# 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

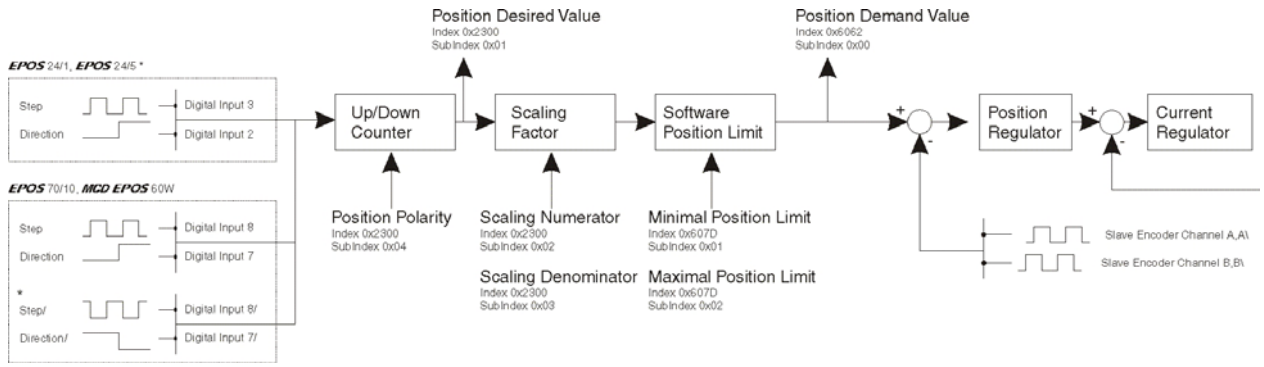



*Figure 1: System Structure*

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

## Up-/Down Counter

**EPOS 24/1, EPOS 24/5**

| | |
|---|---|
| Step | Digital Input 3 |
| Direction | Digital Input 2 |
| Digital Position Desired Value (Polarity = 0) | |

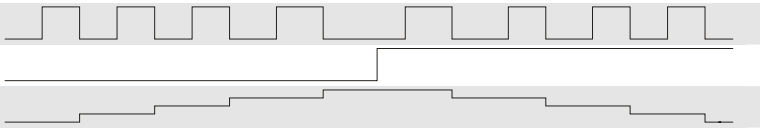


*Figure 2: Up/Down Counter*

| | 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**

| | | |
|---|---|---|
| Step | | Digital Input 8 |
| Direction | | Digital Input 7 |
| Step/ | (optional) | Digital Input 8/ |
| Direction/ | (optional) | Digital Input 7/ |
| Digital Position Desired Value (Polarity = 0) | | |

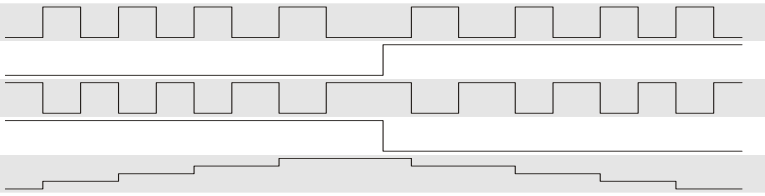


*Figure 3: Up-/Down Counter*

| | 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)

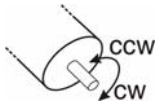



*Figure 4: Motor direction definitions*

## 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.<br>(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. |

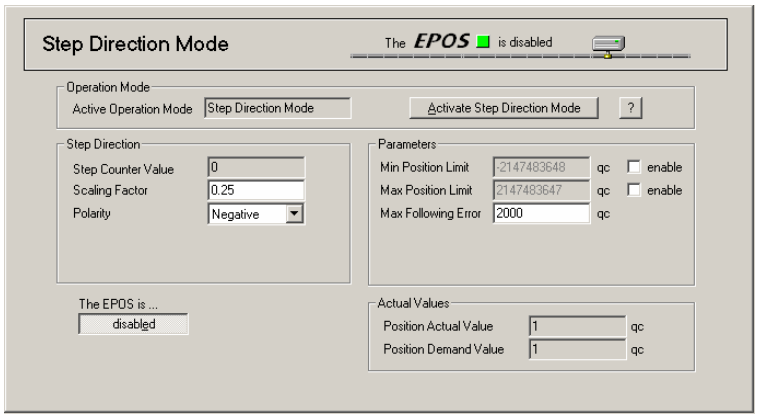
**Notes:**

- For a better behaviour use a scaling factor ≤ 1. In fact that no interpolation is implemented, movements with factors >> 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:**<br>System Configuration | Do the standard system configuration using the EPOS Studio and the Startup Wizard. (Document 'Getting Started')<br>  <br>Startup Wizard<br>Topics:<br>- Minimum External Wiring<br>- Communication Setting<br>- Motor Type<br>- Motor Pole Pair<br>- Motor Data<br>- Position Sensor Type<br>- Position Resolution |
| **Step 2:**<br>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').<br>**Notes:** For testing the behaviour of the regulators use the Profile Position Mode! Only for small steps use the Position Mode!<br>  <br>Regulation Tuning<br>Current Regulator (Current Step)<br>Position Regulator (Profile Position Step) |
| **Step 3:**<br>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 | Step<br>Direction | -> Digital Input 3<br>-> Digital Input 2 |
| EPOS 70/10,<br>MCD EPOS 60W | Step<br>Direction | -> Digital Input 8, 8/<br>-> Digital Input 7, 7/ |
|  <br>I/O Configuration Wizard | Digital Input 2 or 7<br>Digital Input 3 or 8<br>Any free digital input<br>Any free digital output | -> General Purpose A<br>-> General Purpose B<br>-> Enable (optional) *<br>-> Ready (optional) ** |

| | |
|---|---|
| **Step 4:**<br>Step Direction Mode | Activate and configure the step direction mode. Use the tool EPOS Studio.<br>  <br><br>  <br> |
| **Step 5:**<br>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'.

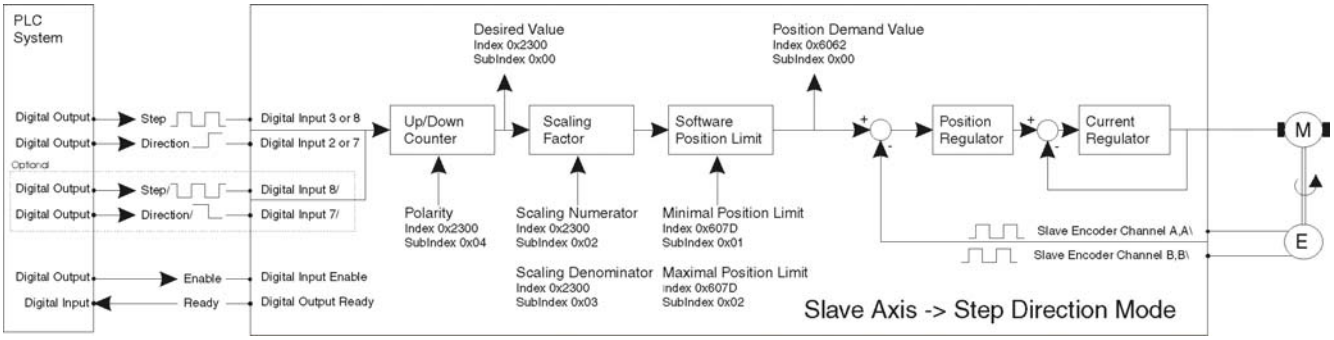



*Figure 5: Application Example 'I/O Commanding'*

### Input Frequency / Velocity Calculation

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

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

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

*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)