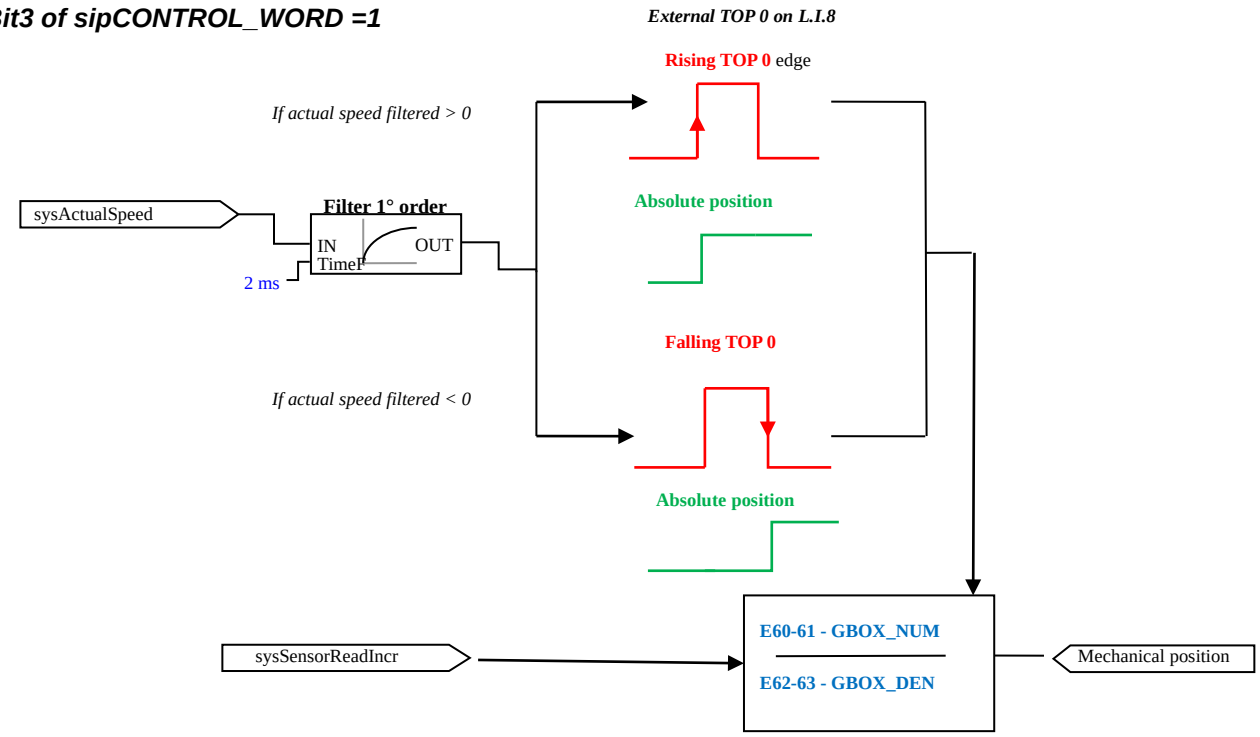


Fig. 15-External zero top detection

Bit 4 of **sipCONTROL_WORD** enable the autoset function. When **Bit 4 = 1** the actual position (1 turn = 65536) is writed in the current target selected. Automatically **Bit 4** return to **0.**

IMPORTANT: When stop in position function the core ramps (P21....P24) are active, if the Profile velocity mode is enabled the Dsp402 ramps are automatically disable when stop in position function starts.

Example:

Stop in position function active (**bit 11** of **rCONTROL_WORD = 1**),
Index speed (E68-69) = 65536 ie/s (2% of MOT_SPD_MAX),
Speed for automatic stop (E78-79) = 98304 ie/s (3% of MOT_SPD_MAX),
sipCONTROL_WORD = 0x0003 (same direction and speed reference, no gear box and sensor connector),
target 0 selected, position = 49152 ie (75% of 360°),
Profile velocity mode, pTARGETVEL = 131072 ie/s --> 32768 ie/s, pPROFACC = pPROFDEC = 65536 ie/s

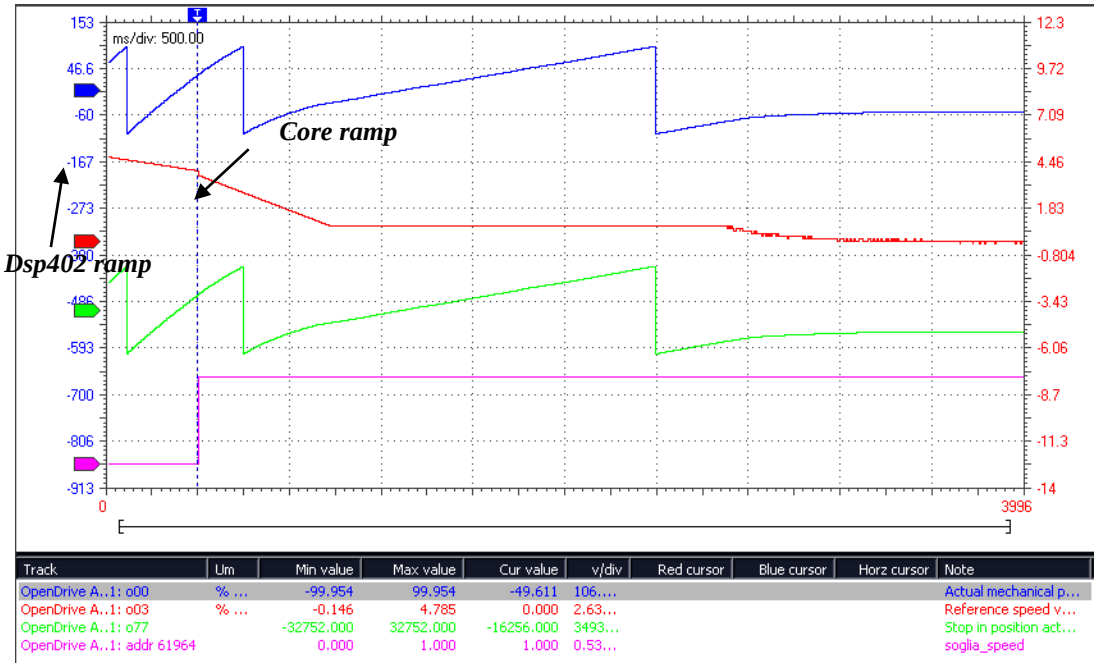
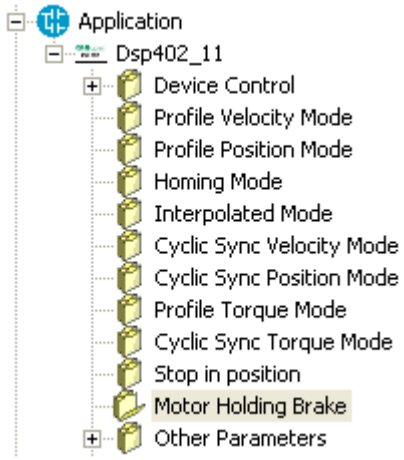


Fig. 16-Application's ramps

The blu signal is **o00-Actual mech position** (in % of ±180°), the red signal is **o03-Speed reference** (in % of speed max), the green signal **is o77-Actual position** (in ie), the purple signal is a **flag** which confirm that the speed for automatic stop has been reached.
The graphic show the change of ramp when stop in position is activated.

2.13 HOLDING BRAKE



This function can work in the device control of the system and it jump in an additional state named “Brake” when the brake is activated or disabled.
An additional status word “**STATUS_WORD2**” has been developed and the three less significant bit give information about the Brake state.

For the ls bits, the setting is:

bit	value	definition
0	0	System not in the “Brake State”
	1	**System in “Brake State”**
1	0	Disable timer not activated or not end
	1	Disable timer end
2	0	Enable timer not activated or not end
	1	Enable timer end

Tab. 28 Status word 2 bits

2.13.1 HOLDING BRAKE PARAMETERS

With parameter **E95-EN_HLD_BRAKE=Yes** it’s possible enable the command to open and close an external mechanical brake. The parameter **E96-HLD_BRAKE_DIS_DLY** defines the delay time at start, while the parameter **E97-HLD_BRAKE_EN_DLY** the delay time at stop.

Name	Description	Min	Max	Default	UM	Scale
EN_HLD_BRAKE	E95 – Enable Motor Holding brake	0	1	0		1
HLD_BRAKE_DIS_DLY	E96 – Motor holding brake disable delay at start	0	19999	0	ms	1
HLD_BRAKE_EN_DLY	E97 – Motor holding brake enable delay at stop	0	19000	0	ms	1
HLD_BRAKE_DIS_ET	E126 - Motor Holding brake disable elapsed time					
HLD_BRAKE_EN_ET	E127 - Motor Holding brake enable elapsed time					

Tab. 29 Holding brake parameters

If the holding brake detection is not enabled, the system works in the standard Dsp402 mode.

2.13.2 DISABLING BRAKE AT START

In the following example the system works in **3-Profile Velocity mode** and the brake is enabled.

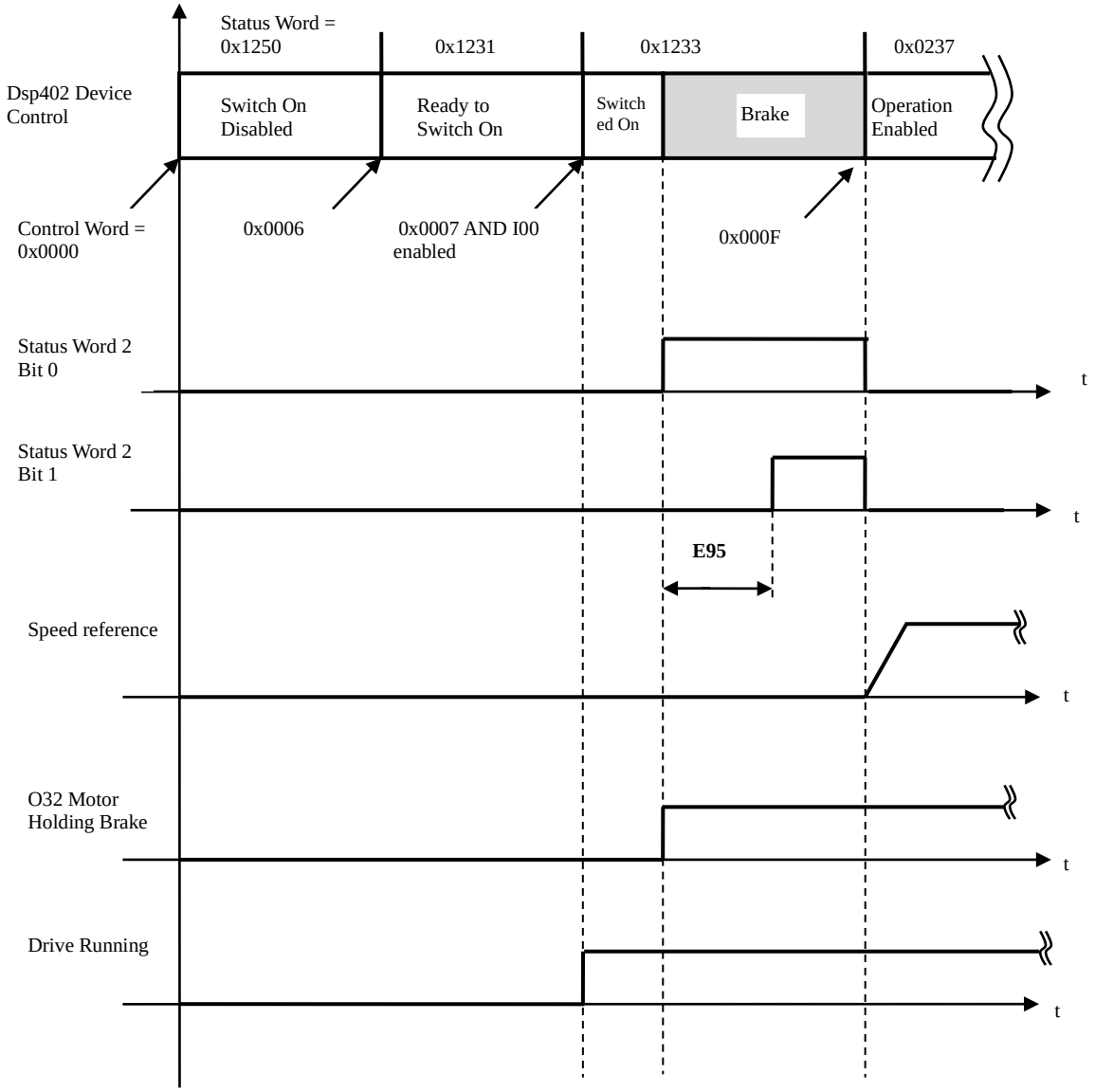


Fig. 17-Disabling brake at start

The figure above shows the steps for disabling the brake at start. When the state is ***Ready to Switch On*** state, bit 0 of **Control Word** is given and I00-Run Command is enabled the device control jump for a very few time (< 1ms) in ***Switched On*** state and the drive is in Run.
Immediately, the device goes in ***Brake*** state, the Output O32 is activated and the Timer starts. **Status Word** doesn't change but Bit 0 of **Status Word 2** is enabled. When the timer reach **E95**, Bit 0 of **Status Word 2** is enabled and the system is ready to jump in ***Operation Enabled*** and start to move.
If Bit 3 of **Control Word** is given before ending of timer the device remains in ***Brake*** state till the timer end.
After disable the brake, the system can jump freely between **Operation Enabled** and **Switched On** without effect on the brake.

2.13.2.0 ENABLING BRAKE

When the system is in Operation enabled or in Switched On and Run Command is disabled or Bit 0 of Status Word is reset, the device jump in Brake state and the mechanical Brake is activated.
The following example referred to Operation Enabled conditions:

Bit 0 of Control Word disabled:

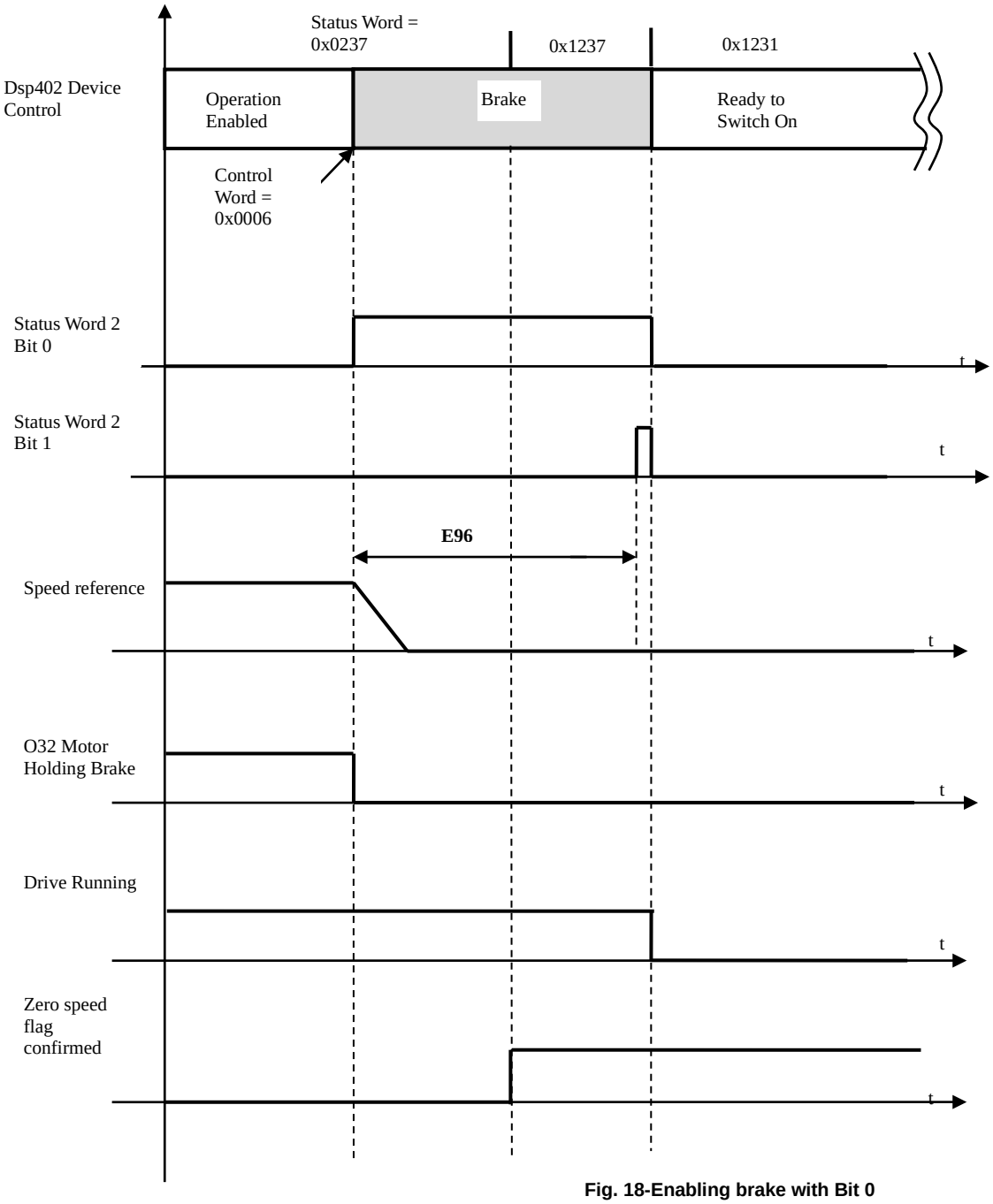


Fig. 18-Enabling brake with Bit 0

When the Bit 0 of **Control Word** is disabled the device control jump in ***Brake*** state, the Bit 0 of Status Word 2 is enabled and Status Word initially doesn't change. The speed references is automatically disabled with a ramp and Output O32 is disabled. At this moment the timer starts. When **E96** is reached Bit 2 of Status Word is immediately enabled for few time,

run state is disabled and the device control jump in **Switch On Disabled** state. To enable the transition from ***Brake*** to ***Ready to switch On*** the system has to see enabled the internal flag of Zero speed (speed < **E18 - pTHRVEL**), if the timer reaches the value of **E96-HLD_BRAKE_EN_DLY** before this flag is enabled, the system wait for it. In the previous example **I00-Run command** was always enabled.

I00 Run Command disabled:

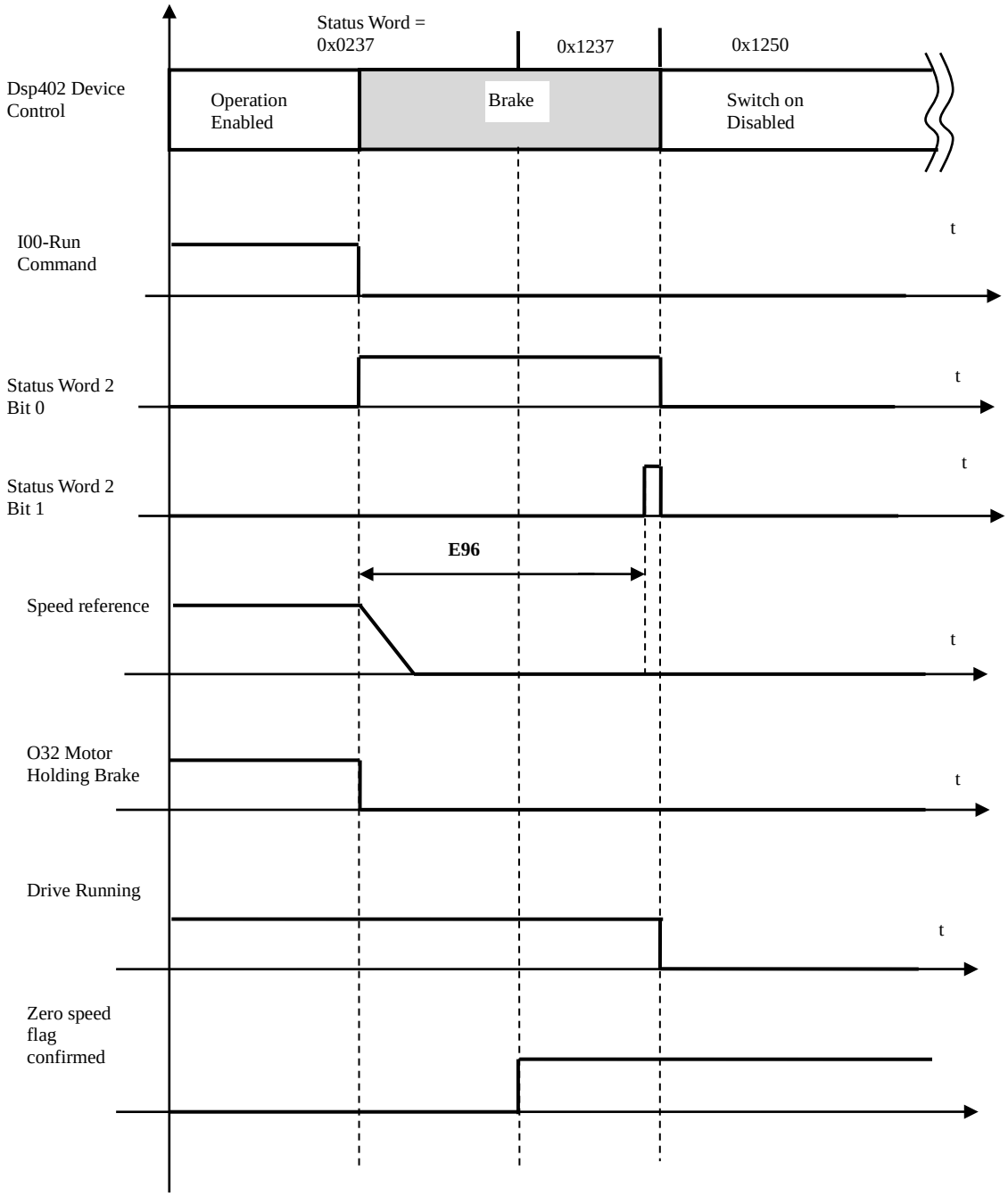


Fig. 19-Enabling brake with Run

The situation is the same, but the device jump in ***Switch On disabled*** after ***Brake***. The check of the zero speed flag is done.

2.13.3 OTHER CONDITIONS

If Bit 1 of Control Word is disabled the system automatically trip in ***Switch On Disabled*** state. Both Drive Run Status and O32 are disabled immediately without the brake management. The system doesn't jump in ***Brake*** state.
If an alarm appear, the system automatically trip in ***Fault*** state.

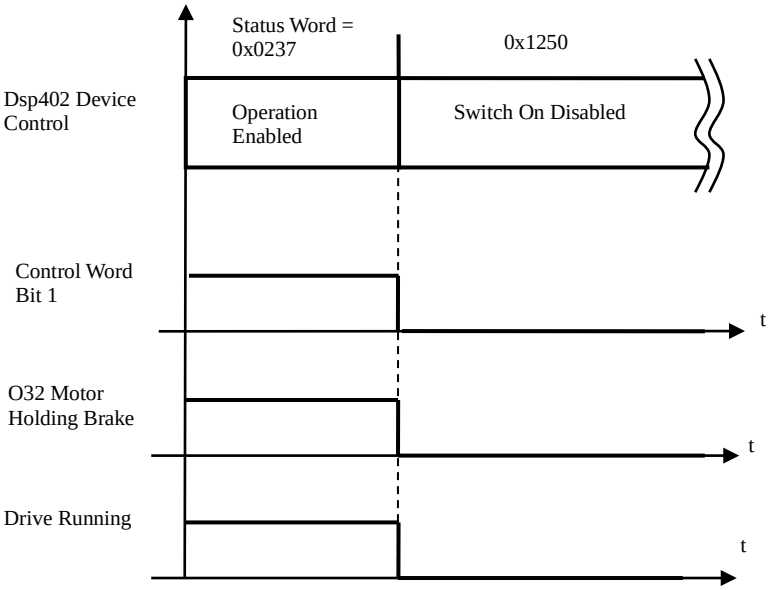


Fig. 20-Enabling brake with Bit 1

2.13.4 QUICK STOP

When the Quick stop is activated with **E38-pQSOPTC** ≠ 6 the system trip in ***Quick Stop Active*** state till the internal flag of Zero Speed is confirmed.
Then the device control jump in ***Brake*** state and starts the timer and output O32 is disabled. When it ends the ***Switch On Disabled*** State is confirmed. Status Word 2 shows the Brake sta

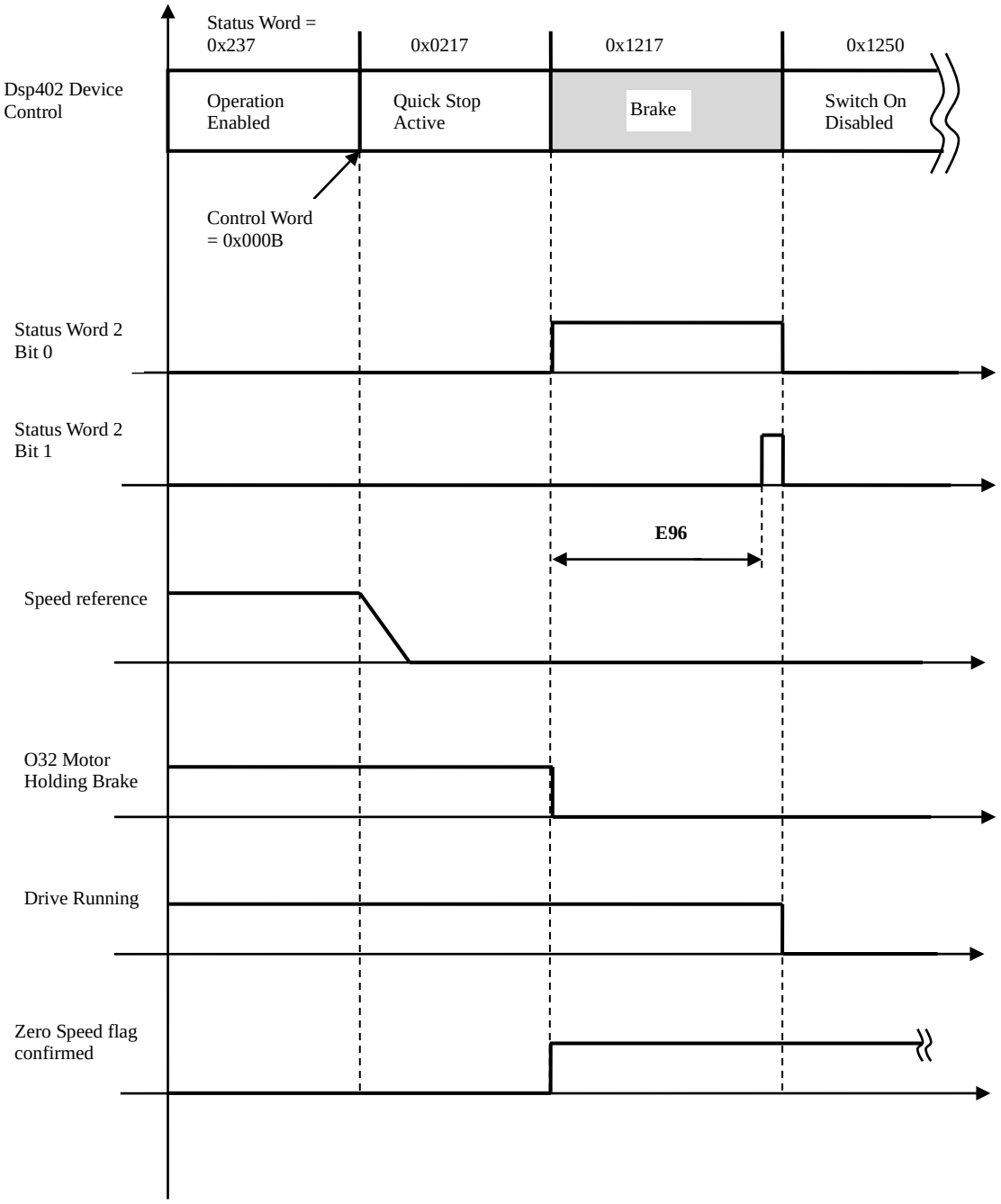
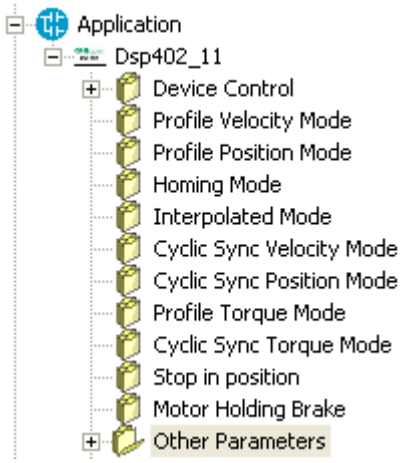


Fig. 21-Quick stop

2.14 OTHER PARAMETERS



Other Parameters folder contains the parameters for other special function.

Name	Description	Min	Max	Default	UM	Scale
rCONTROL_WORD	E100 – Control Word	0		0000		1
sipCONTROL_WORD	E67 – Stop in Position Control Word	0000	FFFF	0000		1
STATUS_WORD	D64 – Status Word					1
STATUS_WORD2	D72 – Status Word					1
RD_STATE_MACHINE	E101 – Finite State Automotion					1
pANTRQLIMIT	E52 – Enable analog torque limit	Range 0 - 0 - No 1 - 1 - Analog Input 1 2 - 2 - Analog Input 2 3 - 3 - Analog Input 3 4 - 4 - Analog Input 16				1
pTHRVEL_SENS2	E53 – Sensor 2 speed Threshold	0.00	0.00	100.00	% MOT_SPD_MAX	100
pDELTA_SPEED	E54 – Speed difference for enable alarm	0.00	0.00	100.00	% MOT_SPD_MAX	100
SENS_DIFFERENCE	d76-77 – Difference position SENS1 – SENS2					1
pCYCLICPERIOD	E94 – Cyclic Period Duration	1.0	0.2	10.0	ms	10

Tab. 30 Other Parameters Table

2.14.1 Torque limit by analogue input and fieldbus

bit	value	definition
6	0	Enable torque limit by analogue Input
	1	Disable torque limit by analogue Input
7	0	Enable Torque limit by Fieldbus
	1	Disable Torque limit by Fieldbus

Tab. 31 sipCONTROL_WORD Torque Limit bits

bit	value	definition
3	0	Torque limitation from analogue input disabled
	1	Torque limitation from analogue input enabled
4	0	Torque limitation from fielbus disabled
	1	Torque limitation from fielbus enabled

Tab. 32 STATUS_WORD2 Torque Limit bits

Bit 6 of **sipCONTROL_WORD – E67** enable the torque limit from analog input. The source of analog input can be chosen with the parameter **E52 – pENTRQLIMIT**, the selection is:

0- No (Disabled),
1- Analog Input 1,
2- Analog Input 2,
3- Analog Input 3,
4- Analog Input 16 (High Resolution).

It works directly on the positive and negative torque limits of the drive (**sysMaxPositiveTorque**, **sysMaxNegativeTorque**) and they directly refer to per cent value (0..10 V- 0-100%) of core's torque limits (**P42 – PRC_DRV_CW_TMAX** and **P43 – PRC_DRV_CCW_TMAX**).

For example if P42 = 200.0 (% MOT_T_NOM), Analog Input can write on **sysMaxPositiveTorque** a value between 0.0 (0%) and 2.0 (200%).

Bit 7 of **sipCONTROL_WORD – E67** enable the torque limit from fieldbus. The user can directly write on the object 0x201b, is a 16 bit array (3 variables, with scale 40.96) with the following meaning:

- Sub-index 0x00 write on the variables **sysFieldbusMaxTorque** which is internal assigned to **sysMaxTorque,** is the symmetrical torque limit referred to %MOT_T_NOM,
- Sub-index 0x01 writes on the variables **sysFieldbusMaxPositiveTorque** which is internal assigned to **sysMaxPositiveTorque** directly**,**
- Sub-index 0x02 writes on the variables **sysFieldbusMaxNegativeTorque** which is internal assigned to **sysMaxPositiveTorque** directly**.**

In this way the user can act separately on all the torque limits of the drive.
If both limits from fieldbus and from analog inputs are enabled the system keeps the less.

2.14.2 Jump from Sensor 1 to sensor 2 function

bit	value	definition
8	0	Enable Second Sensor calculation
	1	DisableSecond Sensor calculation
9	0	Enable Second sensor Zero Top Correction
	1	DisableSecond sensor Zero Top Correction
10	0	Enable Jump from First Sensor to Second Sensor
	1	Enable Jump from Second Sensor to First Sensor

Tab. 33 sipCONTROL_WORD jump from sensor1/sensor2

bit	value	definition
5	0	Switch position function disabled
	1	Switch position function enabled
6	0	Set sensor disabled
	1	Set sensor enabled

Tab. 34 STATUS_WORD2 jump from sensor1/sensor2

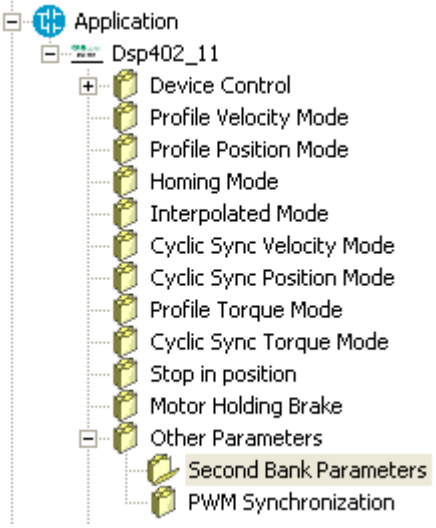
Bits 8 – 10 are used to jump from sensor 1 to sensor 2 (and viceversa) directly during a positioning (profile position or interpolated position).

With the Bit 8 is activated the calculation of the second sensor, but the position loop is still close on the first sensor. The bit 9 (rising edge) is used to align the sensor 2 position to sensor 1 position, when bit 11 is activated the position feedback is close directly to sensor 2. The user can check the position difference directly on **d76 -77 – SENS_DIFFERENCE**.

Bit 10 is used eventually to disable the zero top correction on second sensor's position.

The drive automatically calculates actual speed filtered of First Sensor and Second Sensor. When speed read from sensor 2 is lower than the threshold set in the parameter **E53 – pTHRVEL_SENS2** and the speed difference between the two sensor becames greather than **E54 - pDELTA_SPEED** the alarm **A4.5** is enabled.

2.15 SECOND BANK PARAMETERS



bit	value	definition
11	0	Enable second sensor bank
	1	Disable second sensor bank

Tab. 35 sipCONTROL_WORD enable second sensor bank bit

bit	value	definition
7	0	Speed Bank 2 not active
	1	Speed Bank 2 actived

Tab. 36 STATUS_WORD2 enable second sensor bank bit

Is possible to enable a second bank of speed (and position) enabling the logical input I26 or bit 11 of **sipCONTROL_WORD**. The following picture shows the behavior:

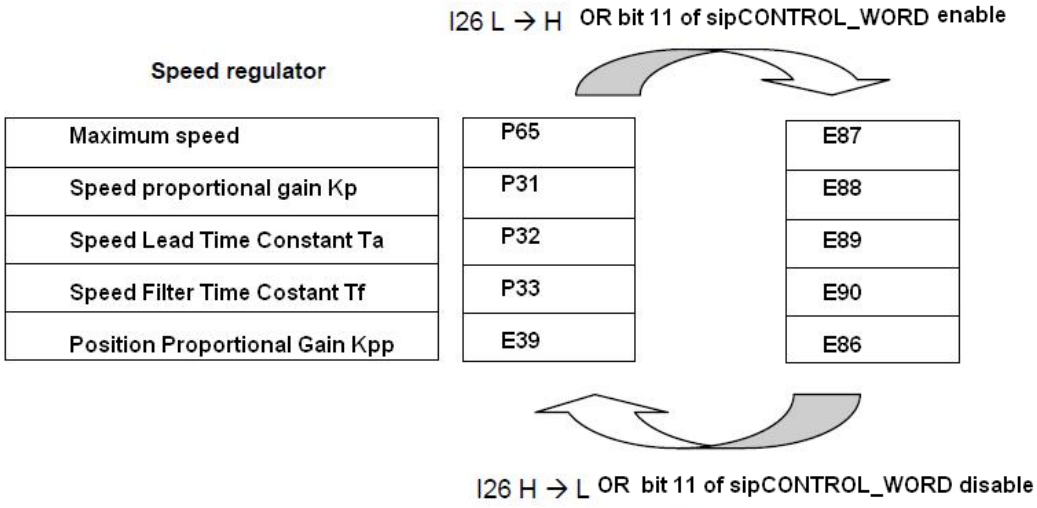
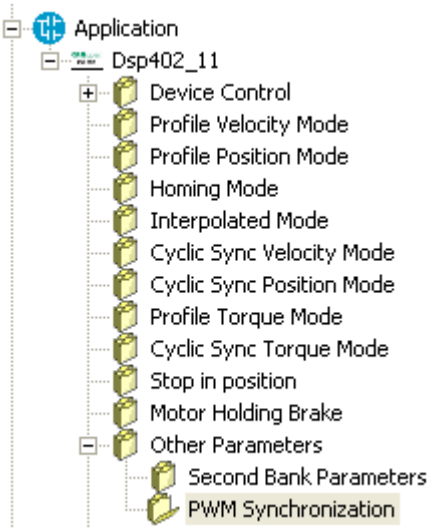


Fig. 22-Speed regoulator sensor bank enable

When the second bank is enabled bit 7 of **STATUS_WORD 2** and digital output **O33 - OD_BANK2** are enabled.

2.16 PWM SYNCHRONIZATION



Name	Description	Min	Max	Default	UM	Scale
EN_PWM_SYNCH	E82 – Enable PWM - Synchronization	Range		0		1
		0	0 - No			
		1	1 - Master			
		2	2 - Slave			
PWM_SYNCH_PHASE	E83 – PWM Synchronization plhase	-175	175	0	°	1
PWM_SYNCH_DELAY	D81 – PWM SYNCH Delay	-400.0	400.0	0.0	us	1

Tab. 37- PWM Synchronization

With this function it's possible to synchronize two or more OPDE at PWM level.
Parameter **E85 – EN_PWM_SYNCH** is used to select the drive function:

1 Master= Every PWM period the third digital output (O3) is configured like PWM syncrhronization output.
2 Slave= Eigth physical input (I08) is used to synchronize the drive.

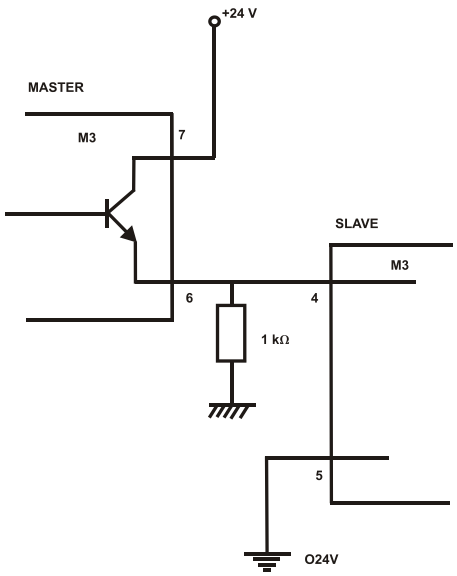


Fig. 23- PWM Synchronization

In the slave there is a tracking loop with gain Kp (P11) e Ta (P12). It's possible to set also the phase between master and slave with parameter **E86 – PWM Synchronization plhase**.

Note1: Master and slave have to be set with the same PWM frequency (P101)

Note2: If the PWM frequency is great than 5kHz is necessary to use a pull-down 1kΩ resistance 1W.

2.17 OTHER MAPPED OBJECTS

Index (hex)	Object	Type	Name	Description	PDO Mapping	Access
6075	VAR	UNSIGNED 32	Motor rated current	This object indicates the configured motor rated current. It is taken from the motor's name-plate. The value is given in mA.	Yes	Reading
6076	VAR	UNSIGNED 32	Motor rated torque	This object indicates the configured motor rated torque. It is taken from the motor's name-plate. The value is given in mNm (milli Newton metre)	Yes	Reading
6077	VAR	INTEGER16	Torque actual value	This object indicates the actual value of the torque. It corresponds to the instantaneous torque in the motor. The value is given per thousand of rated torque.	Yes	Reading
6078	VAR	INTEGER16	Current actual value	This object indicates the actual value of the current. It correspond to the current in the motor. The value is given per thousand of rated current.	Yes	Reading
6079	VAR	UNSIGNED 32	DC link circuit voltage	This object indicates the instantaneous DC link current voltage at the drive device. The value is given in mV.	Yes	Reading
60F4	VAR	INTEGER32	Following error actual value	This object indicates the actual value of the following error. The value is given in user-defined position units. OPD Explorer Internal Value: **d70-d71**	Yes	Reading
60FD	VAR	UNSIGNED 32	Digital inputs	This object shall provide digital inputs. The object structure is: **bit 0**: Negative Limit Switch **bit 1**: Positive Limit Switch **bit 2**: Home Switch **bit 3**: Interlock **bit 4** – **bit 15**: Reserved **bit 16**: Run command (Manufacturer specific) **bit 17**: External enable (Manufacturer specific) **bit 18**: Reset alarms (Manufacturer specific) **bit 19**: Motor thermo-switch (Manufacturer specific) **bit 21**: Touch Probe 1 (Manufacturer specific) **bit 22**: Touch Probe 2 (Manufacturer specific) **bit 23**: Quick Stop command (Manufacturer specific)	Yes	Reading

Tab. 38 Other mappd objects

2.18 APPLICATION DIGITAL INPUTS

		NAME	INPUT LOGIC FUNCTIONS
I	0	ID_RUN	Run command
I	2	ID_EN_EXT	External enable
I	3	ID_TOUCH1	Touch probe 1
I	4	ID_TOUCH2	Touch probe 2
I	8	ID_RESET_ALR	Reset alarms
I	19	ID_EN_POS	Enable Stop in position function (in OR with bit 12 of **rCONTROL_WORD**)
I	20	ID_EN_POS_MOV	Enable Stop in position movement (Enable Stop in position movement (in OR with bit 13 of **rCONTROL_WORD**))
I	21	ID_POS_SEL0	Stop in position target selection (bit0, in OR with bit 14 of **rCONTROL_WORD**)
I	22	ID_POS_SEL1	Stop in position target selection (bit1, in OR with bit 15 of **rCONTROL_WORD**)
I	23	ID_TC_SWT_MOT	Motor thermo-switch
I	26	ID_EN_SB	Enable speed regulator second bank
I	28	ID_POS_LMN_SWT	Positive Limit Switch
I	29	ID_NEG_LMN_SWT	Negative Limit Switch
I	30	ID_HOME_SWT	Home switch

Tab. 39 Application's logical inputs

2.19 APPLICATION DIGITAL OUTPUT

		NAME	INPUT LOGIC FUNCTIONS
O	32	OD_MOT_HBRK	Motor holding brake
O	33	OD_BANK2	Speed Bank 2 active

Tab. 40 Application's logical output

2.20 ANALOGUE OUTPUTS AND MONITORS

		OUTPUT ANALOG FUNCTIONS
O	68	PWM period counter between various SYNC
O	69	Position reference received (less significant word)
O	70	Position reference received
O	71	Actual position (less significant word)
O	72	Actual position
O	73	Absolute position error

O	74	Reference from fieldbus, object 0x607A for PP, 0x60C1 for IP (less significant word)
O	75	Reference from fieldbus, object 0x607A for PP, 0x60C1 for IP
O	76	Stop in position target (more significant word) ie
O	77	Stop in position actual position (more significant word) ie
O	78	Stop in position error (more significant word) ie
O	79	Stop in position o33 timer [ms]

Tab. 41 Application's Analogue Output and Monitor

2.21 ALARMS

ALARM			DESCRIPTION	CORRECTION
HEX	DEC	TYPE		
A.4.0.H	A4.0	Life guarding alarm	Master's time out	Check the correct time setting of the master
A.4.1.H	A4.1	SYNC Period too much different from theoretical value	Time difference between two sync is greater than the value set in **E65**	Check the correct time setting of the master
A.4.2.H	A4.2	Following error alarm	Following error (between reference and real position) is greater than maximum admitted error	Verify the drive's correct functioning, check the speed and current loop. Verify the position control. Increase, if possible, the maximum admitted error.
A.4.3.H	A4.4	Excessive indexing speed	In equiverse indexing the indexing speed has a maximum value admitted; depending on max speed (**P65**) and position loop gain (**P38**).	Reduce indexing speed E59 or change indexing mode, selecting minimum track
A.4.4.H	A4.4	Zero TOP missing	4 motor revolutions completed without reading Zero Top	Check sensor and cable.
A.4.5.H	A4.5	Speed difference greather than Threshold	Speed read by sensor 2 is greather than threshold **E53** and speed difference between sensor 1 and sensor 2 is greather than threshold **E54.**	Check the two sensors.

Tab. 42 Application's alarms

3. APPLICATION REVISION HISTORY

Rev. 8.11 (24/01/2014), Minimum core target: Opendrive Brushless 22.0/ Async 12.0

Issues fixed

1	Disabled always the core's ramps is stop in position function is not enabled (sysOnRamps). With previous versions, if the quick start up ramps were enabled and then disabled, the application's ramps didn't work correctly until the drive were switched off and switched on again.

New Functionality

1	**Holding Brake:** Motor Holding brake function

Rev. 8.09 (01/10/2014), Minimum core target: Opendrive Brushless 22.1/ Async 12.1

Issues fixed

1	**Interpolated position**. Bug fixed on calculation of position reference in particoular condition

New Functionality

1	**Position Shifted.** Is possible to chose the sensor resolution for the position.
2	**Cyclic Task.** Is possible to set the time of cyclic task (default 1 ms). Addesd S-Ramps
3	**Function Jump Sensor 1/Sensor2.** Function which allows to jump from Sensor 1 to Sensor 2 and viceversa

Rev. 8.10 (08/10/2015), Minimum core target: Opendrive Brushless 22.1/ Async 12.1

Issues fixed

1	**Position loop gain.** Bug fixed on calculation of position gains in caso of position shifted
2	**Holding brake.** Bug fixed on conyinuosly enable/disable of the brake.

New Functionality

1	**Speed sensor bank.** Is possible to choose the second sensor bank for speed
2	**Node Guarding:** Is now possible to choose the quick stop with the node guarding

Rev. 8.11 (06/05/2016), Minimum core target: Opendrive Brushless 22.1/ Async 12.1

Issues fixed

1	**SYNCH detection:** Bug fixed on SYNCH detection when operative mode is changed
2	**Stop in position Gain:** Set unique parameter E39 for Stop in position gain.

New Functionality

1	**Torque Profile:** Now is possible to use Cyclic Synch Torque Profile and Profile Torque Mode
2	**PWM Synchronization.**
3	**Quick Stop:** Add quick stop like digital input

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