Validation aid for the use of ROBA®-topstop® safety brakes as a safety-related part in accordance with DIN EN ISO 13849-2

This document provides machine manufacturers with important information with respect to validating the installed ROBA®-topstop® safety brakes in accordance with DIN EN ISO 13849-2.

Validity

This validation aid applies exclusively to the named types in standard design, as well as approved special designs. Special designs deviate from the standard and can be identified by the suffix "S" in the type name.

Use the 7-digit *mayr*® article number to ask *mayr*® power transmission whether this validation aid is approved for your special design.

The validation aid applies to the following types:

Construction size	Types
All	899.0_ _._ _
	899.1_ _._ _
	899.3_ _._ _
	8990._ _ _ _ _
	8991._ _ _ _ _
	8993._ _ _ _ _

Safety Parameters

The following safety parameters are required for calculating the performance level:

- ❑ $B10_d$ - Medium number of cycles until 10 % of the components have failed dangerously

Construction size	$B10_d$ switching cycles
100	15 000 000
120	15000000
150	15000000
175	10 000 000
200	10000000
230	5 000 000
260	5000000

The **$B10_d$** value states the medium number of cycles until 10% of the brakes have failed dangerously. The $B10_d$ value for the ROBA®-topstop® brakes refers to the mechanical switching procedure, i.e. the movement of the armature disk and the application of the spring force.
Attention: It does not include the braking torque or the wear on the rotor.

The $B10_d$ value is a statistical value that does not indicate any guaranteed lifetime or failure-free period. The brake provides no single error reliability. A fault, and the resulting loss of braking torque, is possible.

- ❑ T_M – service life – period covering the equipment's prescribed useful life

  T_M = 20 years

  To ensure that the brake is functioning correctly over its period of application, regular inspections or maintenance tasks are necessary. These activities concern the rotor, the brake mounting and the shaft-hub connection. Refer to the original operating instructions for specific information on inspections, maintenance tasks and wear tests.

Category according to DIN EN ISO 13849-1

Determining the required category according to DIN EN ISO 13849-1 depends on the specific application and is therefore the responsibility of the user.

The ROBA®-topstop® safety brake has been designed in such a way that it meets the requirements of category 1 according to DIN EN ISO 13849-1. Dimensioning and use of the brake in accordance with the original operating instructions must be ensured here.
The relevant fundamental and established safety principles, according to DIN EN ISO 13849-2 for mechanical systems, are applicable to the electromagnetic ROBA®-topstop® safety brakes, see annex.

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Tried and tested springs and screw connections are also used.

mayr® power transmission has plenty of experience dealing with numerous types of brakes that have been designed and manufactured according to the same principles and used successfully in a wide range of applications over many years. Different and more challenging conditions (additional requirements) require an agreement with the manufacturer in accordance with VDE 0580.

Dimensioning

To ensure safe and reliable braking and correct operation of ROBA®-topstop® safety brakes, the following is required: adequate dimensioning in accordance with the original operating instructions, intended use, compliance with application limits and technical fringe parameters as outlined in the original operating instructions.

For this, the static holding torque, the dynamic braking torque, the speed, the friction work per braking action, the switching frequency and the braking time are to be determined so that the required load torque and test torque can be held reliably, and the required braking distance can be reliably maintained.

Refer to the original operating instructions for specific information on brake dimensioning.
mayr® power transmission, your reliable partner, is happy to assist you in selecting the correct brake dimensioning.

Test / Diagnostic

The efficacy and function of the brake is to be inspected due to the overall risk assessment to be carried out and the resulting measures for risk minimisation depending on the application case through suitable tests at appropriate time intervals.

The brake safety is generated through the braking torque. Some faults, e.g. braking torque too low due to oily friction linings, can only be detected by performing a cyclical brake test. Faults affecting the braking torque cannot be detected by the release monitoring signal.

Refer to the original operating instructions for recommendations on how to perform a brake test.

This release monitoring signal is a feedback signal of the actuator (output unit, output) ROBA®-stop safety brake as a test and monitoring measure, related to the brake component as part of the safety channel, and is used to estimate the diagnostic coverage DC in accordance with Annex E DIN EN ISO 13849-1 of the brake.

This helps detect any brake faults affecting the release of the armature disk or the energization of the brake.

We recommend a DC value of 60% for the actuator by way of release monitoring including an additional plausibility check – e.g. with the safe brake control ROBA®-SBCplus or a similar safe control unit. For higher DC values, we recommend taking further measures, e.g. a cyclical brake test. The DC values specified by the control unit manufacturers can then be applied. MTTF values are available for applications in category 2 according to DIN EN ISO 13849-1.

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Annex

Basic safety principles

Basic safety principle	Explanations
Application of suitable materials and appropriate manufacturing methods	Use of tried and tested materials and manufacturing methods
Proper dimensioning and design	Design and dimensioning according to established internal specifications
Suitable selection, combination, arrangement, assembly and installation of components / system	Use of tried and tested components and design
Application of energy-separation principle	The reliable condition is achieved through separation of the energy source, and thus accords with the required safety aspects, for example during power failure or EMERGENCY STOP. In de-energized condition, several thrust springs press against an armature disk. The rotor is clamped between the armature disk and the flange through mounted friction linings, and is braked. The rotor is positively locked to the shrink disk hub via a toothing. A magnetic force is generated in the coil carrier through application of the coil nominal voltage. The armature disk is attracted against the spring pressure to the coil carrier. The rotor becomes free and the brake is released. The shrink disk hub can rotate freely.
Suitable mounting	Dimensioning of screw connection according to established internal specifications
Limiting production and/or transmission of force and similar parameters	Braking torque tolerance, see original operating instructions
Limiting range of environmental parameters	Ambient conditions are defined in the original operating instructions.
Limitation of speed and similar parameters	Technical data according to original operating instructions • Maximum permitted radial force F_R • Maximum speed n_{max} • Permitted Switching Work $Q_{r\ zul.}$ per Braking • Permitted Friction Work $Q_{r\ ges.}$ up to Rotor Replacement • Permitted Breakdown Torque $M_{k\ zul.}$ • Max. permitted acceleration and deceleration torque M_{Beschl} on the servomotor on the brake • Max. dynamic braking torque M_{Brems} by the motor on the brake The permitted values are documented in the original operating instructions.
Suitable reaction time	Switching time according to the original operating instructions • Connection time (close) t_1 • Response delay on connection t_{11} • Separation time (release) t_2
Protected against unexpected start-up	An unexpected start-up, i.e. brake is opened, is only possible by energizing the coil. Machine manufacturers/operators must take measures to reliably prevent this from occurring. Disassembling the brake results in a loss of braking torque.
Simplification	Generation of torque according to simple principle
Separation	Use of brake only for safety-related functions under the responsibility of the machine manufacturer
Suitable lubrication	Lubrication not required – dry running Permanently lubricated, sealed bearing

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Suitable protection against penetration of liquids and dust	Protection of brakes, see original operating instructions Protection only applies to the external penetration of water and dust. The penetration of dirt from the drive end (machine side) via the shaft cannot be ruled out.

Tried and tested safety principles

Tried and tested safety principle	Explanations
Application of carefully selected materials and manufacturing methods	Use of long established materials and manufacturing methods
Use of oriented failure mode components	The most common failure behavior of brakes is described in the “Malfunctions” section of the original operating instructions.
Overdimensioning/safety factor	Dimensioning according to established internal specifications Dimensioning appropriate for the application is important!
Secured position	Movement of the armature disk with springs
Increased OFF force	Not relevant. Energy-separation principle, fail-safe principle
Careful selection, combination, arrangement, assembly and installation of components/systems for respective application	Use of tried and tested components and design The specifications contained in the “Installation” section of the original operating instructions apply to the installation of brakes by the machine manufacturer, pictures of the installation are also available. Also refer to the “Electrical Connection and Wiring” section of the original operating instructions for information on electrical connections.
Careful selection of the mounting method for the respective application	Dimensioning of screw connection according to established internal specifications Installation according to original operating instructions, see above.
Positive mechanically created effect	Functional principle safety brake
Proliferation of parts	Use of multiple springs to generate force
Application of tried and tested springs	Use of tried and tested springs, design and dimensioning in accordance with internal specifications The dimensioning of the thrust springs in the dynamic fatigue strength range avoids a loss of spring force over the lifetime of the brake. The available braking torque does not reduce by more than 20 % even if a spring fails. This is achieved through: • The use of several thrust springs • The use of thrust springs with a coil distance which is smaller than the wire diameter. In case of wire breakage, the coils cannot wind into each other. The pre-tension on the thrust spring does not reduce to an unpermitted extent and the braking torque remains guaranteed.
Reduced range of force and similar parameters	Braking torque tolerance, see original operating instructions

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Tried and tested safety principle	Explanations
Reduced range of speed and similar parameters	Technical data according to original operating instructions • Maximum permitted radial force F_R • Maximum speed n_{max} • Permitted Switching Work $Q_{r\ zul.}$ per Braking • Permitted Friction Work $Q_{r\ ges.}$ up to Rotor Replacement • Permitted Breakdown Torque $M_{k\ zul.}$ • Max. permitted acceleration and deceleration torque M_{Beschl} on the servomotor on the brake • Max. dynamic braking torque M_{Brems} by the motor on the brake The permitted values are documented in the original operating instructions.
Reduced range of environmental parameters	Ambient conditions are defined in the original operating instructions.
Reduced range of response time, hysteresis limitation	Information in original operating instructions, cyclical brake test Certain conditions can result in a loss of braking torque during operation, e.g. • aging of friction lining • Wear in the toothing • Oil contamination • Mounting to motor and machine That is why regular maintenance work / inspections must be carried out in accordance with the specifications in the original operating instructions. The brake must be checked for effectiveness and function. This must be carried out on the basis of the overall risk assessment to be conducted and the resulting measures for risk minimization, depending on the application case, through suitable tests at appropriate time intervals (brake test, safe brake management, safe brake and holding system, etc.).

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ROBA®-topstop® safety brakes are components according to VDE0580:2011-11. We are not referring to a harmonized standard in terms of European directives, but rather all references to standards are in relation to EN/IEC and ISO standards. VDE0580:2011-11 must be regarded as state of the art.

Basic safety principles

Basic safety principle	Explanations
Application of suitable materials and manufacturing methods	Long established component according to VDE 0580, CSA-approved Data according to product drawing, original operating instructions, catalog
Correct dimensioning and design	Long established component according to VDE 0580, CSA-approved Data according to product drawing, original operating instructions, catalog
Correct protective conductor connection	Where specified or labeled on plug connector or cable, see VDE0580, section 4.6 (see IEC 60204-1, 9.4.3.1)
Application of energy-separation principle	Fail-safe principle of ROBA®-stop safety brakes via safe separation of energy supply
Suppression of voltage peaks	See VDE 0580, section 4.7 Included when using mayr (fast acting) rectifiers according to specifications
Reduction in response times	Choose suitable wiring in accordance with original operating instructions
Compatibility	Long established component according to VDE 0580, CSA-approved Data according to product drawing, original operating instructions, catalog
Resistance to environmental demands	Long established component according to VDE 0580, CSA-approved Data according to product drawing, original operating instructions, catalog
Protected against unexpected start-up	Safe separation of energy supply
Control circuit protection	Safety devices in the electrical equipment according to the original operating instructions

Tried and tested safety principles	Explanations
Mechanically connected contacts	Part of the machine manufacturer's electrical equipment, in accordance with the risk analysis, in compliance with the original operating instructions
Preventing faults in cables	Separation of energy and sensor systems, short circuits or earth short-circuits do not cause the brake to release
Distances between electrical conductors	Use of suitable plugs and terminals
Limitation of electrical parameters	Limitation of current and voltage via machine manufacturer's electrical equipment in compliance with the technical data according to the original operational instructions
Preventing undefined states	Quiescent current/fail-safe principle of ROBA®-stop safety brakes via safe separation of energy supply by machine manufacturer

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Tried and tested safety principles	Explanations
Adjusting states in the event of failures	Quiescent current/fail-safe principle of ROBA®-stop safety brakes via safe separation of energy supply by machine manufacturer
Fail-over	Quiescent current/fail-safe principle of ROBA®-stop safety brakes via safe separation of energy supply by machine manufacturer Interruption, short-circuit, earth fault, together with the prescribed fuses, always result in a de-energized state = braked safe state
Over-dimensioning	Thermal class of the coil at least one level higher than the operating temperature during standard use
Reduction in possible faults	Observation of the plausibility of switching times, switching states, feedback signals and movements of the axis

Tried and tested components	Explanations
Fuse	Part of the machine manufacturer's electrical equipment, in compliance with the original operating instructions
Circuit breaker	Part of the machine manufacturer's electrical equipment, in compliance with the original operating instructions
Cable	In accordance with technical specifications or machine manufacturer requirements
Plug and socket	In accordance with technical specifications or machine manufacturer requirements

Fault and fault exclusions for lines/cables	Explanations
Short-circuit between any two conductors	YES, interruption, short-circuit, earth fault, together with the prescribed fuses, always result in a de-energized state = braked safe state, taking into account machine manufacturer specifications and IEC60204-1 requirements
Short-circuit between any conductor and an exposed conducting part or earth or protective conductor connection	YES, interruption, short-circuit, earth fault, together with the prescribed fuses, always result in a de-energized state = braked safe state, taking into account machine manufacturer specifications and IEC60204-1 requirements
Interruption of conductor	YES, interruption, short-circuit, earth fault, together with the prescribed fuses, always result in a de-energized state = braked safe state, taking into account machine manufacturer specifications and IEC60204-1 requirements

Fault and fault exclusions for clamping units	Explanations
Short-circuit between neighboring terminals	Internal terminals comply with normative specifications or those of the machine manufacturer, in accordance with the specified protection class

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Fault and fault exclusions for multipolar plug connectors	Explanations
Short-circuit between any two neighboring connector pins	YES, interruption, short-circuit, earth fault, together with the prescribed fuses, always result in a de-energized state = braked safe state, taking into account machine manufacturer specifications and IEC60204-1 requirements
Mixed-up or incorrectly inserted pin if there is no mechanical method to prevent this	No, ISO 13849-2 specifications Plug according to machine manufacturer specifications
Short-circuit between any conductor (see comment) and earth or a conducting part or the protective conductor	No, ISO 13849-2 specifications Plug according to machine manufacturer specifications
Interruption of individual connector pins	No, ISO 13849-2 specifications Plug according to machine manufacturer specifications

Fault and fault exclusions for inductivities	Explanations
Interruption	YES, interruption, short-circuit, earth fault, together with the prescribed fuses, always result in a de-energized state = braked safe state
Short-circuit	YES, interruption, short-circuit, earth fault, together with the prescribed fuses, always result in a de-energized state = braked safe state
Random change in value 0.5 LN < L < LN + difference, whereby LN is the nominal value of inductivity	YES, interruption, short-circuit, earth fault, together with the prescribed fuses, always result in a de-energized state = braked safe state; necessary diagnosis (release monitoring can detect faults)

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