SEW EURODRIVE

Manual

Brake Diagnostics for Controllers (V170.100 or Later)

Edition 05/2016

22752250/EN

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1 General information

1.1 About this documentation

The documentation is part of the product and contains important information. The documentation is for everyone who works with this product.

The documentation must be accessible and legible. Make sure that persons responsible for the system and its operation as well as persons who work independently with the software and the connected units of SEW-EURODRIVE have read through the manual carefully and understood it. If you are unclear about any of the information in this documentation or if you require further information, please contact SEW-EURODRIVE.

1.2 Structure of the safety notes

1.2.1 Meaning of signal words

The following table shows the grading and meaning of the signal words for safety notes.

Signal word	Meaning	Consequences if disregarded
⚠ **DANGER**	Imminent hazard	Severe or fatal injuries.
⚠ **WARNING**	Possible dangerous situation	Severe or fatal injuries.
⚠ **CAUTION**	Possible dangerous situation	Minor injuries
NOTICE	Possible damage to property	Damage to the drive system or its environment.
INFORMATION	Useful information or tip: Simplifies handling of the drive system.	

1.2.2 Structure of section-related safety notes

Section-related safety notes do not apply to a specific action but to several actions pertaining to one subject. The hazard symbols used either indicate a general hazard or a specific hazard.

This is the formal structure of a safety note for a specific section:

SIGNAL WORD

Type and source of hazard.

Possible consequence(s) if disregarded.

- Measure(s) to prevent the hazard.

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Meaning of the hazard symbols

The hazard symbols in the safety notes have the following meaning:

Hazard symbol	Meaning
	General hazard
	Warning of dangerous electrical voltage
	Warning of hot surfaces
	Warning of risk of crushing
	Warning of suspended load
	Warning of automatic restart

1.2.3 Structure of embedded safety notes

Embedded safety notes are directly integrated into the instructions just before the description of the dangerous action.

This is the formal structure of an embedded safety note:

⚠ **SIGNAL WORD** Type and source of hazard. Possible consequence(s) if disregarded. Measure(s) to prevent the hazard.

1.3 Right to claim under warranty

A requirement of fault-free operation and fulfillment of any rights to claim under limited warranty is that you adhere to the information in the documentation at hand. Therefore, read the documentation before you start working with the software and the connected units from SEW-EURODRIVE.

Make sure that the documentation is available to persons responsible for the machinery and its operation as well as to persons who work independently on the units. Also ensure that the documentation is legible.

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1.4 Content of the documentation

The current version of the documentation is the original.

This document contains additional safety-relevant information and conditions for use in safety-related applications.

1.5 Exclusion of liability

Please observe this documentation as well as the documentation for the software used and the SEW-EURODRIVE devices connected. This documentation must be observed to ensure that the devices operate safely and that the specified product properties and performance characteristics are achieved.

SEW-EURODRIVE assumes no liability for injury to persons or damage to equipment or property resulting from non-observance of the documentation. In such cases, SEW-EURODRIVE assumes no liability for defects.

1.6 Applicable documentation

Observe the following applicable documentation:

- "Application configurator for CCU" manual.
- Manual / online help to the MOVITOOLS® MotionStudio engineering software.
- Documentation for connected SEW-EURODRIVE units (e.g. inverters, controllers).
- Documentation for connected units from other manufacturers.

Always use the latest edition of documentations and software.

The SEW-EURODRIVE website (www.sew-eurodrive.com) provides a wide selection of documents for download in various languages. If required, you can also order printed and bound copies of the documentation from SEW-EURODRIVE.

1.7 Product names and trademarks

The brands and product names in this documentation are trademarks or registered trademarks of their respective titleholders.

1.8 Copyright notice

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2 Safety notes

2.1 General

The following basic safety notes are intended to prevent injury to persons and damage to property. The user must ensure that the basic safety notes are read and observed.

Ensure that persons responsible for the machinery and its operation as well as persons who work independently have read through the documentation carefully and understood it. If you are unclear about any of the information in this documentation or if you require further information, please contact SEW-EURODRIVE.

The following safety notes refer to the use of the software. Also observe the supplementary safety notes in this documentation and in the documentation for the connected units from SEW-EURODRIVE.

This document does not replace the detailed documentation for the connected units. This documentation assumes that the user has access to and is familiar with the documentation for all connected units from SEW-EURODRIVE.

Never install or operate damaged products. Report any damage to the shipping company immediately.

Depending on the degree of protection, units may have live, uninsulated, and sometimes moving or rotating parts, as well as hot surfaces during operation.

Removing required covers without authorization, improper use or incorrect installation and operation may result in severe injury to persons, or damage to machinery. Consult the documentation for further information.

2.2 Target group

Work with the software in this solution may only be performed by adequately qualified personnel. Qualified personnel in this context are persons who have the following qualifications:

- Appropriate training in their relevant field.
- Knowledge of this documentation and other applicable documentation.
- SEW-EURODRIVE recommends additional product training for products that are operated using this software.

All mechanical work on connected units is to be performed exclusively by adequately qualified personnel. Qualified personnel in the context of this documentation are persons familiar with the design, mechanical installation, troubleshooting and servicing of the product, who possess the following qualifications:

- Training in mechanical engineering, e.g. as a mechanic or mechatronics technician (final examinations must have been passed).
- Knowledge of this documentation and other applicable documentation.

All electrical work on connected units is to be performed exclusively by adequately qualified electricians. Qualified electricians in the context of this documentation are persons familiar with electrical installation, startup, troubleshooting and servicing of the product, who possess the following qualifications:

- Training in electrical engineering, e.g. as an electrician or mechatronics technician (final examinations must have been passed).
- Knowledge of this documentation and other applicable documentation.

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- Knowledge of the relevant safety regulations and laws.
- Knowledge of all other standards, directives and laws named in this documentation.

The above-mentioned persons must have the express authorization of the company to operate, program, configure, label and ground units, systems and circuits in accordance with the standards of safety technology.

All work in the areas of transportation, storage, operation and waste disposal must be carried out by persons who are trained appropriately.

2.3 Designated use

The following sections describe the designated use. The information given must be strictly observed.

- The software function "brake diagnostics" is designated for industrial systems.
- For technical data and information on the approved operation conditions of the brake diagnostics, refer to this documentation.
- When installed in machines, startup (i.e. start of designated operation) is prohibited until it is determined that the machine complies with the local laws and directives. In the EU/EC area of applicability, the Machinery Directive 2006/42/EC must be observed.
- For functional safety, brake diagnostics fulfills the requested diagnosis in a safe braking system, e.g. to realize the safety functions "Safe Brake Actuation (SBA)" and "Safe Braking Hold (SBH)" with electromechanical brakes.
- In addition to the functional safety, brake diagnostics can be used as a diagnostics function for braking systems, e.g. to enhance machine safety or to optimize maintenance intervals.
- Brake diagnostics can be used for horizontal and vertical applications. For information on application restrictions, refer to this documentation. Restrictions must be strictly observed.

2.4 Bus systems

A bus system makes it possible to adapt frequency inverters and/or motor starters to the particulars of the machinery within wide limits. This results in the risk that a change of parameters that cannot be detected externally can result in unexpected, though not uncontrolled, system behavior.

2.5 Functional safety technology

The device must not perform any safety functions without a higher-level safety system, unless explicitly allowed by the documentation.

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3 System description

Brake diagnostics supplements a (safe) braking system that consists of various system components and poses requirements to the interface between the various components.

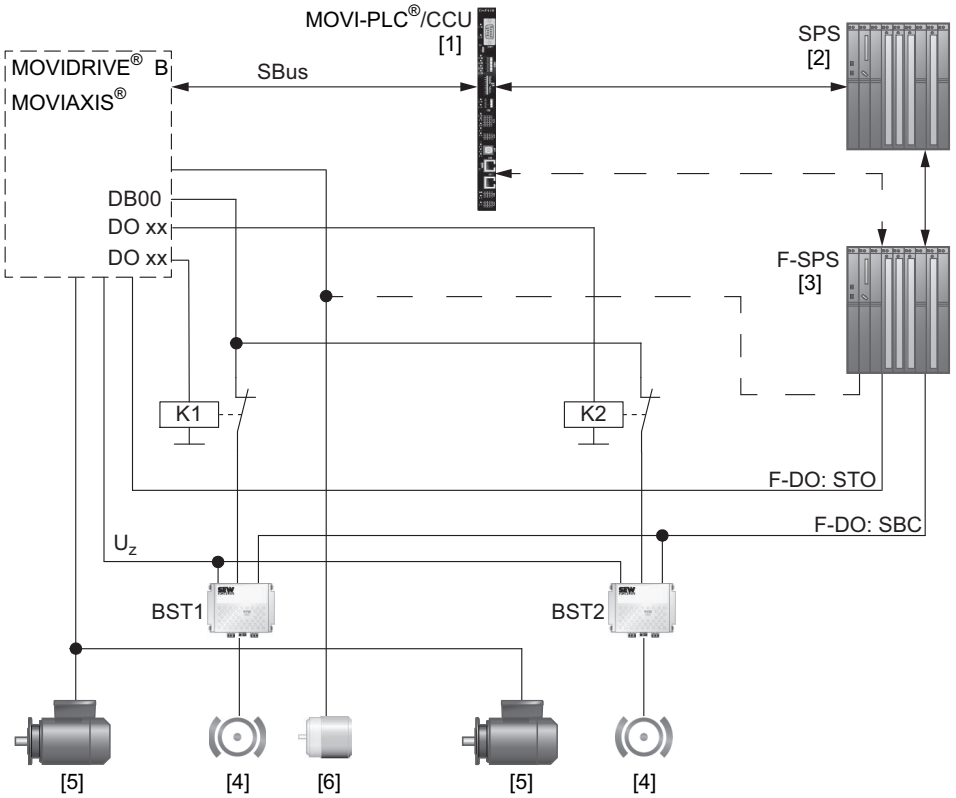
The braking system structure varies depending on the application use:

- To realize a safety function (protection of persons)
- In addition to the functional safety technology (protection of machines)

The following two examples show the simplified system structure of a redundant braking system and a redundant safe braking system with integrated brake diagnostics. The 2 redundant brakemotors are operated as multi-motor drive at a frequency inverter.

3.1 Integration in a safe braking system

Depending on the requirements for the safe braking system (e.g. application type, performance level, used system components), a number of different variants of safe braking systems is possible.



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No.	Description
[1]	Controller (MOVI-PLC® or CCU design): • Brake diagnostics procedure • Brake control • Result at PLC or S-PLC

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No.	Description
[2]	Machine control (PLC): • Approach test position • Optional use of collected brake/machine data
[3]	Safe controller (F-PLC, e.g. MOVISAFE® UCS..B): • Brake diagnostics requirements • Result OK: Machine enable • Result not OK: Implement measures
[4]	Brake 1/2 connected to safe braking system BST 1/2.
[5]	Motor 1/2.
[6]	Encoder.
DB 00	Output signal for brake control.
DO xx	Control signal to control external relays K1 and K2.
K1	Interruption DB 00 via external relay K1 for brake 1.
K2	Interruption DB 00 via external relay K2 for brake 2.
F-DO:SBC	Safe control signal to the brake module BST for safe brake control (safety function SBC).
F-DO:STO	Safe control signal to the MOVIDRIVE® B or MOVIAXIS® for safe torque off (safety function STO, according to SS1).
U_z	DC link voltage from MOVIDRIVE® B or MOVIAXIS® to supply BST1 and BST2.

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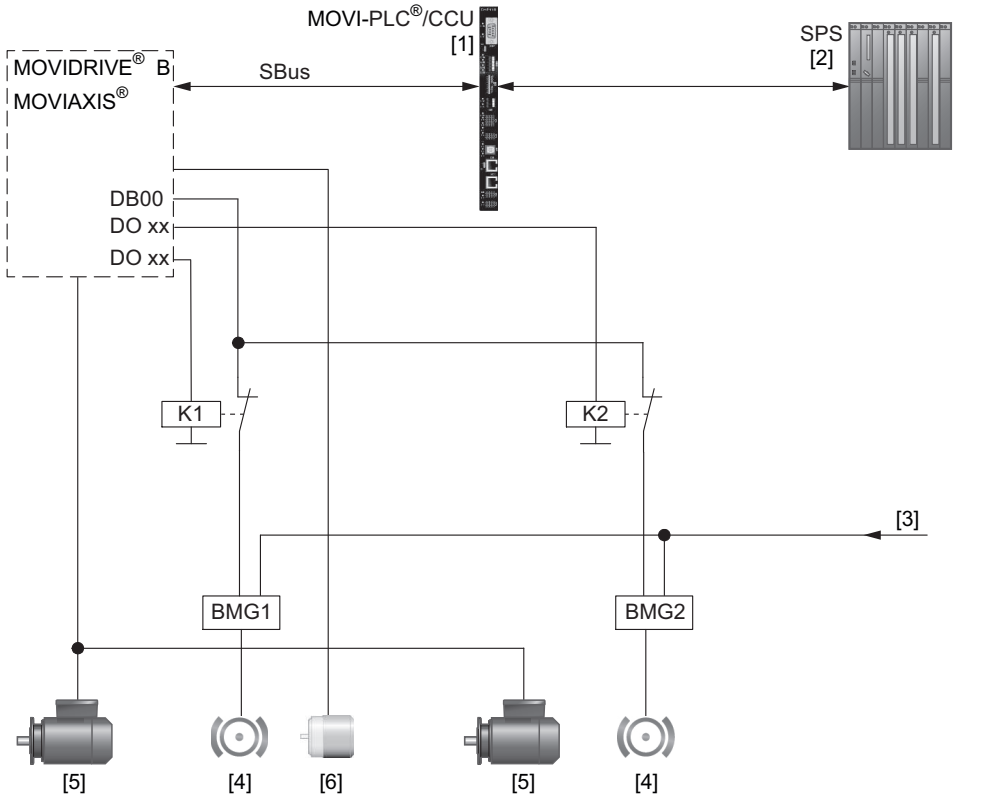
3.2 Integration in a braking system

Depending on the requirements for the braking system, e.g. application as well as system components, a number of different variants of braking systems is possible.



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No.	Description
[1]	Controller (MOVI-PLC® or CCU design): • Brake diagnostics procedure • Brake control • Result at PLC
[2]	Machine control (PLC): • Approach test position • Optional use of collected brake/machine data
[3]	Voltage supply of brakes 1 and 2.
[4]	Brake 1/2 connected to brake rectifier (e.g. BMG 1/2).
[5]	Motor 1/2.
[6]	Encoder.
DB 00	Output signal for brake control.
DO xx	Control signal to control external relays K1 and K2.
K1	Interruption DB 00 via external relay K1 for brake 1.
K2	Interruption DB 00 via external relay K2 for brake 2.
BMG 1/2	Brake rectifier BMG 1/2 for brake 1/2.

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3.3 Test rate in safe brake systems

3.3.1 General information

Brake diagnostics is executed via a higher-level controller and must be ensured by the user. SEW-EURODRIVE recommends to execute brake diagnostics via a safe controller.

3.3.2 Single execution of brake diagnostics

Brake diagnostics must be performed at the unit after the following events:

- At initial unit startup
- After emergency stop braking
- After voltage failure
- After the unit is switched on
- After inspection, maintenance or repair of the brake

3.3.3 Cyclic execution of brake diagnostics

In addition to the events stated above, brake diagnosis must be performed cyclically in a safe brake system. The performance frequency (test rate) is distinguished by type and diagnostics, and results from application and normative requirements.

Static brake diagnostics

For control systems of category 2, EN ISO 13849-1 specifies that the test rate must be 100 times more frequent than the demand rate of the safety function. According to the IFA report (edition 07/2013), a test frequency as high as for control systems is practically not necessary for (motor) brakes.

For a static brake diagnosis a cyclic test after approx. 8 hours or one shift is regarded as sufficient. The same applies for systems of category 2 and 3.

INFORMATION

Machines with access regulation:

In machines where access to the danger zone is prevented with safety measures (e.g. via security doors with active closing), diagnostics can be performed before access, immediately after the request to open the safety door has been transmitted. Access to the danger zone may only be granted after a positive diagnostics result.

Dynamic brake diagnostics

The test rate of the dynamic brake diagnostics depends on the application and ambient conditions. According to the IFA report (edition 07/2013), the diagnostics must be executed at least once per year.

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3.3.4 Diagnostic coverage (DC)

The diagnostic coverage (DC) is a measurement for the effectiveness of the diagnostics according to EN ISO 13849-1:2008. The diagnostic coverage is determined as the relation of failure rate of discovered dangerous failures to overall dangerous failures. Diagnostics is required from a system architecture of category 2 on.

In a safe braking system, the described brake diagnostics can detect the following possible failures in regard to electromechanical brakes:

- Brake does not release / application does not move
- Brake does not apply / brake cannot hold application
- Braking torque is reduced

For an overall evaluation of the achieved performance level of the safe braking system, the following DC values can be set for brake diagnostics depending on the encoder monitoring:

- DC = 90% with encoder monitoring via safety controller (F-PLC according to SIL 3, e.g. MOVISAFE® UCS..B). Thus performance level e can be achieved in the safe braking system.
- DC = 85% without encoder monitoring via safety controller. Thus maximal performance level d can be achieved in the safe braking system.

INFORMATION

For brake diagnostics no requirements are posed on the FS encoder.

But an FS encoder or FS encoder system can be required by other safety functions (e.g. SLS, SDI, etc.) in the entire safety system.

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4 Diagnostic types

Brake diagnostics can be used for horizontal and vertical applications. The following 2 diagnostic types are distinguished:

- Static brake diagnostics

  During static brake diagnostics, each brake must be separately tested per axis.

- Dynamic brake diagnostics

  During dynamic brake diagnostics, a separate test of each single brake is not possible. In this case all brakes of an axis are always tested simultaneously.

⚠ WARNING

Performing brake diagnostics at a damaged brake/unit can lead to undesired movement of the unit.

Severe or fatal injuries.

- No person may be present in the danger zone during active brake diagnostics.
- The mechanics of a hoist must be prepared for a possible crash (e.g. via buffers).
- Before dynamic brake diagnostics is performed, static brake diagnostics must be completed with a positive result.
- Brake diagnostics must be performed in a suitable test position of the machine. The user must ensure the test position.

4.1 Static brake diagnostics

Static brake diagnostics determines whether the tested brake can hold a static test torque. The driving motor therefore generates a configurable test torque that is applied to the active brake. In brake systems with more than one brake (e.g. redundant brake systems) the static brake diagnostics must be implemented for each brake separately.

By using the brake as a holding brake, the friction process to regenerate the brake lining is missing. Therefore SEW-EURORIVE recommends to perform a dynamic brake diagnostics at least once a year in addition to the static brake diagnostics. Depending on the application environment and actual use of the brake, a different frequency of dynamic brake diagnostics might be required. Before a dynamic brake diagnostics is performed the static brake diagnostics must be finished with a positive result.

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4.1.1 Description

Static brake diagnostics determines whether the tested brake can hold a configurable static test torque. Diagnostics is performed in several steps to clearly detect the various possible errors and to minimize the effects of the unit on the diagnostics result. The drive moves at the beginning of static brake diagnostics. This movement can be parameterized and usually includes few motor revolutions. Static brake diagnosis must be performed in a suitable test position that enables this movement. This must be ensured by the user.

Static brake diagnostics determines the current load situation at the drive with each execution and includes this in the further diagnostics process. This dynamic load recognition at the beginning of the diagnostics replaces a defined test load.

4.1.2 Scope of static brake diagnostics

Static brake diagnosis can be performed in positive or negative direction of movement. Positive and negative refers to the set user units of the application (e.g. min^{-1}, mm/s, etc.) and relates to increasing (positive) or decreasing (negative) encoder values.

The user defines the test direction of the static brake diagnosis via the scope of diagnostics. This means the user defines whether the brake diagnosis is performed in one or both directions of movement. If both directions of movement are used for diagnostics, the following description is repeated in the opposite direction in step 3.

INFORMATION

The following figures are examples and refer to a load torque in positive direction. The figures may vary depending on actual load situation and respective settings.

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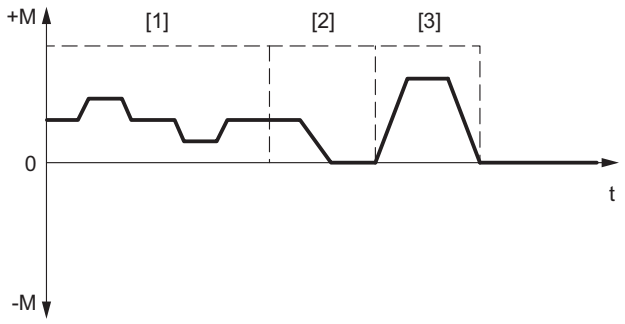
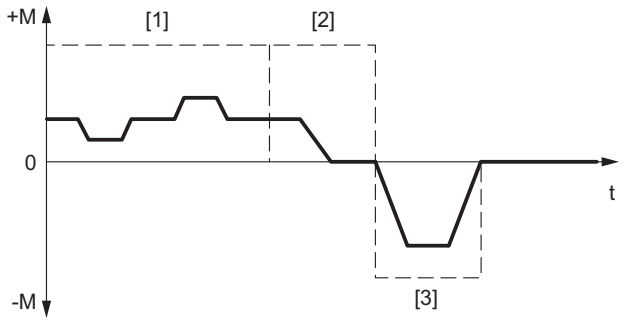
Scope of diagnostics		Procedure
One direction of movement	Positive	 *9007212601496459* • [1] Step 1 • [2] Step 2 • [3] Step 3
	Negative	 *9007212601504267* • [1] Step 1 • [2] Step 2 • [3] Step 3

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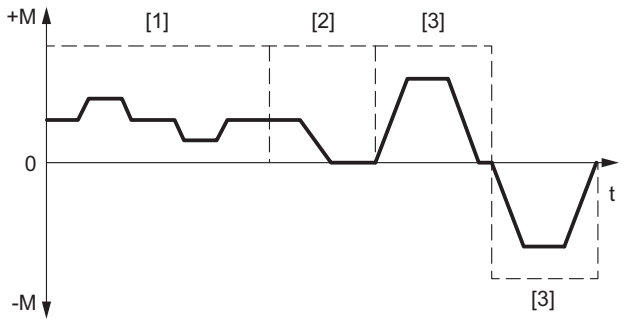
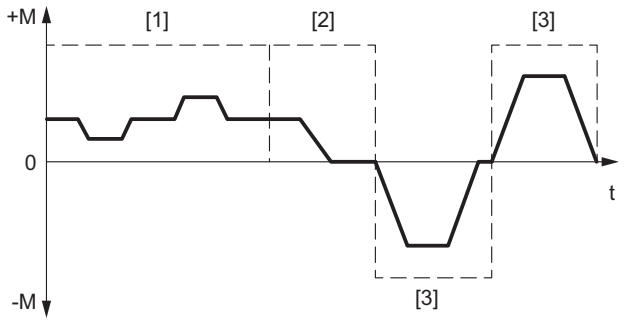
Scope of diagnostics		Procedure
Both directions of movement	Positive	 *9007212601610251* • [1] Step 1 • [2] Step 2 • [3] Step 3
	Negative	 *9007212601616651* • [1] Step 1 • [2] Step 2 • [3] Step 3

4.1.3 Static brake diagnostics procedure

The static diagnostics is performed in several steps.

- Step 1: Determination of load situation and inspection for movement
- Step 2: Inspection whether brake applies
- Step 3: Testing with test torque

Step 1

Determining the load situation

Static brake diagnostics determines the current load situation at the drive with each execution and includes this in the further diagnostics process. After the load is determined, an internal test is performed to determine whether the configured test torque can be applied in regard to the present load situation, MOVIDRIVE® B or MOVIAXIS® configuration and static brake configuration. If the configured test torque cannot be applied, static brake diagnostics is aborted and an error message is generated.

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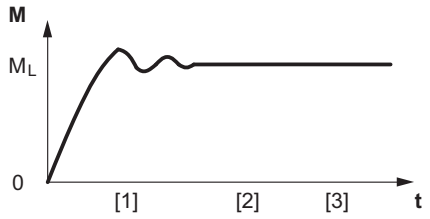
Due to the automatic load determination, static brake diagnostics can be performed at any loading condition of the system. Defined test conditions such as adding a test load are not necessary with static brake diagnostics.



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[1] Starting static brake diagnostics. Setting the position control.
[2] Waiting time
[3] Measuring time to determine the load

1. After static brake diagnostics is initiated, it starts the drive in position control [1].
2. The drive remains in position control during the waiting time [2].
3. The current load situation in position control is determined for the measuring time to determine the load [3].

INFORMATION

With present load at the static brake diagnostics and test scope in **both directions** adhere to the following information.

- The static brake diagnostics is intended for systems with **load applied in opposite directions**.

  In case of vertical drives, the downward test direction according to gravity is the positive load direction. With opposite test direction upward, the direction of gravity is the negative load direction. In the further process, the load behavior is automatically considered by the static brake diagnostics.
- With **deviating load behavior, e.g. positive load direction in both test directions** the diagnostic result deviates from the actual value. In units with this type of load behavior, the static brake diagnostics is performed **in one direction of movement** (positive or negative). To perform static brake diagnostics in both directions, the diagnostic process is performed twice in one direction of movement (once in positive and once in negative direction of movement).

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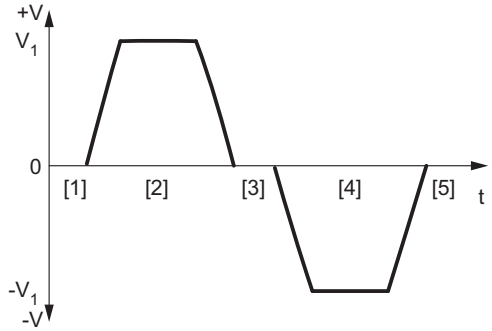
Inspecting the movement

After determination of the current load situation, a specific application movement is performed (see following figure).



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[1] Acceleration to test velocity
[2] Constant movement at test velocity
[3] Waiting time
[4] Movement back to initial position
[5] End of step 1

1. After determination of the current load situation, the drive is accelerated to a configured test velocity v_1 [1].
2. If test velocity v_1 [2] is reached, measurement data is collected via constant movement for 1 second at test velocity v_1 [2]. The drive is stopped afterwards.
3. After a waiting time [3], the drive moves back to the initial position [4] and remains in position control for the duration of waiting time [5].

INFORMATION

Observe the following information during configuration:

- A mechanical backlash in the unit can be configured and is considered by the diagnostics in the process.
- The maximum approved movement for step 1 can be configured. This must be larger than the configured mechanical backlash.
- The waiting time enables the application to settle before the next diagnostics step starts.

If no movement occurs, the MOVIDRIVE® B or MOVIAXIS® output current is increased up to the current limit and held for a maximum of 2 seconds. Static brake diagnostics is then aborted and an error message is issued.

If step 1 is completed successfully, step 2 of the static brake diagnostics starts.

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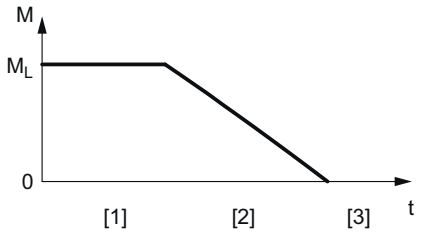
Step 2: Inspection whether brake applies

During step 2, diagnostics tests whether the brake applies and can hold the current load M_L.



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[1] Delay time 1 s
[2] Switch-off of position control
[3] End of step 2 with fixed waiting time of 1 s

1. The brake is applied with active position control. After a delay time of 1 second [1] (not changeable) the position control is switched off [2]. The delay time [1] considers the response time to apply the brake including brake control.
2. During the switch-off of the position control [2] for 1 second, the position is monitored with a configurable positional tolerance. A breach of the tolerance limit leads to the abortion of static brake diagnostics.
3. After a defined waiting time of 1 second, step 2 is completed [3].

If step 2 is completed successfully, step 3 of the static brake diagnostics starts.

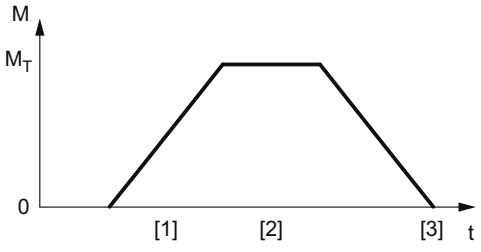
INFORMATION

Observe the following information during configuration:

- To allow for performing step 2 without errors, the application must be in complete idle state of charge at the end of step 1.
- To obtain the complete idle state of charge for the application, the wait time in step 1 can be increased or settings in MOVIDRIVE® B/MOVIAXIS® can be adjusted.

Step 3: Testing with test torque

In step 3, the applied brake is loaded with the desired test torque (M_T).



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[1] Generating the test torque
[2] Holding the test torque
[3] Switching off the test torque

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1. The test torque M_T is generated via a ramp [1] and applied to the brake. Brake diagnostics generates torque at the motor that is applied to the active brake. This torque already considers the existing load situation (size and direction of the load) at the start of the diagnostics.
2. The test torque is held for a holding time [2] at the applied brake. While the test torque is generated and held, the position is monitored with a configurable positional tolerance. A breach of the tolerance limit leads to the abortion of static brake diagnostics.
3. After the test with test torque is successfully completed and the holding time expired, step 3 ends when the test torque [3] is switched-off for 2 seconds. At the end of step 3, the frequency inverter remains in the state controller inhibit.

INFORMATION

Observe the following information during configuration:

- The positional tolerance in step 3 must be less than 90% of the approved movement in step 1.
- With diagnostics configuration for both directions of movement, the procedures of step 3 are repeated for each opposing direction of motion.

Diagnostic result

Static brake diagnostics generates the following results.

Result	Meaning	Measures
• OK O3:Bit 4 (fieldbus output data) • Parameter *TestResult* = 4 (See chapter "Parameter channel")	Static brake diagnostics successful.	No further measures necessary.
• NOK (Not OK) O3:Bit 2 (fieldbus output data) • Parameter *TestResult* = 1 (See chapter "Parameter channel")	Static brake diagnostics not successful.	Creating a safe application state. The safe application state must be maintained until the error has been corrected and the static brake diagnostics is performed with the result "OK".

INFORMATION

The safe application state is not part of brake diagnostics and must be ensured by the users according to their risk assessment / safety concept.

Besides the data necessary for brake diagnostics, the user is presented with further diagnostic data of the unit:

- Unit friction
- Mechanical backlash of the system
- Test torque with and without brake slipping

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Evaluation and further use of this additional data proceeds optionally in the machine control and is in the responsibility of the user. The additional diagnostic data enables optimization of maintenance work and leads to an enhanced system availability.

4.2 Dynamic brake diagnostics

Dynamic brake diagnostics supplements the static brake diagnostics. Dynamic brake diagnostics determines whether a configured and approved braking distance is maintained under equal test conditions.

The braking work performed by the brake during brake diagnostics must be considered when calculating maintenance intervals.

4.2.1 Description

Dynamic brake diagnostics checks the maximal approved braking distance under defined test conditions. For this purpose, the brake is applied at a defined speed. The resulting braking distance is then determined. When the brake is applied, the motor is switched without torque.

Dynamic brake diagnostics performs a drive movement. The movement varies depending on the configuration, the application and the condition of the brake. The dynamic brake diagnostics must be performed in a suitable test position. The application must allow this movement. This must be ensured by the user.

The test conditions, speed and load situation must be identical for each time the dynamic brake diagnostics is performed.

4.2.2 Scope of dynamic brake diagnostics

Dynamic brake diagnostics can be performed in positive or negative direction of movement. Positive and negative refers to the set user units of the application (e.g. min^{-1}, mm/s, etc.) and relates to increasing (positive) or decreasing (negative) encoder values.

The user defines the test direction of dynamic brake diagnostics via the scope of diagnostics. This means the user defines whether the dynamic brake diagnostics is performed in one or both directions of movement. If both directions of movement are used, the test step in the following description is repeated in the opposite direction.

INFORMATION

The following figures are examples of a defined test environment. The figures may vary depending on settings and respective test environment.

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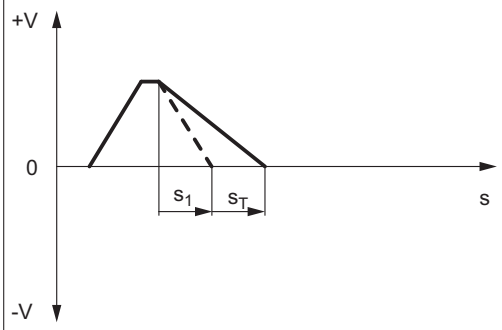
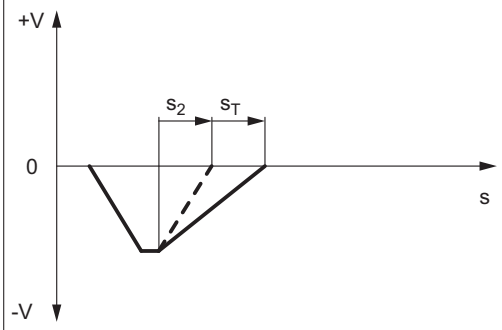
Scope of diagnostics		Procedure
One direction of movement	Positive	 *9007212602142603* • s_1: Expected braking distance in positive direction of movement s_1 • s_T: Permitted tolerance for the expected braking distance
	Negat-ive	 *9007212602146187* • s_2: Expected braking distance in negative direction of movement s_2 • s_T: Permitted tolerance for the expected braking distance

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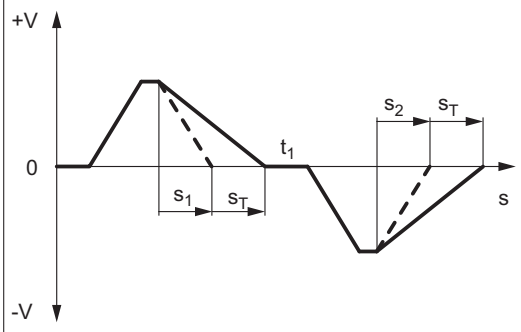
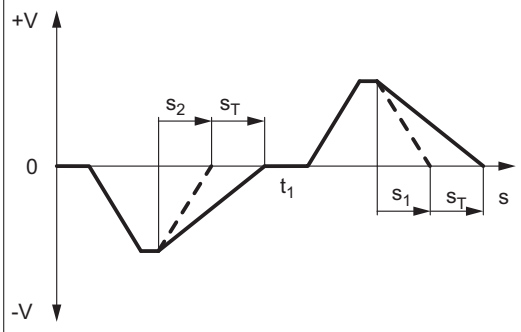
Scope of diagnostics		Procedure
Both directions of movement	Positive	 *18014411857058827* • s_1, s_2: Expected braking distance in positive (s_1) or negative (s_2) direction of movement • s_T: Permitted tolerance for the expected braking distance • t_1: Waiting time
	Negat-ive	 *18014411857062795* • s_2, s_1: Expected braking distance in positive (s_1) or negative (s_2) direction of movement • s_T: Permitted tolerance for the expected braking distance • t_1: Waiting time

The direction of rotation is predetermined at startup of the frequency inverter (user unit Default or Inverse). The test scope (diagnostics in one or both directions of movement) is configured by the parameter *Scope of brake diagnostics*.

The application is accelerated to test velocity. If the test velocity is reached, the all brakes at this frequency inverter are applied and the controller inhibit activated simultaneously. The drive is brought to standstill by the brake. The resulting braking distance as well as the resulting braking time from the moment of brake application to drive standstill are determined. The application is considered as stopped if the actual speed is lower than 10 min^{-1}. At the end, the frequency inverter remains in the state controller inhibit.

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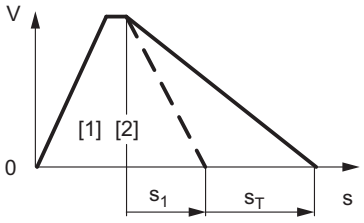
If the tolerated braking distance (s_1 + s_T or s_2 + s_T) is exceeded, dynamic brake diagnostics is aborted and an error message is issued.



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[v] Speed
[0] Speed = 0
[1] Acceleration to test velocity
[2] Activation of controller inhibit and simultaneous application of brakes
[s] Distance
[s_1] Expected braking distance in positive direction of movement
[s_T] Permitted tolerance for the expected braking distance

INFORMATION

During configuration note that the configured test velocity must be less than the configured maximum speed of the MOVIDRIVE® B or MOVIAXIS®.

4.2.3 Diagnostic result

The evaluation basis for dynamic brake diagnostics is the determined braking distance if the brake is applied. The result of the dynamic brake diagnostics is displayed to the user via the parameter *TestResult*. The following parameters are generated.

Result	Meaning	Measures
• OK O3:Bit 4 (fieldbus output data) • Parameter *TestResult* = 4 (See chapter "Parameter channel")	Dynamic brake diagnostics successful. The tolerated braking distance was not exceeded.	No further measures necessary.
• NOK (Not OK) O3:Bit 2 (fieldbus output data) • Parameter *TestResult* = 1 (See chapter "Parameter channel")	Dynamic brake diagnostics not successful. The tolerated braking distance was exceeded.	Creating a safe application state. The safe application state must be maintained until the error has been corrected and the dynamic brake diagnostics performed with the result "OK".

Besides the data necessary for brake diagnostics, the user is presented with further diagnostic data of the unit:

- Determined braking distance under configured test environment
- Determined braking time under configured test environment

Evaluation and further use of this additional data proceeds optionally in the machine control and is in the responsibility of the user. The additional diagnostic data enables optimization of maintenance work and leads to an enhanced system availability.

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4.3 Diagnostic type combinations

Static and dynamic brake diagnostics can be configured in combination for the same brake. The 2 types of brake diagnostics are usually performed with different test rates (see chapter "Test rate in safe braking system").

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5 Project planning notes

5.1 MOVIDRIVE® B and MOVIAXIS®

- Brake diagnostics can be used in combination with MOVIDRIVE® B or MOVIAXIS® by SEW-EURODRIVE.
- MOVIDRIVE® B or MOVIAXIS® must be started up in operating mode CFC or SERVO. The operating mode must be considered during project planning for MOVIDRIVE® B / MOVIAXIS®.
- Brake diagnostics is only compatible to parameter set 1.
- When using brake diagnostics with controllers of CCU design, the outputs DØ01 to DØ05 are reserved at the MOVIDRIVE® B (DØ00 to DØ03 at the MOVIAXIS®). They are not available for other applications. When using controllers of MOVI-PLC® design, the MOVIDRIVE® B / MOVIAXIS® outputs can be selected by the user.
- The necessary test torque for brake diagnostics must be considered in the configuration of the inverter.
- The settings of the parameters *Current limit* and *Torque limit* must enable the test torque to be generated.
- Static brake diagnostics applies internal positioning functions and therefore requires a referenced axis.
- Static brake diagnostics considers the thermal motor utilization. The settings of parameter *Motor protection 1* are tested. If parameter *Motor protection* is set to "Off", brake diagnostics changes it to the following value:
  - "On asynchronous" (for operating mode CFC)
  - "On servo" (for operating mode Servo)

  After brake diagnostics is performed, the initial value is set again.
- Static brake diagnostics considers the brake connection at the MOVIAXIS®. The settings of parameter *Brake* are tested. If parameter *Brake* is set to "Direct connection" (Index 9833.1 = 2), brake diagnostics changes it to the following value:
  - "To brake rectifier" (Index 9833.1 = 1)

  After brake diagnostics is performed, the initial value is set again.
- The active motor protection can cause the following errors during brake diagnostics:
  - Fault F84 (Motor protection) at MOVIDRIVE® B
  - Fault F69 (Prewarning motor overtemperature) at MOVIAXIS®

  Brake diagnostics checks the current settings of parameter *Response to motor overload* upon initiation. If the motor protection is active, brake diagnostics automatically changes the value to "Display errors". After brake diagnostics is performed, the initial value is set again.
- The permitted maximum speed of the frequency inverter must be higher than the set test velocity of the dynamic brake diagnostics.

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5.1.1 Overview of parameters and indexes

The following table shows the parameters used with MOVIDRIVE® B and the respective indexes with MOVIAXIS®.

Parameter name	MOVIDRIVE® B (Parameters)	MOVIAXIS® (Indexes)
Minimum speed	P301	–
Maximum speed	P302	9579.1 / 9579.10
Current limit	P303	–
Torque limit	P304	9740.1
Motor protection	P340	–
Speed monitoring	P500	8557.0
Motor overload response	P832	–
Lag error window	P923	9729.18
Brake	–	9833.1

5.2 Motors

The brake diagnostics function is permitted for motors from SEW-EURODRIVE in combination with MOVIDRIVE® B or MOVIAXIS®. Observe the existing requirements for motors in CFC or SERVO operating mode.

5.2.1 Multi-motor drives

- Use identical motors for multi-motor drives.
- For multi-motor drives, enter the torque constant (k_T) of a motor.

INFORMATION

In case of multi-motor drives, the single drives must be connected using a rigid mechanical coupling. A backlash due to the application, for example due to the gear unit, can be set in the configuration of the diagnostics. In case of missing mechanical coupling, adhere to chapter "Synchronized axes".

5.3 Encoder system

Brake diagnostics requires encoder feedback to the frequency inverter. Depending on the encoder option card used in the frequency inverter, the following encoder connections can be used:

- MOVIDRIVE® B:
  - X15 for motor encoder
  - X14 for distance encoder
  - X62 for absolute encoder
- MOVIAXIS®:
  - X13 for motor encoder

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– X63 for distance encoder
– X64 for absolute encoder

Observe the existing requirements for encoders (e.g. encoder resolutions) in CFC or SERVO operating mode.

Brake diagnostics uses the encoder connections and their settings of the respective application environment. Additional encoder connections are not required for the brake diagnostics.

5.4 User units

Brake diagnostics uses the user units of the respective application environment. The user units are set as follows:

- Controller in MOVI-PLC® design:

  Software platform MultiMotion or MultiMotion light.
- Controller in CCU design:

  Application module in Application Configurator (from 6 PD on).

5.5 Controller

Brake diagnosis is compatible with the following controllers of the "advanced" and "power" performance class.

Controller type of the "advanced" performance class	Controller design	
	MOVI PLC®	CCU
DHE41B	x	–
DHR41B	x	x
DHF41B	x	x

Controller type of the "power" performance class	Controller design	
	MOVI PLC®	CCU
UHX71B	x	–

5.5.1 Controller MOVI-PLC® design

Applications can be programmed as required with controllers in MOVI-PLC® design.

Brake diagnostics is integrated in the "MPLCAdditionalFunctionHandler" library as function block.

INFORMATION

The function block "Brake diagnostics" requires the MultiMotion software or MultiMotion light as application environment.

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5.5.2 Controller in CCU design

Applications can be easily programmed with controllers in CCU design. The Application Configurator software interface, that is integrated in the MOVITOOLS® MotionStudio engineering software, can be used for configuring standardized application modules.

After the configuration of the MOVIDRIVE® B or a MOVIAXIS® axis with a compatible application module, the "Brake diagnostics" function module can be selected via "Functions" and can be configured.

INFORMATION

Brake diagnostics requires an application module (e.g. bus positioning, universal module from 6 PD on) for defining the user units.

5.5.3 Technology level

The use of brake diagnostics on the respective controller requires at least the following technology level:

- Controller in CCU design

  Technology level T1
- Controller in MOVI-PLC® design

  Technology level T1

The technology level is checked by brake diagnostics. If other functions with technology level T1 or higher are present on the controller, brake diagnostics is already included. An additional technology level is not required in this case.

5.5.4 Synchronized axes

Controller in CCU design

The "Universal Technology" application module is equipped with the "Gearing" technology function for synchronized operation of several axes.

INFORMATION

During brake diagnostics, the application module is executed in "default" operating mode. The axes that have been synchronized via the "Gearing" technology function remain in the last position during active brake diagnostics. Only the axis on which brake diagnostics is executed is moving. The "gearing" technology function is available without restrictions if brake diagnostics is deactivated.

Controller MOVI-PLC® design

Applications with synchronously moving axes during brake diagnostics can be realized with MOVI-PLC®. Contact SEW-EURODRIVE for this purpose.

5.6 IPOS$^{plus®}$ application modules

Brake diagnostics is not compatible with IPOS$^{plus®}$ application modules. If existing systems with IPOS$^{plus®}$ application modules are retrofitted, the functions must be programmed in the controller in MOVI-PLC® design or switched to the Application Configurator for controllers in CCU design.

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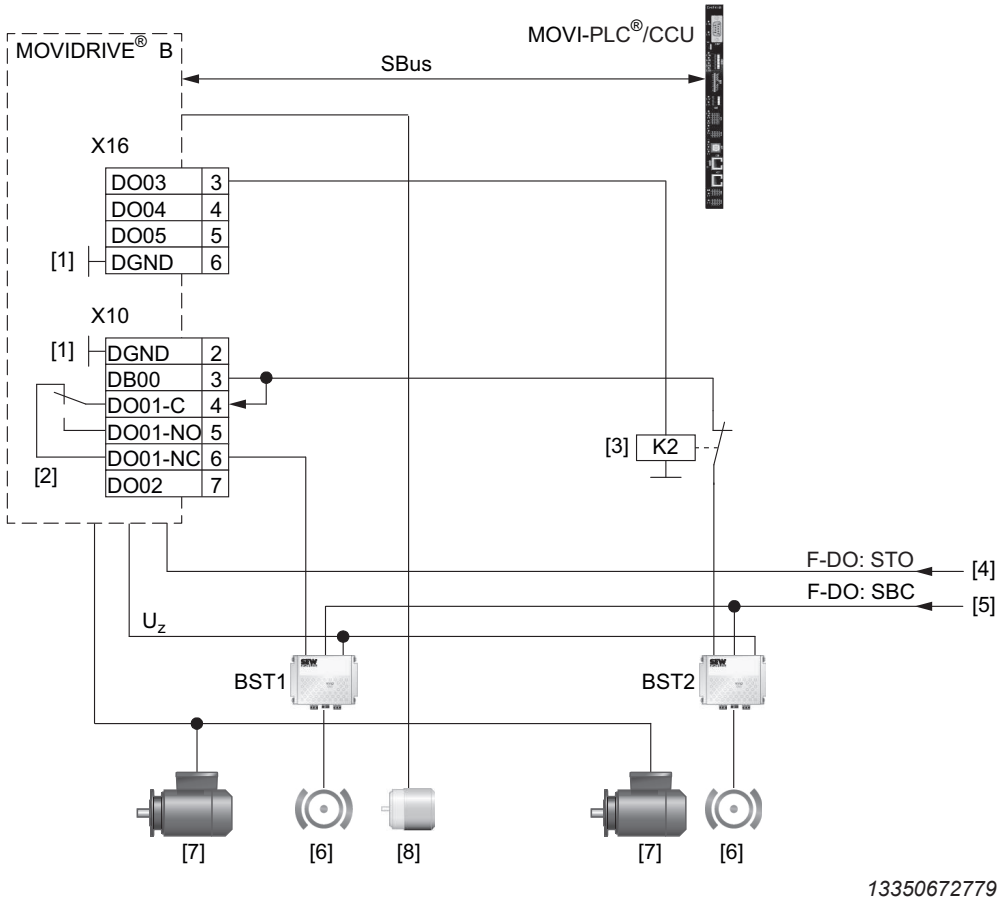
5.7 Brake control

5.7.1 Static brake diagnostics

For static brake diagnostics, the test principle requires the interruption of the functional brake control of the MOVIDRIVE® B or MOVIAXIS® (output DB00). During this test step, brake diagnostics switches a relay via an output and the DB00 control signal to the functional brake control is interrupted. The brake is applied by the brake diagnostics during the test step.

The interruption of brake control takes place in the functional control and must be realized separately for each brake to be tested. The interruption of the safe brake control (SBC safety function) is not necessary for brake diagnostics.

The following simplified sample circuit with MOVIDRIVE® B shows the possibilities how to interrupt brake control DB00 with two brakes. For the first brake, DB00 is sent via the internal relay DØ01 [2] before the signal is then sent to the safety-related brake module (in this example: BST 1) or to the brake rectifier. For the second brake, digital output DØ03 switches an external relay (in this example: K2) [3]. The external relay K2 interrupts brake control DB00 before the signal is then sent to the safety-related brake module (in this example: BST 2) or to the brake rectifier. The safe control via the SBC safety function is carried out independently via a safety relay [5] as is the STO safety function [4].



No.	Description
[1]	Reference potential.
[2]	DB00 interruption via internal relay DØ01.
[3]	DB00 interruption via external relay K2.

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No.	Description
[4]	Safe control signal to MOVIDRIVE® B for Safe Torque Off (STO).
[5]	Safe control signal to the brake module BST 1/2 for safe brake control (safety function SBC).
[6]	Brake 1 and brake 2.
[7]	Motor 1 and motor 2.
[8]	Encoder.

The digital output and relay output used for brake control interruption can be assigned freely with controllers in MOVI-PLC® design. With controllers in CCU design, the outputs of MOVIDRIVE® B or MOVIAXIS® are permanently assigned in the Application Configurator.

Brake / axis	Controller in design		
	CCU (Outputs at MOVIDRIVE® B)	CCU (Outputs at MOVIAXIS®)	MOVI PLC® (Outputs can be assigned freely)
1	DØ01 or DØ02	DØ00	Outputs can be assigned freely.
2	DØ03	DØ01	
3	DØ04	DØ02	
4	DØ05	DØ03	
≥ 5	–	–	

5.7.2 Dynamic brake diagnostics

For the dynamic brake diagnostics no measures for the interruption of the functional brake control are required.

5.8 Safe brake control

The use of the electromechanical brake in functional safety technology requires the safety function "Safe Brake Control" (SBC). The SBC safety function is defined in DIN EN 61800-5-2.

Safe brake control is not part of safety diagnostics but part of the safe brake system and must be realized by the user.

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5.9 Number of brakes/axes

The "brake diagnostics" function can diagnose several brakes on various axes with the controller. The axis assignment and the specific parameters can be configured individually for each brake.

- Controller in MOVI-PLC® design

  The maximum number of axes is based on the used controller and the functionalities required by the application (for example max. 16 axes for performance class "advanced" and max. 32 axes for performance class "power"). The number of brakes per axis can be programmed freely.

- Controller in CCU design

  The maximum number of axes is based on the used controller and the functionalities required by the application (for example max. 16 axes for performance class "advanced" and max. 32 axes for performance class "power"). A maximum of 4 brakes per axis can be configured.

INFORMATION

Simultaneous activation of several brake diagnostic functions for different brake/axis is currently not possible. Wait for the active brake diagnostics to be completed before you start the next one.

5.10 Diagnostic results

The result of each performed brake diagnostics is stored on the SD card inserted in the controller as a result data file sorted by axis number and brake number. The number of files per brake is limited to 100. When this number is exceeded, the oldest file is overwritten.

In case you require more than 100 files per brake, proceed as follows:

- Read the files via the parameter channel and save them
- Read the files from the controller via the PC and save them

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6 Startup

6.1 Brake diagnostics as CCU function module

6.1.1 Requirements

Note the following prerequisites for a successful brake diagnostics startup.

Software

Installation of the current version of the MOVITOOLS® MotionStudio engineering software. You can download the latest version from the SEW-EURODRIVE website.

Components

Correct project planning for all components included in the brake diagnostics. For startup, the components must be available and ready for operation.

6.1.2 Startup procedure

DriveStartup

Before starting Drive Startup, select the drive you want to take into operation in the network view of MOVITOOLS® MotionStudio.

1. Start up the single axis or the axis system.
2. Configure the communication with the controller.

Application Configurator

Before stating the Application Configurator, mark the controller in the network view of MOVITOOLS® MotionStudio.

1. Insert the MOVIDRIVE® B or MOVIAXIS® axis in the axis configuration.
2. Set an application module compatible with brake diagnostics.
3. Configure the "brake diagnostics" function module (see chapter "Configuring the brake diagnostics function module").
4. Save the configuration to your controller SD card.

Observe the following note after startup of the brake diagnostics function module.

INFORMATION

Changing the user units of the application after startup of the brake diagnostics function module.

Changed user units are not updated in the brake diagnostics function module. The brake diagnostics function module uses the previous settings.

The brake diagnostics function module requires a complete configuration of the application module. If you make additional changes, reopen the configuration of the brake diagnostics function module and check the settings.

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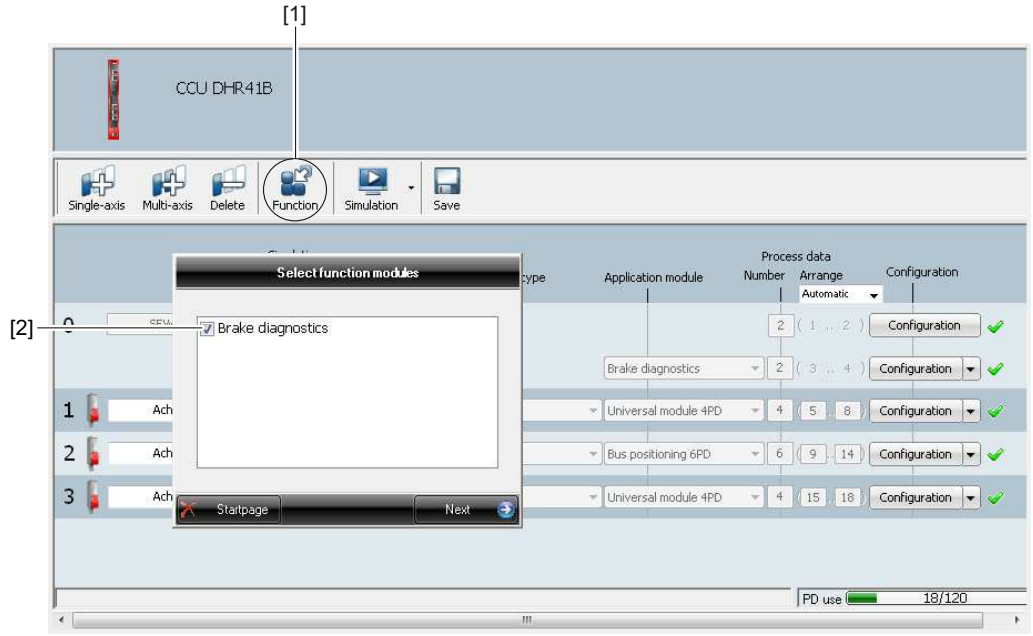
6.1.3 Configuring the brake diagnostics function module

Selecting a function module

Proceed as described (see the following figure):

1. Click on the "Function" symbol [1]. The window "Selecting the function module" is displayed.
2. Check the "Brake diagnostics" box [2] and click [Next].



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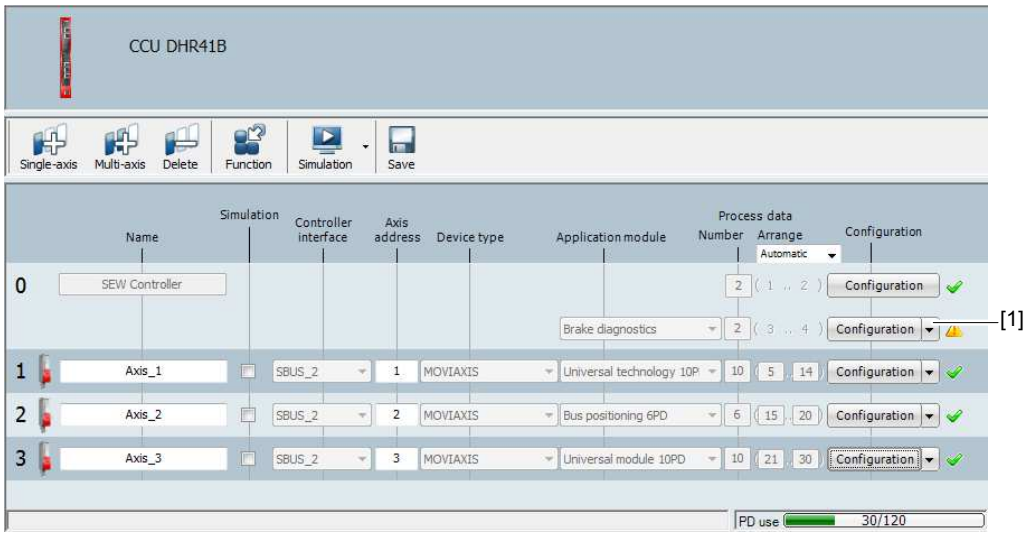
Open configuration

Proceed as follows:

1. To open the brake diagnostics configuration, open the "configuration" drop-down list [1] and select "Open" (see following figure).



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The drop-down list [1] offers the following options:

- Open

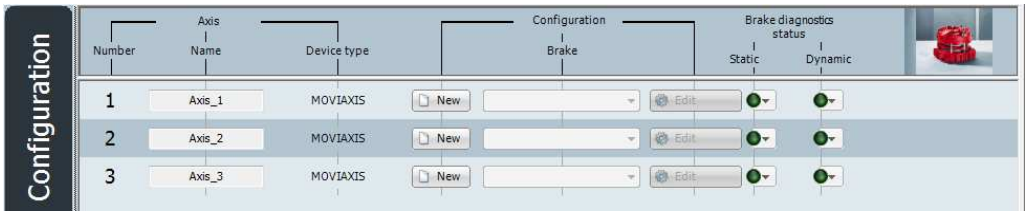
  Opens brake diagnostics configuration.
- Reset

  Resets the configuration.
- Status
  - Green check mark : Configuration complete
  - Yellow delta (Notice!) : Configuration incomplete

Selecting an axis

Proceed as follows:

1. Once you opened the brake diagnostics configuration, you have the following options to configure an axis (see following figure).



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Column	Description
Number	Displays the axis number of the configured axis.
Axis name	Displays the axis name of the configured axis.
Device type	Displays the configured device type.
Configuration New	Click on [New] to open the configurator for brake diagnostics. • If the brake is configured for the first time, the configurator opens immediately. For further steps, refer to the section "General settings". • If a brake is configured for the selected axis, it is possible to extend the configuration for more brakes (maximum of 4 brakes per axis). In this case, select the brake with the standard values you want to apply in the column "brake". You can adapt the standard values during configuration. If you want to open an empty configuration, select "No".
Brake	Select the brake for which you want to edit the configuration. An LED indicates for the selected brake whether a static or dynamic brake diagnostics is configured.
Static	An LED indicates if a static brake diagnostics is configured for the selected brake. You can reset the settings in the drop-down list.
Dynamic	An LED indicates if a dynamic brake diagnostics is configured for the selected brake. You can reset the settings in the drop-down list.

INFORMATION

Compatible axes can be activated and parameterized individually. The settings are saved in an xml file and can be transferred to the controller.

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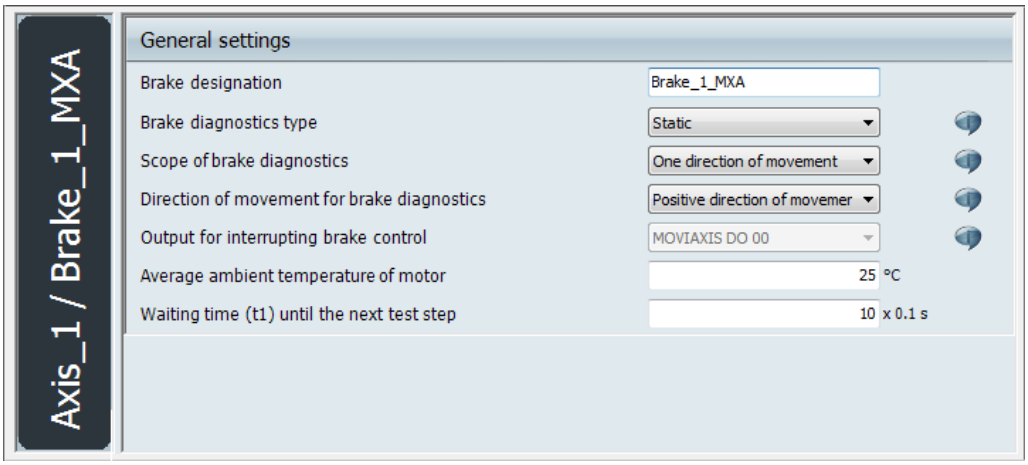
General settings

First, define the general settings of the brake diagnostics in the "General settings" box (see following figure).



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Edit the following parameters in the parameter group "General settings".

- "Brake designation" edit box

  Enter a brake designation.

- "Brake diagnostic type" drop-down list

  Select a brake diagnostics type.

  – Static

    Selecting "static" forwards you to the required settings for static brake diagnostics (see section "Static brake diagnostics parameters").

  – Dynamic

    Selecting "dynamic" forwards you to the required settings for static brake diagnostics (see section "Static brake diagnostics parameters").

  – Static and dynamic

    Selecting "static and dynamic" leads you to the required settings for static and dynamic brake diagnostics.

- "Scope of brake diagnostics" drop-down list

  Select the scope of brake diagnostics.

  – One direction of movement

    Brake diagnostics is performed in the selected direction of movement.

  – Both directions of movement

    Brake diagnostics is performed in both directions of movement. Brake diagnostics starts with the first selected direction of movement.

- "Direction of movement for brake diagnostics" drop-down list

  Select the direction of movement for brake diagnostics.

  – Positive direction of movement (Increase of encoder data)

  – Negative direction of movement (Decrease of encoder data)

  If the scope of brake diagnostics is set to "Both directions of movement", set the first direction of movement here.

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- "Output for interrupting brake control" drop-down list

  MOVIDRIVE® B: Select an output for brake control interruption.

  – Brake 1: DØ01 or DØ02 (internal/external relay)
  – Brake 2: DØ03 (cannot be changed)
  – Brake 3: DØ04 (cannot be changed)
  – Brake 4: DØ05 (cannot be changed)

  MOVIAXIS®: Select an output for brake control interruption.

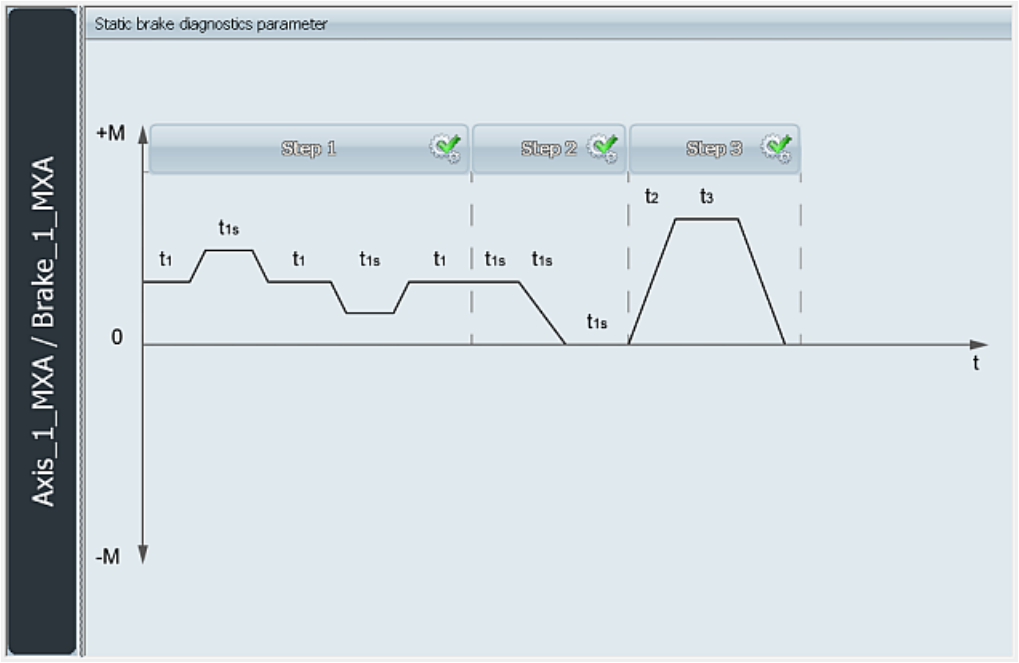
  – Brake 1: DØ00 (cannot be changed)
  – Brake 2: DØ01 (cannot be changed)
  – Brake 3: DØ02 (cannot be changed)
  – Brake 4: DØ03 (cannot be changed)
- "Average ambient temperature of motor" edit box

  Enter the average motor ambient temperature.
- "Waiting time (t_1) until next test step" edit box

  Enter a waiting time t_1. The entered value is multiplied by the factor 0.1 s. The waiting time allows for the movement in the application to fade before the next test step.

Static brake diagnostics parameters

The following figure shows an example of the static brake diagnostics progress. The progress varies depending on the settings and entries made in the section "General settings".



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- Step 1

  Set the parameter for step 1.
- Step 2

  Set the parameter for step 2.

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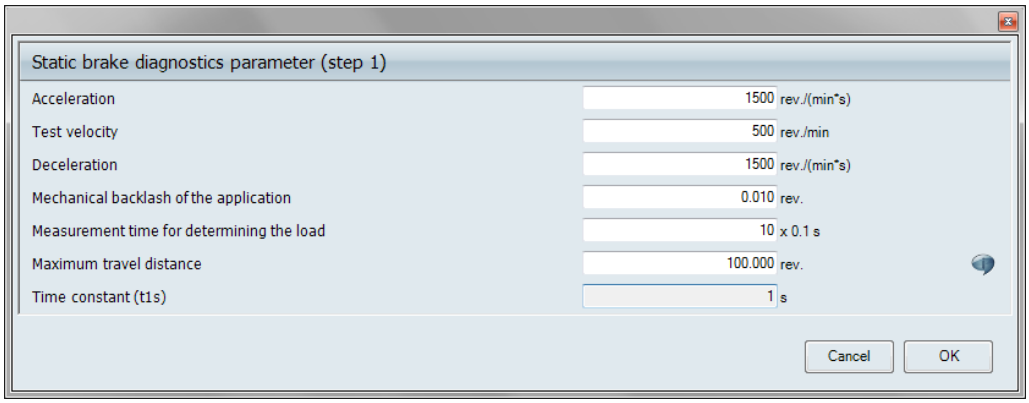
- Step 3

  Set the parameter for step 3.
- Configuration status (display per step):
  - Green check mark  : Configuration complete
  - No green check mark  : Configuration incomplete

Parameters in step 1

The following figure shows the parameters for static brake diagnostics in step 1.



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Edit the following parameters in parameter group "Static brake diagnostics parameters (step 1)".

- "Acceleration" edit box

  Enter an acceleration value with which the application is accelerated to test velocity.
- "Test velocity" edit box

  Enter a speed value to which the application should be accelerated.
- "Deceleration" edit box

  Enter a deceleration value with which the application is decelerated to standstill.
- "Mechanical backlash of the application" edit box

  Enter the mechanical backlash of the application. The static brake diagnostics considers the mechanical backlash and prevents incorrect diagnostic results.
- "Measurement time to determine the load" edit box

  Enter the measuring time to determining the current load situation of the application.
- "Maximum travel distance" edit box

  Enter the maximum travel distance that the application may travel during step 1 of the static brake diagnostics.

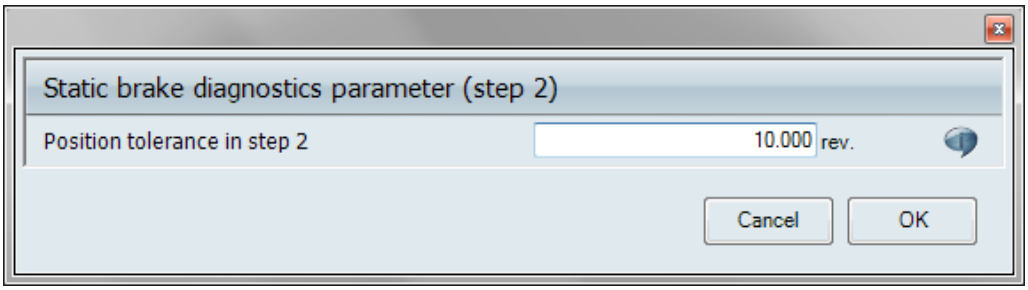
  Observe:
  - The maximum travel distance must be larger than the mechanical backlash of the application.
  - The maximum travel distance must be larger than the movement with the set setpoints at the set speed during 1 second.

  - Static brake diagnostics must thus be performed in an suitable test position where the movement is possible.
- "Time constant (t_{1s})" display field

  Display of the time constant (t_{1s}) of 1 s. The time constant is implemented several times in the procedure and cannot be changed.

Parameters in step 2

The following figure shows the parameters for static brake diagnostics in step 2.



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Edit the following parameters in parameter group "Static brake diagnostics parameters (step 2)".

- "Position tolerance in step 2" edit box

  Set the positional tolerance for step 2. The positional tolerance permits movement of the drive. If the positional tolerance is exceeded, static brake diagnostics is canceled.

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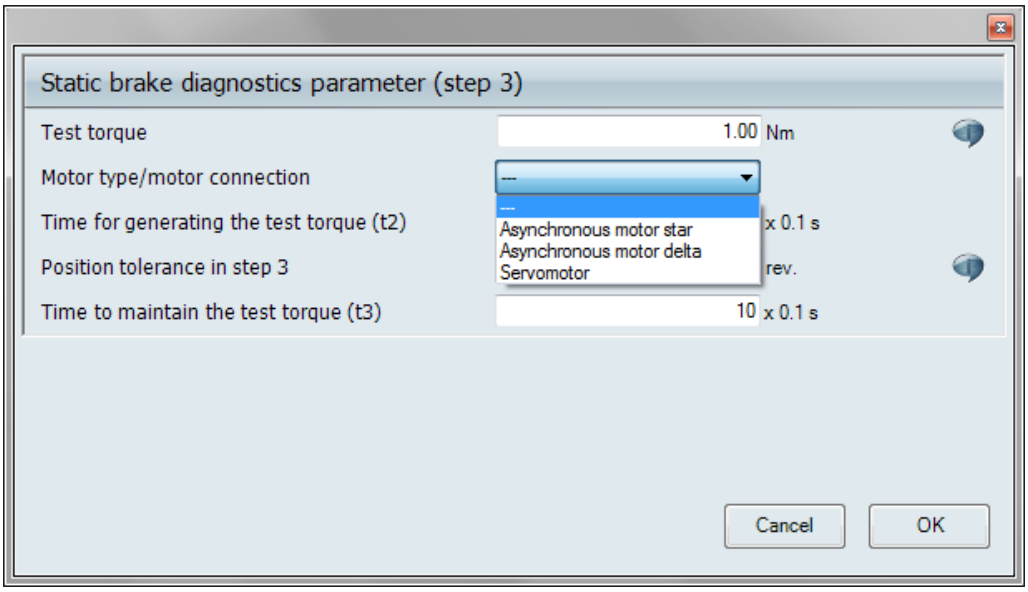
Parameters in step 3

The following figure shows the parameters for static brake diagnostics in step 3.



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Edit the following parameters in parameter group "Static brake diagnostics parameters (step 3)".

- "Test torque" edit box

  Enter a test torque for brake diagnostics. The test torque refers to the motor shaft.

- "Motor type/motor connection" drop-down list

  Select the motor connection for your application:

  – Asynchronous motor star or delta

    For asynchronous motors (star or delta) enter the motor-specific torque constant (k_T factor). Refer to the motor tables in the MOVIDRIVE® MDX60/61B system manual for the k_T factor.

  – Servomotor

    For servomotors, enter the motor-specific data (Servomotor nominal torque M_0" and "Servomotor nominal current I_0"). Refer to the motor nameplate and the respective documentation for the motor-specific data.

- "Time for generating a test torque (t_2)" edit box

  Enter the time (t_2) for generating the test torque. The test torque is generated based on the ramp in the set time.

- "Position tolerance in step 3" edit box

  Set the positional tolerance for step 3. The positional tolerance permits slipping of the brake. If the positional tolerance is exceeded, static brake diagnostics is canceled.

- "Time to maintain the test torque (t_3)" edit box

  Enter the test torque holding time (t_3). During this time, the test torque is applied at the brake.

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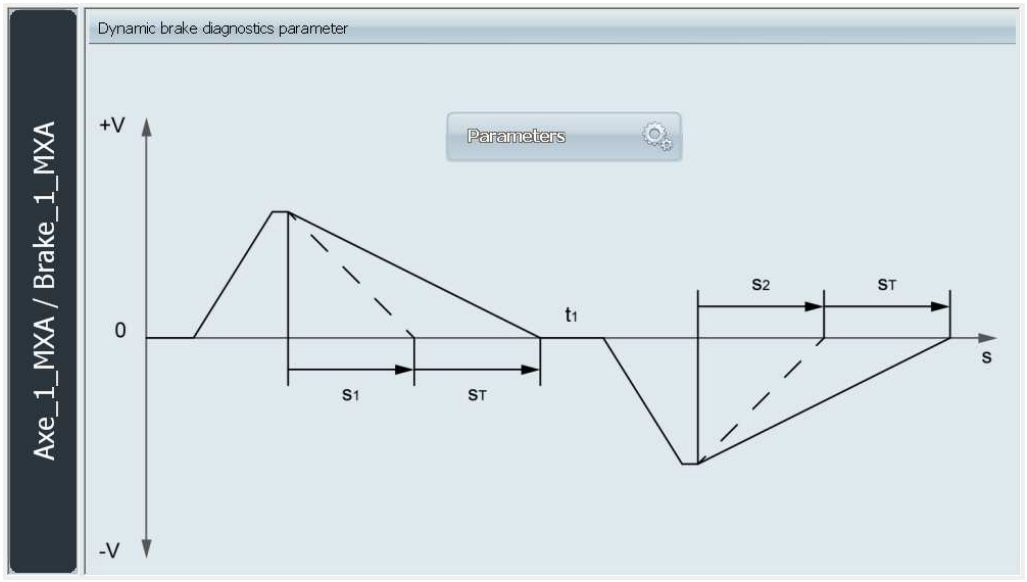
Dynamic brake diagnostics parameters

The following figure shows an example of the dynamic brake diagnostics progress. The progress varies depending on the settings and entries made in the section "General settings".



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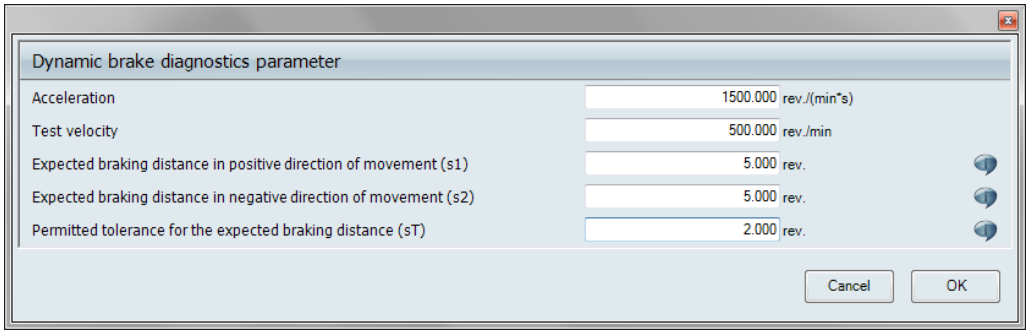
The configuration status is shown as follows:

- Green check mark in the "parameter" display field  : Configuration complete
- No green check mark in the "parameter" display field  : Configuration incomplete



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The following parameter must be set for dynamic brake diagnostics.

- "Acceleration" edit box

  Enter an acceleration value with which the application is accelerated to test velocity.
- "Test velocity" edit box

  Enter a speed value to which the application should be accelerated.
- "Expected braking distance in positive direction of movement (s_1)" edit box

  Enter the expected braking distance in positive direction of movement (s_1).

  Determine the expected braking distance e.g. by project planning or measurement during startup with testing conditions (load and speed).

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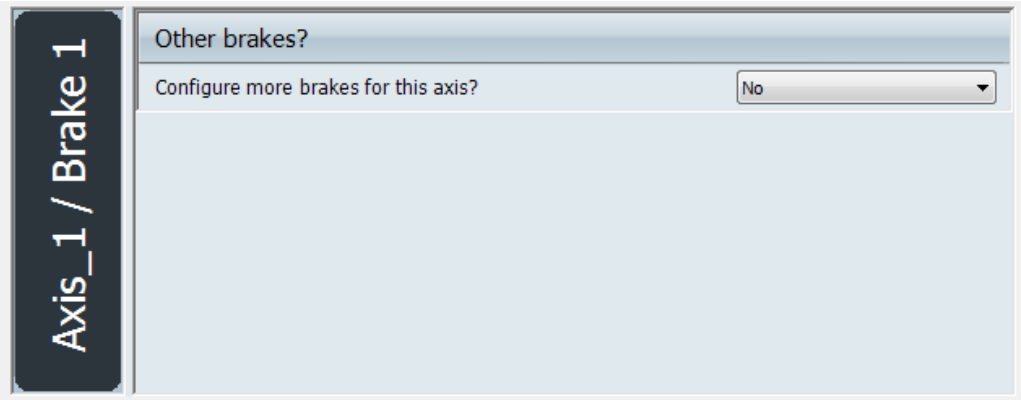
- "Expected braking distance in negative direction of movement (s_2)" edit box

  Enter the expected braking distance in negative direction of movement (s_2).
- "Permitted tolerance for the expected braking distance (s_T)" edit box

  Enter the permitted tolerance for the expected braking distance (s_T). The value is valid for both directions of movement. If the expected braking distance and the tolerance is exceeded, the dynamic brake diagnostics is canceled.

Configuring additional brakes



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Edit the following parameters in the parameter group "Additional brake?".

- "Configure more brakes for this axis" drop-down list?

  Choose whether you want to configure an additional brake for the axis.

  – Yes

    The configuration is continued for the additional brake. Choose whether you want to use the previous configuration as default setting for the next brake.

  – No

    Configuration is completed.

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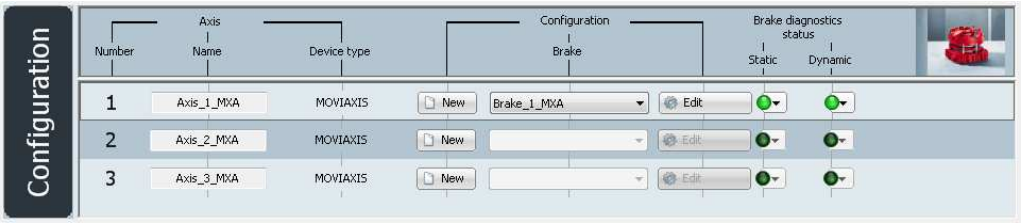
Completing the configuration

If you do not want to configure an additional brake, the configuration is closed and you see an overview of the configured brake diagnostics (see following figure).



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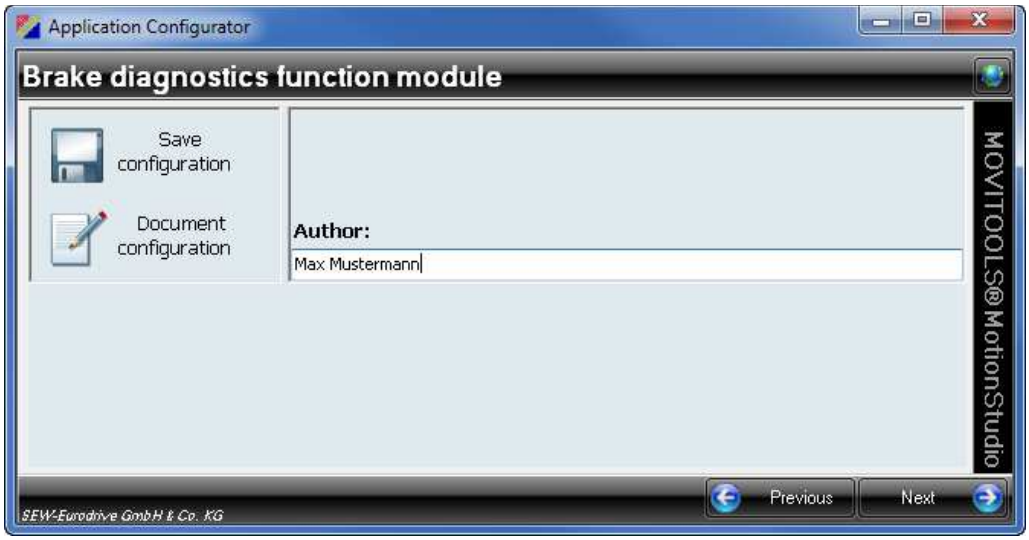
You can save and document the configuration, and transfer it to the controller SD card (see following figure).



14506327563

Function	Description
Save configuration	Opens a dialog window for saving the xml file of the configuration on your local computer. The xml file can be read and edited via "Load configuration".
Document the configuration	Opens a dialog window for saving a PDF file of the current configuration of brake diagnostics.

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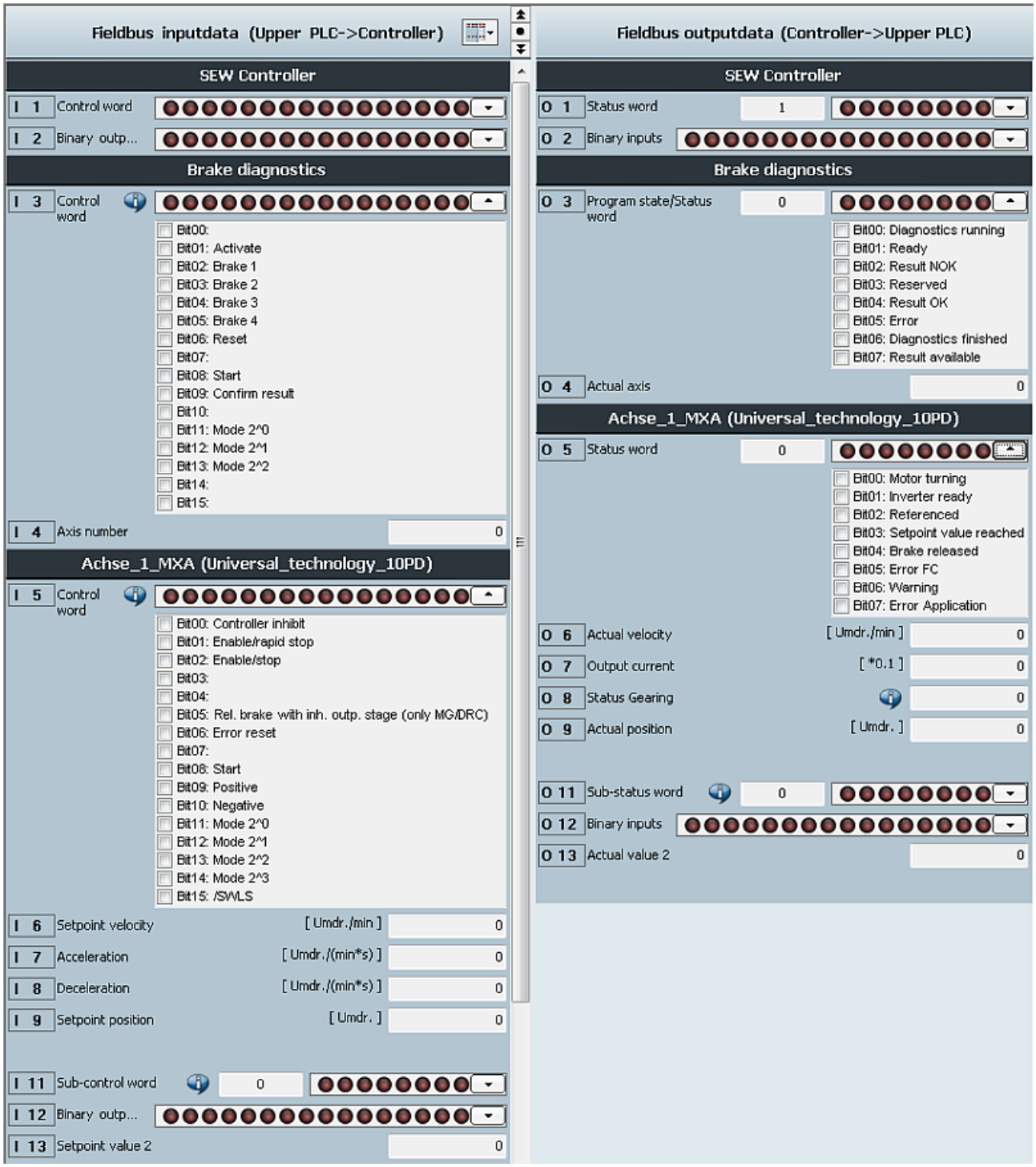
6.1.4 Fieldbus interface

2 process data words (PD) are assigned for the brake diagnostics function module. The one after the process data of the SEW controller and previous to the process data of the singe axes (application modules) (see the following figure).



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6.1.5 Process data assignment

Fieldbus input data (2 PD)

The following table describes the fieldbus input data for control via fieldbus.

PD word	Meaning	Bit	Function	
I3	Control word	0	–	
		1	Activate	
		2	Brake 1	
		3	Brake 2	
		4	Brake 3	
		5	Brake 4	
		6	Reset	
		7	–	
		8	Start	
		9	Confirm result	
		10	–	
		11	Mode 2^0	001 = Static diagnostics
		12	Mode 2^1	010 = Reserved
		13	Mode 2^2	011 = Reserved 100 = Dynamic diagnostics
		14	–	
		15	–	
I4	Axis number	Axis number		

Fieldbus output data (2 PD)

The following table describes the fieldbus output data for control via fieldbus.

PD word	Description	Bit	Function
O3	Program status/ status word	0	Diagnostics running
		1	Ready for operation
		2	Result NOK
		3	Reserved
		4	Result OK
		5	Diagnostics error
		6	Diagnostics complete
		7	Result available
		8 – 15	Current step/error number
O4	Current axis	Axis number	

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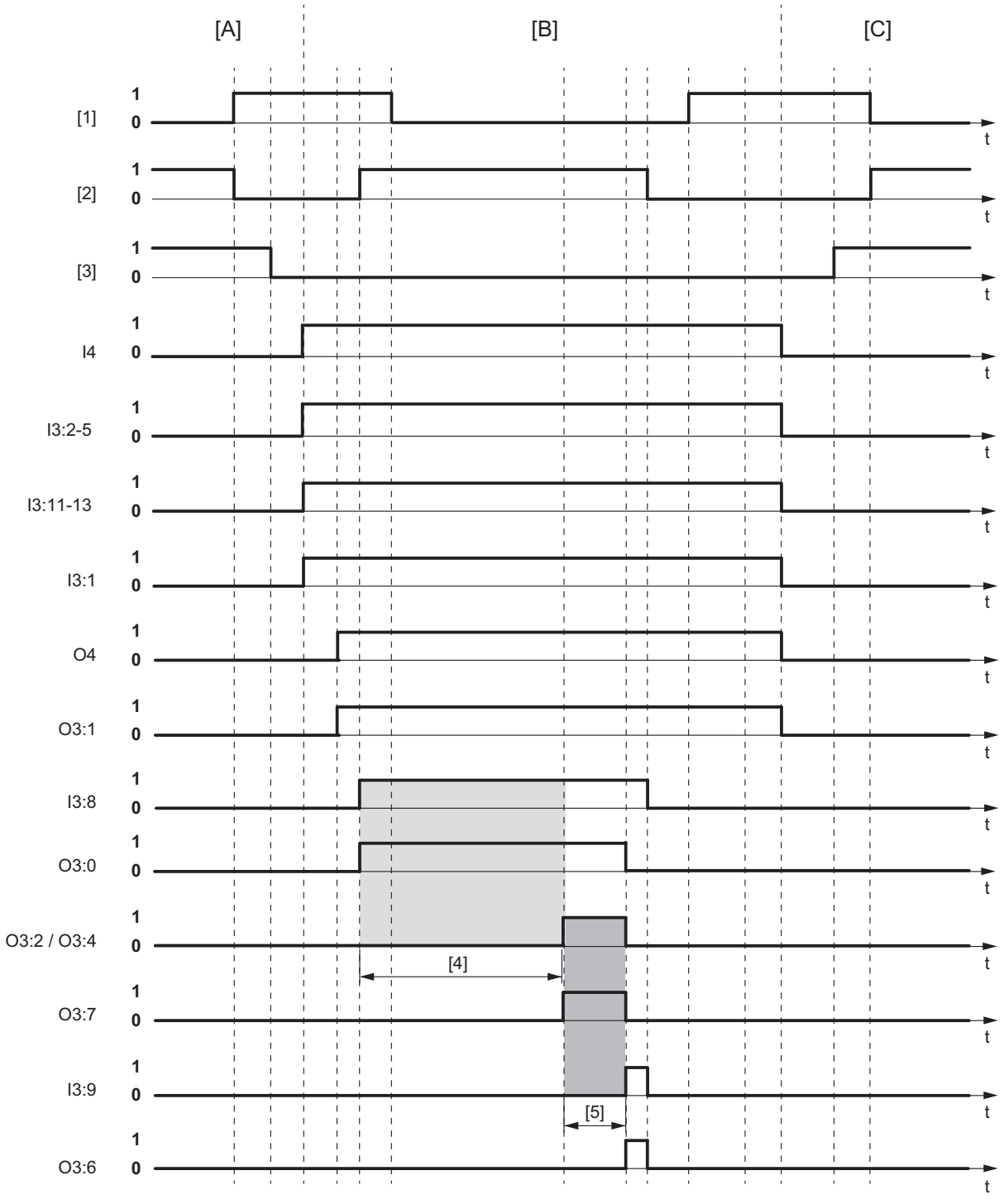
Cycle diagram

Brake diagnostics can be controlled via the process data interface or via the diagnostics monitor. Observe the following signal course between the control and status word of the brake diagnostics. The displayed signal course refers to operation without malfunctions, meaning no cancellation of brake diagnostics. The signal course is identical for both diagnostics types (static and dynamic).



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[A]	Switching to brake diagnostics mode
[B]	Brake diagnostics mode

[C]	Switching to normal operating mode
[1]	State of the axis: "Controller inhibit"
[2]	State of the axis: "Enable"
[3]	Mode 0 (Default Mode) of the enabled application module
[4]	Interval in which the diagnostic steps are performed
[5]	Interval in which the result is collected
I4	Select axis number
I3:2 – 5	Select brake
I3:11 – 13	Select test mode
I3:1	Activate
O4	"Current axis" feedback
O3:1	"Ready for operation" feedback
I3:8	Start
O3:0	"Diagnostics running" feedback
O3:2 / O3:4	"Result OK" or "Result NOK" feedback
O3:7	"Result available" feedback
I3:9	Confirm result
O3:6	"Diagnostics complete" feedback

The required axis must be in "controller inhibit" state. To select an axis, enter the axis number in the process data word (I4), select the brake to be tested (I3:2 – 5), select test mode (I3:11 – 13) and then activate the operational availability with *Activate* (I3:1).

If you select an enabled axis, the function module issues an error. If you select a correct axis, *Current axis* (O4) and *Ready for operation* (O3:1) are set in the status word.

In brake diagnostics operating mode, the enable types controller inhibit, enable/stop, enable/rapid stop, and reset axis error are available for MOVIDRIVE® B /MOVIAXIS®. Brake diagnostics requires an axis enabled in default mode [3]. The signals are still evaluated and controlled via the process data interface of the corresponding application module.

Brake diagnostics starts with (I3:8) in the control word. The diagnostic procedure [4] starts. The active brake diagnostics signals *Diagnostics running* (O3:0) in the status word. In addition, the current diagnostics step is issued in the status word.

The brake diagnosis ends with the feedback *Result OK* (O3:4) or *Result NOK* (O3:2). Further, *Result available* (O3:7) is set. Acknowledge the result data [5] with *Confirm result* (I3:9). After successful acknowledgment, the result and the message *Diagnostics running* (O3:0) is revoked. At the same time, *Diagnostics complete* (O3:6) is fed back to confirm successful completion of brake diagnostics.

If *Diagnostics complete* (O3:6) is fed back, brake diagnostics is completed successfully. In this case, revoke enable of the selected axis [2]. Start bit (I3:8) can be revoked and the *Diagnostics complete* feedback (O3:6) is deleted. To switch the axis back to normal operating mode, the axis must be in "controller inhibit" state. The status word of brake diagnostics can now be deleted completely and normal operating mode can be activated.

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INFORMATION

- Make sure that the brake diagnostics responds with *Diagnostics complete* (O3:6) before successfully completing the control. This applies for fault-free and faulty operation.
- The brake diagnostics actively changes parameters in MOVIDRIVE® B / MOVIAXIS®. The changes are reset automatically at the end of the brake diagnostics process. In case of voltage failure, the changes are lost and the startup settings are reset.

6.1.6 Brake diagnostics reset

Error in brake diagnostics

If an error occurs during brake diagnostics, proceed as follows to reset brake diagnostics:

1. Activate controller inhibit at the frequency inverter.
2. Deactivate all bits of brake diagnostics.
3. Activate the reset bit (I3:6) of brake diagnostics.
4. Deactivate the reset bit (I3:6) of brake diagnostics.
5. Deactivate controller inhibit at the frequency inverter.

6.1.7 Parameter channel

In addition to the fieldbus interface, the data described below is available for the user via the 12 byte MOVILINK® parameter channel. The data can optionally be collected by the machine control for further use (read only). For a detailed description of the 12 byte MOVILINK® parameter channel, refer to the "Configuration Software Application Configurator for CCU" manual.

The unit "UU" corresponds to the set user units in the application module. The set UU are transferred in the parameter channel as follows:

- UU = (UserUnit) / (SpeedTimeBase)

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General parameters

Name	Description/setting	Index	Subindex	Unit
VersionNumber	Version number of the module.	20215	41	
TestType	Configured diagnostic type: • 1: Static brake diagnostics • 4: Dynamic brake diagnostics	20215	42	
BrakeTested	Result whether brake diagnostics has been completely successfully. • 0: Brake diagnostics not completed • 1: Brake diagnostics completed	20215	43 (Bit 0)	
Status	Result whether an error occurred during brake diagnostics. • 0: No fault • 1: Fault	20215	43 (Bit 2)	
DirectionTested	Result of the direction(s) of movement during brake diagnostics. • 0: No brake diagnostics performed • 1: Brake diagnostics performed in "default" direction of movement • 2: Brake diagnostics performed in "inverse" direction of movement	20215	44	
LastCheckup	Date and time of the last brake diagnostics. Time stamp is set to *BrakeTested = 1*. This value corresponds to seconds after 01.01.1970 00:00:00 (dd.mm.yyyy, hh:mm:ss).	20215	45	s
TestResult	Brake diagnostic result. • 0: No result • 1: Brake diagnostics not okay (NOK) • 4: Brake diagnostics okay (OK)	20215	47	
StatusID	Error number, e.g. 61444dez → F004hex	20215	48	

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Static brake diagnostics parameters

Name	Description/setting	Index	Subindex	Unit
LoadTorque	Determined load torque.	20215	49	×0.01 Nm
Required Torque	Required test torque.	20215	50	×0.01 Nm
Additional Torque_default	Torque that must be additionally generated by the motor in "default" direction of movement.	20215	51	×0.01 Nm
Addition-alTorque_invers	Torque that must be additionally generated by the motor in "inverse" direction of movement.	20215	52	×0.01 Nm
EffectiveT-orque_default	Actual torque used to test the brake in "default" direction of movement.	20215	53	×0.01 Nm
EffectiveT-orque_invers	Actual torque used to test the brake in "inverse" direction of movement.	20215	54	×0.01 Nm
Backlash	Determined movement due to mechanical backlash during brake diagnostics.	20215	55	×0.01 AE
Friction	Determined application friction.	20215	56	×0.01 Nm

Dynamic brake diagnostics parameters

Name	Description/setting	Index	Subindex	Unit
StopDistan-ceReference_de-fault	Value set in the function module for the expected braking distance in "default" direction of movement.	20215	57	×0.01 AE
StopDistan-ceReference_in-vers	Value set in the function module for the expected braking distance in "inverse" direction of movement.	20215	58	×0.01 AE
TimeToStop_de-fault	Determined braking time in "default" direction of movement.	20215	59	ms
Distan-ceToStop_default	Determined braking distance in "default" direction of movement.	20215	60	×0.01 AE
TimeToStop_in-vers	Determined braking time in "inverse" direction of movement.	20215	61	ms
Distan-ceToStop_invers	Determined braking distance in "inverse" direction of movement.	20215	62	×0.01 AE
SpeedTimeBase	Value set in the application module for the time base of the user unit. • 0: Minute • 1: Second	20215	63	
UserUnit	Value set in the application module for the user units (decimal). The transferred value must be converted in ASCII.	20215	64 – 66	
TestVelocityD	Set test velocity for dynamic brake diagnostics.	20215	67	×0.01 AE

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Operation and diagnostics

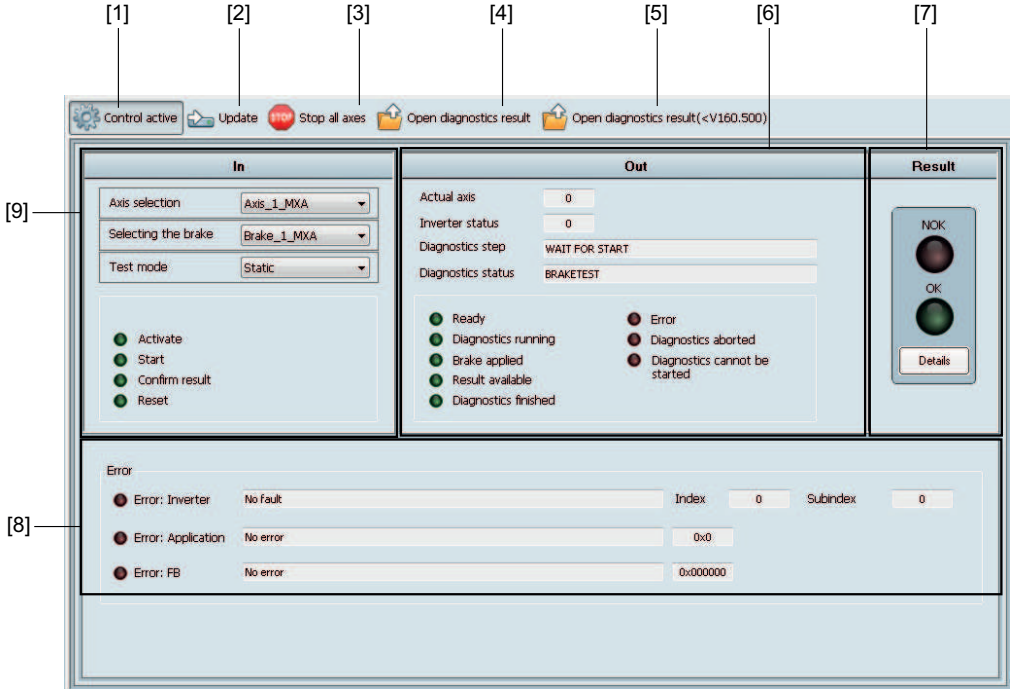
The functions for operation and diagnostics of the application module are integrated in the "Application Configurator" software, from where they are called.

For detailed information about the procedure, refer to the documentation (manual or online help) of the Application Configurator.

6.1.8 Module diagnostics

The Application Configurator offers a module diagnostics function for many application modules and function modules. In this way you obtain specific diagnostic information about the process data interface, operating states and errors of the respective module.

To open the module diagnostics, click the [Diagnostics] button in the Application Configurator start window. The "Module diagnostics" window opens. Select brake diagnostics or the required axis and click the [Module diagnostics] button. The following figure is displayed on the "Module diagnostics: Brake diagnostics" window.



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No.	Button/group	Description
[1]	[Monitor active] / [Control active] button	Switches between control mode and monitor mode.
[2]	[Update] button	The [Update] button is only enabled in control mode. Use this button to send all control signals and setpoints to the higher-level controller.
[3]	[Stop all axes] button	Use this button to stop all axes (e.g. in case of danger). Deceleration is carried out via the emergency stop ramp. **Information:** The [Stop all axes] button is only enabled in control mode and does not replace the emergency off switch on the machine/plant.

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No.	Button/group	Description
[4]	[Open diagnostics result] button	You can open reports of already performed brake diagnostics. For more information, refer to the section "Opening diagnostics result".
[5]	[Open diagnostics result (< V160.500)] button	You can open reports of already performed brake diagnostics. For more information, refer to the section "Opening diagnostics result (< V160.500)".
[6]	"Out" group	In the "Out" group, the module diagnostics reports the inverter status and the brake diagnostics status. The following display options are available: • “Actual axis” display field Displays the activated axis. • "Inverter status" display field Displays the inverter status. For details on the inverter state, refer to the operating instructions of the inverter. • "Diagnostics status" display field Displays the brake diagnostics status. The single LEDs may have the following status: • LED off: inactive • LED lights up green: active • LED lights up red: Group error The LEDs have the following meaning: • "Ready" LED Indicates operational availability. • "Diagnostics running" LED Indicates ongoing brake diagnostics. • "Brake applied" LED Indicates that the selected brake is applied via brake control interruption. • "Result available" LED Indicates that a brake diagnostics result is available. • "Diagnostics finished" LED Indicates that brake diagnostics is completed. • "Error" LED Indicates that a group error is present. • "Diagnostics aborted" LED Indicates that brake diagnostics was aborted. • "Diagnostics cannot be started" LED Indicates that brake diagnostics cannot be started.

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No.	Button/group	Description
[7]	"Result" group	The module diagnostics signals the brake diagnostics result. • Red LED "NOK" If the "NOK" LED lights up red, brake diagnostics was not passed. **Information:** The safe application state must be maintained until the error has been corrected and the static brake diagnostics was performed with the result "OK". • Green LED "OK" If the "OK" LED lights up green, brake diagnostics was passed. • [Details] button Click the [Details] button to display the result data for the currently performed brake diagnostics.
[8]	"Error" group	In the "error" group, the module diagnostics reports the following errors: • "Error: Inverter" display field Displays inverter error with index and subindex. • "Error: Application" display field Display application module error. • "Error: FB" display Displays an error in the brake diagnostics function block.

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No.	Button/group	Description
[9]	"In" group	In the "In" group, you control the configured brake diagnostics. The following item options are available: • "Axis selection" drop-down list Select the axis for which you want to perform brake diagnostics. • "Selecting the brake" drop-down list Select the brake you want to test using brake diagnostics. • "Test mode" drop-down list Select the brake diagnostics type that is to be performed. Activate the control signals of the inverter by clicking the respective LED (only possible in control mode). Click [Update] to transfer the control signals to the controller. • LED off: inactive • LED lights up green: active The LEDs have the following meaning: • "Activate" LED Activates brake diagnostics. • "Start" LED Starts brake diagnostics. • "Confirm result" LED Confirm the present brake diagnostics result. • "Reset" LED Resets all pending error of brake diagnostics.

Detailed diagnostics result

After successful brake diagnostics, you can open the detailed diagnostics results via the [Details] button.

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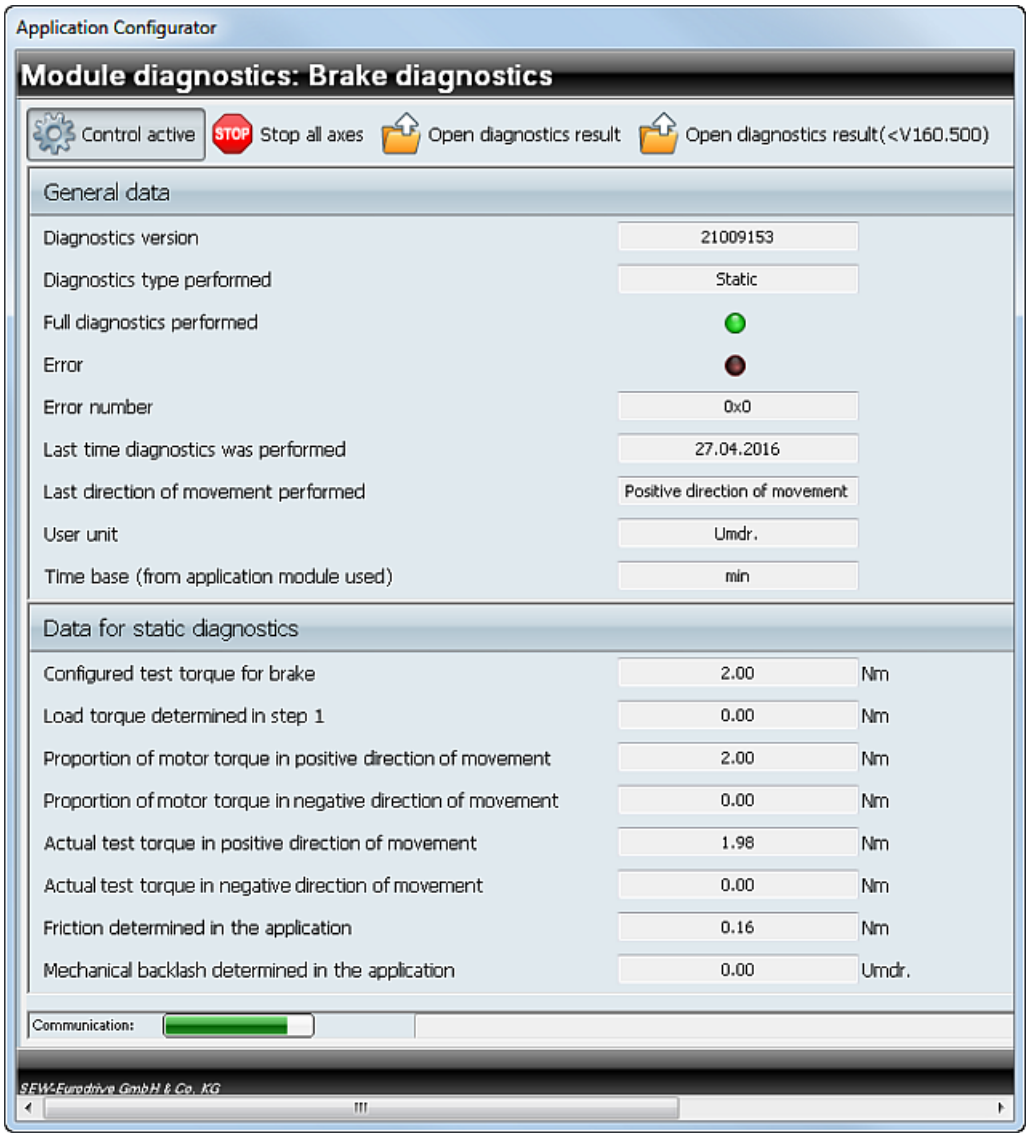
Detailed result data of static brake diagnostics

The following figure shows an example of the detailed result data of static brake diagnostics.



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Display field / LED / Group	Description
"General data" group	Displays the general data of the performed brake diagnostics.
"Diagnostics version" display field	Displays the version number of the function block.
"Diagnostics type performed" display field	Displays the performed type of diagnostics: • Static • Dynamic
"Full diagnostics performed" LED	• LED off: Brake diagnostics was not performed completely. • LED lights up green: Brake diagnostics was performed completely.

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Display field / LED / Group	Description
"Error" LED	• LED off: Brake diagnostics was performed without error. • LED lights up red: An error occurred during brake diagnostics (see error number").
"Error number" display field	Displays the error number.
"Last time diagnostics was performed" display field	Displays date and time of the last time a brake diagnostics was performed.
"Last direction of movement performed" display field	Displays the direction of movement during the last brake diagnostics.
"User unit" display field	Displays the user unit from the used application module.
"Time base (from application module used)" display field	Displays the time base from the used application module.
"Data for static diagnostics" group	Displays the result data of the static brake diagnostics.
"Configured test torque for brake" display field	Displays the configured test torque.
"Load torque determined in step 1" display field	Displays the determined load torque.
"Proportion of motor torque in positive direction of movement" display field	Displays the test torque that must be additionally generated by the motor in positive direction of movement.
"Proportion of motor torque in negative direction of movement" display field	Displays the test torque that must be additionally generated by the motor in negative direction of movement.
"Actual test torque in positive direction of movement" display field	Displays the actual test torque that was used to test the brake in positive direction of movement.
"Actual test torque in negative direction of movement" display field	Displays the actual test torque that was used to test the brake in negative direction of movement.
"Friction determined in the application" display field	Displays the determined friction in the application.
"Mechanical backlash determined in the application" display field	Displays the determined movement due to mechanical backlash during brake diagnostics.

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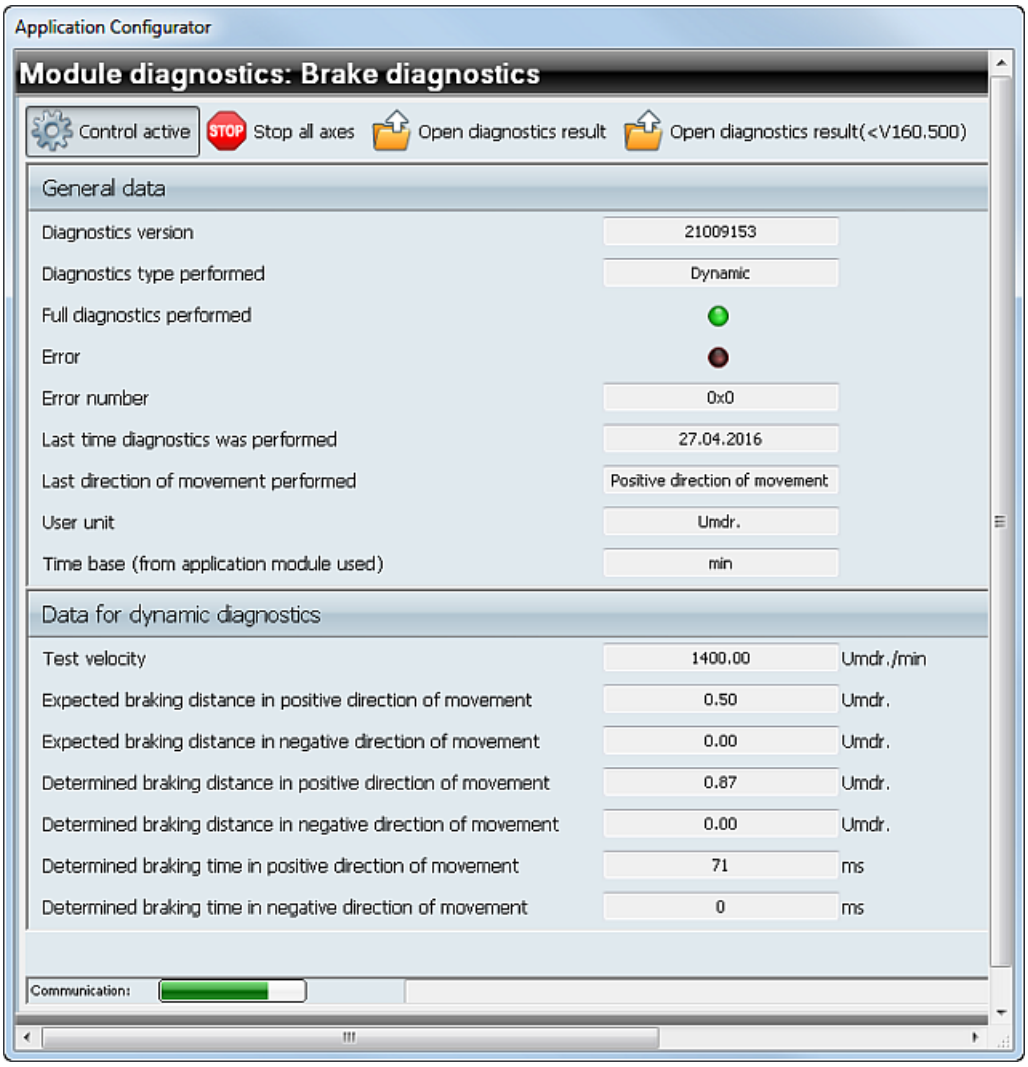
Detailed result data of dynamic brake diagnostics

The following figure shows an example of the detailed result data of dynamic brake diagnostics.



9007213742829451

Display field / LED / Group	Description
"General data" group	Displays the general data of the performed brake diagnostics.
"Diagnostics version" display field	Displays the version number of the function block.
"Diagnostics type performed" display field	Displays the performed type of diagnostics: • Static • Dynamic
"Full diagnostics performed" LED	• LED off: Brake diagnostics was not performed completely. • LED lights up green: Brake diagnostics was performed completely.

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Display field / LED / Group	Description
"Error" LED	• LED off: Brake diagnostics was performed without error. • LED lights up red: An error occurred during brake diagnostics (see error number").
"Error number" display field	Displays the error number.
"Last time diagnostics was performed" display field	Displays date and time of the last time a brake diagnostics was performed.
"Last direction of movement performed" display field	Displays the direction of movement during the last brake diagnostics.
"User unit" display field	Displays the user unit from the used application module.
"Time base (from application module used)" display field	Displays the time base from the used application module.
"Data for dynamic diagnostics" group	Displays the result data of the dynamic brake diagnostics.
"Test velocity" display field	Displays the configured test velocity.
"Expected braking distance in positive direction of movement" display field	Displays the configured braking distance in positive direction of movement.
"Expected braking distance in negative direction of movement" display field	Displays the configured braking distance in negative direction of movement.
"Determined braking distance in positive direction of movement" display field	Displays the determined braking distance in positive direction of movement.
"Determined braking distance in negative direction of movement" display field	Displays the determined braking distance in negative direction of movement.
"Determined braking time in positive direction of movement" display field	Displays the determined braking time in positive direction of movement.
"Determined braking time in negative direction of movement" display field	Displays the determined braking time in negative direction of movement.

Retrieving diagnostics result

The result of performed brake diagnostics is stored on the SD card inserted in the controller. The module diagnostics can be used to retrieve and display detailed result data of the diagnostics. If also result data from a previous version (<V160.500) are available on the SD card, they are displayed in a different way than the data from V170.100. The following figure shows how to retrieve result data of the several versions.

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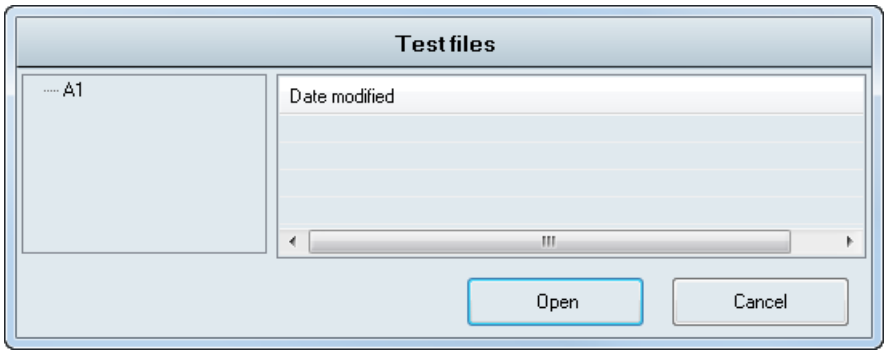
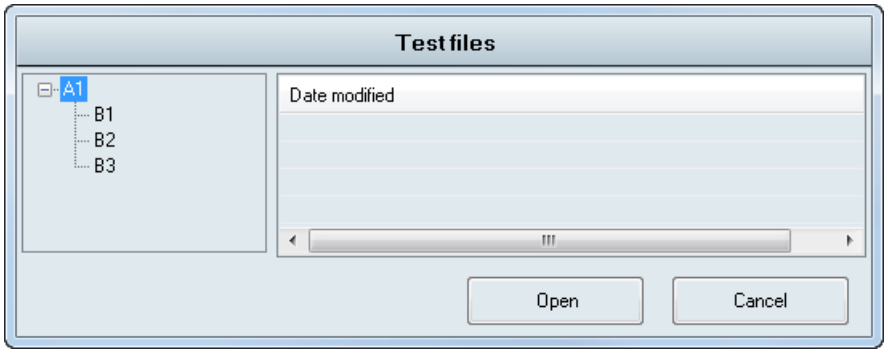
Opening diagnostics result

Click the [Open diagnostics result] button. All axes created on the SD card are displayed (see following figure).



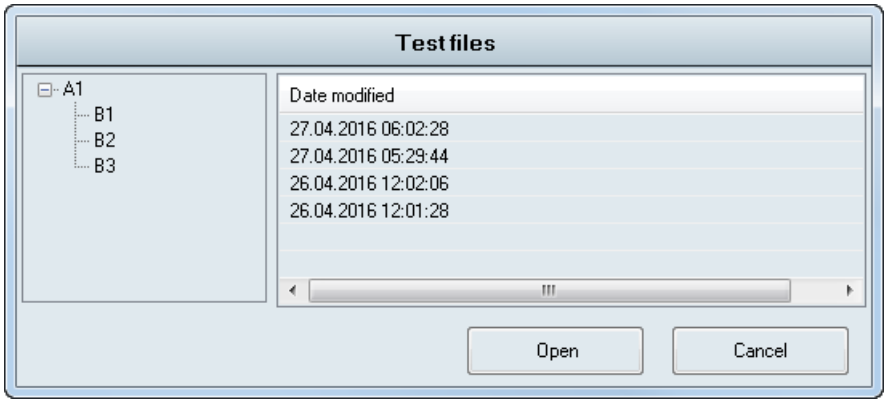
17194608395

Double click on the desired axis to read all brakes related to this axis.



18042339851

Double click on the desired brake to read the brake data.



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The results data is listed by date of creation. The file name (modification date) of the saved result data has the following structure.

Example	Meaning
A1	Axis number
B1	Brake number
27.04.2016	Date (dd.mm.yyyy)
06:02:28	Time (hh:mm:ss)

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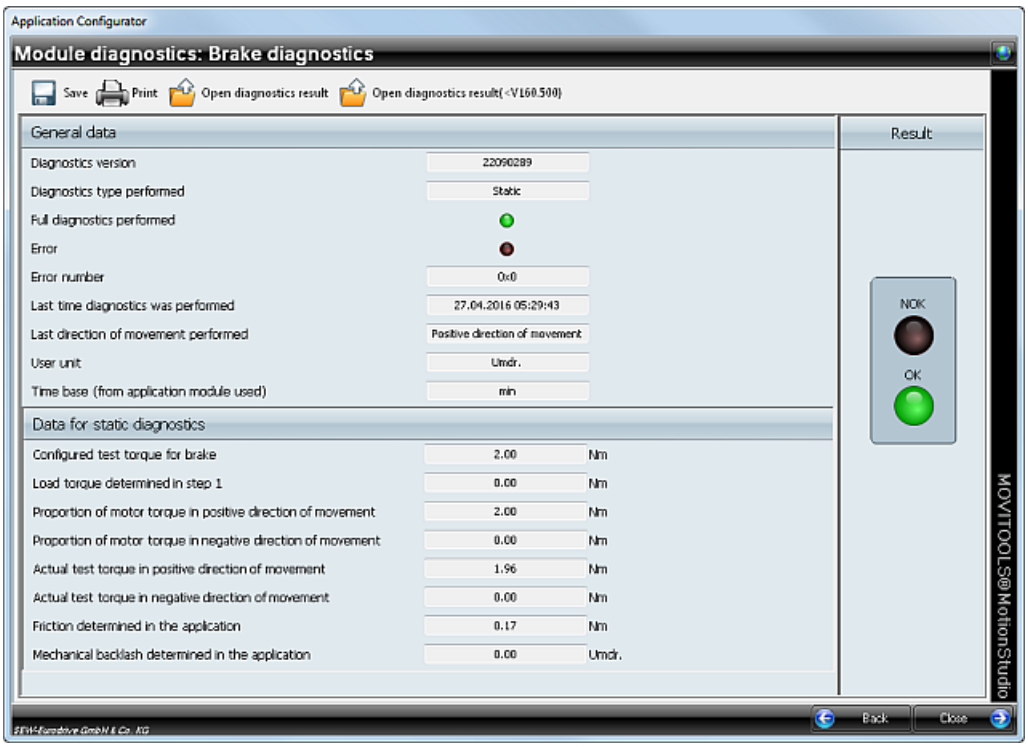
Click [Open] to open a selected result file. The following figure shows an example of the opened result file of static brake diagnostics.



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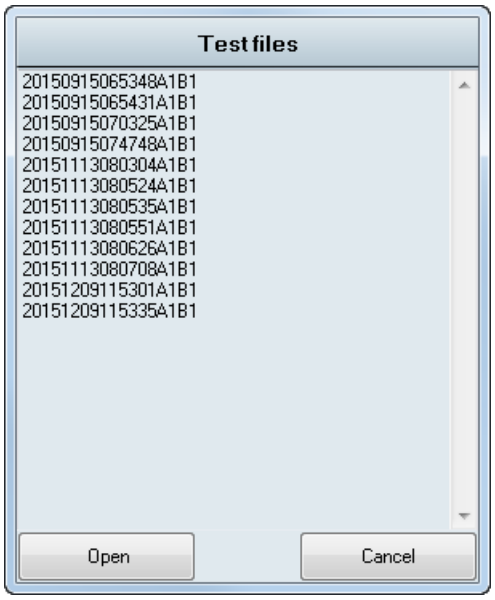
In the "result" group, the LEDs indicate if brake diagnostics (static or dynamic) was performed successfully.

- LED OK lights up green: Brake diagnostics successful
- LED NOK lights up red: Brake diagnostics not successful

Opening diagnostics result (< V160.500)

Click the [Open diagnostics result (< V160.500)] button. All results stored on the SD card are displayed (see following figure).



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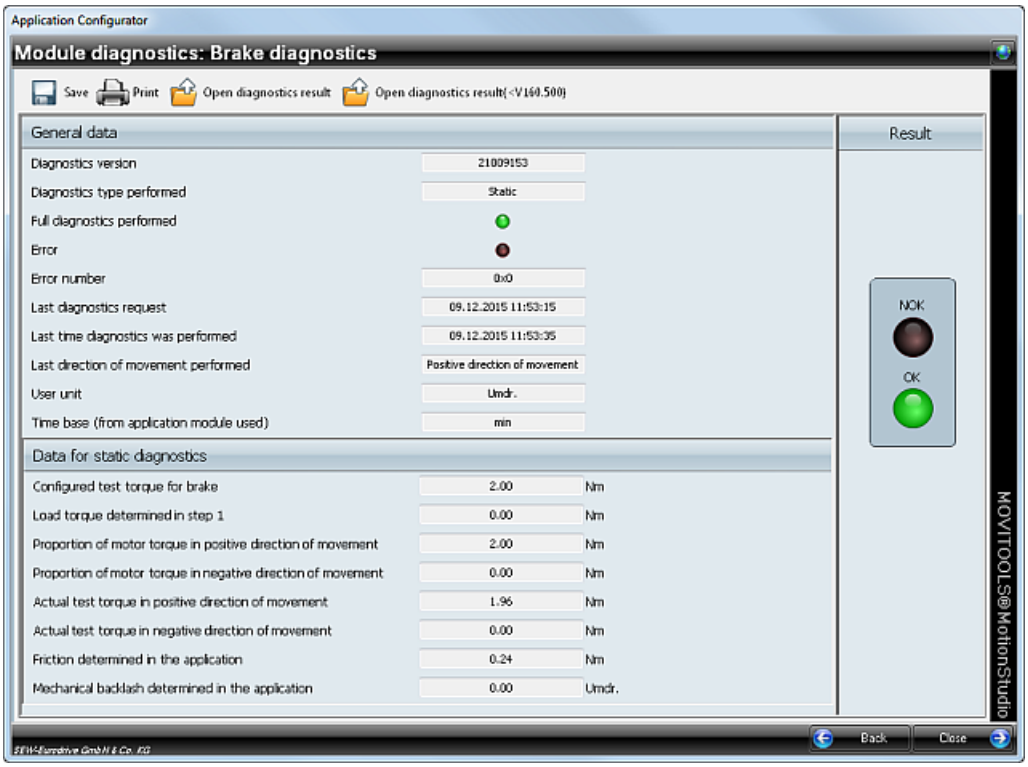
The file name of the stored result files (e.g. 20151209115335A1B1) are structured as follows.

Example	Meaning
20151209	Date (yyyymmdd)
115335	Time (hhmmss)
A1	Axis number
B1	Brake number

Click [Open] to open a selected result file. The following figure shows an example of the opened result file of static brake diagnostics.



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In the "result" group, the LEDs indicate if brake diagnostics (static or dynamic) was performed successfully.

- LED OK lights up green: Brake diagnostics successful
- LED NOK lights up red: Brake diagnostics not successful

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6.1.9 Validation

Perform a validation to complete the startup. This serves to protocol a correct behavior of the brake diagnostics, and to discover project planning mistakes or faulty settings if necessary. The validation is part of the safety-relevant validation of the entire system, especially for implementation of the brake diagnostics as diagnostics of the safety functions "Safe brake actuation (SBA)" or "Safe brake hold (SBH)".

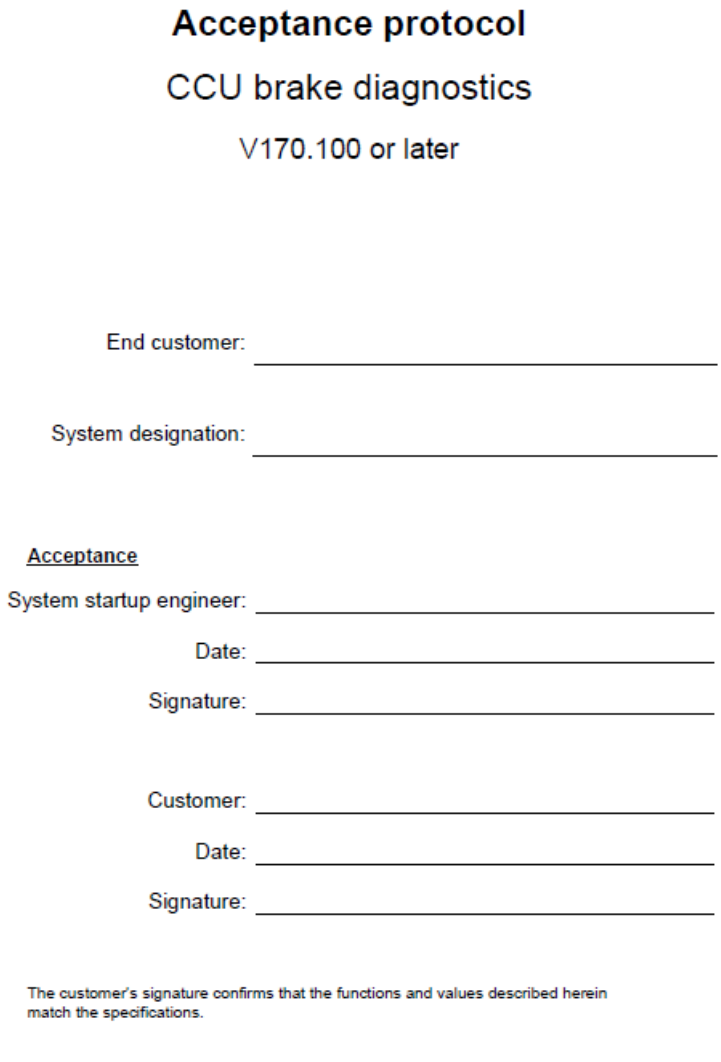
The validation is required for machine startup, as well as for changes at the software or hardware that affect the brake diagnostics. The validation must be performed by authorized personnel.

To document a successful startup, the acceptance protocol is available in the appendix (see chapter "Acceptance protocol").

The following section step-by-step describes how to fill in the acceptance protocol.

Step 1: Fill in the report header

The first page of the acceptance protocol is the report header (see following figure).



Acceptance protocol

CCU brake diagnostics

V170.100 or later

End customer: _____

System designation: _____

Acceptance

System startup engineer: _____

Date: _____

Signature: _____

Customer: _____

Date: _____

Signature: _____

The customer's signature confirms that the functions and values described herein match the specifications.

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Provide the following information in the report header:

- End customer

  Enter the name of the end customer.

- System designation

  Enter a brief system designation, for example a system name or plant reference.
- System startup engineer

  Enter the name of the first approver (system startup engineer).
- Date/signature (system startup engineer)

  With date and signature, the system startup engineer confirms that the functions and values described in the acceptance protocol meet the requirements.
- Customer

  Enter the name of the second approver (customer).
- Date/signature (customer)

  With date and signature, the customer confirms that the functions and values described in the acceptance protocol meet the requirements.

Step 2: Fill in the contact persons

Step 2 describes the section "1. Contact persons" of the acceptance protocol (see following figure).

1. Contact persons

System:		HID:		Version:	
End customer:		Phone:		Fax:	
Supplier:		Phone:		Fax:	
System startup engineer:		Phone:		Fax:	

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Provide the following information in section "1. Contact persons":

- System

  Enter a brief system designation, for example a system name, plant reference (HID) or version.
- End customer

  Enter name, telephone and fax number of the customer (user of the system).
- Supplier

  Enter name, telephone and fax number of the supplier. The supplier must be the manufacturer of the machine.
- System startup engineer

  Enter name, telephone and fax number of the company performing the startup.

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Step 3: Fill in the system description

Step 3 describes the section "2. System description" of the acceptance protocol (see following figure).

2. System description

End customer: _____

System startup engineer: _____

Installation site: _____

Startup date: _____

Functional characteristics: _____

_____

_____

_____

_____

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Provide the following information in section "2. System description":

- End customer

  Enter the name of the end customer/user of the system.
- System startup engineer

  Enter the name of the company performing the startup.
- Installation site

  Enter the country and location of the system.
- Date of startup

  Enter the startup date of the system.
- Functional description

  Enter the brake(s) to be monitored by the brake diagnostics, for example motor brake(s), double brake, etc.

Step 4: General data

Step 4 describes the section "3. General data" of the acceptance protocol (see following figure).

3. General data

Controller:	DHR 41B ☐	DHF 41B ☐	
Software module used:	Patch version:	Patch release:	
Application module used:			
Axis number:			
Axis designation:			
Device type:	MOVIDRIVE® B ☐	MOVIAXIS® ☐	
User units (AE):	_____ (unit, such as mm, m, ...)		
Time basis:	Seconds [s] ☐	Minutes [min] ☐	

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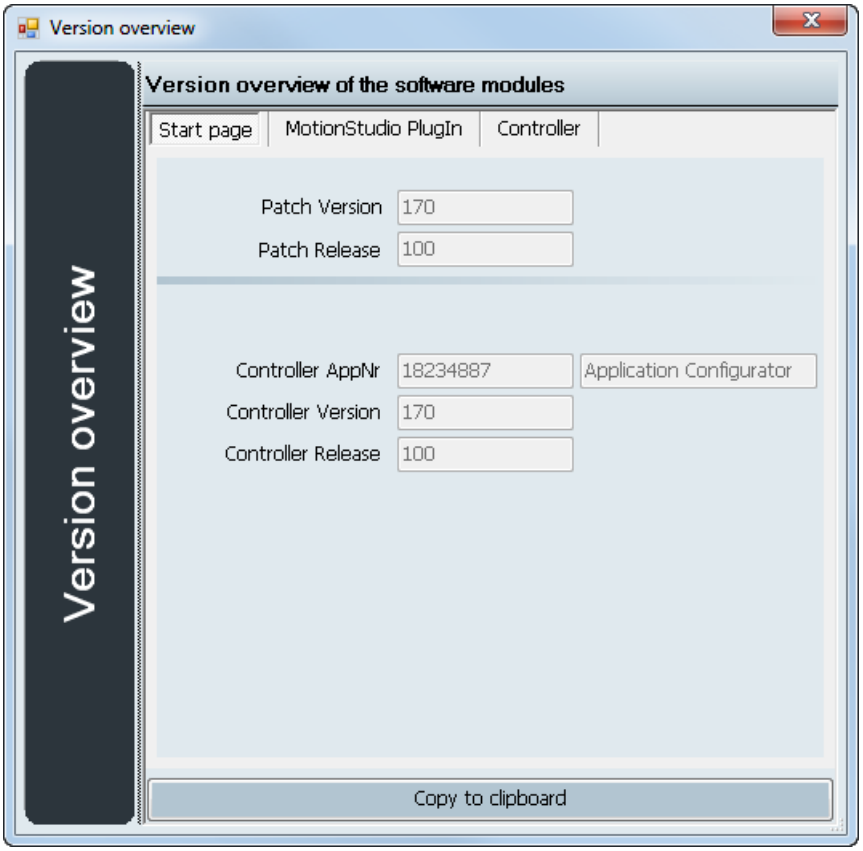
Provide the following information in section "3. General data":

- Controllers

  Select the controller type used.

- Software module used

  Enter the patch version (e.g. 170) and the patch release (e.g. 100) of the used software module. This information can be found in the version overview of the Application Configurator in the MOVITOOLS® MotionStudio engineering software (see following figure).



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- Application module used

  Enter the used application module of the axis on which the brake diagnostics is configured. In the following example: Universal module 6PD.

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- Axis number

  Enter the axis number (e.g. 1) of the axis on which the brake diagnostics is configured.

- Axis designation

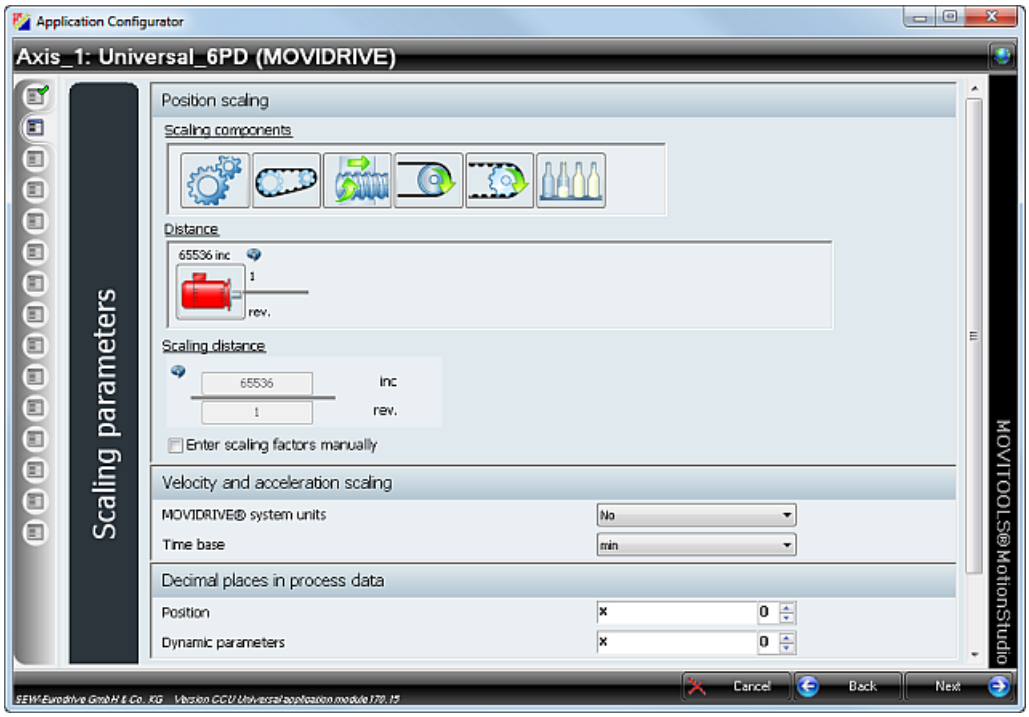
  Enter the name (e.g. lifting axis) of the axis on which the brake diagnostics is configured.

- Device type

  Select the device type used.

- User unit (AE)

  Enter the user units (scaling parameters) set in the application module. In the following example the user unit (AE) "Rev." and the time basis "min" are selected.



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Step 5: Fill in the configuration

In Step 5, enter the present settings of the relevant configuration window in section "4. Configuration".

Step 6: Function of brake diagnostics

Step 6 describes the section "5. Function of brake diagnostics" of the acceptance protocol (see following figure).

5. Function of brake diagnostics

Limit values determined as expected:	Yes ☐	No ☐	
Message sent to higher-level system as expected:	Yes ☐	No ☐	
Brake diagnostics function as expected:	Yes ☐	No ☐	

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Provide the following information in section "5. Function of brake diagnostics":

- Limit values are determined as expected (Yes/No)

  Enter if the limit values are recognized as expected. It is recommended to perform a failure simulation to test the brake on NOK. A specific adjustment to the brake diagnostics settings can lead to a violation to the limit value, for example an increased test torque.
- Message sent to higher-level system as expected (Yes/No)

  Enter if the messages to the higher-level system are as expected, for example feedback OK, NOK; transfer of optional data.
- Brake diagnostics function as expected (Yes/No)

  Enter if the brake diagnostics functions as expected.

⚠ WARNING

Changing the setting values for validation can influence the safety functions of the brake (safe brake actuation, safe brake hold).

Severe or fatal injuries

- After the validation is complete, check the brake diagnostics setting values and correct them if necessary.

6.2 MOVI-PLC® function block

Brake diagnostics is included in the "MPLCAdditionalFunctionHandler" library as MC_BrakeTestV2_MDX/MC_BrakeTest_MX function block.

6.2.1 Startup

For correct configuration and startup of brake diagnostics as PLC function block, contact SEW-EURODRIVE.

The following chapters briefly describe the interfaces and parameters of the function block.

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Information

The following additions are required for MultiMotion Light:

- Libraries
  MPLCAdditionalFunctionHandler.lib
  MPLCAdditionalFunctionHandler_Internal.lib
- Structure
  AddFuncHandler: ST_AddFuncHandler

6.2.2 Interfaces of the function block

Inputs

Inputs	Type	Meaning
Enable	BOOL	• 1: Start brake diagnostics • 0: Stop/Cancel brake diagnostics
Confirm	BOOL	Confirm result data via higher-level controller.
BrakeTestRequired	BOOL	No function.
AxisNumber	UINT	The *axis number* input signal specifies the motor axis for which brake diagnostics is to be executed.
TestConfig	STRUCT	MC_BRAKETESTCONFIGV2_MDX MC_BRAKETESTCONFIG_MX Configuration data for brake diagnostics.
TestDiag	STRUCT	MC_BRAKETESTDIAGV2_MDX MC_BRAKETESTDIAG_MX Displays the current diagnostics step.
TestLogData	STRUCT	MC_BRAKETESTLOGV2_MDX MC_BRAKETESTLOG_MX Result data of last brake diagnostics.

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Outputs

Outputs	Type	Meaning
Done	BOOLEAN	Brake diagnostics state. • 0: Brake diagnostics not active or not completely finished • 1: Brake diagnostics completed
Busy	BOOLEAN	Brake diagnostics state. • 0: Brake diagnostics not active • 1: Brake diagnostics active
Save	BOOLEAN	State if result is available. • 0: Result not available • 1: Result available
BrakeTestAborted	BOOLEAN	State if brake diagnostics is canceled. • 0: No cancellation • 1: Brake diagnostics aborted during execution
BrakeClose	BOOLEAN	State brake control interruption. • 0: Output not switched (no interruption) • 1: Output switched (interruption)
Status	BOOLEAN	State if diagnostics execution is canceled. • 0: Diagnostics not started or not cancellation • 1: Diagnostics canceled
StatusID	DWORD	Output of error number in case of diagnostics cancellation.
Error	BOOLEAN	State if internal function block error is present. • 0: No error • 1: Internal function block error present
ErrorID	DWORD	Output of error number of the internal function block error.
MvlReturnCode	DWORD	Output of error number in case of MOVILINK® error.
TestConfig	STRUCT	MC_BRAKETESTCONFIGV2_MDX MC_BRAKETESTCONFIG_MX Configuration data for brake diagnostics.
TestDiag	STRUCT	MC_BRAKETESTDIAGV2_MDX MC_BRAKETESTDIAG_MX Displays the current diagnostics step.
TestLogData	STRUCT	MC_BRAKETESTLOGV2_MDX MC_BRAKETESTLOG_MX Result data of last brake diagnostics.

Cycle diagram

Observe the information in sub-chapter "Cycle diagram" (→ 🗎 49) of the main chapter "Brake diagnostics as CCU function module".

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INFORMATION

- Make sure that brake diagnostics responds with *Diagnostics complete* (O3:6) before successfully completing the control. This applies for fault-free and faulty operation.
- The brake diagnosis actively changes parameters in MOVIDRIVE® B / MOVIAXIS®. The changes are reset automatically at the end of the brake diagnostics process. In case of voltage failure, the changes are lost and the startup settings are reset.

6.2.3 TestConfig parameters

General parameters (for static and dynamic brake diagnostics)

TestType	
Data type	INT
Unit	–
Setting range	1 or 4
Default value	–
Description	Selecting the type of diagnostics. • 1: Static brake diagnostics • 4: Dynamic brake diagnostics
Data source	User specification.

TestCoverage	
Data type	BOOL
Unit	–
Setting range	0 or 1
Default value	0
Description	Scope of brake diagnostics. Specifies if the brake is tested in one direction of movement or both directions of movement. If brake diagnostics in both directions of movement is selected, step 3 is repeated in opposite direction of movement. • 0: Brake diagnostics in one direction of movement • 1: Brake diagnostics in both directions of movement
Data source	User specification.

DefaultTestDirection	
Data type	BOOL
Unit	–
Setting range	0 or 1
Default value	0

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DefaultTestDirection	
Description	First direction of movement during brake diagnostics. • 0: Default setting (Direction of movement according to user unit in MOVIDRIVE® B / MOVIAXIS®). • 1: Inverse (Direction of movement opposite to user unit in MOVIDRIVE® B / MOVIAXIS®).
Data source	User specification.

TestVelocity	
Data type	LREAL
Unit	User unit (AE)
Setting range	>0.0
Default value	1.0
Description	Setpoint for travel and positioning movement.
Data source	User specification.

Acceleration	
Data type	LREAL
Unit	ms
Setting range	>0.0
Default value	0.0
Description	Time to accelerate to *TestVelocity*.
Data source	User specification.

Deceleration	
Data type	LREAL
Unit	ms
Setting range	>0.0
Default value	0.0
Description	Stop ramp for *TestVelocity*.
Data source	User specification.

ControlWaitTime	
Data type	DINT
Unit	0.1 s
Setting range	0 – 50
Default value	10
Description	Waiting time until next diagnostics step after movement or possible movement via brake diagnostics.
Data source	User specification. Test during startup.

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Parameters for static brake diagnostics

SpeedFilter	
Data type	DINT
Unit	0.1 s
Setting range	0 – 50
Default value	10
Description	Measuring time to determine the load.
Data source	User specification.

AmbienceTemperature	
Data type	LREAL
Unit	°C
Setting range	-60.0 to +100.0 °C
Default value	0.0
Description	Average ambient temperature of the motor for which brake diagnostics is performed.
Data source	Project planning of the application.

MaxDistance	
Data type	LREAL
Unit	User unit (AE)
Setting range	>0
Default value	0.0
Description	Tolerated travel movement in step 1. Travel movements exceeding the value result in cancellation of brake diagnostics.
Data source	Project planning of the application.

Backlash	
Data type	LREAL
Unit	User unit (AE)
Setting range	>0
Default value	5.0
Description	Tolerated movement due to mechanical backlash during brake diagnostics.
Data source	Project planning of the application.

TorqueConstant	
Data type	LREAL
Unit	Nm/A
Setting range	0.00 – 99.00
Default value	1.0

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TorqueConstant	
Description	• Asynchronous motors: Motor-specific torque constant k_T. • Synchronous motors: User must calculate the torque constant k_T (based on M_0/I_0).
Data source	• Asynchronous motors: MOVIDRIVE® MDX60B/61B system manual. • Synchronous motors: "Synchronous Servomotors" operating instructions or specifications on the motor nameplate.

TestTorque	
Data type	LREAL
Unit	Nm
Setting range	1 – 4000
Default value	1
Description	Test torque used for testing the brake during brake diagnostics.
Data source	User specification.

RampSwitchOnTorque	
Data type	DINT
Unit	0.1 s
Setting range	10 – 200
Default value	50
Description	Time to generate test torque in step 3.
Data source	SEW-EURODRIVE recommends to adopt the start ramp of project planning.

PositionTolerance1	
Data type	LREAL
Unit	User unit (AE)
Setting range	>0
Default value	10.0
Description	Positional tolerance in step 2. If the movement exceeds the *PositionTolerance1*, brake diagnostics is canceled and issues an error message.
Data source	Project planning of the application.

PositionTolerance2	
Data type	LREAL
Unit	User unit (AE)
Setting range	>0
Default value	10.0

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PositionTolerance2	
Description	Positional tolerance in step 3. If the movement exceeds the *PositionTolerance2*, brake diagnostics is canceled and issues an error message.
Data source	Project planning of the application.

Parameters for dynamic brake diagnostics

StopDistanceReference_Default	
Data type	LREAL
Unit	User unit (AE)
Setting range	>0
Default value	1
Description	Braking distance to be expected under the defined test conditions (motor speed, load, etc.) in "default" direction of movement.
Data source	Project planning of the application. SCOPE recording during startup if necessary.

StopDistanceReference_Invers	
Data type	LREAL
Unit	User unit (AE)
Setting range	>0
Default value	1
Description	Braking distance to be expected under the defined test conditions (motor speed, load, etc.) in "inverse" direction of movement.
Data source	Project planning of the application. SCOPE recording during startup if necessary.

StopDistanceToleranceLong	
Data type	LREAL
Unit	User unit (AE)
Setting range	>0
Default value	1
Description	Tolerated exceeding of the expected braking distance. This value applies to both directions of movement (default and inverse). Exceeding the value results in an brake diagnostics error.
Data source	Project planning of the application. SCOPE recording during startup if necessary.

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6.2.4 TestLogData parameters

General parameters (for static and dynamic brake diagnostics)

VersionNumber	
Data type	DWORD
Unit	–
Description	Version number of the module.

TestType	
Data type	INT
Unit	–
Description	Performed type of diagnostics. • 1: Static brake diagnostics • 4: Dynamic brake diagnostics

BrakeTested	
Data type	BOOL
Unit	–
Description	Result whether brake diagnostics has been completely successfully. • 0: Brake diagnostics not completed • 1: Brake diagnostics completed

DirectionTested	
Data type	BYTE
Unit	–
Description	Result which direction of movement was tested last. • 0: No brake diagnostics was performed • 1: Brake diagnostics was performed in "default" direction of movement • 2: Brake diagnostics was performed in "inverse" direction of movement

LastCheckup	
Data type	DT
Unit	–
Description	Date and time of the last brake diagnosis. Time stamp is set to *BrakeTested = 1*.

TestResult	
Data type	BYTE
Unit	–

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TestResult	
Description	Brake diagnostic result. • 0: No result available • 1: NOK – Diagnostics not successful • 4: OK – Diagnostics successful

Status	
Data type	BOOL
Unit	–
Description	Result whether an error occurred during brake diagnostics. • 0: No fault • 1: Fault

StatusID	
Data type	DWORD
Unit	–
Description	Error number, e.g. F004.

Parameters for static brake diagnostics

LoadTorque	
Data type	DINT
Unit	0.01 Nm
Description	Determined load torque.

RequiredTorque	
Data type	DINT
Unit	0.01 Nm
Description	Required test torque.

AdditionalTorque_default	
Data type	DINT
Unit	0.01 Nm
Description	Torque that must be additionally generated by the motor in "default" direction of movement.

AdditionalTorque_invers	
Data type	DINT
Unit	0.01 Nm
Description	Torque that must be additionally generated by the motor in opposite direction of movement (inverse).

EffectiveTorque_default	
Data type	DINT
Unit	0.01 Nm

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EffectiveTorque_default	
Description	Actual test torque used to test the brake in "default" direction of movement.

EffectiveTorque_invers	
Data type	DINT
Unit	0.01 Nm
Description	Actual test torque used to test the brake in opposite direction of movement (inverse).

Backlash	
Data type	DINT
Unit	User unit (AE).
Description	Determined movement due to mechanical backlash during brake diagnostics.

Friction	
Data type	DINT
Unit	0.01 Nm
Description	Determined friction of the application during brake diagnostics.

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Parameters for dynamic brake diagnostics

StopDistanceReference_Default	
Data type	LREAL
Unit	User unit (AE).
Description	See *StopDistanceReference_Default* in section "TestConfig parameters". The input value is adopted in *TestLogData*.

StopDistanceReference_Invers	
Data type	LREAL
Unit	User unit (AE).
Description	See *StopDistanceReference_Invers* in section "TestConfig parameters". The input value is adopted in *TestLogData*.

TimeToStop_Default	
Data type	DINT
Unit	ms
Description	Determined braking time under configured diagnostics conditions. "Default" direction of movement refers to the direction according to startup of MOVIDRIVE® B / MOVIAXIS®.

DistanceToStop_Default	
Data type	LREAL
Unit	User unit (AE).
Description	Determined braking distance under configured diagnostics conditions. "Default" direction of movement refers to the direction according to startup of MOVIDRIVE® B / MOVIAXIS®.

DistanceToStop_Default	
Data type	LREAL
Unit	User unit (AE).
Description	Determined braking distance under configured diagnostics conditions. "Default" direction of movement refers to the direction according to startup of MOVIDRIVE® B / MOVIAXIS®.

TimeToStop_Invers	
Data type	DINT
Unit	ms
Description	Determined braking time under configured diagnostics conditions. "Inverse" direction of movement refers to the direction according to startup of MOVIDRIVE® B / MOVIAXIS®.

DistanceToStop_Invers	
Data type	LREAL
Unit	User unit (AE).
Description	Determined braking distance under configured diagnostics conditions. "Inverse" direction of movement refers to the direction according to startup of MOVIDRIVE® B / MOVIAXIS®.

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SpeedTimeBase	
Data type	DINT
Unit	–
Description	Time base for user units. • 0: Minutes • 1: Seconds

UserUnit	
Data type	ASCII
Unit	–
Description	User unit for application.

TestVelocityD	
Data type	LREAL
Unit	User unit (AE).
Description	Set test velocity for dynamic brake diagnostics.

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7 Appendix

7.1 Error list

No.	Error message	Possible cause	Measure
01	Motor torque insufficient for diagnostics.	Motor is unable to provide the required test torque.	• Check input values of brake diagnostics and at frequency inverter. • Check test direction in hoist. • Check test environment (base load) • Drive/frequency inverter must be dimensioned bigger.
02	Movement in step 1 not sufficient.	Drive could not be moved sufficiently.	• Check whether motor is supplied. • Check if drive runs freely. • Check if brake is released.
		Adapt parameterization.	• Increase acceleration. • Increase maximum travel distance. • Reduce the speed.
03	Positional tolerance in step 2 exceeded.	Positional tolerance in step 2 was exceeded.	• Check if brake closes. • Check whether the brake lining is worn or dirty. • Check mechanical backlash of application and adapt parameters if necessary.
04	Positional tolerance in step 3 exceeded.	Positional tolerance in step 3 was exceeded.	• Check the interruption of the DB00 brake control. • Check whether the brake lining is worn or dirty. • Brake maintenance is required.
		The actual test torque was to low (< 90%).	• Check input values at the frequency inverter. • Was frequency inverter switched off during active brake diagnostics?
05	Invalid configuration.	Configuration is not plausible.	Positional tolerance must be smaller than 0.9 × maximum travel distance.

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No.	Error message	Possible cause	Measure
06	Drive in wrong operating mode.	Operating mode of frequency inverter is not compatible.	CFC or SERVO operating mode required.
07	–	Reserved	–
08	–	Reserved	–
09	Maximum braking distance exceeded.	Only with dynamic brake diagnostics. The maximum braking distance was exceeded.	• Check diagnostics conditions (speed, load) • Check whether the brake lining is worn or dirty. • If required, perform brake maintenance.
10	Brake diagnostics was canceled.	Active brake diagnostics was canceled.	–
11	Axis is not referenced.	The axis to be tested is not referenced.	–
12	Diagnostics result could not be saved.	The diagnostics result could not be saved on the SD card.	Check if write protection is active on SD card.
13	Configuration not compatible.	The selected configuration is not compatible to the present version.	Configure the diagnostics with the present version.
21	Type of diagnostics not configured.	The selected type of diagnostics is not configured.	–
22	Type of diagnostics not implemented.	The selected type of diagnostics is not implemented.	–
240	Controller inhibit required.	To activate brake diagnostics, the axis must be in "controller inhibit" state.	–
241	No communication with axis.	No communication between controller and frequency inverter of axis.	–
242	The selected axis is not supported by brake diagnostics.	Frequency inverter or application module is not compatible to brake diagnostics.	–

7.2 Program state

The program state (O3) of brake diagnostics can be read in the process data monitor (see chapter "Fieldbus interface") in the fieldbus output data. The program state indicates the current step that is currently performed by brake diagnostics.

Program state	Text	Description
0	Wait For Start	Brake diagnostics ready to start.

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Program state	Text	Description
5	Check Operation Mode	Operating mode of frequency inverter is checked.
10	Wait For Enable	Waiting for frequency inverter enable.
12	Test Velocity	Acceleration to test velocity (for dynamic brake diagnostics).
13	Save Param V2	Saving frequency inverter parameters.
15	Check Settings	Configuration plausibility.
17	Wait 17	Activation of position control.
20	Act Torque	Determining the current load condition.
32	Check Torque	Check plausibility of required test torque.
34	Speed	Step 1 of static brake diagnostics.
35	Wait 35	Waiting for duration of set waiting time.
70	Brake Close	Step 2 of static brake diagnostics.
80	Brake Test	Step 3 of static brake diagnostics.
85	Brake Test NIO	Brake diagnostics result NOK.
100	Brake Test Dir IO	For diagnostics in both directions of movement: Diagnostics in first direction of movement OK.
105	Brake Test IO	Brake diagnostics result OK.
200	Brake Test Evaluation	Creating log data, waiting for user approval.
210	Restore Param	Storing parameters back in frequency inverter.
220	Brake Test Done	Brake diagnostics completed.

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7.3 Acceptance protocol (template)

Acceptance protocol, CCU brake diagnostics

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Acceptance protocol

CCU brake diagnostics

V170.100 or later

End customer: _____

System designation: _____

Acceptance

System startup engineer: _____

Date: _____

Signature: _____

Customer: _____

Date: _____

Signature: _____

The customer's signature confirms that the functions and values described herein match the specifications.

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Acceptance protocol, CCU brake diagnostics

1. Contact persons

System:		HID:		Version:	
End customer:		Phone:		Fax:	
Supplier:		Phone:		Fax:	
System startup engineer:		Phone:		Fax:	

2. System description

End customer: _____

System startup engineer: _____

Installation site: _____

Startup date: _____

Functional characteristics: _____

_____

_____

_____

_____

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Acceptance protocol, CCU brake diagnostics

3. General data

Controller:	DHR 41B ☐	DHF 41B ☐	
Software module used:	Patch version:	Patch release:	
Application module used:			
Axis number:			
Axis designation:			
Device type:	MOVIDRIVE® B ☐	MOVIAXIS® ☐	
User units (AE):	_____ (unit, such as mm, m, …)		
Time basis:	Seconds [s] ☐	Minutes [min] ☐	

4. Configuration

	Parameter name		Unit	Setting range	Value
General settings					
1.	Brake designation		-		
2.	Brake diagnostic type		-	Static Dynamic Static + dynamic	☐ ☐ ☐
3.	Scope of brake diagnostics		-	One direction of movement Both directions of movement	☐ ☐
4.	Direction of movement for brake diagnostics / 1. Direction of movement for brake diagnostics		-	Positive direction of movement Negative direction of movement	☐ ☐
5.	Output for interrupting brake control				
	a) For MOVIDRIVE® B				
		Avail. for first brake	-	MOVIDRIVE® B: DO 01 or MOVIDRIVE® B: DO 02	☐ ☐
		For second brake For third brake For fourth brake	-	MOVIDRIVE® B: DO 03 MOVIDRIVE® B: DO 04 MOVIDRIVE® B: DO 05	☐ ☐ ☐
	b) For MOVIAXIS®				
		For first brake For second brake For third brake For fourth brake	-	MOVIAXIS®: DO 00 MOVIAXIS®: DO 01 MOVIAXIS®: DO 02 MOVIAXIS®: DO 03	☐ ☐ ☐ ☐

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Acceptance protocol, CCU brake diagnostics

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	Parameter name	Unit	Setting range	Value
6.	Average ambient temperature of motor	°C	-60.0 … +100.0	
7.	Waiting time (t1) until the next test step	0.1 s	≥ 5	
Static brake diagnostics parameters (Step 1)				
8.	Acceleration	User units	> 0	
9.	Test velocity	User units	> 0	
10.	Deceleration	User units	> 0	
11.	Mechanical backlash of the application	User units	≥ 0	
12.	Measuring time to determine the load	0.1 s	≥ 5	
13.	Maximum travel distance	User units	≥ 0	
Static brake diagnostics parameters (Step 2)				
14.	Position tolerance in step 2	User units	≥ 0	
Static brake diagnostics parameters (Step 3)				
15.	Test torque	Nm	≥ 0.5	
16.	Motor type / motor connection	-	Asynchronous motor star ☐ Asynchronous motor delta ☐ Servomotor ☐	
17.	Torque constant kT of the motor (If asynchronous motor selected)	Nm/A	> 0	
18.	Nominal torque M_0 of servomotor (If servomotor selected)	Nm	> 0	
19.	Nominal current I_0 of servomotor (If servomotor selected)	A	> 0	
20.	Time for generating the test torque (t2)	0.1 s	≥ 10.0	
21.	Position tolerance in step 3	User units	≥ 0	
22.	Time to maintain the test torque (t3)	0.1 s	≥ 10.0	
Dynamic brake diagnostics parameters				
23.	Acceleration	User units	> 0	
24.	Test velocity	User units	> 0	
25.	Expected braking distance in positive direction of movement (s1) [1)]	User units	> 0	

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	Parameter name	Unit	Setting range	Value
26.	Expected braking distance in negative direction of movement (s2) [1]	User units	> 0	
27.	Permitted tolerance for the expected braking distance (sT)	User units	≥ 0	

[1] The combination of parameters to use is dependent on the general settings in parameters no. 3 (Scope of brake diagnostics) and no. 4 (Direction of movement for brake diagnostics).

5. Function of brake diagnostics

Limit values determined as expected:	Yes ☐	No ☐	
Message sent to higher-level system as expected:	Yes ☐	No ☐	
Brake diagnostics function as expected:	Yes ☐	No ☐	

6. Comments

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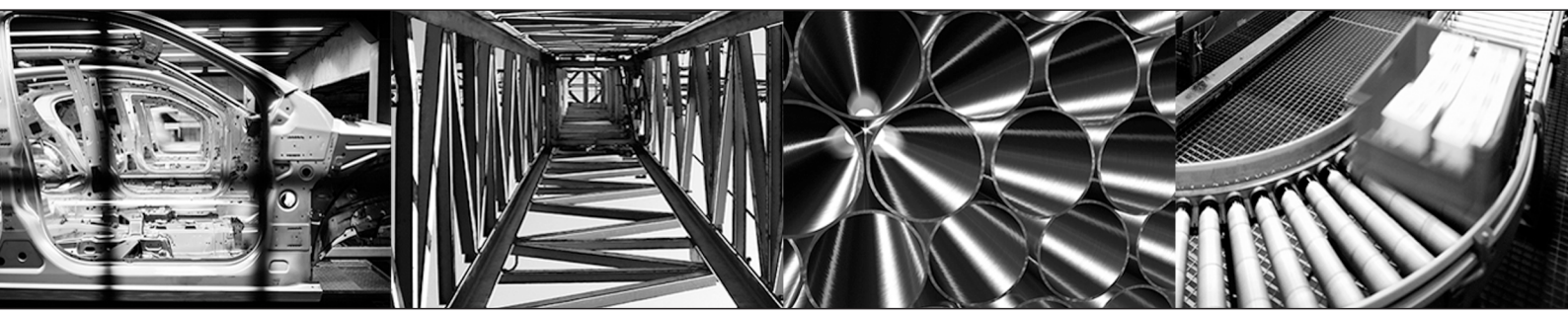

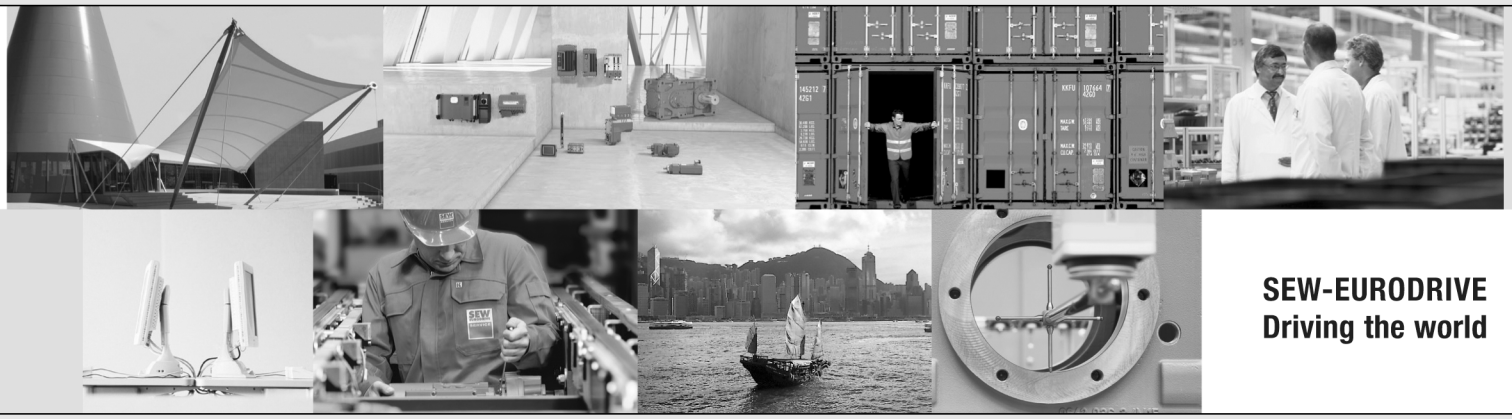

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