

EPOS

Positioning Controller

Application Note **"Step Direction Mode"**

Edition December 2008

EPOS 24/1, EPOS 24/5, EPOS 70/10, MCD EPOS 60W
Firmware version 2000h 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 'Step Direction 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

Step Direction Mode

System Structure

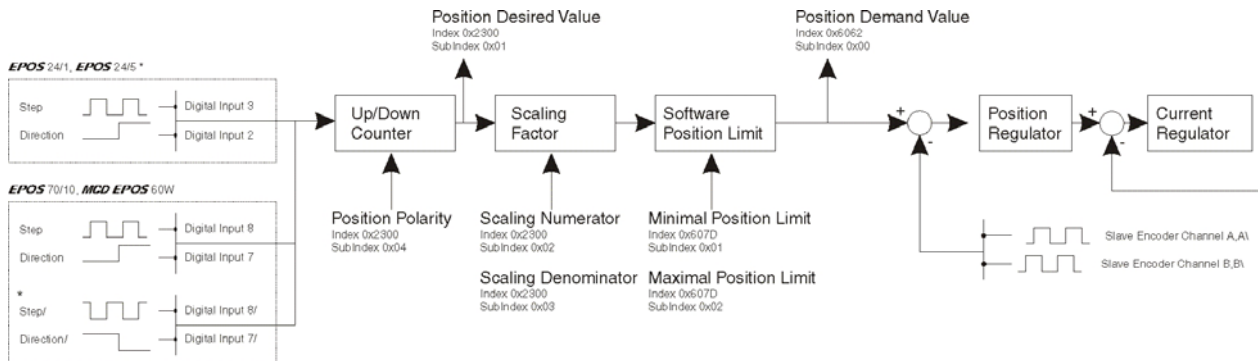


Figure 1: System Structure

* **Note:** Optional wiring. Can be used as single ended or differential input.

Up-/Down Counter

EPOS 24/1, EPOS 24/5

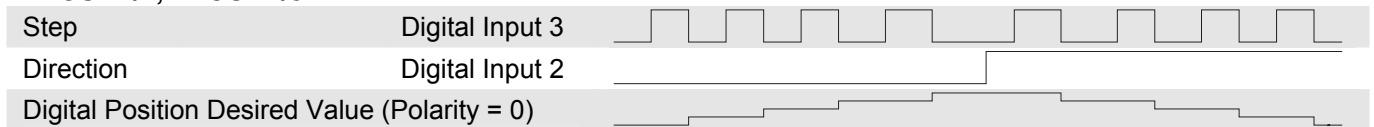


Figure 2: Up-/Down Counter

	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

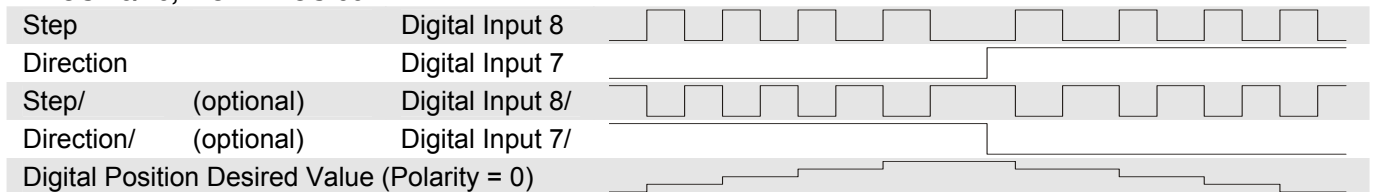


Figure 3: Up-/Down Counter

	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

Note: Direction Input Low = ccw,
Direction Input High = cw
(viewed onto the motor output flange)



Figure 4: Motor direction definitions

Parameter Input

Name	Index	Sub-index	Description
Digital Position Scaling Numerator	0x2300	0x02	Numerator of the scaling factor. Can be used for electronic gearing or to reduce to input frequency.
Digital Position Scaling Denominator	0x2300	0x03	Denominator of the scaling factor. Can be used for electronic gearing or to reduce the input frequency.
Digital Position Polarity	0x2300	0x04	Polarity of the direction input. (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.

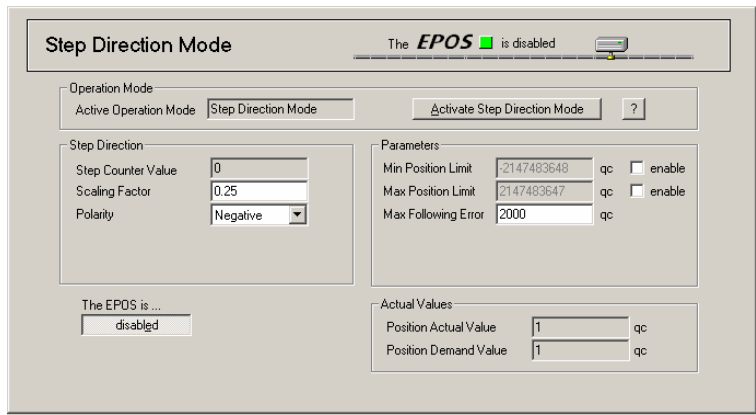
Parameter Output

Name	Index	Sub-index	Description
Digital Position Desired Value	0x2300	0x01	Counter value of the up/down counter. This value is the base for the scaling and limiting functions.
Position Demand Value	0x6062	0x00	Output of the step direction 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 $\gg 1$ 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 - 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! <table><tr><td>EPOS 24/1, EPOS 24/5</td><td>Step Direction</td><td>-> Digital Input 3 -> Digital Input 2</td></tr><tr><td>EPOS 70/10, MCD EPOS 60W</td><td>Step Direction</td><td>-> Digital Input 8, 8/ -> Digital Input 7, 7/</td></tr></table>  I/O Configuration Wizard <table><tr><td>Digital Input 2 or 7</td><td>-> General Purpose A</td></tr><tr><td>Digital Input 3 or 8</td><td>-> General Purpose B</td></tr><tr><td>Any free digital input</td><td>-> Enable (optional) *</td></tr><tr><td>Any free digital output</td><td>-> Ready (optional) **</td></tr></table>	EPOS 24/1, EPOS 24/5	Step Direction	-> Digital Input 3 -> Digital Input 2	EPOS 70/10, MCD EPOS 60W	Step Direction	-> Digital Input 8, 8/ -> Digital Input 7, 7/	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) **
EPOS 24/1, EPOS 24/5	Step Direction	-> Digital Input 3 -> Digital Input 2													
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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: Step Direction Mode	Activate and configure the step direction 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

A typical application for the 'Step Direction' mode is a one or more axis system commanded and controlled by digital I/Os like stepper motors. During the process, no serial interface is necessary. The device can be completely controlled by the digital inputs and outputs. An interface (RS232 or CAN bus) is only necessary for configuration. The device is enabled by a digital input and a digital output indicates whether the device is ready (no error) or not. The velocity or position is commanded by the digital inputs 'Step' and 'Direction'.

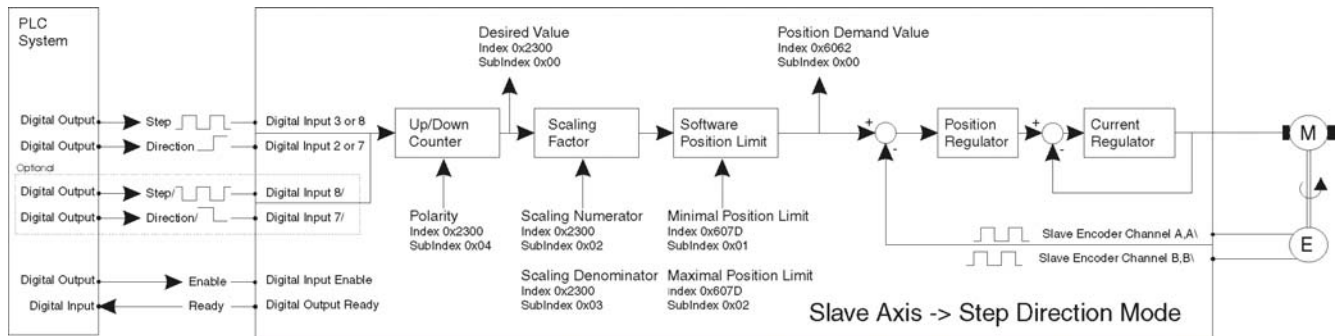


Figure 5: Application Example 'I/O Commanding'

Input Frequency / Velocity Calculation

The velocity of the slave axis is defined by the input frequency of the step input and the scaling factor.

$$\text{Step Input Frequency [Hz]} = \text{Velocity [rpm]} \cdot \frac{4 \cdot \text{Encoder Resolution [pulse/turn]}}{60 [\text{s/min}]} \cdot \frac{\text{Scaling Denominator}}{\text{Scaling Numerator}}$$

$$\text{Velocity [rpm]} = \text{Step Input Frequency [Hz]} \cdot \frac{60 [\text{s/min}]}{4 \cdot \text{Encoder Resolution [pulse/turn]}} \cdot \text{Polarity}[1,-1] \cdot \frac{\text{Scaling Numerator}}{\text{Scaling Denominator}}$$

Figure 6: Input Frequency / Velocity Calculation

Limiting Factors

The primary limiting factor is the input frequency of the step signal. The table below shows the maximum velocity of the slave axis assuming a scaling factor of 1. To command higher velocities the scaling factor can be used to reduce the input frequency of the step input.

Max. Step Input Frequency	Max. Velocity (Scaling Factor 1)	Encoder
EPOS 24/1 500 kHz	15'000 rpm	500 pulse/turn
EPOS 24/5 100 kHz	3'000 rpm	
EPOS 70/10 1 MHz	> 25'000 rpm	
MCD EPOS 60 W 500 kHz	15'000 rpm	
EPOS 24/1 500 kHz	7'500 rpm	1000 pulse/turn
EPOS 24/5 100 kHz	1'500 rpm	
EPOS 70/10 1 MHz	15'000 rpm	
MCD EPOS 60 W 500 kHz	7'500 rpm	
EPOS 24/1 500 kHz	1'500 rpm	5000 pulse/turn
EPOS 24/5 100 kHz	300 rpm	
EPOS 70/10 1 MHz	3000 rpm	
MCD EPOS 60 W 500 kHz	1'500 rpm	

Figure 7: Limiting Factors / Step Direction Mode

Note: Higher velocities can be reached by increasing the scaling factor > 1 (consider restriction [notes](#) on page 3)