EPOS

Positioning Controller

Application Note
"Master Encoder Mode"

Edition December 2008

EPOS 24/1, EPOS 24/5, EPOS 70/10, MCD EPOS 60W
Firmware version 2010h or higher

Introduction

The EPOS positioning controller is a digital positioning system suitable for DC and EC (brushless) motors with incremental encoders in a modular package. The performance range of these compact positioning controllers ranges from a few watts up to 700 watts.

A variety of operating modes allows all kinds of drive and automation systems to be flexibly assembled using positioning, speed and current regulation. The built-in CANopen interface allows networking to multiple axis drives and online commanding by CAN bus master units.

As an alternative, the EPOS can also be commanded by digital position values. Either an incremental encoder (Master Encoder Mode) is used for setting the values of the device, or a PLC generating step pulses (Step Direction Mode) can be used to command the device.

Objectives

This application note explains the structure and use of the operating mode 'Master Encoder Mode'.
Application examples and limitations are discussed.

References and Required Tool

The latest editions of maxon motor documents and tools are freely available at http://www.maxonmotor.com category «Service & Downloads» or in the maxon motor e-shop http://shop.maxonmotor.com.

Document	**Suitable order number for EPOS Positioning Controller**
EPOS Firmware Specification	280937, 302267, 302287, 317270, 326343, 275512, 300583

Tool	
EPOS Studio Version 1.30 or higher	280937, 302267, 302287, 317270, 326343, 275512, 300583

Master Encoder Mode

System Structure

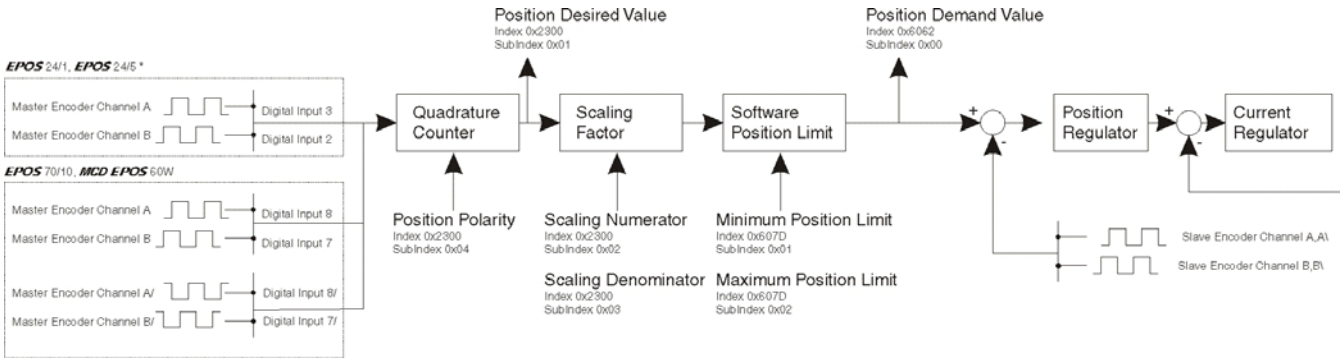


Figure 1: System Structure

Quadrature Counter

EPOS 24/1, EPOS 24/5

Channel A	Digital Input 3
Channel B	Digital Input 2
Desired Value (Polarity = 0)	

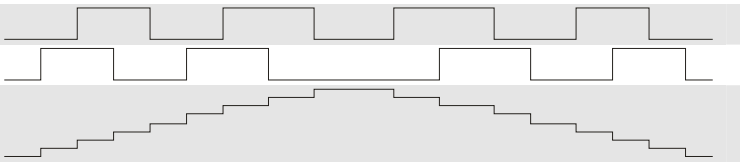


Figure 2: Quadrature Counter

	EPOS 24/1	EPOS 24/5
Input Voltage	0 … 24 VDC	0 … 24 VDC
Max. Input Voltage	-30 … + 30 VDC	-30 … + 30 VDC
Logic 0	< 0.7 VDC	< 1.5 VDC
Logic 1	> 2.4 VDC	> 3.0 VDC
Max. Input Frequency	500 kHz	100 kHz

EPOS 70/10, MCD EPOS 60W

Channel A	Digital Input 8
Channel B	Digital Input 7
Channel A/	Digital Input 8/
Channel B/	Digital Input 7/
Desired Value (Polarity = 0)	

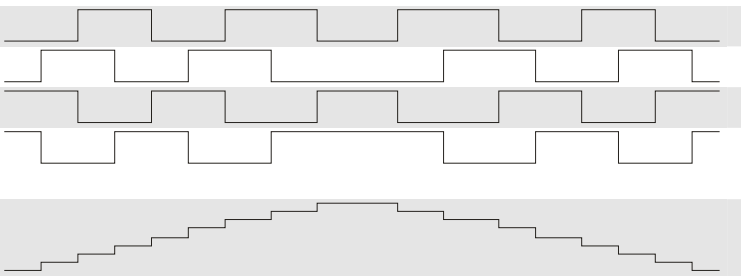


Figure 3: Quadrature Counter

	EPOS 70/10	MCD EPOS 60W
Input Voltage	0 … 5 VDC	0 … 5 VDC
Max. Input Voltage	-24 … + 24 VDC	-24 … + 24 VDC
Logic 0	< 2.0 VDC	< 2.0 VDC
Logic 1	> 3.0 VDC	> 3.0 VDC
Max. Input Frequency	1 MHz	500 kHz

Parameter Input

Name	Index	Sub-index	Description
Digital Position Scaling Numerator	0x2300	0x02	Numerator of the scaling factor. Can be used for electronic gearing.
Digital Position Scaling Denominator	0x2300	0x03	Denominator of the scaling factor. Can be used for electronic gearing.
Digital Position Polarity	0x2300	0x04	Polarity of the quadrature counter. The direction can be changed. (0 = Positive; 1 = Negative)
Minimum Position Limit	0x607D	0x01	Defines the negative position limit for the position demand value.
Maximum Position Limit	0x607D	0x02	Defines the positive position limit for the position demand value.

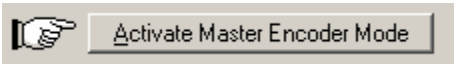
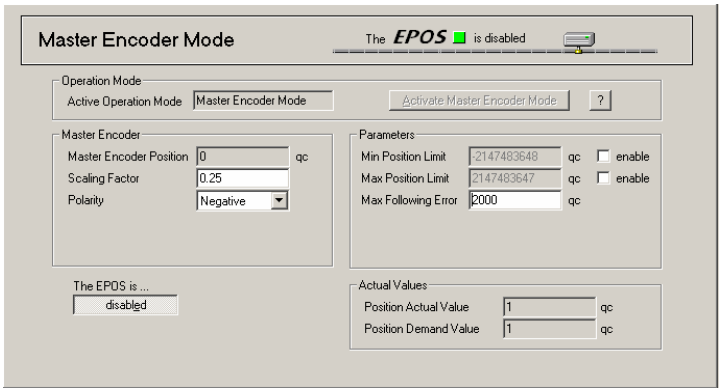
Parameter Output

Name	Index	Sub-index	Description
Digital Position Desired Value	0x2300	0x01	Counter value of the quadrature counter. This value is the base for the scaling and limiting functions.
Position Demand Value	0x6062	0x00	Output of the master encoder mode after scaling and limiting. This is the setting value for the position regulator.

Notes:

- For a better behaviour use a scaling factor ≤ 1. In fact that no interpolation is implemented, movements with factors >> 1 result in bigger position jumps which produces current peaks.
- Switch off the software position limitation, setting the values of maximum and minimum position limit to INT32_MAX resp. INT32_MIN!

Configuration

Step 1: System Configuration	Do the standard system configuration using the EPOS Studio and the Startup Wizard. (Document 'Getting Started')  Startup Wizard Topics: - Minimum External Wiring - RS232 Communication Setting - Motor Type - Motor Pole Pair - Motor Data - Position Sensor Type - Position Resolution
Step 2: Regulation Tuning	Using the 'Step Direction' mode the current regulator and the position regulator have to be tuned. The speed regulator is not used. (see document 'Getting Started'). **Notes:** For testing the behaviour of the regulators use the Profile Position Mode! Only for small steps use the Position Mode!  Regulation Tuning Current Regulator (Current Step) Position Regulator (Profile Position Step)
Step 3: I/O Configuration and Wiring	Do the wiring for the step direction mode. All used digital inputs or outputs have to be configured for the correct purpose. Use the I/O Configuration Wizard!
	EPOS 24/1, EPOS 24/5 — Master Encoder Channel A -> Digital Input 3; Master Encoder Channel B -> Digital Input 2
	EPOS 70/10, MCD EPOS 60 W — Master Encoder Channel A -> Digital Input 8, 8/; Master Encoder Channel B -> Digital Input 7, 7/
	 I/O Configuration Wizard Digital Input 2 or 7 -> General Purpose A Digital Input 3 or 8 -> General Purpose B Any free digital input -> Enable (optional) * Any free digital output -> Ready (optional) **
Step 4: Master Encoder Mode	Activate and configure the master encoder mode. Use the tool EPOS Studio.  
Step 5: Save All Parameters	Execute the menu item 'Save All Parameter' in the context menu from the used node (EPOS Studio – Navigation Window → Workspace or Communication).

* In order to clear the fault condition the device must be reset. Set the 'Enable' input from inactive to active.
* The 'Ready' output can be used to report a fault condition.

Application Example 'Dual Axis System'

A typical application for the master encoder mode is a dual axis system. The master axis is configured, enabled and commanded via the serial interface (RS232 or CAN bus) and is working in the 'Profile Position' or 'Profile Velocity' mode. The slave axis is working in the 'Master Encoder' mode. The CAN bus interface is only used for configuration, monitoring and enabling. The set values for the slave axis are calculated using the encoder signals of the master axis.

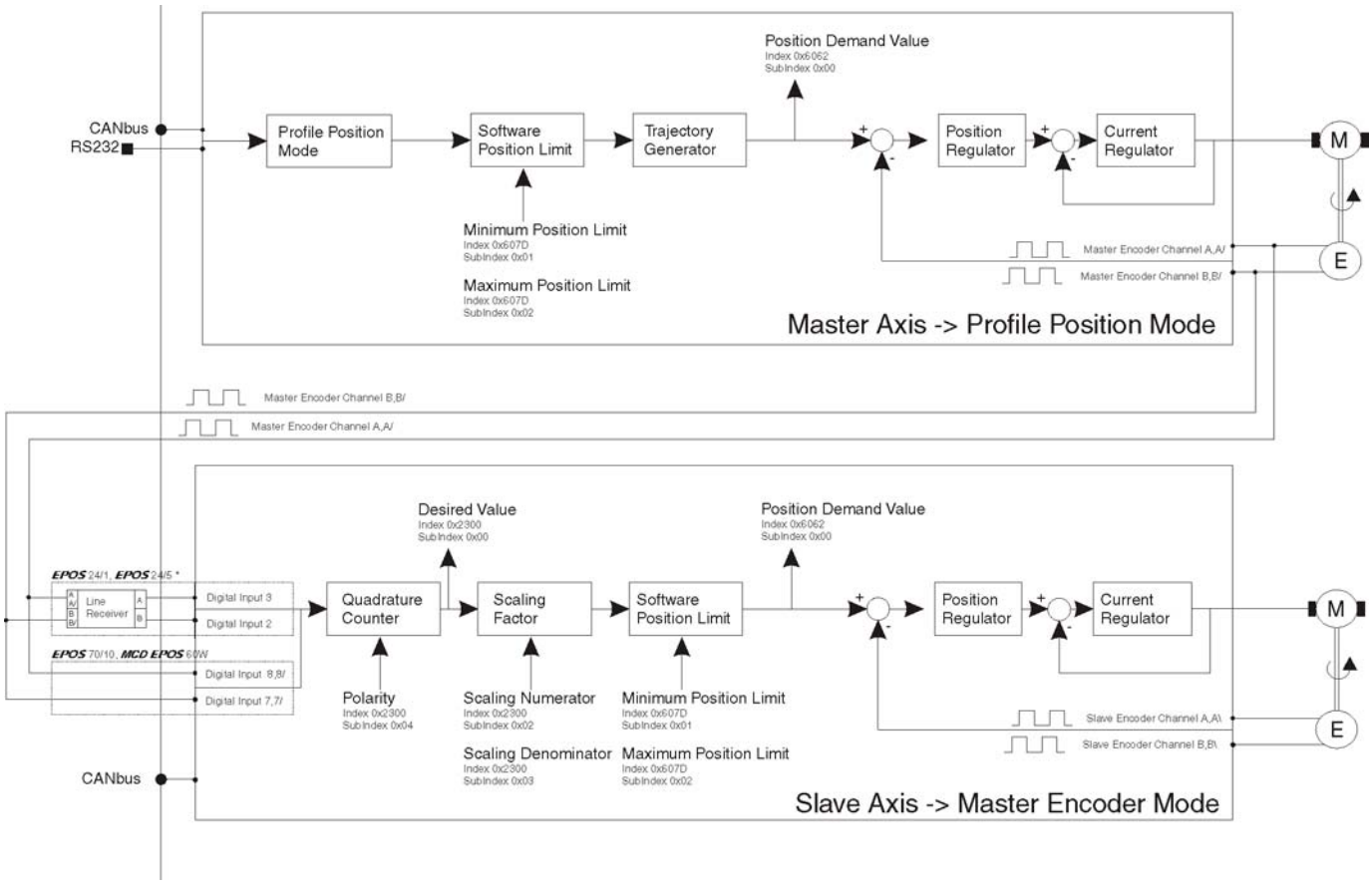


Figure 4: Application Example 'Dual Axis System'

*** Note:** To reach optimal signal conditions, use an external line receiver for EPOS 24/1 and EPOS 24/5!

Calculation Velocity Slave Axis

The velocity of the slave axis is not only defined by the scaling factor, but also by the ratio of the encoder resolution of the master and slave axis.

$$\text{Velocity}_{\text{SlaveAxis}}[\text{rpm}] = \text{Velocity}_{\text{MasterAxis}}[\text{rpm}] \cdot \frac{\text{EncRes}_{\text{MasterAxis}}[\text{pulse/turn}]}{\text{EncRes}_{\text{SlaveAxis}}[\text{pulse/turn}]} \cdot \text{Polarity}[1,-1] \cdot \frac{\text{ScalingNumerator}_{\text{SlaveAxis}}}{\text{ScalingDenominator}_{\text{SlaveAxis}}}$$

Figure 5: Calculation Velocity Slave Axis / Master Encoder Mode

Limiting Factors

The main limiting factor is the input frequency of the encoder signals.

Max. Input Frequency Slave Axis		Encoder Master Axis	Max. Velocity (Scaling Factor 1) Master Axis
EPOS 24/1	500 kHz	500 pulse/turn	> 25'000 rpm (no limitations)
EPOS 24/5	100 kHz		12'000 rpm
EPOS 70/10	1 MHz		> 25'000 rpm (no limitations)
MCD EPOS 60W	500 kHz		> 25'000 rpm (no limitations)
EPOS 24/1	500 kHz	1000 pulse/turn	> 25'000 rpm (no limitations)
EPOS 24/5	100 kHz		6'000 rpm
EPOS 70/10	1 MHz		> 25'000 rpm (no limitations)
MCD EPOS 60W	500 kHz		> 25'000 rpm (no limitations)
EPOS 24/1	500 kHz	5000 pulse/turn	6'000 rpm
EPOS 24/5	100 kHz		1'200 rpm
EPOS 70/10	1 MHz		12'000 rpm
MCD EPOS 60W	500 kHz		6'000 rpm

Figure 6: Limiting Factors / Master Encoder Mode

Note: Higher velocities of the slave axis can be reached by increasing the scaling factor > 1 (Consider restriction notes on page 3).

Axis Synchronisation

Synchronisation works only in one direction: from the master to the slave. The opposite direction (from the slave to the master) can not be synchronized. This means that a following error of the master axis can be corrected, but a following error of the slave axis can not be corrected.