

maxon motor control Getting Started EPOS Positioning Controller December 2008 Edition



# **Positioning Controller**

# Documentation

# **Getting Started**



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Application

EPOS

Application Notes

**Application Samples** 

### 3 Introduction

This documentation 'Getting Started' provides the first steps in using EPOS positioning controller. It describes the standard procedure when the device is put into operation. The document facilitates the installation and configuration of a basic EPOS 70/10 system.



maxon motor EPOS 70/10 is a small-sized full digital smart motion controller. Due to the flexible and high efficient power stage the EPOS 70/10 drives brushed DC motors with digital encoder as well as brushless EC motors with digital Hall sensors and encoder.

The sinusoidal current commutation by space vector control offers to drive brushless EC motors with minimal torque ripple and low noise. The integrated position-, velocity- and current control functionality allows sophisticated positioning applications. It is specially designed being commanded and controlled as a slave node in the CANopen network. In addition

Figure 1: EPOS 70/10 photo

the unit can be operated through any RS-232 communication port. The latest edition of this "Getting Started", additional documentation and software to the EPOS 70/10 positioning controller may also be found on the internet under <u>http://www.maxonmotor.com</u> category <Service & Downloads> or in the maxon motor e-shop <u>http://shop.maxonmotor.com</u>.

# 4 How to use this guide



#### Getting Started

## Installation

# EPOS 7010 Cate factor at

Cable Starting Set



 Hardware Reference



Configuration

Graphical User Interface



Programming



IEC1131 Libraries



Firmware Specification



Figure 2: EPOS documentation hierarchy

# **5** Safety Instructions



#### Skilled Personnel

Installation and starting of the equipment shall only be performed by experienced, skilled personnel.

#### Statutory Regulations

The user must ensure that the positioning controller and the components belonging to it are assembled and connected according to local statutory regulations.



#### Load Disconnected

For primary operation the motor should be free running, i.e. with the load disconnected.



#### **Additional Safety Equipment**

An electronic apparatus is not fail-safe in principle. Machines and apparatus must therefore be fitted with independent monitoring and safety equipment. If the equipment breaks down, if it is operated incorrectly, if the control unit breaks down or if the cables break, etc., it must be ensured that the drive or the complete apparatus is kept in a safe operating mode.



#### Repairs

Repairs may be made by authorized personnel only or by the manufacturer. It is dangerous for the user to open the unit or make repairs to it.



#### Danger

Do ensure that during the installation of the EPOS 70/10 no apparatus is connected to the electrical supply. After switching on, do not touch any live parts!



#### Max. Supply Voltage

Make sure that the supply voltage is between 11 and 70 VDC. Voltages higher than 77 VDC or of wrong polarity will destroy the unit.



#### **Electrostatic Sensitive Device (ESD)**

## 6 Installation and Configuration

#### 6.1 Step 1: Software Installation

Install the software from the EPOS CD-ROM. The CD-ROM contains all necessary information and tools for installation and operation of the EPOS controllers (Manuals, Firmware, Tools, and Windows DLLs).



Figure 3: EPOS CD-ROM

The latest edition of the software to the EPOS positioning controller may be downloaded from the maxon motor homepage <u>http://www.maxonmotor.com</u> category <Service & Downloads> or from the maxon motor e-shop http://shop.maxonmotor.com.

Minimum system requirements:

Windows ME, Windows NT 4.0, Windows 2000, XP 486 processor, 128 MB RAM 200 MB free storage space on hard drive Screen resolution 1024 x 768 pixels at 256 colours

Follow the next instructions to install the whole software on your computer:

#### 1. Insert CD-ROM

Insert the EPOS CD-ROM into the CD-ROM drive of your computer.

- 2. Start the installation program 'EPOS\_CD-ROM.exe'
  - Normally the installation program starts automatically after inserting EPOS CD-ROM. Alternatively, double click the item in the explorer to start the installation program 'EPOS\_CD-ROM.exe'
- 3. Follow the instructions during the installation program

Please read each instruction carefully. During the installation procedure you will be asked for a working directory. (Recommendation: C:\Programme\maxon motor EPOS CD-ROM)

#### 4. Check the new shortcuts and items in the start menu

All necessary files are copied to the hard drive 'maxon motor EPOS CD-ROM' item allows accessibility to all 'Contents'. On the desktop, a new shortcut to the 'EPOS\_UserInterface.exe' will be added. Check the new shortcuts in the start menu and on the desktop.

#### 5. Modify or remove the EPOS software

To change application features or to uninstall the EPOS software, start the installation program 'EPOS\_CD-ROM.exe' and follow the instructions.

EPOS 70/10 Getting Started

#### 6.2 Step 2: Minimum External Wiring

Select the motor variant used with EPOS 70/10 for minimum wiring:

- '6.2.1 EPOS 70/10 for maxon EC motor'
- '6.2.2 EPOS 70/10 for maxon DC motor'

#### 6.2.1 EPOS 70/10 for maxon EC motor

Install the EPOS 70/10 hardware. Use the maxon cable assemblies below for wiring.

You should have:

EPOS 70/10 positioning controller	order number 300583
EPOS power cable (Connector J1)	order number 275829
EPOS motor cable (Connector J2)	order number 275851
EPOS Hall sensor cable (Connector J3)	order number 275878
EPOS encoder cable (Connector J4)	order number 275934
EPOS RS232-COM cable (Connector J6)	order number 275900

Follow the steps and see also figure 4.

#### 1. Connect EPOS power cable

Connect the power cable (Order No. 275829) to the connector J1 of the EPOS 70/10. On the opposite side connect to a power supply (+11 ... +70 VDC).

The necessary output current is depending on load. (Continuous max. 10 A; acceleration, short-time max. 25 A)

**Note!** Make sure that the supply voltage is between +11 and +70VDC. Voltages higher than +77 VDC or of wrong polarity will destroy the unit.

#### 2. Connect EPOS motor cable

Connect the motor cable (Order No. 275851) to the connector J2 of the EPOS 70/10. On the opposite side connect to terminal blocks. Connect the motor power lines to the opposite side of the terminal blocks.

#### 3. Connect EPOS Hall sensor cable

Connect the Hall sensor cable (Order No. 275878) to the connector J3 of the EPOS 70/10. On the opposite side connect to terminal blocks. Connect the motor Hall sensor lines to the opposite side of the terminal blocks.

#### 4. Connect EPOS encoder cable

Connect the encoder cable (Order No. 275934) to the connector J4 of the EPOS 70/10. On the opposite side connect to the encoder of the motor.

#### 5. Connect EPOS RS232-COM cable

Connect the RS232-COM cable (Order No. 275900) to the connector J6 of the EPOS 70/10. On the opposite side connect to a free RS-232 port of your computer.

**Note!** If you do not use the maxon cables, you have to do the wiring using the 'Cable Starting Set' manual.



Figure 4: Minimum wiring for maxon EC motor

#### 6.2.2 EPOS 70/10 for maxon DC motor

Next option allows hardware installation of EPOS 70/10 for maxon DC motor. Use the maxon cable assemblies below for wiring.

#### You should have:

EPOS 70/10 positioning controller	order number 300583
EPOS power cable (Connector J1)	order number 275829
EPOS motor cable (Connector J2)	order number 275851
EPOS encoder cable (Connector J4)	order number 275934
EPOS RS232-COM cable (Connector J6)	order number 275900

Follow the steps and see also figure 5.

#### 1. Connect EPOS power cable

Connect the power cable (Order No. 275829) to the connector J1 of the EPOS 70/10. On the opposite side connect to a power supply (+11 ... +70 VDC).

The necessary output current is depending on load. (Continuous max. 10 A; acceleration, short-time max. 25 A)

**Note!** Make sure that the supply voltage is between +11 and +70 VDC. Voltages higher than +77 VDC or of wrong polarity will destroy the unit.

#### 2. Connect EPOS motor cable

Connect the motor cable (Order No. 275851) to the connector J2 of the EPOS 70/10. On the opposite side connect to a terminal blocks. Connect the motor power lines to the opposite side of the terminal blocks.

#### 3. Connect EPOS encoder cable

Connect the encoder cable (Order No. 275934) to the connector J4 of the EPOS 70/10. On the opposite side connect to the encoder of the motor.

#### 4. Connect EPOS RS232-COM cable

Connect the RS232-COM cable (Order No. 275900) to the connector J6 of the EPOS 70/10. On the opposite side connect to a free RS-232 port of your computer.

**Note!** If you do not use the maxon cables, you have to do the wiring using the 'Cable Starting Set' manual.



Figure 5: Minimum wiring for maxon DC motor

## 6.3 Step 3: System Configuration

In this section you will configure the EPOS 70/10 for your drive system.

#### Please note:

• The EPOS User Interface provides an online help. It contains all available documentation.

To open online help functions: - press F1

- or use the help buttons 🤌 😫
- or click the right mouse button
- You have to know some technical data about your system. Use the maxon catalogue or the datasheets of the components used.

To configure your drive system:

#### 1. Power-up

Switch on the EPOS 70/10 power supply.

2. Start the 'EPOS User Interface' Version 2.00 or higher

Double click on the item 'EPOS UserInterface.exe' on the desktop to start the graphical user interface (GUI). By starting the 'EPOS User Interface' the 'Startup Wizard' will be started automatically.

#### 3. 'Startup Wizard' Step 1: Minimum External Wiring

- a) Verify that your hardware installation is correct. Please refer to chapter <u>'6.2 Step 2: Minimum External Wiring'</u>.
- b) If you have already read the 'Getting Started' document, click on the button 'Confirm that you've read the 'Getting Started' document'. Otherwise it is possible to display the document online by clicking on the button 'Show Getting Started'.



Figure 6: Startup wizard dialog for minimum external wiring

c) Click on the button 'Weiter' for the next step.

- 4. 'Startup Wizard' Step 2: Communication Setting!
  - a) Verify that your RS-232 wiring is correct.<sup>1</sup> Please refer to chapter <u>'6.2 Step 2: Minimum External Wiring'</u>.
  - b) Click on the button 'Search Communication Setting' to search the used COM port and the adjusted baudrate automatically.

Startup Wizard		×
	Step 2: Communication Setting!	
	Select the correct communication settings!	
	Communication via 💿 RS232 or 🔿 CANopen	
	Interface RS232	
	Serial Port COM1 💌	
	Baudrate 38400 💌 😰	
Hit -	NOTE: For a correct wiring of the communication have a look at the document "Getting Started" !	
	< <u>Z</u> urück <u>₩</u> eiter> Abbr	echen

Figure 7: Startup wizard dialog for setting RS-232 communication

c) If a correct communication setting is found, the following dialog is displayed.

EPOS_Us	erInterface X
<b>(f)</b>	Correct communication setting found!
4	Port: Com1 Baudrate: 38400 baud
	OK

Figure 8: Communication settings found

- d) Click on the 'OK' button to confirm and accept the values.
- e) Click on the button 'Weiter' for the next step.

#### 5. 'Startup Wizard' Step 3: Motor Type

a) Select the used motor type.

Startup Wizard	[Node 1]	x
Maxon http://www.maxonmotor.com	Step 3: Motor Type Select the correct motor type I maxon DC motor O maxon <u>D</u> C motor maxon <u>EC motor</u> O maxon <u>EC motor</u>	
	<u>≺Z</u> urück <u>W</u> eiter≻ Abbrech	ien

Figure 9: Startup wizard dialog for choosing motor type

b) Click on the button 'Weiter' for the next step.

<sup>&</sup>lt;sup>1</sup>It is also possible to run 'EPOS User Interface' via CANopen communication. In this case, a PC CAN- interface card from IXXAT or Vector has to be used.

For correct wiring please see 'EPOS 70/10 Hardware Reference' document.

#### EPOS 70/10 Getting Started

- 6. 'Startup Wizard' Step 4 for EC motors: Motor Pole Pair
- a) Select the correct number of pole pairs.



Figure 10: Startup wizard dialog for choosing EC motor pole pairs

- b) Click on the button 'Weiter' for the next step.
- 7. 'Startup Wizard' Step 5 for EC motors: Motor Data
- a) Select the maximum permissible speed.
- b) Select the nominal current (maximum continuous current).
- c) Select the thermal time constant of the winding.



Figure 12: Startup wizard dialog for setting EC motor data

d) Click the button 'Weiter' for the next step.

- 6. 'Startup Wizard' Step 4 for DC motors: Motor Data
- a) Select the maximum permissible speed.
- b) Select the nominal current (maximum continuous current).
- c) Select the thermal time constant of the.

Startup Wizard	[Node 1]	×
Maxon http://www.maxonmotor.com	Step 4: Motor Data   Select the correct motor data ! (see catalogue motor data)   Max. permissible speed   Max. permissible speed   Nominal (max. continuous) current   5000 mA   Max. output current limit 10000   Thermal time constant winding 4.0 s	
	<u>≺Z</u> urück <u>W</u> eiter> Abbrect	nen

Figure 11: Startup wizard dialog for setting DC motor data

d) Click the button 'Weiter' for the next step.

#### 'Startup Wizard' Step 5 for DC motors: Position Sensor Type

a) Select the used position sensor type

Startup Wizard	[Node 1]	×
	Step 5: Position Sensor Type Select the correct position sensor I Channel incremental encoder with line driver - channel A, A\ - channel B, B\ C 2 channel index, Index.\ C 2 channel index, Index.\ - channel A, A\ - channel B, B\	
	< <u>∠</u> urück <u>W</u> eiter> Abbrech	nen

Figure 13: Startup wizard dialog for choosing DC motor position sensor type

b) Click the button 'Weiter' for the next step.

- 8. 'Startup Wizard' Step 6 for EC motors: Position Sensor Type
- a) Select the used position sensor type



*Figure 14: Startup wizard dialog for choosing EC motor position sensor type* 

- b) Click the button 'Weiter' for the next step.
- c) Important remarks for using Hall sensors: For a proper function of the regulation, please be aware of the following restrictions.

arning Hall Sensors			
WARNING!	WARNING!	WARNING!	WARNING!
The option 'Hall Sen: Only the following ap	sors' results in plication case	a low position resident a low position re	esolution!
Position Regulation : Velocity Regulation : Current Regulation :	Multi Pole B Velocity hig No Restrict	EC Motors (4 po pher than 1000 r ions	le pairs and higher) pm (1 pole pair motors)
A	ccept	Don't /	Accept

*Figure 15: Recommendations for using Hall sensors as position sensors* 

d) Please consider this warning carefully before clicking the 'Accept' button for the next step.

- 8. 'Startup Wizard' Step 6 for DC motors: Position Resolution
- a) Enter the resolution of the used encoder.



Figure 16: Startup wizard dialog for setting DC motor encoder resolution

b) Click the button 'Weiter' for the next step.

#### EPOS 70/10 Getting Started

- 9. 'Startup Wizard' Step 7 for EC motors: Position Resolution
- a) Enter the resolution of the used encoder.



Figure 17: Startup wizard dialog for setting EC motor encoder resolution

b) Click the button 'Weiter' for the next step.

#### 9. 'Startup Wizard' Step 7 for DC motors: Summary

- A short summary of the most important configuration values is displayed in this window.
- b) If there are any mistakes in the configuration, you can go back and modify the values by clicking on the button 'Zurück'.
- c) If you will not start the startup wizard at the beginning of every EPOS user interface session, you have to deselect the option 'Always start this wizard after program start'.

Startup Wizard	[Node 1]	×
	Step 7: Summary	
	Now you have configured the EPOS !	
	RS232 Baudrate 38400 baud	
	Motor Type maxon DC motor	
i i i i i i i i i i i i i i i i i i i	Position Sensor Type 3 channel incremental encoder	
	Position Resolution 2000 gc/turn	
	Always start this wizard after program start.	
프 포		
	<⊒urück Fertig stellen Abbreche	n

# Figure 18: Startup wizard configuration summary

d) If all settings are correct, click the button 'Fertig stellen' to close the startup wizard.

- 10. 'Startup Wizard' Step 8 for EC motors: Summary
- A short summary of the most important configuration values is displayed in this window.
- b) If there are any mistakes in the configuration, you can go back and modify the values by clicking on the button 'Zurück'.
- c) If you will not start the startup wizard at the beginning of every EPOS user interface session, you have to deselect the option 'Always start this wizard after program start'.



Figure 19: Startup wizard dialog for setting EC motor encoder resolution

d) If all settings are correct, click the button 'Fertig stellen' to close the startup wizard.

#### 11. Save and activate parameters





a) Click the button 'Yes' to accept the parameters.



Figure 21: Confirm parameter activation

b) Confirm by clicking the 'OK' button.

#### 12. Clear CAN error

Now, the object dictionary will be loaded. In case of not connected CAN communication, the error 'CAN in Error Passive Mode' appears.<sup>1</sup>

a) Click on button 'Clear Errors' to clear the error 'CAN in Passive Error Mode'.

I Node 1	1 16 76 0	- PE	- (1 × 1	1 4 H Ø	3 W					
Wizards	Command Ar	nalyser								
R	Velocity Mode	Cum	ent Mode	Master Encode	r Mode	Step Direction Mod	e Dal	taRecording	I/O Monitor	
atup Wigard	Object Dictio	mary	Device Control	Profile P	osition Mode	Homing Mode	Profil	e Velocity Mode	Position	Mode
	Objec	t Dictior	nary Acc	ess		The	EPOS	📕 is in fault state	<u></u>	
Jation Tuning							Active	Object Filter Syste	m Parameter	
-	Index	SubIndex	Name			Type	Access	Value		T
<b>U</b>	0x6065	0x00	Max Follow	ing Error		Ulint32	RW/	2000		-
are Download	0x60F6	0x01	Current Re	gulator P-Gain		Int16	RW	1000		
Wizard	0x60F6	0x02	Current Re	gulator I-Gain		Int16	RW.	300		
	0x60F9	0x01	Speed Reg	julator P-Gain		Int16	RW/	680		
-	0x60F9	Dx02	Speed Rec	julator I-Gain		Int16	RW	200		
	0x60FB	0x01	Position Re	gulator P-Gain		Int16	BW	100		
$\sim$	0x60FB	0x02	Position Be	gulator I-Gain		Int16	BW	10		
Configuration	0x60FB	0x03	Position Be	gulator D-Gain		Int16	BW	200		
Wizard	Dx60FB	0x04	Velocity Fe	edioward Factor		Ulpt16	BW	0		
	Diffe B	0x05	Acceleratio	in Feedforward Fac	tor	Ulot16	BW/	0		
1	0.6 12	0x00	MotorType		104	Ulpt16	BW/	10		
	0.610	0x01	Continuous	Current Limit		Ulint16	Bw/	10000		
Parameter	0.6.10	0x02	Butnut Dur	cont Limit		Ulet16	Rhuf	25000		
port/Import	0.6 10	0x02	PolePair N	umber		Lints	Rw/	1		
	- 0,610	0x04	Maximal Sr	need in DumentMod	•	Ulot16	RW/	30000		
	0-6-10	0-05	Thereal Te	ne Constant Is (nd	v 10	Linete	Rud	40		
$\sim$	0.2 11	0-00	CAN Revel	NO GOTO DE MUNICIPA	3	Linkie	Pha/	0		
	0.2 12	0.00	DC222 Ra			Ulixite	Ph/	3		
nostic Wizard	0x202	0.00	Missal	Autor Autor		UINTE	PW/	0		
	0.218	0.01	Encerane Encerane	us congutation		Unitio	Piw/	500		
	0/2 10	0.02	Position Pr	use number		UINCIS	PW/	1		
🛱 🗗	1 082.10	0802	i Poston Se	uron i Mhe		UINTE	nw	1.1		-
lopen Wizard	1 ERA FOI	UND! Conne	oted EPOS; So	Shusen Corrison Out	022 HardwareV	ersion: 0x6410 App	Number: 0x00	00 AppVersion: 0	×0000	
	Class Enge		201	Enor Marrino	Description					
		11 244	a E mar	Ency 0.0120	CAN in Error	Dansing Made				_
	Error Info	Lates	X FUOL	Effor 0x8120	LAN IN ERIOR	Passive Mode				

Figure 22: Clear CAN error

- b) If other errors occurred, please check wiring and startup configuration. For more information's about errors, refer to EPOS firmware documentation.
- c) Your EPOS is now ready for regulation gains tuning.

<sup>&</sup>lt;sup>1</sup> If the 'EPOS User Interface' is communicating via CANopen, this error will not appear.

#### 6.4 Step 4: Regulation Gains Tuning

The EPOS 70/10 offers a possibility to perform auto-tuning of the regulation gains. You can tune the current, velocity and position gains on the regulators. The auto-tuning function is a good help, but optimal regulation parameters can't be guaranteed. The auto-tuning is a good starting point for a manual tuning.

The following procedure is recommended for the tuning of the regulation gains.

#### 6.4.1 Start the Auto-tuning Tool

a) In the EPOS user interface, double click the button 'Regulation Tuning' to start the auto-tuning tool.

witards	Command Ar	nalyser					
10	Velocity Mode	Curre	nt Mode Master Encoder Mode	Step Direction Mode	Dat	aRecording 1/0	Monitor
tertur u/gard	Object Dictio	inary C	Device Control Profile Position Mode	Homing Mode	Profile	e Velocity Mode	Position Mode
	Objec	t Diction	hary Access	The A	POS	L is disabled	<u>.</u>
gulation Tuning					Active (	bject Filter System P	'arameter
	Index	Subindex	Name	Type	Access	Value	
0	0x6065	0x00	Max Following Error	Ulint32	RW	2000	
ware Download	0x60F6	0x01	Current Regulator P-Gain	Int16	RW	1000	
Wigard	0x60F6	0x02	Current Regulator I-Gain	Int16	RW.	300	
11 12010	0x60F9	0x01	Speed Regulator P-Gain	Int16	BW	680	
	0x60F9	0x02	Speed Begulator I-Gain	Int16	BW	200	
	0x60FB	0x01	Position Regulator P-Gain	Int16	BW	100	
$\sim$	0x60EB	0.02	Position Regulator L Gain	10/16	B/w/	10	
Configuration	0-6050	0.02	Position Regulator D.Gain	let16	Pha/	200	
Wizard	0-6058	0.04	Valashi Faadamuud Fastar	Liletic	Plut	0	
	0-6058	0.05	Acceleration Feedforward Factor	Linte	Piu/	0	
<b>^</b>	0.000FD	0.00	MotorTurne	UIKIO	Piw/	10	
	0.00402	0:00	Continuous Current Limit	Ulfillo	DW/	10000	
	- 0x6410	0.001	Contribucis Current Limit	UINTIB	RW	10000	
arameter	0.05410	0802	Ourput Current Limit	UINTIS	HW	25000	
oroninpott	086410	0.03	PolePar Number	UInt8	HW	1	
	0.6410	0.04	Maxmal Speed in Curren/Mode	UInt16	HW	30000	
	0x6410	0x05	Thermal Time Constant Winding	Ulnt16	RW	40	
-0	0x2001	0x00	CAN Bitiale	UInt16	RW	0	
otic Wizard	0x2002	0x00	RS232 Baudrate	Ulnt16	BW	3	
	0x2008	0x00	Miscellaneous Configuration	UInt16	RW	0	
	0x2210	0x01	Encoder Pulse Number	UInt16	BW	500	
≞ 🗗	0x2210	0x02	Position Sensor Type	UInt16	RW	1	
	NO EDDO	D Car	and EDOC: Collected (assisted 0, 2022) Hand work	femine 0.6410 Arriv	mbur 0.000	0. Ann (miner 0.000	10
Nonen Waard	NUERHUN	H Connec	sted EPUS: SoftwareVersion: 0x2022 HardwareV	/ersion: Ux6410 AppNi	mber: UxUUU	JU AppVersion: UkUUL	<i>J</i> U

Figure 23: Start regulation tuning

m	naxon motor
EPOS 70/10 Getting Started	EPOS Positioning Controller

#### Auto-tuning of the Current Regulator 6.4.2

In a first step, tune the current regulator.

a) Select the menu item 'Current Regulator' in the menu 'Regulator to Tune'.

٦

b) Leave all settings to default values.

lation Tuning [Node 1]				
Regulator to Turk Durrent Regulator Performance Index Falegral of Abs[Error] Step Type Current Step Current Step 2000 mA Enhanc		Siep	Current Regulator	Moder
The <b>EPOS</b> _ is disabled !	Next Eval	uation Setting	Tuning Mode Auto T	funing 💌
Performance Index P-Gain I-Gain	Auto	lame	Value	Delta
		Proportional Gain	1000	0
		ntegral Gain	300	0
				animatical and a second se
	<b>L</b> i.			
Ĺ	lose Regulation Tuning	1		

Figure 24: Auto-tuning of current regulator



Figure 25: Auto-tuning button

- c) Click on 'Start Tuning' button to start the auto-tuning.
- d) Block the motor shaft continuously until current regulator autotuning is finished.



Figure 26: Confirm motor shaft blocking

e) Confirm by clicking on 'Yes' button.

**EPOS Positioning Controller** 

f) Now, auto-tuning will start. It is searching suitable regulation gains for current regulation mode automatically. This procedure can take a few minutes. All tuning steps will be displayed for further analysis.

E	nd of Regulation Tuning	x
	End of Regulation Tuning	_
	If the new regulation gains do not meet your regulation requirements, the tuning has to be repeated!	
	Do you want to restart the regulation tuning?	
	Yes <u>No</u>	

Figure 27: Confirm end of tuning

- g) Confirm the end of tuning by clicking on 'No' button.
- h) If an error occurs and the auto-tuning will not start, please confirm and clear the error. Next adjust the starting parameters by referring to chapter <u>6.4.5 'Manual Tuning'</u>. Afterwards start the auto-tuning again.

EPO5_Us	erInterface 🔀		
Device is in Fault Stat			
	ОК		

Figure 28: Confirm tuning error

			/
The <b>EPOS</b> is disabled !	Error Found! Fault State	₿X	<b>E</b>

Figure 29: Clear tuning error

maxo	n motor
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#### 6.4.3 Auto-tuning of the Velocity Regulator

Now tune the velocity regulator.

- a) Select the menu item 'Velocity Regulator' in the menu 'Regulator to Tune'.
- b) Leave all other settings to default values.

lation Tuning [Node 1]		. 10
Regulator to Tune Velocity megulator Performance Inder Current Regulator Velocity Regulator Position Regulator Step Type Pton Macalu Step Ptofile Velocity Step 1000 rpm Enhance	Profile Cenerator	)
The <b>EPOS I</b> is disabled ! Sest Tuning	Next Evaluation Setting	-
Performance Index P-Gain I-Gain	Auto Name Value Delta	T
	Proportional Gain 680 0	Ē.
	Integral Gain 200 0	
		ահակահահահահահահահահահահահա
		ШШ
	Regulation Tuning	

Figure 30: Auto-tuning of velocity regulator



Figure 31: Auto-tuning button

- c) Click on 'Start Tuning' button to start the auto-tuning.
- d) Be sure the motor shaft is free running.



*Figure 32: Confirm free running of motor*e) Confirm by clicking on 'Yes' button.

f) Now, auto-tuning will start. It is searching suitable regulation gains for velocity regulation mode automatically. This procedure can take a few minutes. During this procedure the motor is performing some rotations to both directions. All tuning steps will be displayed and recorded for further analysis.

End of Regulation Tuning	x
End of Regulation Tuning	
If the new regulation gains do not meet your regulation requirements, the tuning has to be repeated!	
Do you want to restart the regulation tuning?	
V	
Tes No	

Figure 33: Confirm end of tuning

- g) Confirm the end of tuning by clicking on 'No' button.
- h) If an error occurs and the auto-tuning will not start, please confirm and clear the error. Next adjust the starting parameters by referring to chapter <u>6.4.5 'Manual Tuning'</u>. Afterwards start the auto-tuning again.



Figure 34: Confirm tuning error

			/
The <b>EPOS</b> is disabled !	Error Found! Fault State	<b>B</b> X	ন্থা
D IT I			

Figure 35: Clear tuning error

	maxon motor
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#### Auto-tuning of the Position Regulator 6.4.4

Now tune the position regulator.

a) Select the menu item 'Position Regulator' in the menu 'Regulator to Tune'.

٦

b) Leave all other settings to default values.

lation Tuning [Node 1]		
Regulator to Tune Position Regulator Performance Index Provide Regulator Performance Index Position Regulator Performance Regulator Performanc	Profile Generator	tion Accorect Regulator Eccober
The EPOS is disabled !	Next Evaluation Setting	Tuning Mode Auto Tuning
Partomance Index P.Gain L.Gain D.Gain	Auto Name	Value Dalta
Foreing to the Forein Forein Product	Proportional Gain	100 0.
	☑ Integral Gain	10 0
Performance Index P-Gain I-Gain D-Gain		200 0
	Euuluuluul	
<u>Close</u> Reg	ulation Tuning	

Figure 36: Auto-tuning of position regulator



Figure 37: Auto-tuning button

- c) Click on 'Start Tuning' button to start the auto-tuning.
- d) Be sure the motor shaft is free running.



- Figure 38: Confirm free running of motor
- e) Confirm by clicking on 'Yes' button.

f) Now, auto-tuning will start. It is searching suitable regulation gains for position regulation mode automatically. This procedure can take a few minutes. During this procedure the motor is performing some rotations to both directions. All tuning steps will be displayed and recorded for further analysis.

nts,

Figure 39: Confirm end of tuning

- g) Confirm the end of tuning by clicking on 'OK' button.
- h) If an error occurs and the auto-tuning will not start, please confirm and clear the error. Next adjust the starting parameters by referring to chapter <u>6.4.5 'Manual Tuning'</u>. Afterwards start the auto-tuning again.

EPO5_Us	erInterface 🛛 🗙	1
♪	Device is in Fault State!	
	OK	

Figure 40: Confirm tuning error

			/
The <b>EPOS</b> is disabled !	Error Found! Fault State	<b>B</b> X	ন্থা
D IT I			

Figure 41: Clear tuning error

#### 6.4.5 Manual Tuning

EPOS 70/10 Getting Started

If the auto-tuning shows an error or the result of the auto-tuning is not sufficient, you have to tune the appropriate regulator manually. You have to start an iterative search of the regulation gains. Change the system parameters manually, start a single step movement and check the recorded data.

Follow the next instructions:

a) Choose the 'Manual Tuning' mode in the regulation tuning screen and start the tuning.



Figure 42: Manual tuning mode

b) Go to the 'Next Evaluation Setting' and change the regulation gains of the appropriate regulator.

	Industion Cotting		
Auto	Name	Value	Delta
2	Proportional Gain	150	0
2	Integral Gain	100	0
2	Differential Gain	200	0

Figure 43: Manual tuning mode

#### Hints:

Start values for current and velocity regulator are normally not difficult to find.

For positioning regulator, following rule of thumb will be helpful:

**Start values:** 'Integral Gain' = 0 'Proportional Gain' = 2 x 'Differential Gain'

**Overshoot:** Reduce the 'Proportional Gain' or increase the 'Differential Gain'.

Position Error: Increase the 'Proportional Gain' and the 'Differential Gain'.

Integral Gain: Adjust the 'Integral Gain' at the end, if the other two gains are optimized. Increase the 'Integral Gain' until the static position error is small enough.

c) Start a new movement and judge the recorded data.



Figure 44: Next tuning step

d) Repeat this iteration until all regulation gains are optimized.

#### 6.4.6 Save all Regulation Gains

All the regulation gains found by the auto-tuning are stored locally (on your PC) up to now. To take effect permanently you have to store the values on the EPOS.



Figure 45: Save button

a) Click on 'Save button' to save regulation gains.

EPOS_UserInterface				
1	Do you really want to save the regulation gains?			
	<u>la</u> <u>N</u> ein			

Figure 46: Confirm regulation gains saving

b) Confirm the saving of regulation gains by clicking on 'Ja' button.

EPOS_UserInterface		l
⚠	All Parameters are saved!	
	<u>(ОК)</u>	

Figure 47: Confirm saving of all parameters

c) Confirm saving of all parameters by clicking on 'OK' button.

## 7 Conclusion

Now the EPOS 70/10 is ready for operation in one of the supported regulation modes!

For further settings and more detailed information's, use online help by pressing F1 or refer to the <u>EPOS 70/10 documentation</u>.