AX5000 Brake module AX5021

Documentation

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BECKHOFF

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1 Foreword

Appropriate use

The brake module may only be used together with servo drives of the AX51xx-xxxx-02xx or AX52xx-xxxx-02xx series. These devices have serial numbers above 100.000. In addition to the AX5021, the drive system must include at least two further servo drives from the AX5000 range.

Safety

Safety regulations

Please note the following safety instructions and explanations!
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

 DANGER	**Caution – Danger of death!** Even when the AX5000 is disconnected from the mains voltage, dangerous voltage continues to be present at the “X02” terminals of the DC link for 15 minutes. Never touch the terminals within this period.
 WARNING	**Caution – Risk of injury!** Electronic equipment is not fail-safe. The machine manufacturer is responsible for ensuring that the connected motors and the machine are brought into a safe state in the event of a fault in the servo drive.

Personnel qualification

This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.

Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning the components.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.
We reserve the right to revise and change the documentation at any time and without prior announcement.
No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

Copyright

2 Product overview

2.1 AX5021 brake module

Using a brake module it is possible to take up additional braking power in a drive system, because the connection of an external brake resistor without a brake module in a drive system with devices up to max. 25 A rated current is not permissible. A further advantage is the simple installation and the small space requirement of the brake module. The brake module is equipped with a complete DC link and an internal brake resistor and enables the connection of an external brake resistor with the integrated brake chopper. Several brake modules can be integrated into a drive system.

2.2 Electrical data

Electrcal data	AX5021
int. Resistance[1] [W]	150
int. Resistance[2] [W]	14.000
ext. Resistance min. [Ω]	22
ext. Resistance[3] [W]	6.000
ext. Resistance[4] [W]	max. 32.000
Power loss P [W]	max. 250
Charging rate 24 V_{DC} [A]	0.3 – 0.4
DC link capacity [µF]	705

[1] Durability break power P_{rms}

[2] Peak break power P_{peak}

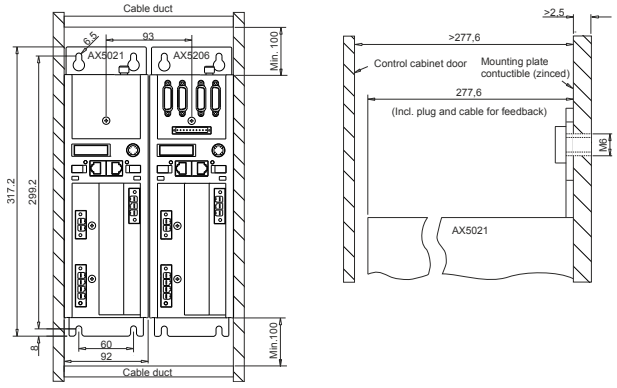
[3] Durability brake power P_{rms}

[4] Peak brake power P_{peak}

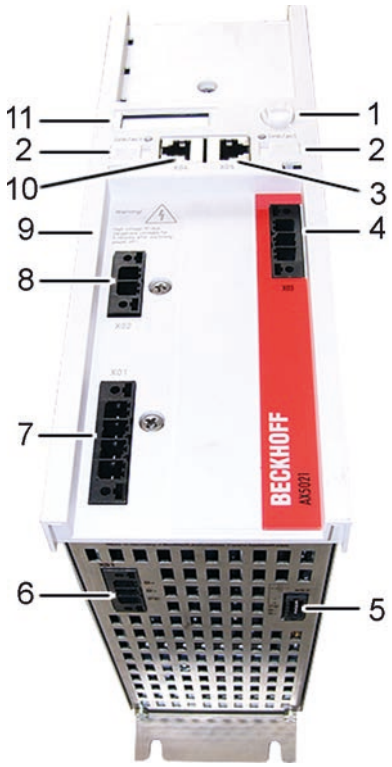
2.3 Mechanical data

The external dimensions of the brake module are identical to the dimensions of the servo drives from the AX5000 series up to 12 A.

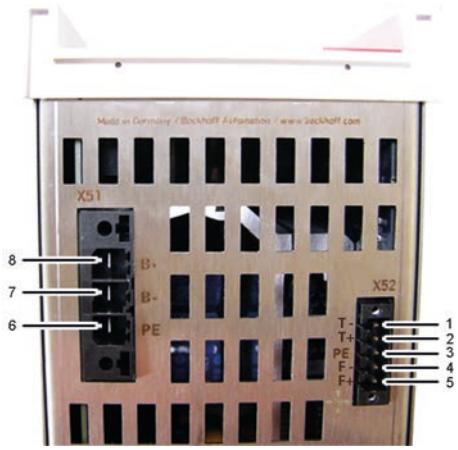
Mechanical data	AX5021
Weight	ca. 4 kg
Width	92 mm
Height without connector	274 mm
Depth without connector / accessories	232 mm



2.4 General overview

No.	Name	
1	Navigation rocker	
2	Labelling field	
3	X05 - socket for EtherCAT output	
4	X03 – power supply 24 V DC Input	
5	X52 - connection of the temperature monitor and the fan of the external brake resistor	
6	X51 - connection of the external brake resistor	
7	X01 – mains supply 100 – 480 V	
8	X02 – DC link output (890 V DC voltage).	
9	**DANGER**	Max. voltage 890 V DC at the DC link terminals (X02). Once the device has been switched off dangerous voltage will still be present for a further 15 minutes. The device is safe once the voltage has fallen below 50 V.
10	X04 - socket for EtherCAT input	
11	Display	

2.5 Pin strip assignment of X51 and X52

No.	Name	
1	**T-** = input of the temperature measurement sensor of the external brake resistor	
2	**T+** = input of the temperature measurement sensor of the external brake resistor	
3	**PE** = protective conductor	
4	**F-** = output to the fan controller of the external brake resistor	
5	**F+** = output to the fan controller of the external brake resistor	
6	**PE** = protective conductor	
7	**B-** = output to the controller of the external brake resistor	
8	**B+** = output to the controller of the external brake resistor	

Please refer to the servo drive ‘Startup’ manual for the pin assignments of the remaining inputs and outputs.

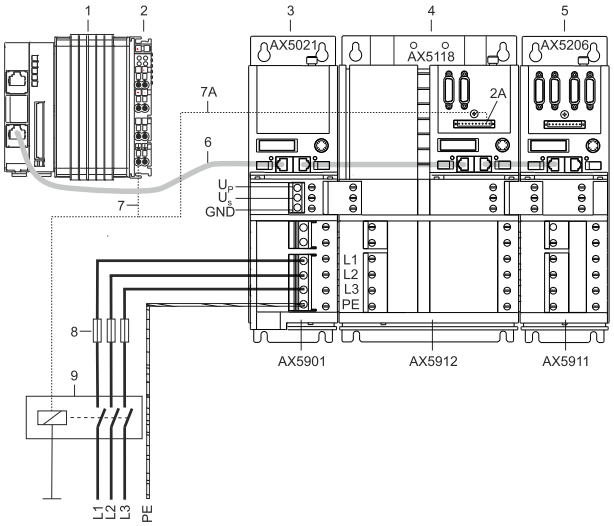
Note	**Temperature rise in the external brake resistor** The temperature rise of the external brake resistor should be monitored continuously via temperature contacts (1) and (2).

2.6 Electrical connection (example)

DANGER	**Serious risk of injury through high electrical voltage!** Due to the DC link capacitors dangerous voltage may persist at the DC link contacts "X02" after the servo drive has been disconnected from the mains supply. Wait 5 minutes after disconnection and measure the voltage on the DC link contacts DC+ and DC-. The device is safe once the voltage has fallen below 50 V.

The example below describes the brake module and several servo drives, which are linked via AX-Bridge modules to make up a drive system. We recommend that the brake module be placed in the first position with the AX-Bridge power supply module (AX5901) and after that the servo drives with decreasing rated current; we assume here that the most powerful servo drive also releases the greatest brake energy.

Attention	**Damage to devices** Please analyze your application. The brake module should always be placed directly beside the servo drive that releases the greatest brake energy. This rule should also be applied if several brake modules are used in a drive system.



Pos.	Name		Pos.	Name
1	PC with TwinCAT and PLC		6	Patch cable
2	Output terminal		7	Control cable from the output terminal
2A	Output "8" of the servo drive digital I/Os		7A	Control cable from output ‘8’ of the servo drive digital I/Os
3	Brake module		8	Mains fuses
4	Servo drive (with the greatest brake energy)		9	Mains contactor
5	Servo Drives			

CAUTION	**Uncontrolled movements!** If the drive system is disconnected from the mains due to a mains failure, all axes of the drive system make uncontrolled movements. Take suitable measures to ensure than no persons are endangered during this time. Vertical axes are particularly dangerous.

2.7 Integration into TwinCAT

The brake module can be integrated in the TwinCAT System Manager as a completely normal I/O device (1) and is parameterized (3) with the TCDrive Manager (2).

Power Management

Configuration in the TC Drive Manager

Pos.	Name		Pos.	Name
1	Power management		6	Activation / deactivation of the internal brake resistor
2	Mains voltage selection		7	External brake resistor parameter list
3	Phase monitoring (deactivate for single-phase mains)		8	0 = Deactivation of the external brake resistor (**not** recommended) 1 = Standard energy management with external brake resistor 2 = Energy management with external brake resistor (standalone)
4	Delay time until the phase monitoring responds (activate if mains is unclean)		9	Enabling / disabling the fan of the external brake resistor and setting the switching thresholds Switch on Level: Percentage specification of the rated capacity value of the external brake resistor.Switch on Temp.: Max. temperature value for the external brake resistor in "°C".
5	Internal brake resistor parameter list			

2.8 Energy management

Intelligent energy management ensures that energy is distributed evenly to the DC links and the internal brake resistors when devices are used commonly in the drive system. This reliably prevents the undesirable permanent load of only one device.

2.8.1 DC link

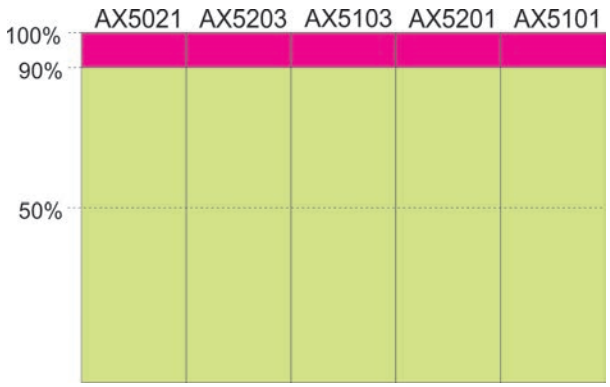
The connected servomotors are supplied with energy from the DC link. It serves as an energy storage and first needs to be charged up after switching the device on, before it can supply the servomotors. The DC link is designed such that it can take up and store a certain degree of surplus energy from the motor (brake energy) and subsequently supply the motor again with this stored energy. If the upper limit of the energy storage is reached, the brake chopper feeds any further brake energy into the internal or external brake resistor, where it is converted into heat; it is then no longer available for the further operation of the motor. The voltage is taken and evaluated as the indicator for the current energy level of the DC link. As soon as the brake resistors have also reached their energy limit, the error ‘FD4C, DC link – overvoltage’ appears and the energy flow to and from the motor is interrupted, i.e. the motor makes uncontrolled movements.

In a drive system, the DC links of the individual devices are connected so that the energy level of all devices is the same, regardless of which motor the brake energy is currently being fed back from. In many cases these feedbacks do not happen at the same time, and **without** a DC link system, for example, a device would be at the limit and would already have to "destroy" energy in a brake resistor, even though other devices could still store energy in the DC link. In a DC link connection the energy could be stored, since the DC link of all linked devices would be loaded first, before the energy in the brake resistors would be converted to heat.

2.8.2 Operation modes of the AX5021

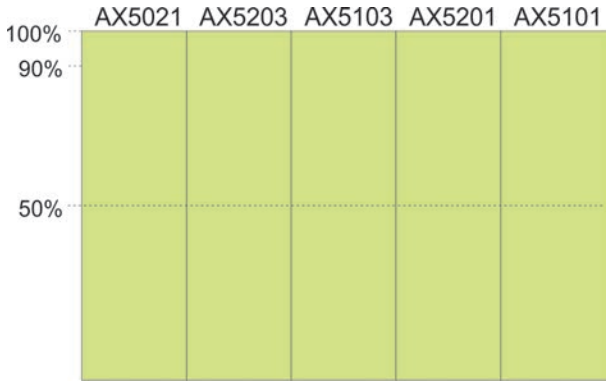
It can be assumed that a brake module is used only if the brake energy cannot be dissipated despite a DC link system and internal brake resistors. The brake module can be operated in two different operation modes, which have a direct influence on the energy management. The operation modes can be selected when using the external brake resistor. The following sketches show the storage capacity of the DC link of the individual devices in relation to the operation modes.

Default operation mode 1 - Ext. brake resistor enabled (system / standard)



In this operation mode the capacity of the DC link of the brake module is reduced by approx. 10%. At 90% DC link load the brake chopper then directs the generated braking energy to the external brake resistor and, when this has reached its capacity limit, into the internal brake resistor. In this case the brake energy is first fed into the brake module, since the brake choppers in the other servo drives are only activated at 100% utilization of the DC link. This operation mode is set as the default, because no further configuration of the devices in the DC link system is necessary apart from the basic configuration of the brake module. If the external brake resistor of the brake module is mounted outside the control cabinet, then the thermal load in the control cabinet is also lower.

Default operation mode 2 - Ext. brake resistor enabled (standalone brake chopper)



In this case the capacity of the DC links is fully utilized. This operation mode must be selected and, apart from the basic configuration of the brake module, the internal brake resistors of the devices in the DC link system should be deactivated, as otherwise the thermal load in the control cabinet will also increase. In order to reduce the thermal load further, it is a good idea to mount an external brake resistor on the brake module outside the control cabinet.

2.8.3 Braking power diagnosis

The current continuous output of the brake resistor can be read via the IDNs P-0-0209 (int. brake resistor) and P-0-0210 (ext. brake resistor). The unit is watts. Loads above 90% of the continuous output of the brake resistor should be avoided. The IDNs can be read cyclically as process data.

The current impulse energy load of the brake resistor can be read via the IDNs P-0-0218 (int. brake resistor) and P-0-0219 (ext. brake resistor). It is specified in % with one decimal place. Loads above 90% should be avoided. The IDNs can be read cyclically as process data.

The maximum energy values since the last reset are stored in IDNs P-0-0220 (int. brake resistor) and P-0-0221 (ext. brake resistor). The values can be reset by entering zero. Duty cycle corresponds to 100 seconds. The energy values are monitored at the specified intervals (100 ms, 1 s, 10 s, 20 s, 40 s and 100 s). The values for 100 s correspond to the continuous output. The maximum values should be approx. 10% below the resistor limits (P-0-0207 or P-0-0208). If a current energy value exceeds the limit value of a brake resistor, this brake resistor is not enabled. In a drive systems or in a configuration with active internal chopper the other brake resistors have to absorb the energy. If this is not possible the DC link voltage will continue to increase until an overvoltage error occurs, followed by disabling of the axes with "Torque off". It is therefore important to ensure that adequate braking power is available in the systems, in order to avoid uncontrolled movements of the axes. The diagnostics should cover the whole system. If not enough reserve capacity is available, an external brake resistor with a higher output should be selected. If the performance limit is still reached, several AX5021 may be used.

Note	**Energy balance** The energy balance is affected positively whenever an axis requires energy and another axis produces generative energy (braking energy). This rule should be observed in all applications.