

## 5 Step/Direction Mode

### 5.1 In Brief

A wide variety of operating modes permit flexible configuration of drive and automation systems by using positioning, speed and current regulation. The built-in CANopen interface allows networking to multiple axes drives as well as online commanding by CAN bus master units.

Alternatively, EPOS2 can also be commanded by digital position values. Used are either an incremental encoder (Master Encoder Mode) for setting the values of the device, or PLC-generating step pulses (Step/Direction Mode) can be used to command the device. Inputs and outputs can easily be configured using the «Configuration Wizard» and may be changed online via CANopen or serial bus.

#### 5.1.1 Objective

In «Step/Direction Mode», the motor axis follows a digital signal step-by-step. This mode can replace stepper motors. It can also be used to control the EPOS2 by a PLC without CAN interface.

The present Application Note explains structure, functionality and use of the operation mode «Step/Direction Mode» and features “in practice examples” suitable for daily use.

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#### 5.1.2 Scope

Hardware	Order #	Firmware Version	Reference
EPOS2		2110h	Firmware Specification
EPOS2 70/10	375711	2120h or higher	
EPOS2 50/5	347717	2110h or higher	
EPOS2 Module 36/2	360665	2110h or higher	
EPOS2 24/5	367676	2110h or higher	
EPOS2 24/2	380264 390003 390438 530239	2121h or higher	

Table 5-58 Step/Direction Mode – covered Hardware and required Documents

#### 5.1.3 Tools

Tools	Description
Software	«EPOS Studio» Version 2.00 or higher

Table 5-59 Step/Direction Mode – recommended Tools

## 5.2 System Structure

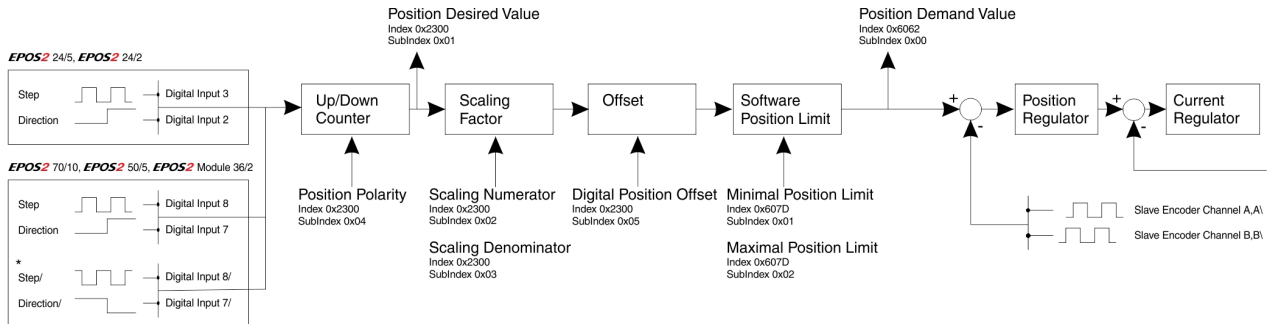


Figure 5-49 Step/Direction Mode – System Structure

### Up/Down Counter

#### EPOS2 70/10, EPOS2 50/5 & EPOS2 Module 36/2

Step	Digital Input 8	
Step\	Digital Input 8\	
Direction	Digital Input 7	
Direction\	Digital Input 7\	
Digital Position Desired Value (Polarity = 0)		

Table 5-60 Up/Down Counter – EPOS2 70/10, EPOS2 50/5 & EPOS2 Module 36/2

#### EPOS2 24/5 & EPOS2 24/2

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

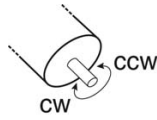
Table 5-61 Up/Down Counter – EPOS2 24/5 & EPOS2 24/2

Value	EPOS2 70/10 EPOS2 50/5	EPOS2 Module 36/2	EPOS2 24/5	EPOS2 24/2
Input Voltage	0...5 VDC	0...5 VDC	0...24 VDC	0...24 VDC
Max. Input Voltage	-12...+12 VDC	-24...+24 VDC	-30...+30 VDC	-30...+30 VDC
Logic 0	typically <1.0 V	typically <0.8 V	typically <1.5 V	typical <0.7 V
Logic 1	typically >2.4 V	typically >2.0 V	typically >3.0 V	typical >2.4 V
Max. Input Frequency	5 MHz (differential) 2.5 MHz (single-ended)	5 MHz (differential) 2.5 MHz (single-ended)	100 kHz (3.3...5.0 V)	300 kHz (3.3...5.0 V)

Table 5-62 Step/Direction Mode – Hardware Description (Digital Inputs)



### Definition of Direction of Rotation



As seen towards motor output flange, definition is as follows:  
 Direction Input Low: CCW  
 Direction Input High: CW

### Input Parameter

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 to input frequency.
Digital Position Polarity	0x2300	0x04	Polarity of the direction input. The direction can be changed (0 = positive, 1 = negative).
Digital Position Offset	0x2300	0x05	Gives a dynamic displacement in reference to the encoder's desired position.
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.
Maximum ProfileVelocity	0x607F	0x00	This value is used as velocity limit in a position (or velocity) profile mode.
Maximum Acceleration	0x60C5	0x00	Allows to limit the acceleration to prevent mechanical damages. Represents the limit of the other acceleration/deceleration objects.

Table 5-63 Step/Direction Mode – Input Parameter

### Output Parameter

Name	Index	Sub-index	Description
Digital Position Desired Value	0x2300	0x01	Counter value of the up/down counter. Serves as base for the scaling and limiting functions.
Position Demand Value	0x6062	0x00	The Step/Direction Mode's output after scaling and limiting. It is the setting value for the position regulator.

Table 5-64 Step/Direction Mode – Output Parameter



### Best Practice

- Use a scaling factor  $\leq 1$  for better behavior. Due to the fact that no interpolation is implemented, movements with factors  $> 1$  will result in bigger position jumps, thus producing current peaks.
- Switch off software position limitation and set maximum /minimum position limits to INT32\_MAX, respectively to INT32\_MIN!

## 5.3 Configuration

### 5.3.1 Step 1: System Configuration

Complete standard system configuration (Startup Wizard) in «EPOS Studio» (→separate document «Getting Started» of respective hardware). Thereby observe following topics:

- Minimum External Wiring
- Communication Setting
- Motor Type
- Motor Pole Pair
- Motor Data
- Position Sensor Type
- Position Regulation



Figure 5-50 Startup Wizard

### 5.3.2 Step 2: Regulation Tuning

In Master Encoder Mode, current regulator and position regulator must be tuned. Speed regulator will not be used (→separate document «Getting Started» of respective hardware).



#### **Best Practice**

- *Use Profile Position Mode to test regulator behavior!*
- *Use Position Mode for small steps, only!*

- Current Regulator (Current Step)
- Position Regulator (Profile Position Step)



Figure 5-51 Regulation Tuning

5.3.3 Step 3: I/O Configuration and Wiring

1) Perform wiring:

Hardware	From	To
EPOS2 70/10 EPOS2 50/5 EPOS2 Module 36/2	Step	Digital Input 8, 8\
	Direction	Digital Input 7, 7\
EPOS2 24/5 EPOS2 24/2	Step	Digital Input 3
	Direction	Digital Input 2

Table 5-65 Step/Direction Mode – Wiring

2) Start I/O Configuration Wizard to configure I/Os.

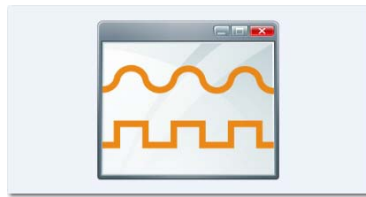


Figure 5-52 Configuration Wizard

3) Configure inputs:

Hardware	Configure...	...as...
EPOS2 70/10 EPOS2 50/5 EPOS2 Module 36/2	Digital Input 7	General Purpose A
	Digital Input 8	General Purpose B
	any available Digital Input	Enable *1)
	any available Digital Output	Ready *2)
EPOS2 24/5 EPOS2 24/2	Digital Input 2	General Purpose A
	Digital Input 3	General Purpose B
	any available Digital Input	Enable *1)
	any available Digital Output	Ready *2)
<b>Remarks:</b>		
*1) In order to clear a fault condition, the device must be reset. Set input "Enable" to active.		
*2) Output "Ready" can be used to report a fault condition.		

Table 5-66 Configuration of Inputs

### 5.3.4 Step 4: Step/Direction Mode

Activate and configure Step/Direction Mode using «EPOS Studio».

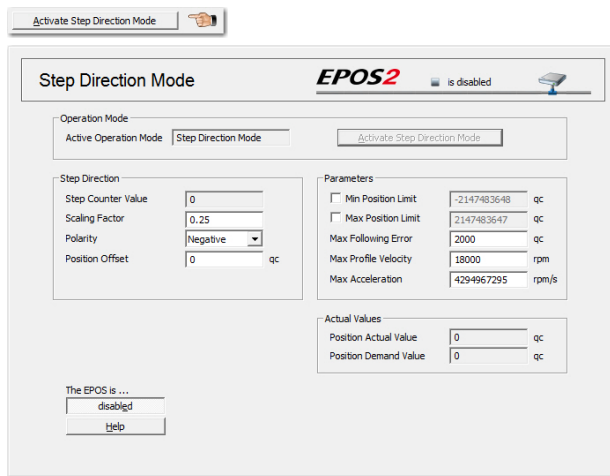


Figure 5-53 Step/Direction Mode – Configuration

### 5.3.5 Step 5: Save all Parameters

- 1) Click right on used node (Navigation Window -> Workspace or Communication).
- 2) Click menu item «Save All Parameters».

## 5.4 Application Examples

Typical applications for the Step/Direction Mode are single or multiple axes systems commanded and controlled by digital I/Os, such as stepper motors.

- During the process, no serial interface will be necessary. The device can entirely be controlled by digital inputs and outputs.
- An interface (RS232, USB or CAN bus) is only necessary for configuration.
- The device is enabled by a digital input, a digital output indicates whether the device is ready (no error) or not.
- Velocity or position are commanded by the digital inputs “Step” and “Direction”.

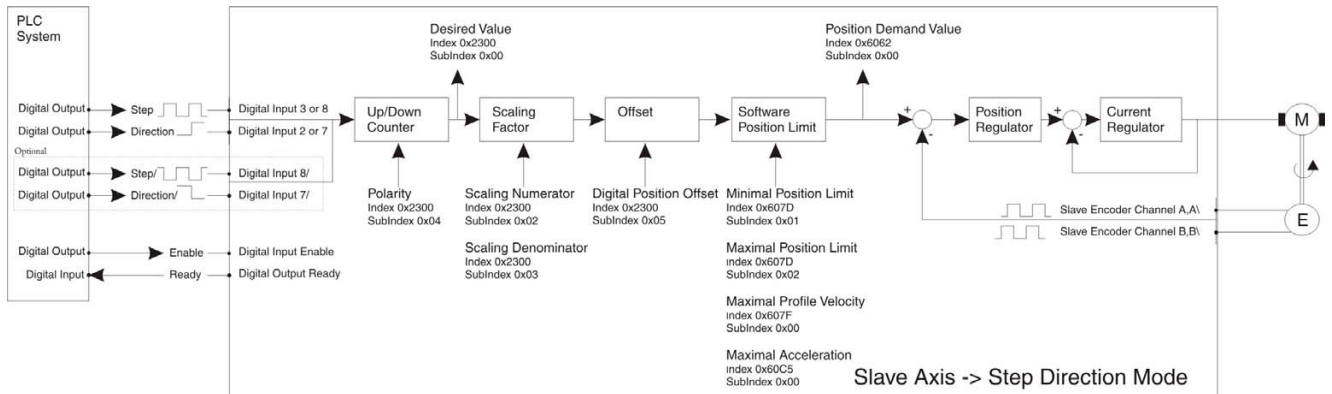


Figure 5-54 Step/Direction Mode – Application Example: Slave Axis System

### Calculation of Input Frequency / Velocity of Slave Axis

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

$$StepInputFrequency = Velocity \cdot \frac{4 \cdot EncRes}{60} \cdot \frac{ScalingDenominator}{ScalingNumerator}$$

$$Velocity = StepInputFrequency \cdot \frac{60}{4 \cdot EncRes} \cdot Polarity[1, -1] \cdot \frac{ScalingNumerator}{ScalingDenominator}$$

*EncRes* [pulses per turn]

*StepInputFrequency* [Hz]

*Velocity* [rpm]

## Limiting Factors



### Maximal permitted Motor Speed

Below figures represent theoretical achievable speeds. For applicable maximum permissible speed of the employed motor → catalog motor data!

The primary limiting factor is the step signal's input frequency. Below table 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 step input's input frequency.

Encoder [pulse/turn]	Max. Step Input Frequency		Max. Velocity [rpm] (Scaling Factor 1)	
500	EPOS2 70/10	differential	5 MHz	150 000
		single-ended	2.5 MHz	75 000
	EPOS2 50/5	differential	5 MHz	150 000
		single-ended	2.5 MHz	75 000
	EPOS2 Module 36/2	differential	5 MHz	150 000
		single-ended	2.5 MHz	75 000
	EPOS2 24/5		100 kHz	3 000
	EPOS2 24/2		500 kHz	15 000
1000	EPOS2 70/10	differential	5 MHz	75 000
		single-ended	2.5 MHz	37 500
	EPOS2 50/5	differential	5 MHz	75 000
		single-ended	2.5 MHz	37 500
	EPOS2 Module 36/2	differential	5 MHz	75 000
		single-ended	2.5 MHz	37 500
	EPOS2 24/5	differential	100 kHz	1 500
	EPOS2 24/2	differential	500 kHz	7 500
5000	EPOS2 70/10	differential	5 MHz	15 000
		single-ended	2.5 MHz	7 500
	EPOS2 50/5	differential	5 MHz	15 000
		single-ended	2.5 MHz	7 500
	EPOS2 Module 36/2	differential	5 MHz	15 000
		single-ended	2.5 MHz	7 500
	EPOS2 24/5		100 kHz	300
	EPOS2 24/2		500 kHz	1 500
<b>Limitations:</b>				
– EC motor, sinusoidal commutation: max. 25 000 rpm				
– EC motor, block commutation: max. 100 000 rpm				

Table 5-67 Step/Direction Mode – Limiting Factors



### Note

Higher velocities can be reached by increasing the scaling factor >1. Thereby consider applicable restrictions (→ “Best Practice” on page 5-69).