6 Device Programming

6.1 In Brief

A wide variety of operating modes permit flexible configuration of drive and automation systems by using positioning, speed and current regulation. The built-in EtherCAT interface allows networking to multiple axes drives as well as online commanding by EtherCAT master units.

6.1.1 Objective

The present Application Note explains typical commanding sequences for different operating modes. The explanations are based on writing/reading commands to access the Object Dictionary. For detailed information on the objects itself ➔separate document «EPOS3 EtherCAT Firmware Specification» (subsequently referred to as “FwSpec”). For detailed information on the command structure ➔«EPOS Studio» (command analyzer). For motor-specific data ➔maxon Catalog.

Contents

6.1.2 Scope

Hardware	Order #	Firmware Version	Reference
EPOS3 EtherCAT		2200h	Firmware Specification
EPOS3 70/10 EtherCAT	411146	2200h or higher	

Table 6-42 Device Programming – covered Hardware and required Documents

6.1.3 Tools

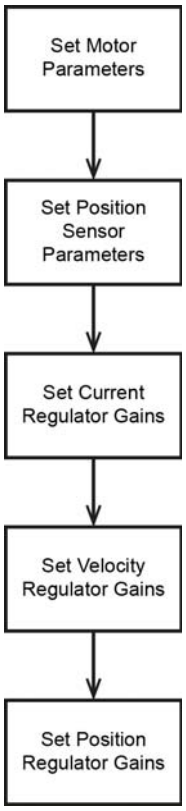
Tools	Description
Software	«EPOS Studio» Version 2.00 or higher

Table 6-43 Device Programming – recommended Tools

6.2 First Step

Before the motor will be activated, motor parameters, position sensor parameters and regulation gains must be set. For detailed description ➔FwSpec.

Note
For detailed information on the command structure ➔«EPOS Studio» (command analyzer).



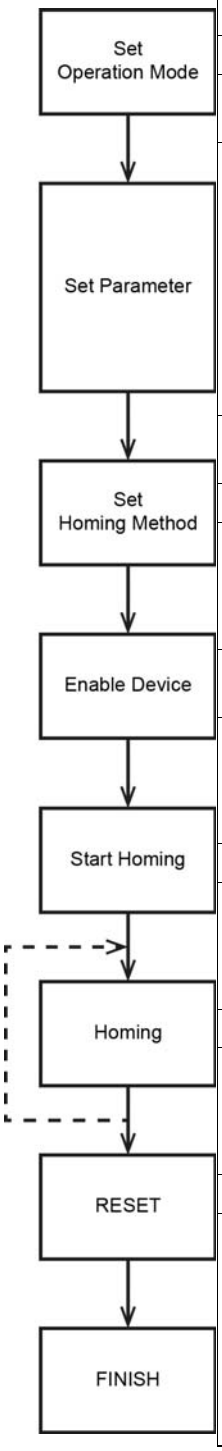
Object Name	Object	User Value [Default Value]
Motor Type Continuous Current Limit Pole Pair Number Thermal Time Constant Winding	0x6402-00 0x6410-01 0x6410-03 0x6410-05	Motor-specific [10] Motor-specific [5000] Motor-specific [1] Motor-specific [40]
Encoder Pulse Number Position Sensor Type	0x2210-01 0x2210-02	Sensor-specific [500] Sensor-specific [1]
Current Regulator P-Gain Current Regulator I-Gain	0x60F6-01 0x60F6-02	Motor-specific. Determine optimal parameter using “Regulation Tuning” in «EPOS Studio».
Speed Regulator P-Gain Speed Regulator I-Gain	0x60F9-01 0x60F9-02	Motor-specific. Determine optimal parameter using “Regulation Tuning” in «EPOS Studio».
Position Regulator P-Gain Position Regulator I-Gain Position Regulator D-Gain	0x60FB-01 0x60FB-02 0x60FB-03	Motor-specific. Determine optimal parameter using “Regulation Tuning” in «EPOS Studio».

Table 6-44 Device Programming – First Step

6.3 Homing Mode

6.3.1 Start Homing

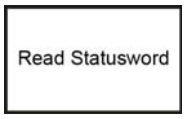
The axis references to an absolute position using the selected homing method.



Object Name	Object	User Value [Default Value]
Modes of Operation	0x6060-00	0x06 (Homing Mode)
Max. Following Error Home Offset Max. Profile Velocity Quick Stop Deceleration Speed for Switch Search Speed for Zero Search Homing Acceleration Current Threshold Homing Mode Home Position	0x6065-00 0x607C-00 0x607F-00 0x6085-00 0x6099-01 0x6099-02 0x609A-00 0x2080-00 0x2081-00	User-specific [2000 qc] User-specific [0 qc] Motor-specific [25000 rpm] User-specific [10000 rpm/s] User-specific [100 rpm] User-specific [10 rpm] User-specific [1000 rpm/s] User-specific [500 mA] User-specific [0 qc]
Homing Method	0x6098-00	Select Homing Method (➔FwSpec)
Controlword (Shutdown) Controlword (Switch-on)	0x6040-00 0x6040-00	0x0006 0x000F
Controlword (Start homing mode)	0x6040-00	0x001F
Statusword (Homing attained)	0x6041-00	wait until bit 12 is set to “1”
Controlword (Switch-on)	0x6040-00	0x000F

Table 6-45 Device Programming – Homing Mode (Start)

6.3.2 Read Status



Object Name	Object	User Value [Default Value]
Statusword (Homing attained)	0x6041-00	Home position is reached if bit 12 is set to “1”.

Table 6-46 Device Programming – Homing Mode (Read)

6.3.3 Stop Positioning

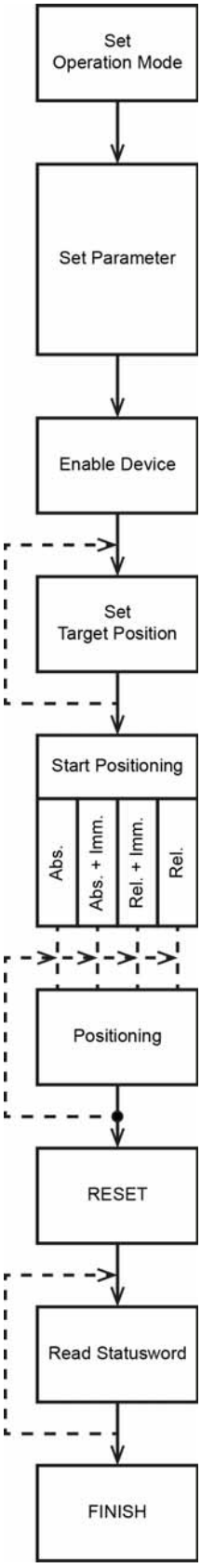
Object Name	Object	User Value [Default Value]
Controlword (Switch-on) or Controlword (Halt homing) or Controlword (Quick stop)	0x6040-00 0x6040-00 0x6040-00	0x000F 0x011F 0x000B

Table 6-47 Device Programming – Homing Mode (Stop)

6.4 Profile Position Mode

6.4.1 Set Position

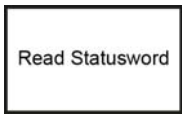
The axis moves to an absolute or relative position using a motion profile (➔next page).



Object Name	Object	User Value [Default Value]
Modes of Operation	0x6060-00	0x01 (Profile Position Mode)
Max. Following Error Min. Position Limit Max. Position Limit Max. Profile Velocity Profile Velocity Profile Acceleration Profile Deceleration Quick Stop Deceleration Motion Profile Type	0x6065-00 0x607D-01 0x607D-02 0x607F-00 0x6081-00 0x6083-00 0x6084-00 0x6085-00 0x6086-00	User-specific [2000 qc] User-specific [-2147483648 qc] User-specific [2147483647 qc] Motor-specific [25000 rpm] Desired Velocity [1000 rpm] User-specific [10000 rpm/s] User-specific [10000 rpm/s] User-specific [10000 rpm/s] User-specific [0]
Controlword (Shutdown) Controlword (Switch-on)	0x6040-00 0x6040-00	0x0006 0x000F
Target Position	0x607A-00	Desired Position [qc]
Controlword (absolute pos.) or Controlword (absolute pos., start immediately) or Controlword (relative pos., start immediately) or Controlword (relative positioning)	0x6040-00 0x6040-00 0x6040-00 0x6040-00	0x001F 0x003F 0x007F 0x005F
Statusword (set point acknowledge)	0x6041-00	wait until bit 12 is set to “1”
Controlword (Bit 12 set point acknowledge will be reset)	0x6040-00	0x000F
Statusword (Target reached)	0x6041-00	wait until bit 10 is set to “1”

Table 6-48 Device Programming – Profile Position Mode (Set)

6.4.2 Read Status



Object Name	Object	User Value [Default Value]
Statusword (Target reached)	0x6041-00	The axis is at target position if bit 10 is set.

Table 6-49 Device Programming – Profile Position Mode (Read)

6.4.3 Stop Positioning

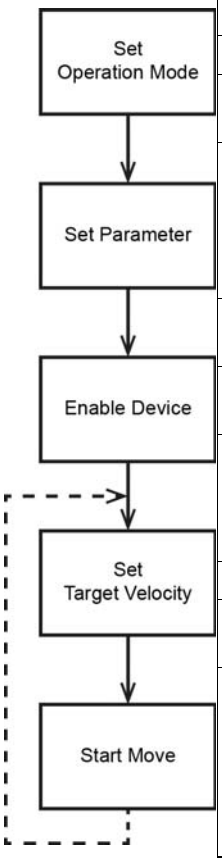
Object Name	Object	User Value [Default Value]
Controlword (Stop positioning) or Controlword (Quick stop)	0x6040-00 0x6040-00	0x010F 0x000B

Table 6-50 Device Programming – Profile Position Mode (Stop)

6.5 Profile Velocity Mode

6.5.1 Start Velocity

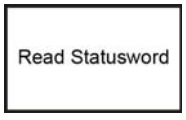
Motor shaft rotates with a certain speed with velocity profile.



Object Name	Object	User Value [Default Value]
Modes of Operation	0x6060-00	0x03 (Profile Velocity Mode)
Max. Profile Velocity Profile Acceleration Profile Deceleration Quick Stop Deceleration Motion Profile Type	0x607F-00 0x6083-00 0x6084-00 0x6085-00 0x6086-00	Motor-specific [25000 rpm] User-specific [10000 rpm/s] User-specific [10000 rpm/s] User-specific [10000 rpm/s] User-specific [0]
Controlword (Shutdown) Controlword (Switch-on)	0x6040-00 0x6040-00	0x0006 0x000F
Target Velocity	0x60FF-00	Velocity for movement [rpm]
Controlword	0x6040-00	0x000F

Table 6-51 Device Programming – Profile Velocity Mode (Start)

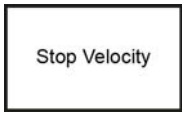
6.5.2 Read Status



Object Name	Object	User Value [Default Value]
Statusword (Target velocity reached)	0x6041-00	Target velocity is reached if bit 10 is set.

Table 6-52 Device Programming – Profile Velocity Mode (Read)

6.5.3 Stop Velocity



Object Name	Object	User Value [Default Value]
Controlword (Halt Profile Velocity Mode) or Controlword (Quick stop)	0x6040-00 0x6040-00	0x010F 0x000B

Table 6-53 Device Programming – Profile Velocity Mode (Stop)

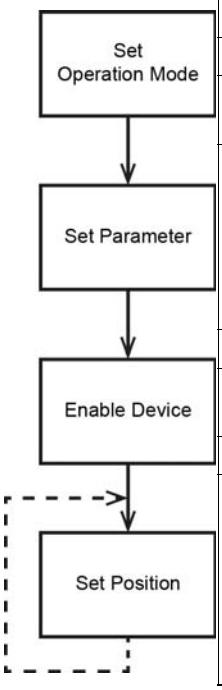
6.6 Interpolated Position Mode (PVT)

For detailed information ➔chapter “4 Interpolated Position Mode” on page 4-31.

6.7 Cyclic Synchronous Position (CSP)

6.7.1 Set Position

The axis moves to the new absolute position. If the difference between actual and new position is greater than “Max Following Error”, an emergency procedure will be launched.



Object Name	Object	User Value [Default Value]
Modes of Operation	0x6060-00	0x08 (Cyclic Synchronous Position)
Max. Following Error Min. Position Limit Max. Position Limit Max. Motor Speed Nominal Current Motor Torque Constant	0x6065-00 0x607D-01 0x607D-02 0x6410-04 0x6410-01 0x6410-06	User-specific [2000 qc] User-specific [-2147483648 qc] User-specific [2147483647 qc] Motor-specific Motor-specific (optional) Motor-specific (optional)
Controlword (Shutdown) Controlword (Switch-on)	0x6040-00 0x6040-00	0x0006 0x000F
Target Position Position Offset Velocity Offset Torque Offset	**0x607A-00** 0x60B0-00 0x60B1-00 0x60B2-00	**New Position [Position units]** [Position units] (optional) [Velocity units] (optional) [‰/rated torque] (optional)

Table 6-54 Device Programming – Cyclic Synchronous Position (Set)

6.7.2 Stop Positioning

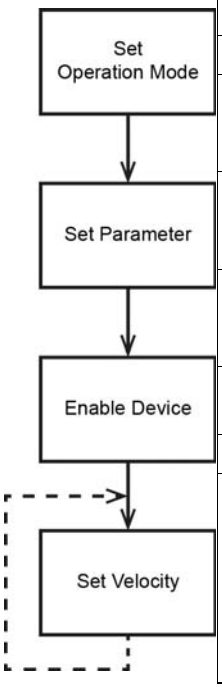
Object Name	Object	User Value [Default Value]
Controlword (Quick stop)	0x6040-00	0x000B

Table 6-55 Device Programming – Cyclic Synchronous Position (Stop)

6.8 Cyclic Synchronous Velocity (CSV)

6.8.1 Set Velocity

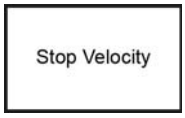
Motor shaft runs with a certain speed.



Object Name	Object	User Value [Default Value]
Modes of Operation	0x6060-00	0x09 (Cyclic Synchronous Velocity)
Max. Motor Speed Nominal Current Motor Torque Constant	**0x6410-04** 0x6410-01 0x6410-06	**Motor-specific** Motor-specific (optional) Motor-specific (optional)
Controlword (Shutdown) Controlword (Switch-on)	0x6040-00 0x6040-00	0x0006 0x000F
Target Velocity Velocity Offset Torque Offset	**0x60FF-00** 0x60B1-00 0x60B2-00	**Velocity per movement [Velocity units]** [Velocity units] (optional) [‰/rated torque] (optional)

Table 6-56 Device Programming – Cyclic Synchronous Velocity (Set)

6.8.2 Stop Velocity



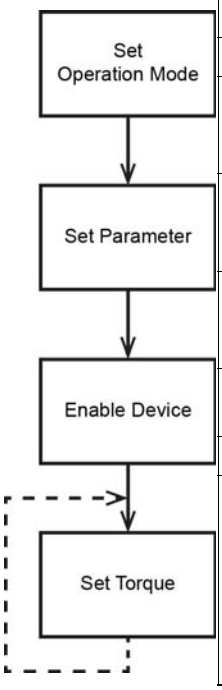
Object Name	Object	User Value [Default Value]
Controlword (Quick stop)	0x6040-00	0x000B

Table 6-57 Device Programming – Cyclic Synchronous Velocity (Stop)

6.9 Cyclic Synchronous Torque (CST)

6.9.1 Set Torque

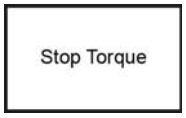
This command applies a certain torque at the motor.



Object Name	Object	User Value [Default Value]
Modes of Operation	0x6060-00	0x0A (Cyclic Synchronous Torque)
Nominal Current Nominal Motor Speed Motor Torque Constant	0x6410-01 0x6410-04 0x6410-06	Motor-specific Motor-specific Motor-specific
Controlword (Shutdown) Controlword (Switch-on)	0x6040-00 0x6040-00	0x0006 0x000F
Target Torque Torque Offset	**0x6071-00** 0X60B2-00	**[‰/rated torque]** [‰/rated torque] (optional)

Table 6-58 Device Programming – Cyclic Synchronous Torque (Set)

6.9.2 Stop Motion



Object Name	Object	User Value [Default Value]
Controlword (Quick stop)	0x6040-00	0x000B

Table 6-59 Device Programming – Cyclic Synchronous Torque (Stop)

6.10 State Machine

6.10.1 Clear Fault

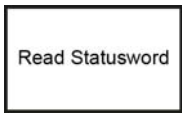
Resetting “Fault” condition sends the Controlword with value 0x0080.

Object Name	Object	User Value [Default Value]
Controlword (Fault Reset)	0x6040-00	0x0080

Table 6-60 Device Programming – State Machine (Clear Fault)

6.11 Motion Info

6.11.1 Get Movement State



Object Name	Object	User Value [Default Value]
Read Statusword	0x6041-00	Bit 10 tells states that target is reached. For details ➔FwSpec.

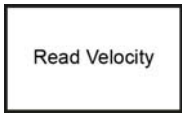
Table 6-61 Device Programming – Motion Info (Get Movement State)

6.11.2 Read Position

Object Name	Object	User Value [Default Value]
Position actual value	0x6064-00	[Position units]

Table 6-62 Device Programming – Motion Info (Read Position)

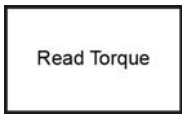
6.11.3 Read Velocity



Object Name	Object	User Value [Default Value]
Velocity actual value	0x 606C-00	[Velocity units]

Table 6-63 Device Programming – Motion Info (Read Velocity)

6.11.4 Read Current



Object Name	Object	User Value [Default Value]
Torque actual value	0x6077-00	[‰/rated torque]

Table 6-64 Device Programming – Motion Info (Read Current)

6.12 Utilities

6.12.1 Store all Parameters

Saves all parameters.

Object Name	Object	User Value [Default Value]
Save All Parameters	0x10101-01	0x65766173 “save”

Table 6-65 Device Programming – Utilities (Store all Parameters)

6.12.2 Restore all default Parameters

Restores all parameters to factory settings.

Object Name	Object	User Value [Default Value]
Restore All Default Parameters	0x1011-01	0x64616F6C “load”

Table 6-66 Device Programming – Utilities (Restore all default Parameters)