Documentation

Brake module AX5021

Please read this document carefully before installing and commissioning the brake module!

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BECKHOFF

Notes on the documentation

Documentation issue status

Version	Comment
1.2	**New chapter** Braking power diagnosis **Chapter update** Safety regulations, Product description, Electrical data, General overview, Electrical connection, Configuration in the TCDriveManager, Operating modes of the AX5021
1.1	Not published
1.0	First edition

Foreword

Disclaimer

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

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH.

The documentation has been prepared with care. The products described are, however, constantly under development.
For that reason the documentation is not in every case checked for consistency with performance data, standards or other characteristics.
In the event that it contains technical or editorial errors, we retain the right to make alterations at any time and without warning.
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.

Appropriate use

The AX5021 brake module is intended exclusively for direct use in a drive system with servo drives from the AX5000 series. The brake modules are installed together with the servo drives as components in electrical systems and machinery and may only be used in this way.

Scope of supply

The scope of supply includes the following components:

brake module, technical documentation and packaging

If one of the components is damaged please notify the logistics company and Beckhoff Automation GmbH immediately.

Safety

Safety regulations

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 and guidelines.

 DANGER	**Caution – Danger of death!** 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. After disconnecting the servo drive wait 5 minutes and measure the voltage at the DC link contacts DC+ and DC-. The device is safe once the voltage has fallen below 50 V.

 WARNING	**Caution - Risk of injury through hot surfaces!** The surface of the brake module housing can become very hot. Please ensure that the housing has cooled down below 40 °C before touching it.

Personnel qualification

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

Product description

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.

 Note	**Operating conditions!** 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 2 further servo drives from the AX5000 range.

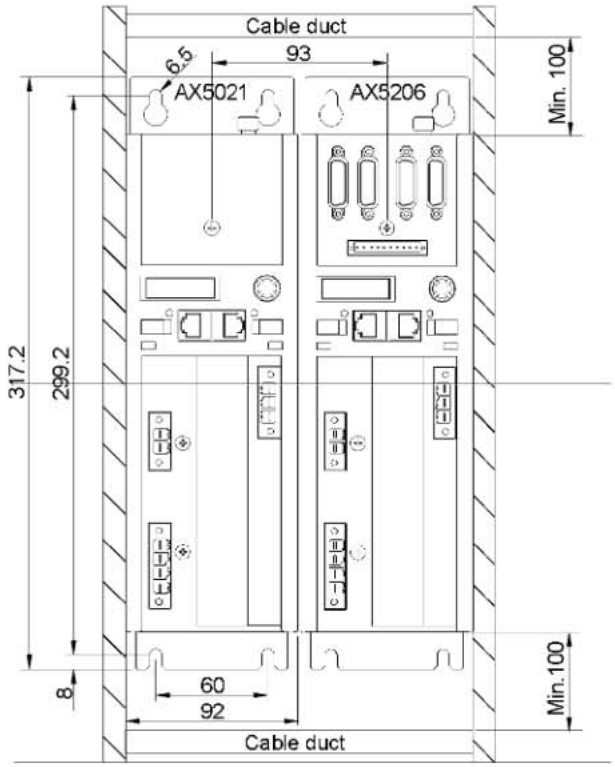
Electrical data

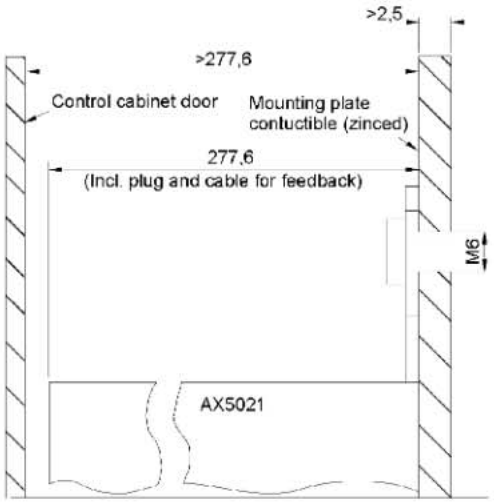
Internal resistance Continuous braking power P_{rms} [W]	Internal resistance Peak braking power P_{peak} [W]	External resistance min. [W]	External resistance Continuous braking power P_{rms} [W]	External resistance Peak braking power P_{peak} [W]
150	14.000	22	6.000	max. 32,000

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.

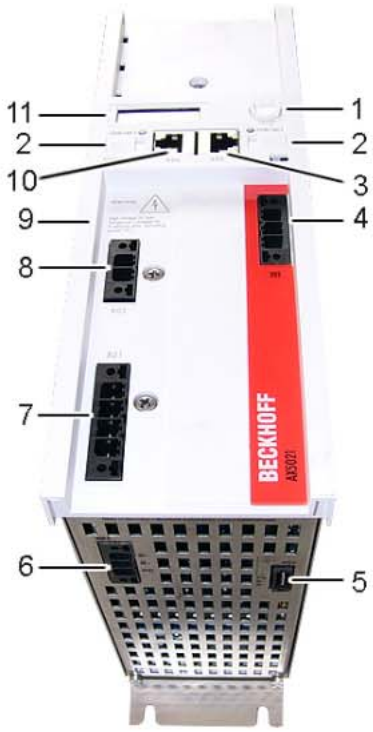
Mechanical data	AX5021
Weight	approx. 4 kg
Width	92 mm
Height without plugs	274 mm
Depth without connectors / accessories	232 mm





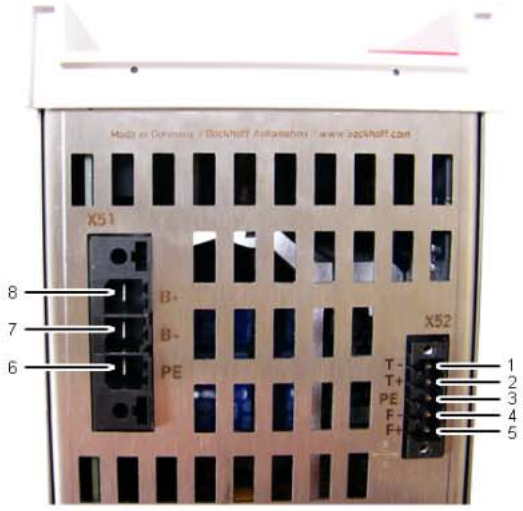
General overview

No	Designation	
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	890 V DC voltage at the DC link terminals. Dangerous voltage may be present for 5 minutes after the device is switched off. The device is safe once the voltage has fallen below 50 V.
10	X04 - socket for EtherCAT input	
11	Display	



Pin strip assignment of X51 and X52

No	Designation
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 an external brake resistor

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

Electrical connection (example)

DANGER

Caution – Danger of death!

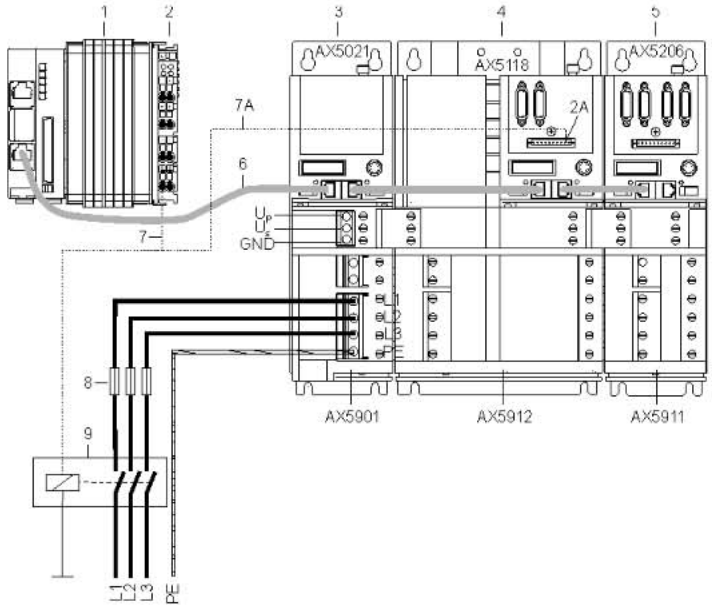
Even when the AX5021 is disconnected from the mains voltage, dangerous voltage continues to be present at the "X02" terminals of the DC link for 5 minutes. Never touch the terminals within this period.

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.

Caution

Hazard to devices

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

Due to the characteristic of the brake module, a mains failure is recognised immediately, hence, it is necessary that you monitor the ready status of the brake module and disconnect the entire drive system from the mains if necessary. Cyclically check bit 4 – 'ext. Umain relay' – in the 'power management status word' (IDN P-0-0205) in the controller. If its value is '0', you must ensure that the mains contactor (9) trips, thus disconnecting the complete drive system from the mains. For this, you can use a separate output terminal (2) or a free output '8' of the digital I/O s (2A) of a servo drive.

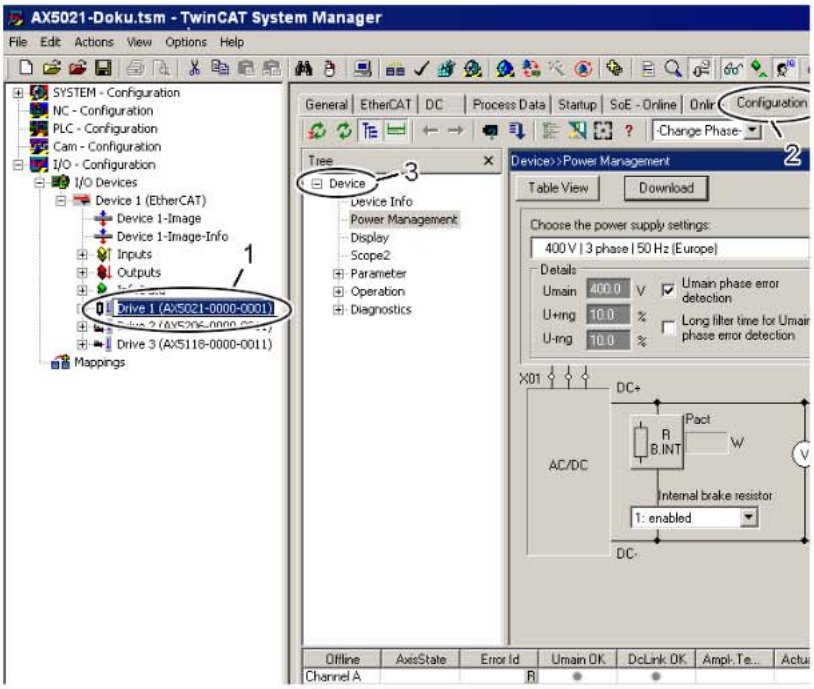
Caution

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.

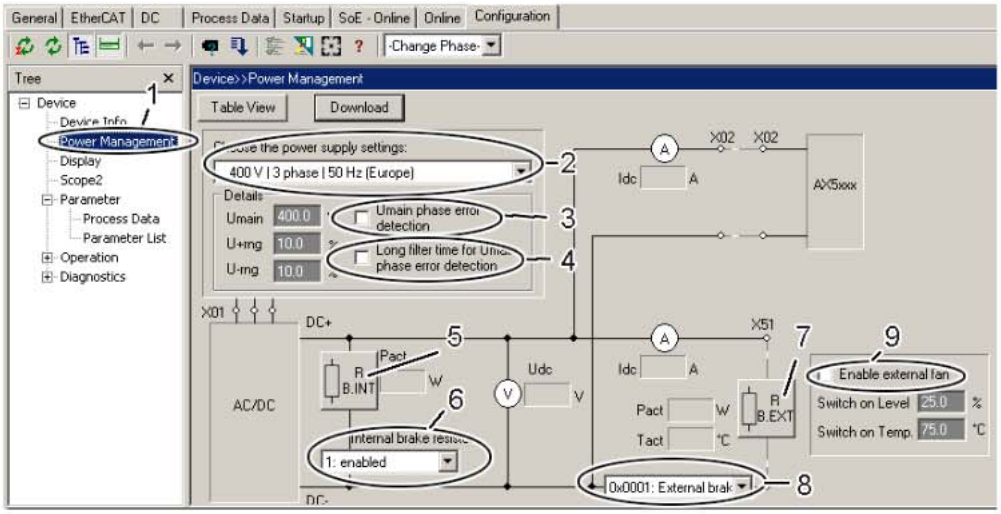
Integration into TwinCAT

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



Configuration in the TCDriveManager

Power Management



Pos.	Designation
1	Power management
2	Mains voltage selection
3	Phase monitoring (deactivate for single-phase mains)
4	Delay time until the phase monitoring responds (activate if mains is unclean)
5	Internal brake resistor parameter list

Pos.	Designation
6	Activation / deactivation of the internal brake resistor
7	External brake resistor parameter list
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)
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 of the external brake resistor in °C.

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.

DC link

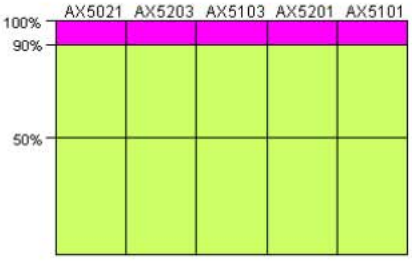
The connected servomotors are supplied with energy from the DC link. It serves as an energy storage and first needs to be charged up after switching the device on, before it can supply the servomotors. The DC link is designed such that it can take up and store a certain degree of surplus energy from 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. The energy could be saved in a DC link system, because the DC links of all connected devices are charged up first, before the energy is converted into heat in the brake resistors.

Operating 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 2 different operating modes, which have a direct influence on the energy management. The operating 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 operating modes.

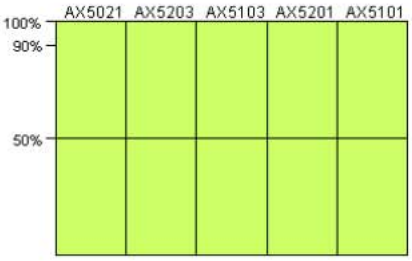
Standard operating mode 1 Ext. brake resistor enabled (system / standard)



In this operating 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.

This operating 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.

Operating mode 2 Ext. brake resistor enabled (standalone brake chopper)



In this case the capacity of the DC links is fully utilised, however, the internal brake resistors of the servo drives should be deactivated, so that the surplus energy is only taken up by the brake module.

This operating 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.

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.

Appendix

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