

BECKHOFF

AX5000 Servo drive

Information Field Weakening | EN



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**Available from firmware v2.12**

The Field Weakening function is available with firmware v2.12 and higher.

This documentation applies to the AX5000 servo drive. The chapters contain information on how to parameterize Field Weakening via the corresponding IDNs.

You then have the option of interpreting answers and reading out errors. Finally, information is provided about different IDNs that are important for the function.

Function

**Check the settings and ensure they are correct**

When activating field weakening, check that the correct commutation angle is set.

Incorrect settings in the function have a negative influence on the performance characteristics of the servomotor and can shorten the service life.

Servomotors can be operated above the nominal speeds by selectively manipulating the magnetic field. The maximum adjustable torque decreases with increasing speed.

When field weakening is used, a functional distinction is made between synchronous motors and asynchronous motors. The aim of the function is to combine low torque with high speed.

Please read up on the function and its effects before parameterizing it.

Synchronous motors

In synchronous motors, a magnetic field is established against the permanent magnets in the rotor so that the servomotor induces lower voltage at the same speed. This enables the servomotor to accelerate to higher speeds.

Asynchronous motors

Asynchronous motors require a reduction of the existing positive [d] current to induce lower voltage. The use of field weakening is common with asynchronous motors.

Requirement

All Beckhoff servomotors are suitable for this function. For advice on third-party motors please contact Beckhoff customer service. Observe the maximum permissible mechanical speeds.

Parameter description

The following information explains which S parameters and P parameters are involved in the function. The commissioning scenarios serve as examples. The configuration is always dependent on the application and various environmental and operational conditions.

Parameter	Name	Description
S-0-0196	Motor rated current	Determination of the rated motor current
P-0-0093	Configured channel current	Determination of the continuous current from the servo drive
P-0-0445	Basic field weakening parameter	Configuration of the "Basic Mode" of field weakening
P-0-0446 available from FW v2.13	Basic field weakening limits	Current valid actual value of the field-weakening current and the maximum permissible speed
P-0-0459	Actual torque / force generating current	Determination of the actual value of the torque-forming current component
P-0-0460	Actual flux generating current	Determination of the actual value of the current forming the field
P-0-0465	Effective q current command value	Determination of the setpoint of the torque-forming current component
P-0-0469	Actual absolute voltage	Determination of the total voltage provided by the current controller
P-0-0470	Voltage controller command value	Setpoint of the total voltage for field weakening
P-0-0471	Effective d current command value	Determination of the setpoint of the current forming the field

P-0-0445



Functional description from firmware v2.12:

The description of the current ratio applies to newly configured machines and systems with firmware version v2.12 or higher and the Basic Field Weakening setting.

When updating from older firmware versions to newer firmware versions, the original field weakening configuration is retained.

The original configuration of the field attenuation can be changed using the Compatibility mode in parameter P-0-0455.

P-0-0445	Basic field weakening parameter			
	Field weakening current ratio	60.00	60.00	%
	Field weakening voltage utilization	80.00	80.00	%
	rsvd	0	0	
	Voltage controller integral action time	5.00	5.00	ms

Current ratio

Synchronous motors

This parameter setting provides information on which current can be impressed for the reduction of the induced voltage.

The total current is limited according to the formula

$$I_{max} \leq \sqrt{I_d^2 + I_q^2}$$

The field weakening current [I_d] is subtracted from the torque-forming current [I_q] based on the equation.



Example

If the default value is 60%, 80% of the torque is available for the speed controller.

$$\text{Usable current flow [q]} \leq \sqrt{100\%^2 - 60\%^2} = 80\%$$

For the percentage indication of the "Current ratio" the smaller Value from the rated motor current S-0-0196 or the rated channel current P-0-0093 is selected as the reference variable.

The resulting maximum field-weakening current is stored in the Parameter P-0-0446 is displayed. This value refers to the maximum channel current in P-0-0092.

Asynchronous motors

A flux-forming current [d] is defined for operation. The current ratio indicates to what extent this current may be reduced in order to maintain the voltage limit.

The value in % by which the flux-forming current [d] may be reduced is now entered in the input mask of the current ratio.

Voltage utilization



Scope:

These settings apply to synchronous motors and asynchronous motors.

Voltage utilization indicates the maximum available voltage in relation to the current DC link voltage. In the input mask you can determine the percentage of this voltage that may be used when the field weakening function is active.

The higher the voltage utilization percentage, the higher the torque that can be set at a given speed. The difference to 100% is the control value reserve for the current control loop.

Reserved input window. No purpose here.

rsvd

Integral Action time

The integral action time is the integral action time of the AX5000 servo drive. The field weakening voltage regulator is superimposed on the current controller. A dynamic range should be maintained when setting the integral action time.

P-0-0455

Mode SM	2: Basic
Mode ASM	0: Disabled
Min mains voltage for field weakening	1: Compatibility
Max mains voltage for field weakening	2: Basic
Max field weakening current	0.000

Mode SM

Selection for synchronous servomotors

Value	Selection	Information
0	Disabled	Field weakening disabled Alternative: No servomotor connected
1	Compatibility	Firmware version v2.10 or earlier: Field weakening enabled
2	Basic	From firmware version v2.12: Field weakening enabled Activation of an additional voltage regulator

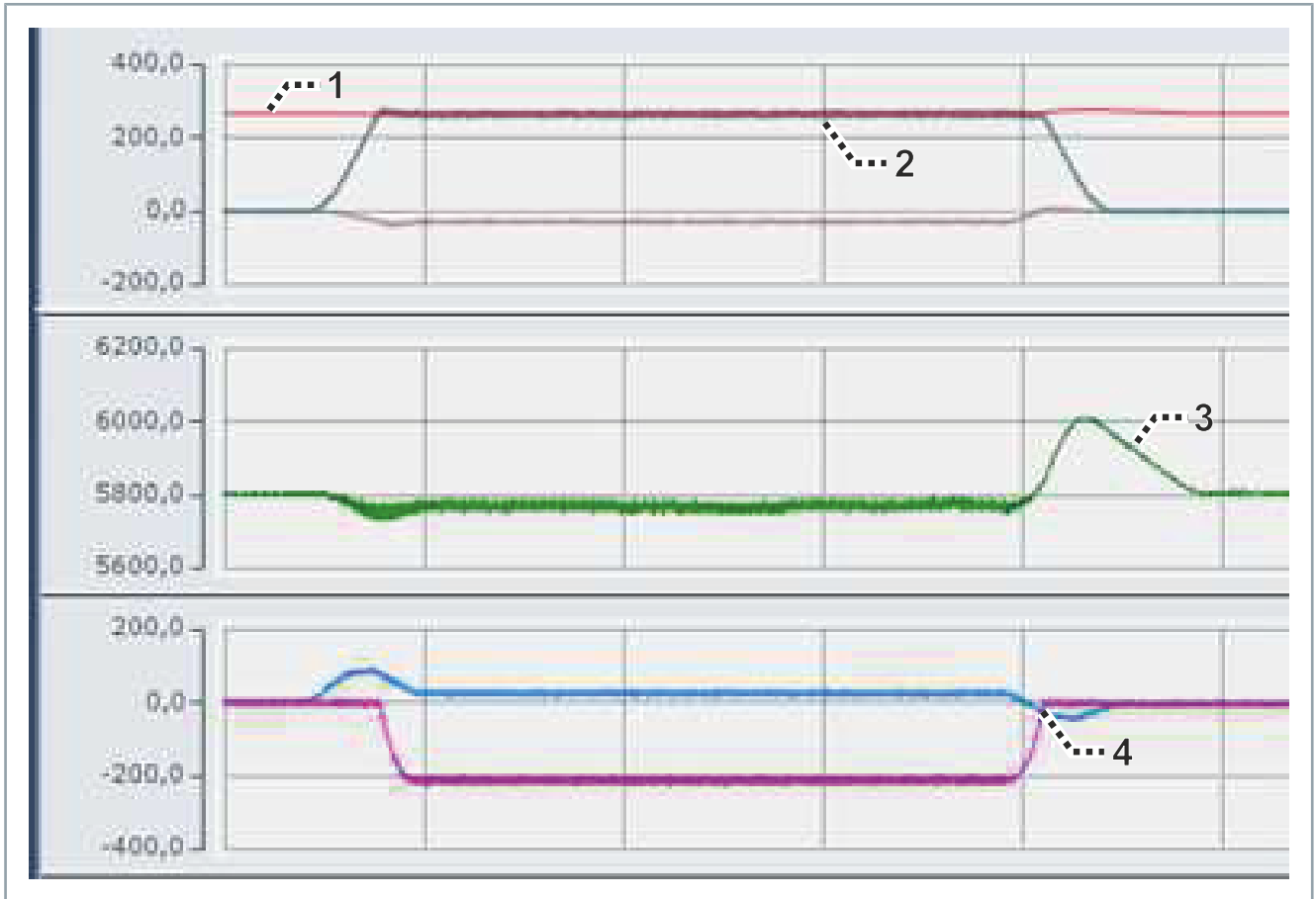
Mode ASM

Selection for asynchronous servomotors

Value	Selection	Information
1	Compatibility	Firmware version v2.10 or earlier: Field weakening enabled
2	Basic	From firmware version v2.12: Field weakening enabled Activation of an additional voltage regulator

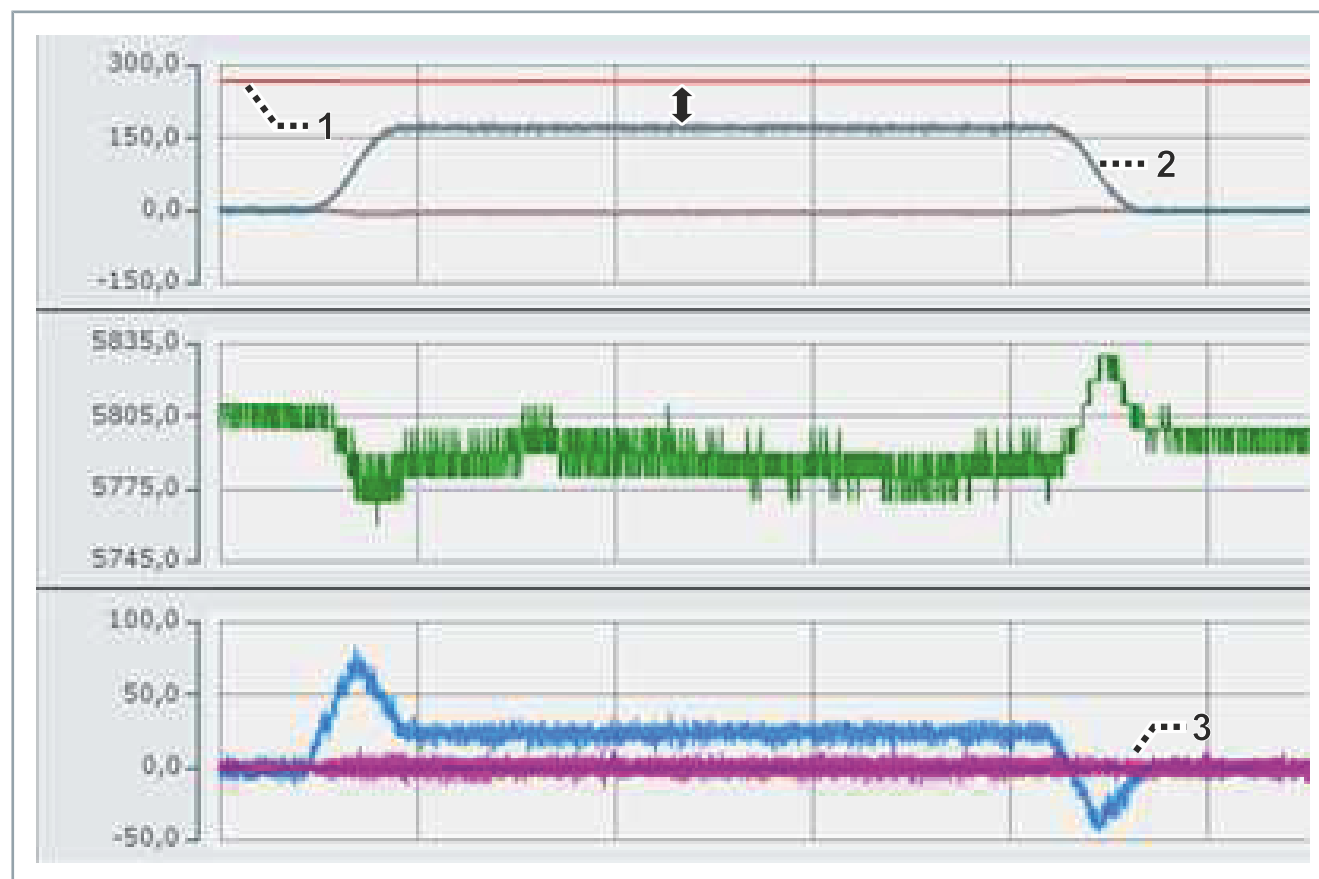
Scope view

All current curves and recordings shown are derived from parameter P-0-0092. This parameter can be used to obtain the configured peak current.

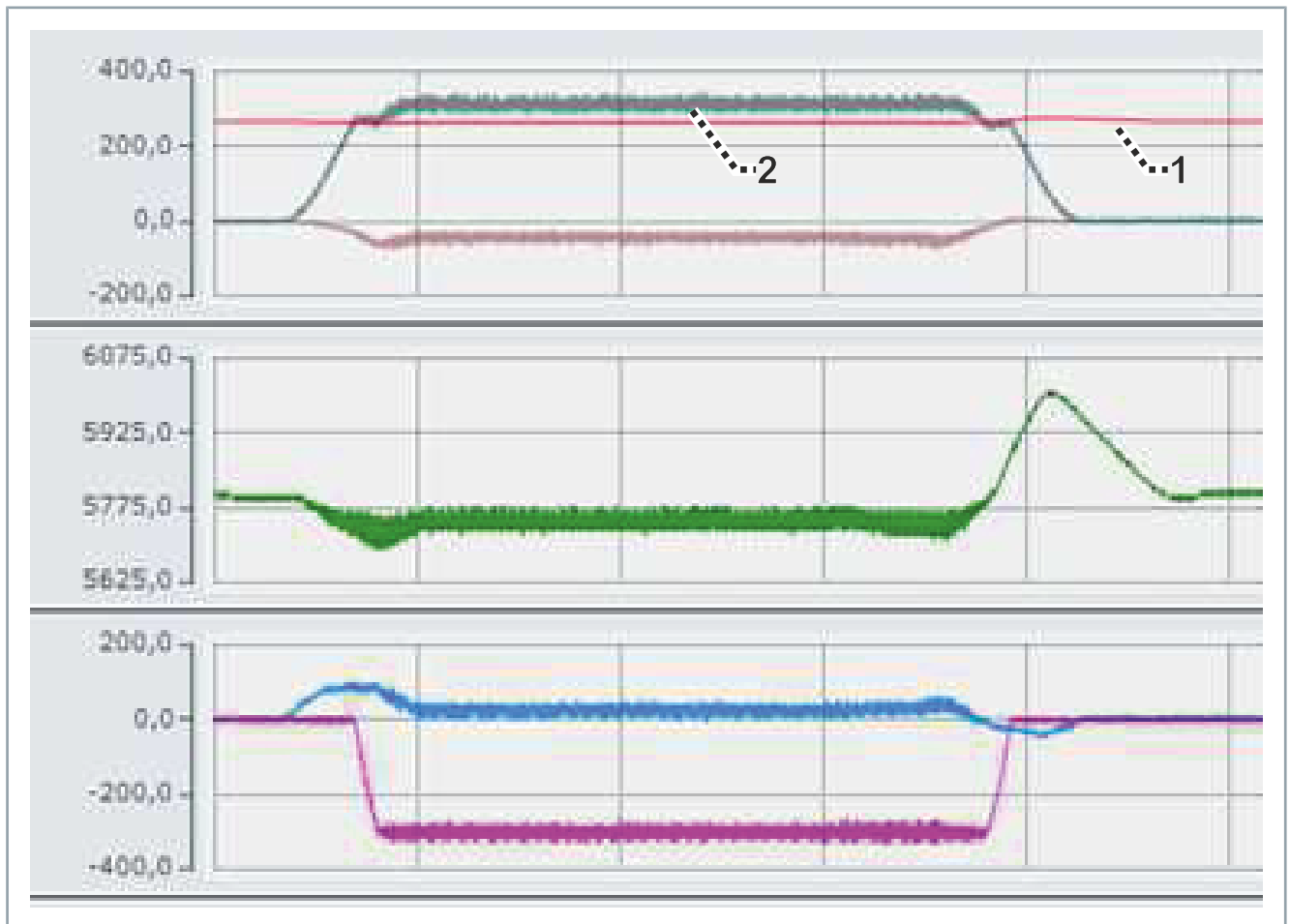


Position	Information
1	Setpoint for the voltage regulator $\text{DC [V]} \times \text{P-0-0445} / \sqrt{3}$ If the voltage requirement of the servomotor is lower than the setpoint, the voltage regulator is inactive. When the setpoint is reached, the field-weakening current is set via the voltage regulator.
2	Effective voltage
3	DC link voltage Increase during braking due to recuperation: Since the setpoint of the voltage regulator is calculated from the instantaneous value of the DC link voltage, the setpoint increases accordingly.
4	Torque-forming and flux-weakening current If the voltage requirement of the servo motor falls below the setpoint, the voltage regulator becomes inactive again.

Field Weakening



Position	Information
1	Setpoint for the voltage regulator
2	The voltage requirement of the servomotor is lower than the setpoint of the voltage regulator. The voltage regulator remains inactive.
3	Current flow for field weakening is not required



Position	Information
1	Setpoint for the voltage regulator
2	<p>The voltage requirement of the motor exceeds the setpoint. The voltage regulator intervenes and impresses a flux-weakening current.</p> <p>When the maximum flux-weakening current value that was entered is reached, the voltage requirement of the motor rises above this value.</p> <p>The voltage regulator is in control value limit mode and cannot prevent the increase</p> <p>A higher field-weakening current is required, which can be configured via the current ratio parameter.</p>

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