maxon motor

maxon motor control	**EPOS Positioning Controller**
Getting Started	**December 2008 Edition**

EPOS 70/10

Positioning Controller

Documentation

Getting Started

maxon document number 752413-06

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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 the unit can be operated through any RS-232 communication port.

Figure 1: EPOS 70/10 photo

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 http://www.maxonmotor.com category <Service & Downloads> or in the maxon motor e-shop http://shop.maxonmotor.com.

4   How to use this guide

Setup

Getting Started

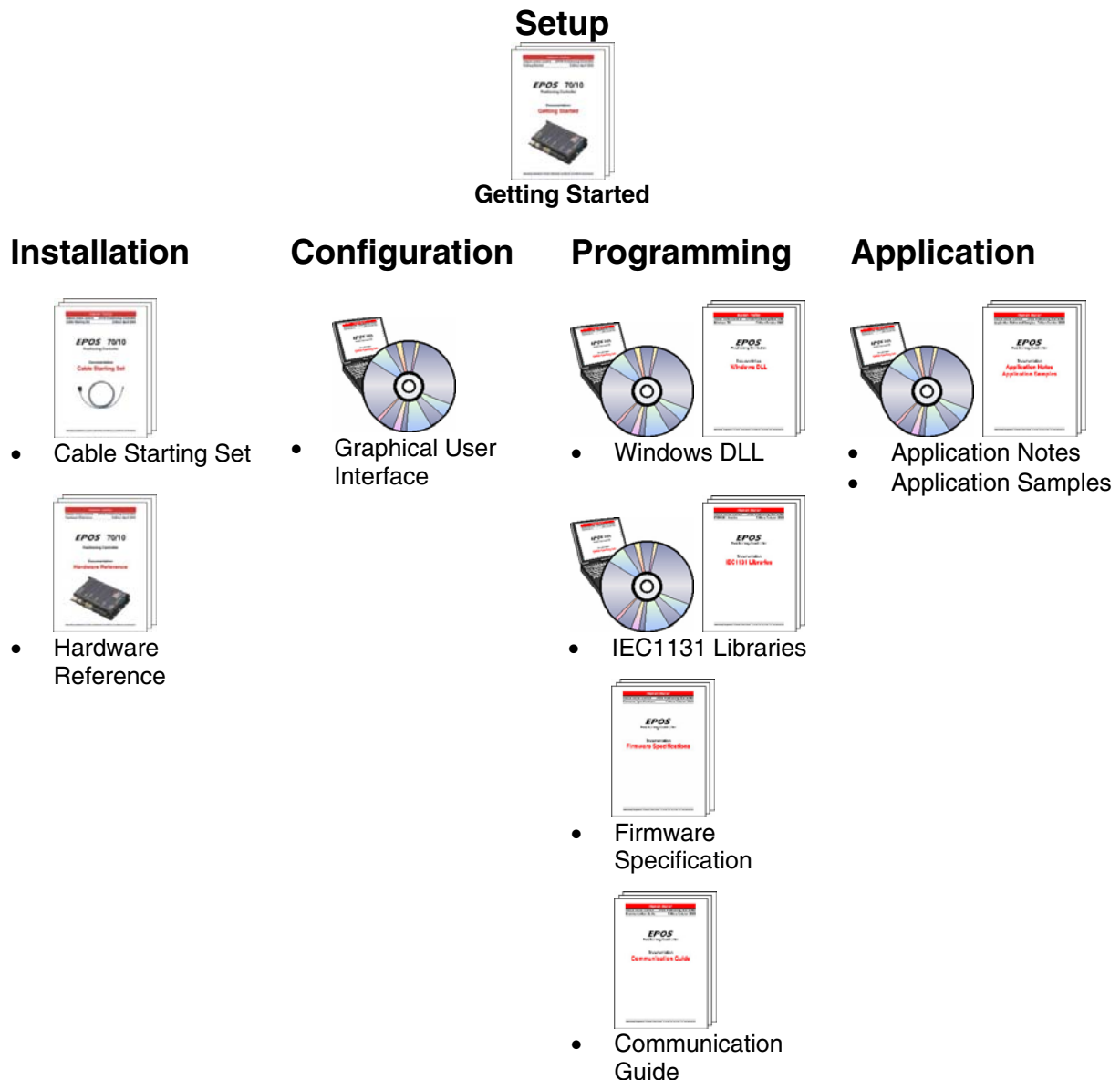| **Installation**	**Configuration**	**Programming**	**Application**
• Cable Starting Set	• Graphical User Interface	• Windows DLL	• Application Notes
• Hardware Reference		• IEC1131 Libraries	• Application Samples
		• Firmware Specification	
		• Communication Guide	

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).
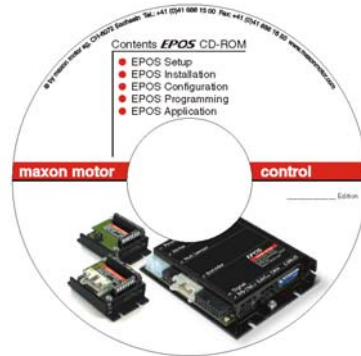

Figure 3: EPOS CD-ROM

The latest edition of the software to the EPOS positioning controller may be downloaded from the maxon motor homepage http://www.maxonmotor.com 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.

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.
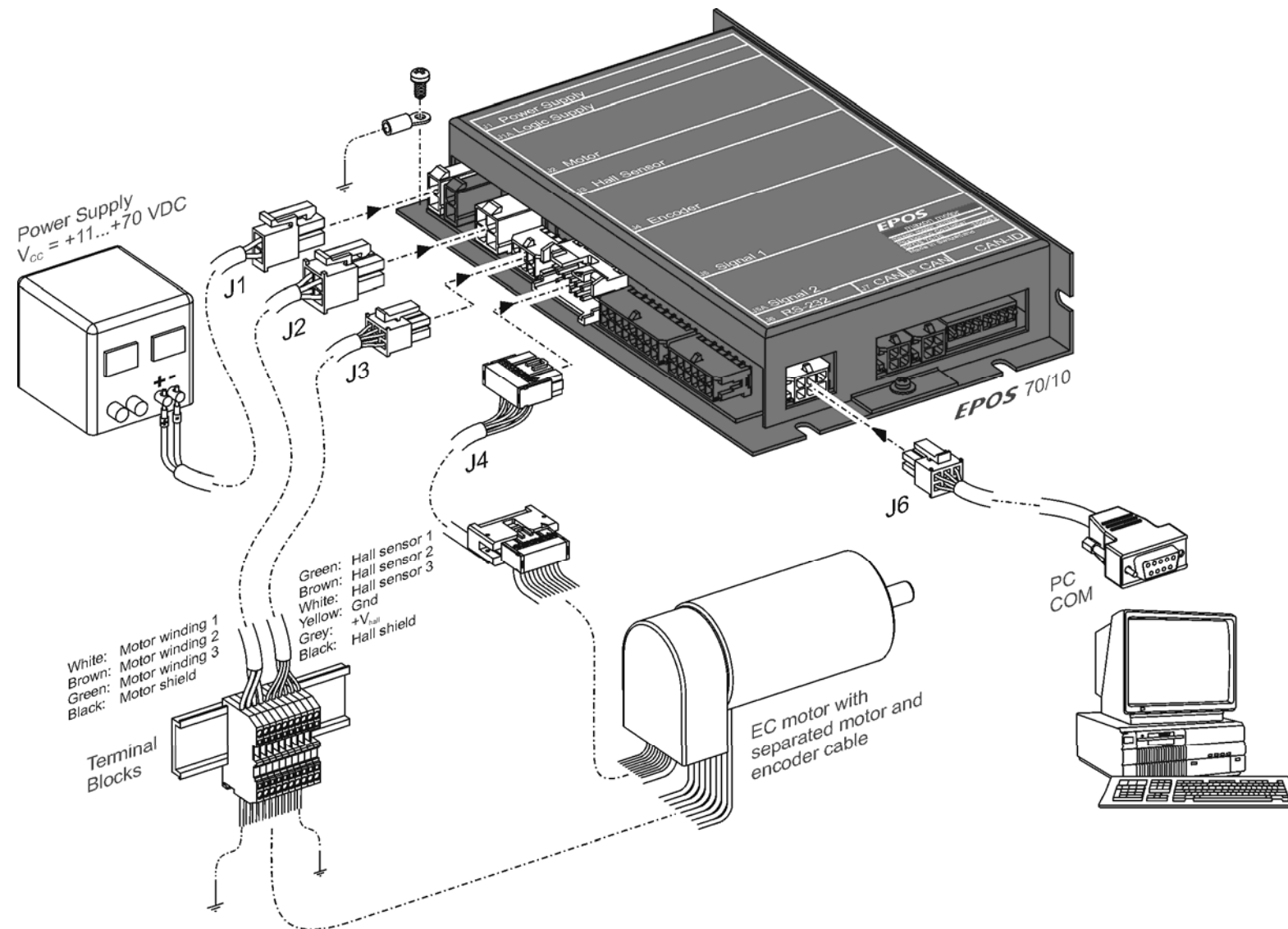
Power Supply
V_{CC} = +11...+70 VDC

J1
J2
J3
J4
J6

Power Supply
Logic Supply
Motor
Hall Sensor
Encoder
Signal 1
Signal 2
RS-232
CAN
CAN
CAN-ID

EPOS 70/10

PC COM

White: Motor winding 1
Brown: Motor winding 2
Green: Motor shield
Black:

Green: Hall sensor 1
Brown: Hall sensor 2
White: Hall sensor 3
Yellow: Gnd
Grey: +V_{hall}
Black: Hall shield

Terminal Blocks

EC motor with separated motor and encoder cable

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.
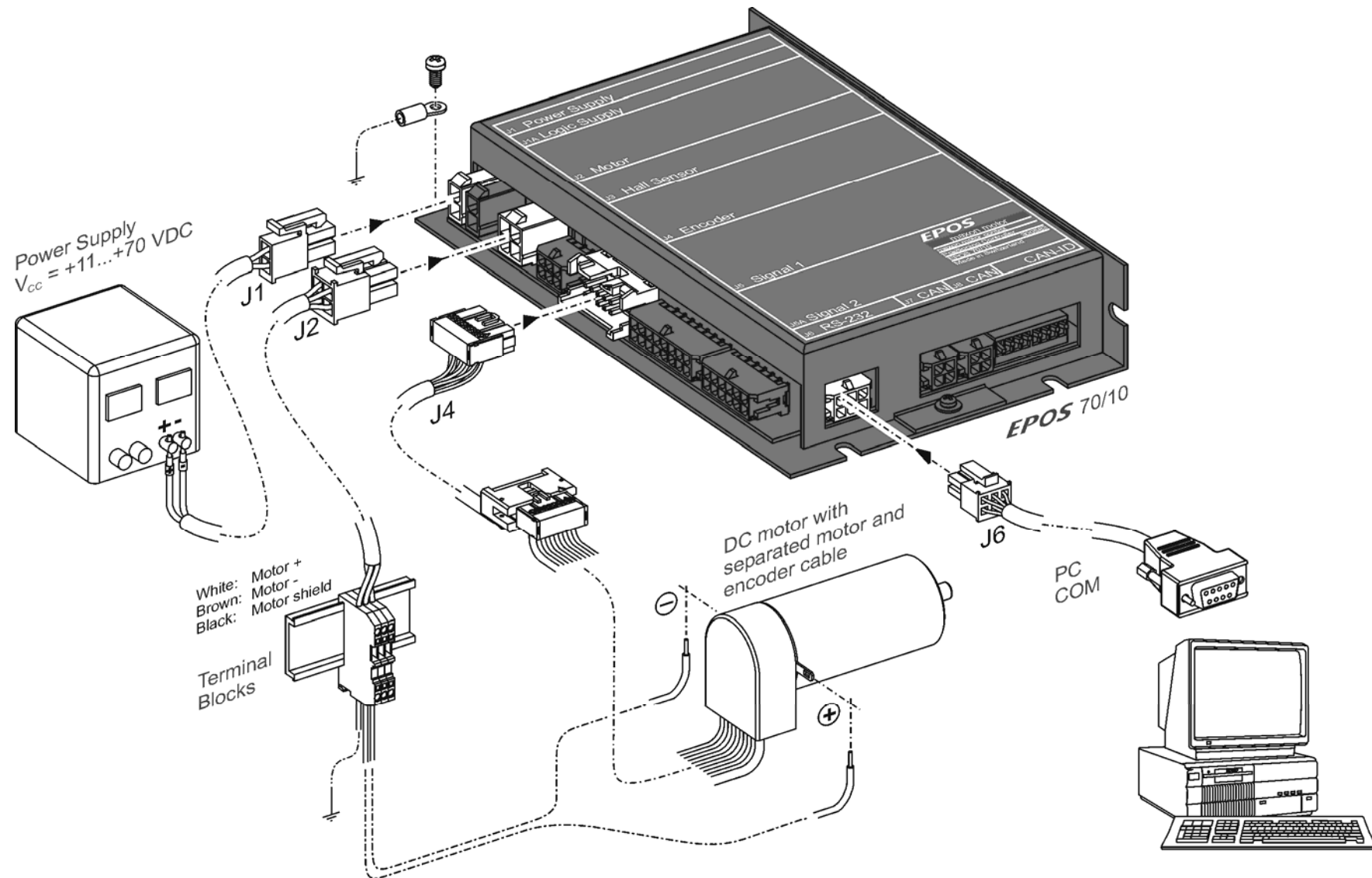
Figure 5: Minimum wiring for maxon DC motor

6.3   Step 3: System Configuration

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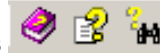
Please note:

- 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 '6.2 Step 2: Minimum External Wiring'.
    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'.
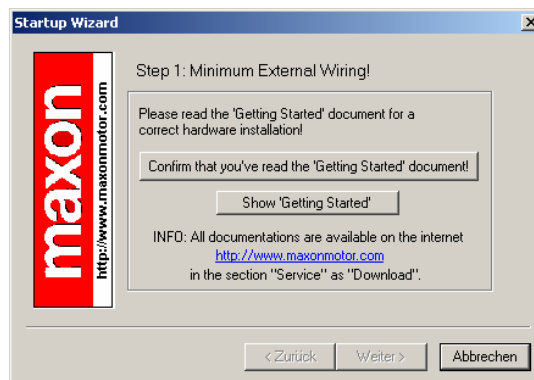

Figure 6: Startup wizard dialog for minimum external wiring

    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.[1] Please refer to chapter '6.2 Step 2: Minimum External Wiring'.
   b) Click on the button 'Search Communication Setting' to search the used COM port and the adjusted baudrate automatically.
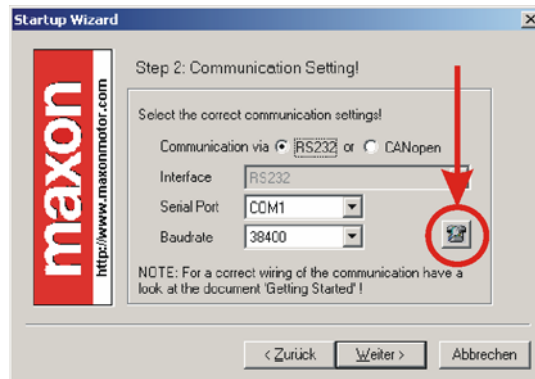

Figure 7: Startup wizard dialog for setting RS-232 communication

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

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.
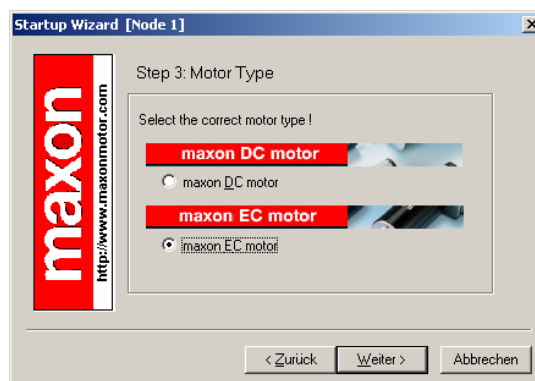
Figure 9: Startup wizard dialog for choosing motor type

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

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[1]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.

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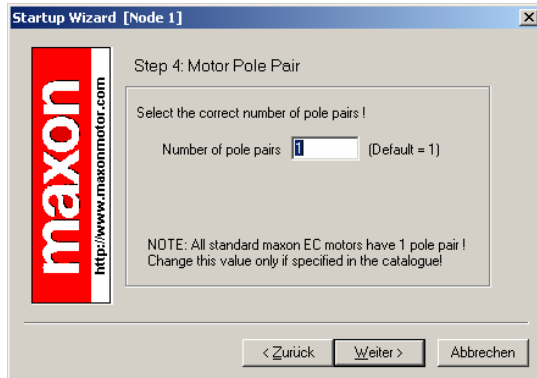a) Select the correct number of pole pairs.

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).
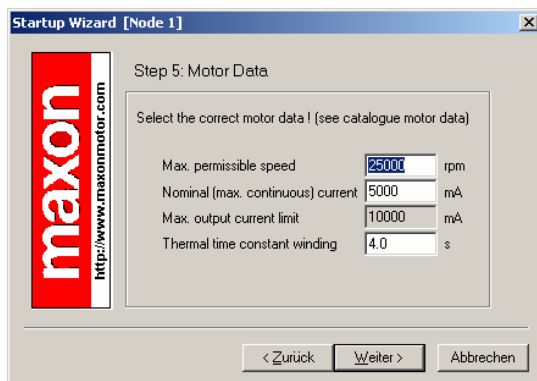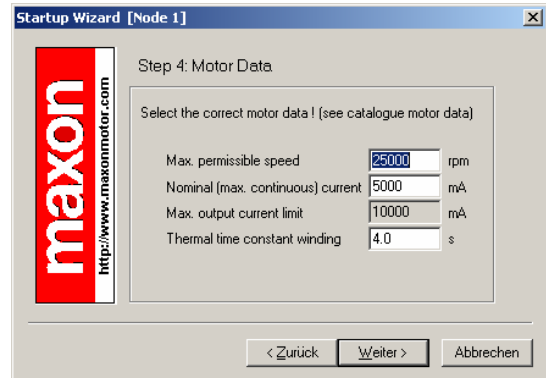c) Select the thermal time constant of the winding.

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.

Figure 11: Startup wizard dialog for setting DC motor data

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

7. 'Startup Wizard'
   Step 5 for DC motors: Position Sensor Type
a) Select the used position sensor type
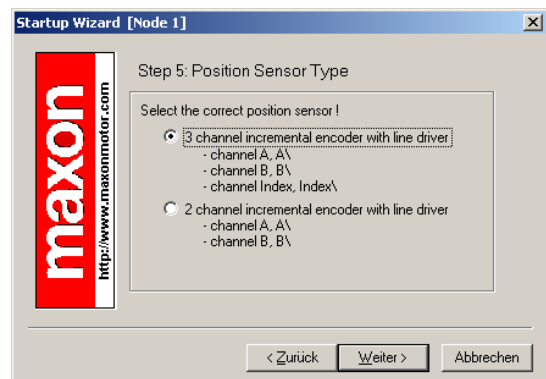
Figure 13: Startup wizard dialog for choosing DC motor position sensor type

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

8. 'Startup Wizard' Step 6 for EC motors: Position Sensor Type

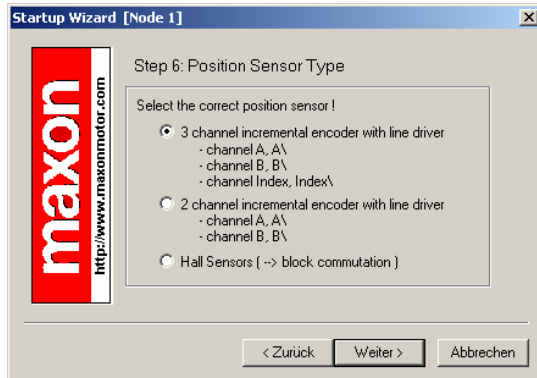a) Select the used position sensor type

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.**
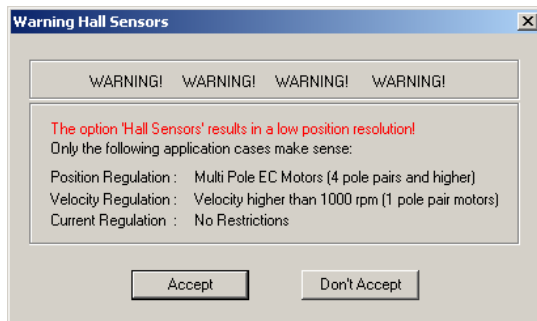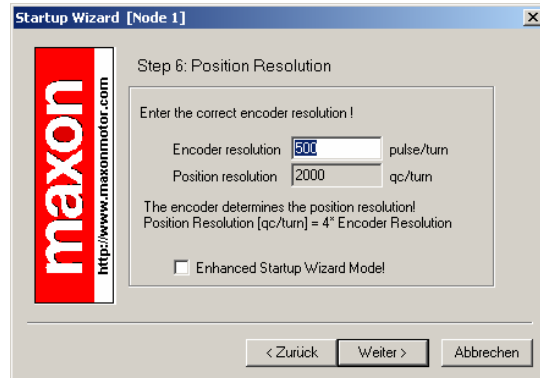

Figure 15: Recommendations for using Hall sensors as position sensors

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
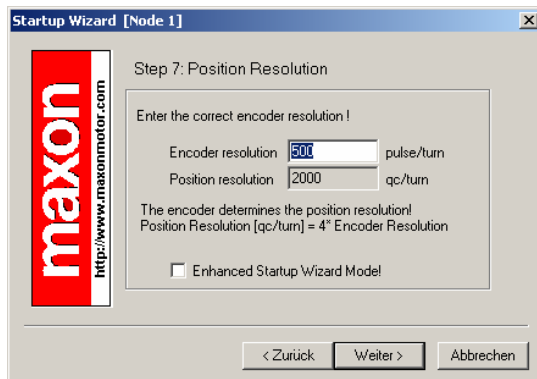
a) Enter the resolution of the used encoder.

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

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

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) 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'.
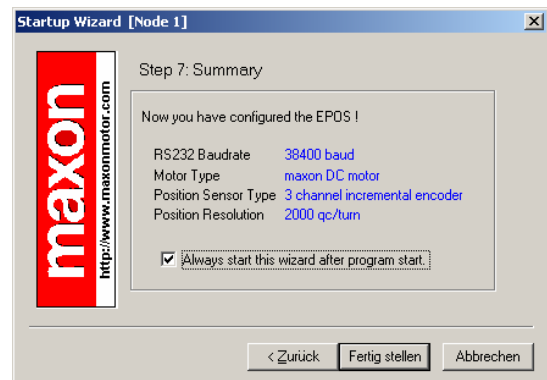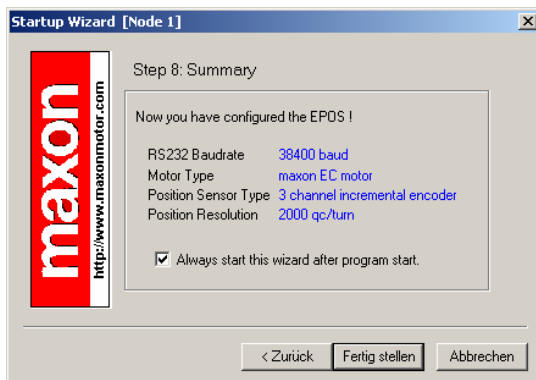

Figure 18: Startup wizard configuration summary

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) 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**
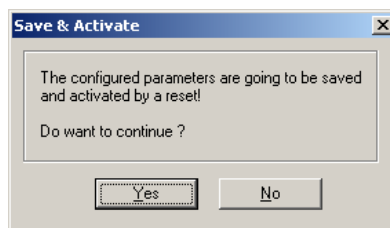
Figure 20: Save & activate the configured parameters

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.[1]

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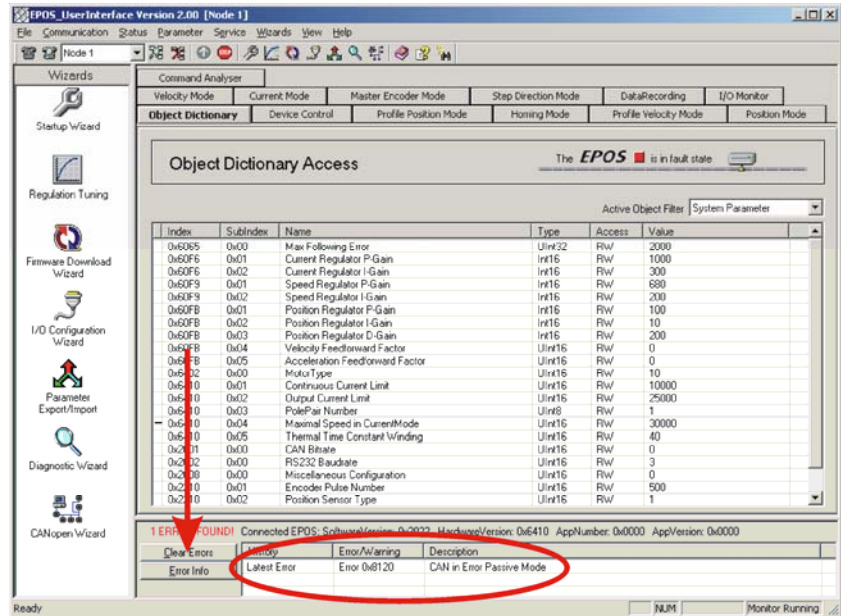

Figure 22: Clear CAN error

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.

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[1] 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.
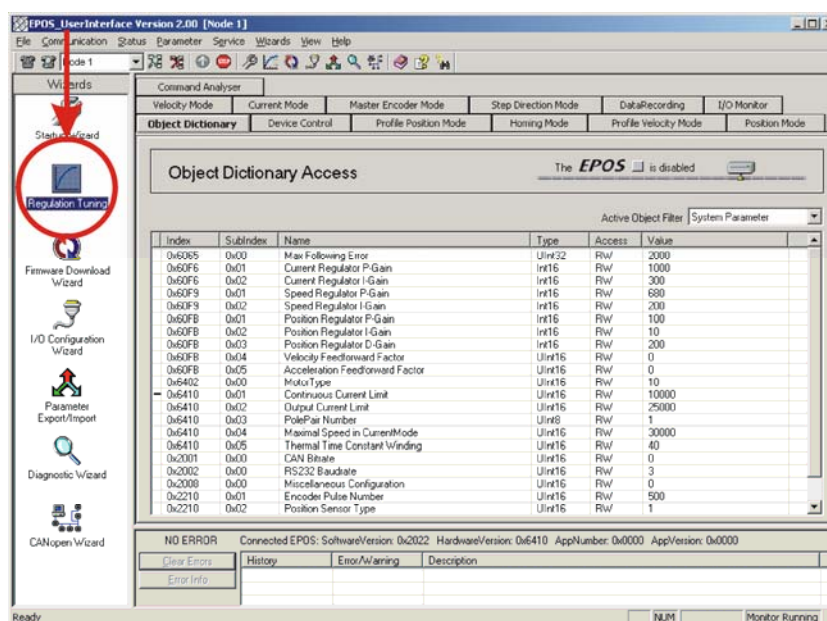
Figure 23: Start regulation tuning

6.4.2 Auto-tuning of the Current Regulator

In a first step, tune the current regulator.

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

    b) Leave all settings to default values.
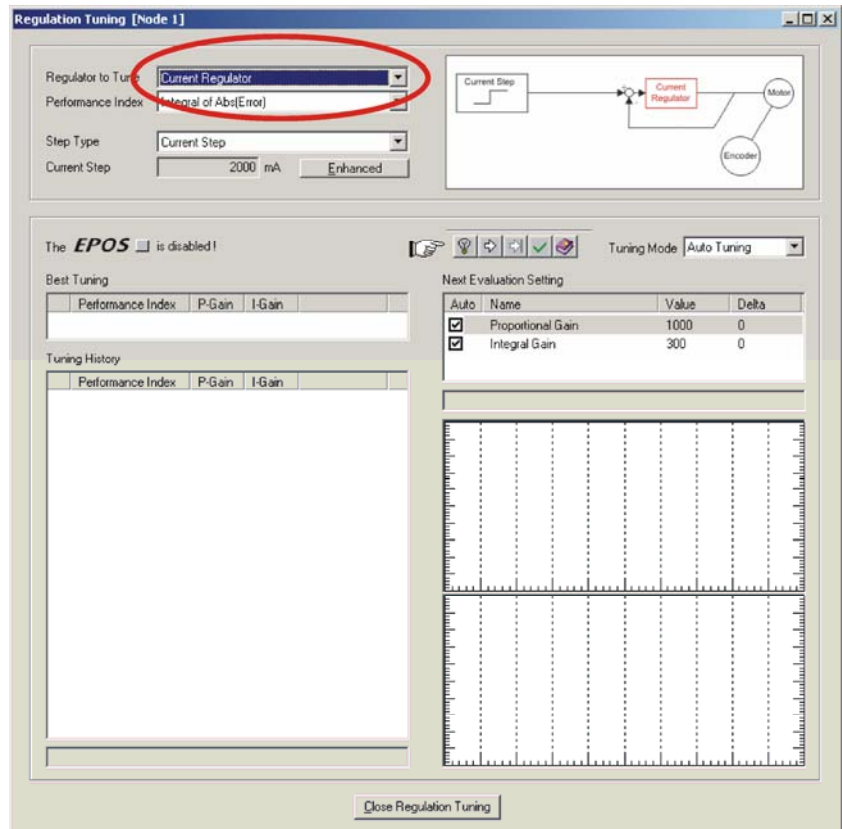
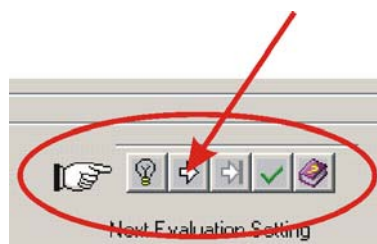*Figure 24: Auto-tuning of current regulator*

Figure 25: Auto-tuning button

    c) Click on 'Start Tuning' button to start the auto-tuning.

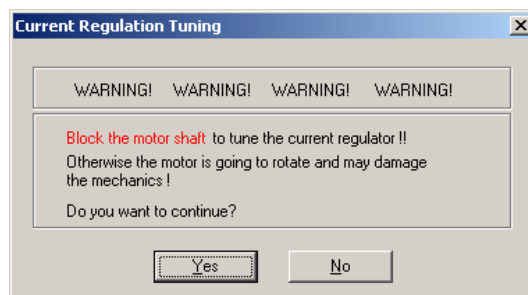   d) Block the motor shaft continuously until current regulator auto-tuning is finished.

Figure 26: Confirm motor shaft blocking

    e) Confirm by clicking on 'Yes' button.

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.
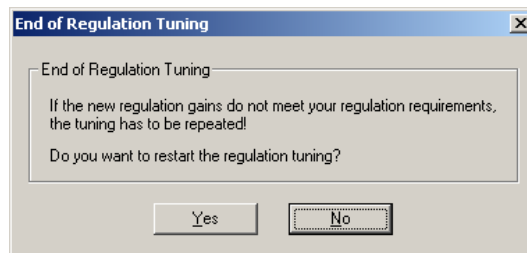

Figure 27: Confirm end of tuning

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 6.4.5 'Manual Tuning'. Afterwards start the auto-tuning again.

Figure 28: Confirm tuning error
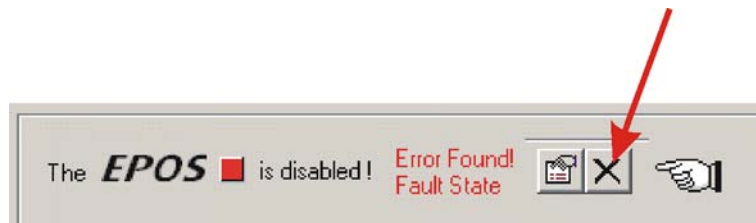
Figure 29: Clear tuning error

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'.

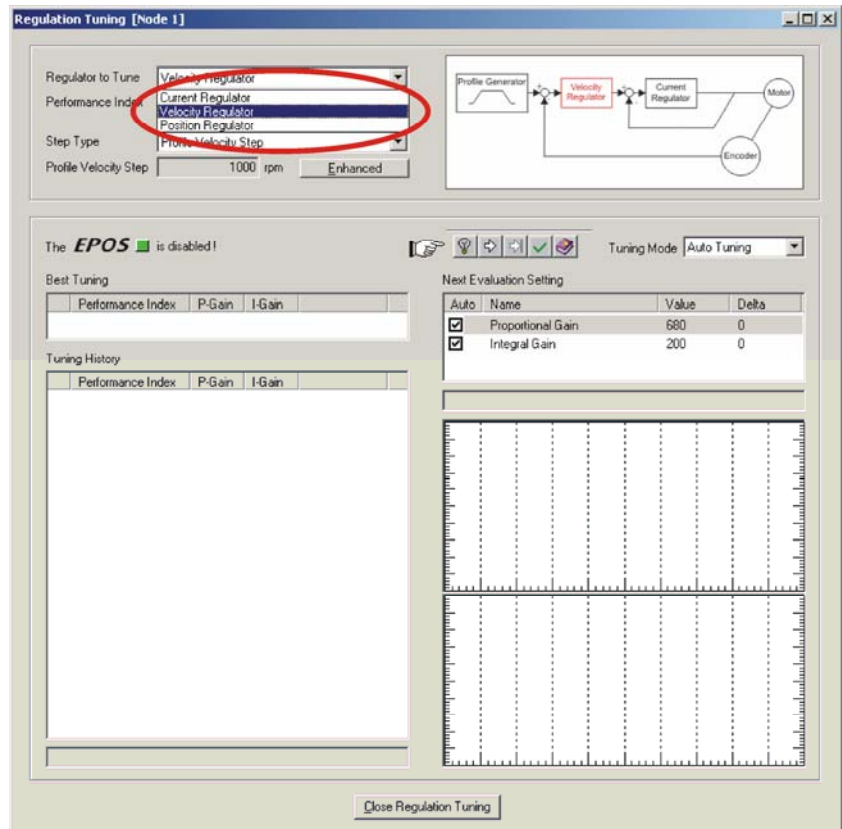   b) Leave all other settings to default values.

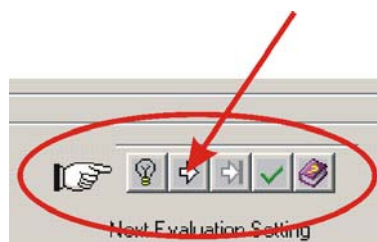*Figure 30: Auto-tuning of velocity regulator*

Figure 31: Auto-tuning button

    c) Click on 'Start Tuning' button to start the auto-tuning.

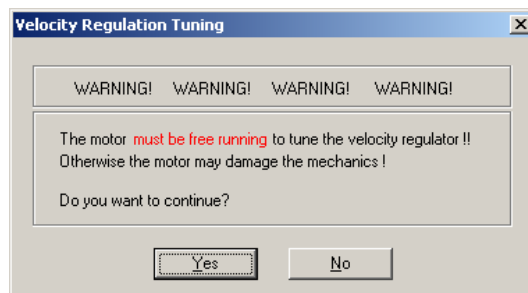   d) Be sure the motor shaft is free running.

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.
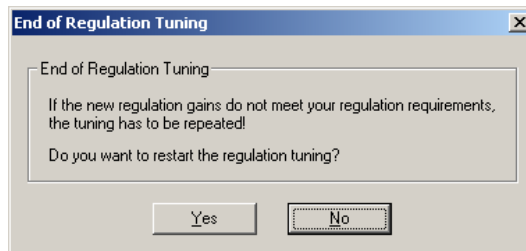

Figure 33: Confirm end of tuning

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 6.4.5 'Manual Tuning'. Afterwards start the auto-tuning again.
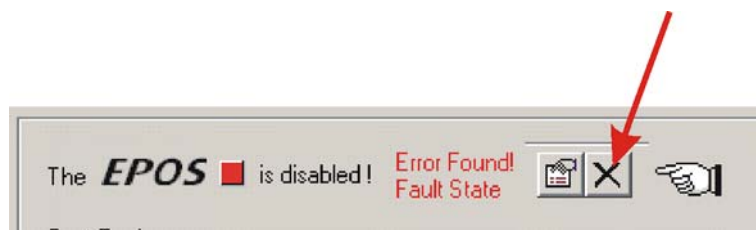

Figure 34: Confirm tuning error

Figure 35: Clear tuning error

6.4.4   Auto-tuning of the Position Regulator

Now tune the position regulator.

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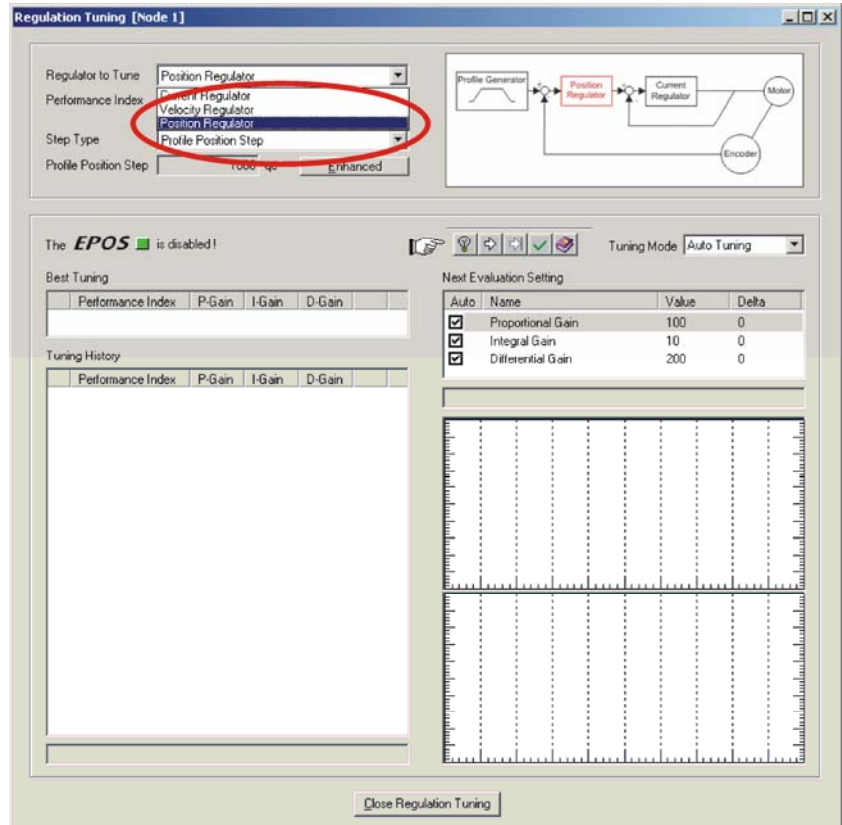
  b) Leave all other settings to default values.

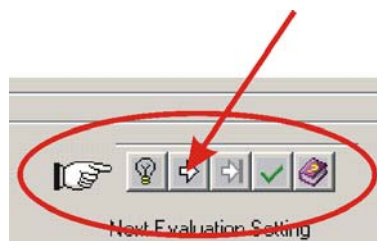*Figure 36: Auto-tuning of position regulator*

Figure 37: Auto-tuning button

  c) Click on 'Start Tuning' button to start the auto-tuning.

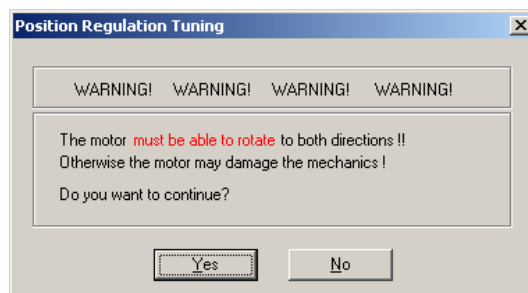 d) Be sure the motor shaft is free running.

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.
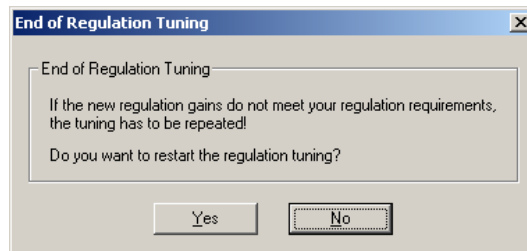

Figure 39: Confirm end of tuning

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 6.4.5 'Manual Tuning'. Afterwards start the auto-tuning again.
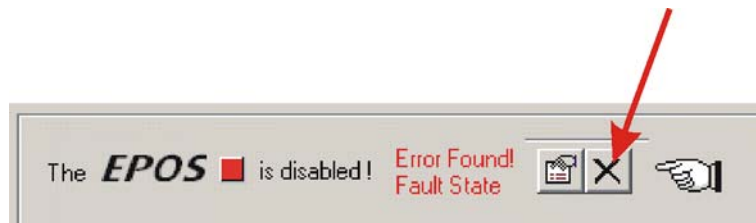

Figure 40: Confirm tuning error

Figure 41: Clear tuning error

6.4.5 Manual Tuning

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:

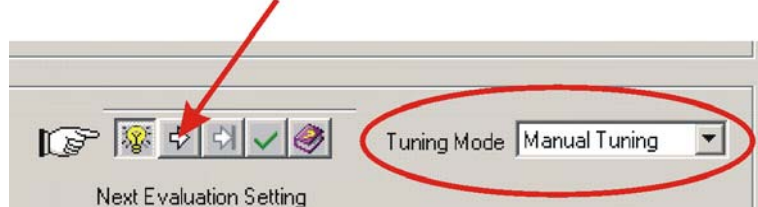a) Choose the 'Manual Tuning' mode in the regulation tuning screen and start the tuning.

Figure 42: Manual tuning mode

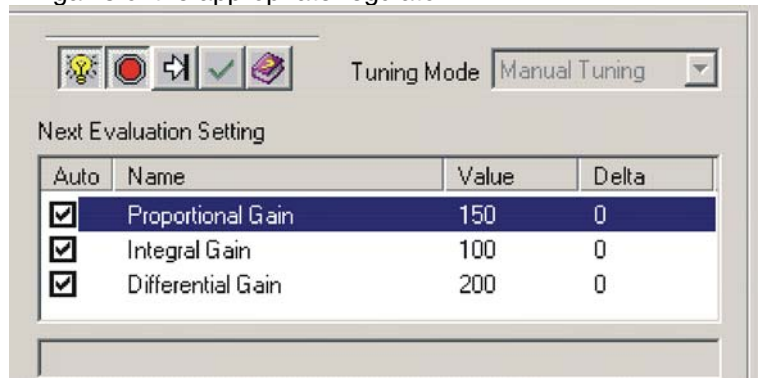b) Go to the 'Next Evaluation Setting' and change the regulation gains of the appropriate regulator.

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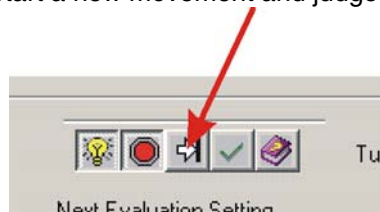
c) Start a new movement and judge the recorded data.

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.
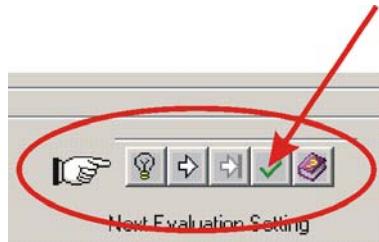

Figure 45: Save button

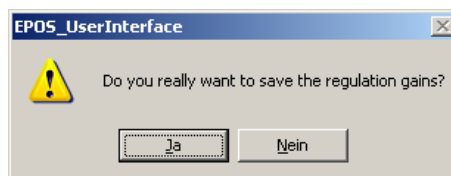a) Click on 'Save button' to save regulation gains.

Figure 46: Confirm regulation gains saving

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

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 EPOS 70/10 documentation.