SEW EURODRIVE

Manual



DR.., DRN.., DRU.., DR2.., EDR.., EDRN.. AC motors

Project Planning for BE.. Brakes

Standard Brake/Safety Brake

Edition 08/2024

31550835/EN



Table of Contents

1 Introduction 5
1.1 Contents and purpose of this documentation 5
1.2 Additional documentation 5
1.3 Product names and trademarks 5
1.4 Copyright notice 5

2 Functional safety 6
2.1 Functionally safe motor options 6
2.2 General information 6
2.3 FS marking 7
2.4 Underlying standards 8
2.5 TÜV certification 8
2.6 Safety sub-functions of the safety brake 8
2.7 Performance levels that can be achieved 9
2.8 Project planning 9
2.9 Acceptance 9

3 Explosion protection 10
3.1 Significance of explosion protection 10
3.2 Certifications and proof of conformity 10
3.3 Applications 11

4 Product description and differentiation 12
4.1 Possible applications 12
4.2 General description 13
4.3 Technical details 19
4.4 Motor combinations 21
4.5 Comparing the characteristics and restrictions 24

5 Mechanical project planning 32
5.1 Introduction 32
5.2 General information 32
5.3 Working brake, also for ATEX, IECEx, HazLoc-NA® 49
5.4 Holding brake/safety brake 60
5.5 Holding brake/safety brake for ATEX, IECEx, HazLoc-NA® 70

6 Thermal project planning 80
6.1 Introduction 80
6.2 General information 80
6.3 Project planning 89

7 Brake test 95
7.1 General information 95
7.2 Explanation of terms 96
7.3 Performing a brake test 96
7.4 Areas of application 96
7.5 Standards and state-of-the-art 96
7.6 Test rate 97

31550835/EN – 08/2024

7.7 Diagnostic coverage 98
7.8 Avoiding erroneous test results 98
7.9 Test torque for the brake 99
7.10 Activating the friction surfaces 101
7.11 Diagnostic unit /DUE 102

8 Technical data 103
8.1 Operating currents 103
8.2 Application factor f_A 108
8.3 Pulse frequencies 108
8.4 No-load starting frequency and switching intervals for holding brakes 110
8.5 Limit speeds $n_{max,0}$ and $n_{max,1}$ 111
8.6 Permitted emergency stop braking work $W_{zul,n}$ 112
8.7 Permitted braking work for service braking operations $W_{per,Z}$ 125
8.8 Braking work until maintenance 134
8.9 Application of load ranges 135
8.10 Output factor $f_{brake,output}$ 136
8.11 Permitted cyclic duration factor and thermal breakpoint speed 136
8.12 Application factor for installation altitude f_{B_AH} 140
8.13 Characteristic safety values 141

9 Contacting SEW-EURODRIVE 143

Index 144

31550835/EN – 08/2024

1 Introduction

1.1 Contents and purpose of this documentation

This "Project Planning for BE.. Brakes" manual describes the project planning for type BE.. brakes in the following designs:

- BE.. brake
- BE.. safety brake
- BE.. brake for explosion-protected motors
- BE.. safety brake for explosion-protected motors

The BE.. brakes are configured for the use on DR.., DRN.., DRU.., DR2.., EDR.., and EDRN.. motors by SEW-EURODRIVE.

Make sure you always use the latest edition of this documentation. The SEW-EURODRIVE homepage (www.sew-eurodrive.com) provides a broad selection of technical documentation downloads in various languages. You can also order the printed documentation from SEW-EURODRIVE. If you are unclear about any of the information in this documentation or if you require further information, contact SEW-EURODRIVE.

1.2 Additional documentation

You can find all the brake information required for project planning in the chapters of this manual. Refer to the following SEW-EURODRIVE catalogs for the required gear unit and motor data:

- DRN63 – 315, DR2S56 – 80, DR2L71 – 80 AC motors
- DR.71 – 315, DT56, DR63 AC motors
- DRN.. gearmotors (IE3)
- DRE.. gearmotors (IE2)
- DRS../DR2S.. gearmotors
- Asynchronous servo gearmotors
- Explosion-protected AC motors
- Explosion-protected drives

If you have any questions about project planning, contact your local SEW-EURODRIVE contact person.

1.3 Product names and trademarks

All product names included in this documentation are trademarks or registered trademarks of the respective titleholders.

31550835/EN – 08/2024

1.4 Copyright notice

© 2024 SEW-EURODRIVE. All rights reserved. Copyright law prohibits the unauthorized reproduction, modification, distribution and use of this document – in whole or in part.

2 Functional safety

2.1 Functionally safe motor options

Drives from SEW-EURODRIVE are also optionally available with functionally safe motor options. These options are intended for implementation of safety functions in safety-relevant applications.

SEW-EURODRIVE assumes responsibility for the delivered drive in terms of compliance of the functionally safe motor options (including their safety-relevant mechanical connections) with the functional safety regulations. Safety-relevant mechanical connections are marked as follows:

- Safety encoder: retaining ring or adhesive label
- Safety brake: locking compound

The markings indicate if there has been any tampering. If these markings are damaged, there is a deviation from the delivery state.

2.2 General information

When implementing safety functions in machines, it is necessary to evaluate in particular whether the components to be used are suitable in terms of functional safety. When using functionally safe motor options from SEW-EURODRIVE, the following safety-related requirements, e.g. in accordance with EN ISO 13849 – parts 1 and 2, are already taken into account:

- Application of basic safety principles
- Application of proven safety principles
- Use of proven components
- Specifications on failure probability (B_{10D}, $MTTF_D$, or PFH_D)
- Common cause failure (CCF)
- Determination of the system structure (HFT) and/or the category (Cat.)
- Determination of the safety integrity level (SIL) and/or the performance level (PL)
- Determination of the service life
- Production monitoring with 100% final inspection
- Retraceability by the unique motor assignment
- Notice of influences and ambient conditions
- Compliance with normative requirements regarding documentation

As an advantage for the machine designer, SEW-EURODRIVE has already fulfilled these safety-relevant requirements for functionally safe motor options. In the overall analysis of safety technology, the machine designer can rely on the manufacturer's confirmation, e.g. based on the product documentation or the German Technical Inspection Association (TÜV) certificate. The internal effort required for evaluation and documentation is reduced considerably.

If other components (standard components) are used for implementing safety functions, the machine designer has to evaluate the safety-related requirements.

31550835/EN – 08/2024

2.3 FS marking

SEW-EURODRIVE labels a functionally safe motor option on the drive with an FS logo and a 2-digit number on the motor nameplate. The number is a code that indicates which components in the drive are safety-related. This makes it possible to uniquely identify an available functional safety motor option via the motor nameplate.

Make sure you observe any present FS logo on the nameplate and its meaning according to the following table:

FS logo	Available functionally safe motor option		
	Decentralized inverters	Safety brake	Safety encoders
	✓	–	–
	–	✓	–
	–	–	✓
	✓	–	✓
	–	✓	✓

✓ The motor option is functionally safe.

– The motor option is not available.

If the FS logo is present on the motor nameplate, e.g. with the code "FS 11", the motor includes a combination of safety encoder and safety brake. Drives can also be equipped with 2 encoders, e.g. a built-in encoder and an add-on encoder. In such cases, the FS logo for the safety encoder always relates to the add-on encoder. If an FS logo is available, adhere to the information specified in the corresponding documentation.

If the FS logo with the code "FS 0X" is present on the motor nameplate, a special design related to functional safety is installed at the motor.

Observe the information concerning the special design in the documentation.

31550835/EN – 08/2024

2.4 Underlying standards

The safety assessment of the safety brakes is based on the following standards:

	EN 62061 EN 61508	EN 61800-5-2	EN ISO 13849
BE..	–	–	✓

Performance level e (PL e) can be achieved if a functionally safe motor option is suitably integrated into a safety system. The requirements (e.g. on the system architecture, required diagnostics and failure probabilities) are to be implemented according to the normative specifications and to the document in hand. If the safety system with safety brakes is to be evaluated in accordance with the safety integrity level (SIL), the necessary verification must be provided by the customer.

2.5 TÜV certification

The following certificate is available for the described safety brakes:

- Certificate of TÜV NORD Systems GmbH & Co. KG

A copy of the TÜV certificate can be obtained from SEW-EURODRIVE.

2.6 Safety sub-functions of the safety brake

The implementation of a safety function with brakes requires that the brake be applied on request. The safety function is activated when the brake is applied. The brake coil has to be de-energized and the energy stored in the brake coil reduced.

By adding a safety brake to a safe overall system, the following safety sub-functions can be implemented:

- SBA (Safe Brake Actuation)
- SBH (Safe Brake Hold)

INFORMATION

The SBA and SBH safety sub-functions are defined by SEW-EURODRIVE based on the standard EN 61800-5-2.

The implementation of the SBA and SBH safety sub-functions additionally require the safety sub-functions SBC and STO in the overall system, in accordance with EN 61800-5-2. For safety-related requests of the brake, SBC and STO ensure that the brake applies and that the drive does not generate a torque against the applied brake.

The SBC and STO safety sub-functions are not part of the brake and have to be additionally implemented in the overall safety system. The performance level (PL) of the SBC and STO safety sub-functions must at least meet the required performance level (PLr) of the application.

SEW-EURODRIVE recommends to stop the drive using stop category 1 according to EN 60204-1 prior to activating the SBC and STO safety sub-functions.

31550835/EN – 08/2024

2.7 Performance levels that can be achieved

The brake complements a safe braking system consisting of several system components.

The achievable performance level of the resulting safe braking system according to EN ISO 13849-1 is mainly determined by the following points:

- The selected safety structure, category (Cat.)
- Reliability of the used system components (PL, B_{10D}, $MTTF_D$, etc.)

  The $MTTF_D$ value is calculated specifically for the application based on the B_{10D} value for the brake and the switching frequency of the application.
- Diagnostic coverage (DC_{avg})

  The diagnostic coverage is fulfilled with a brake test.
- The common cause failure (CCF) with categories 2, 3, and 4.

The achieved performance level must be determined for the selected safe braking system based on an overall evaluation of the system. Observe the characteristic safety values necessary for the brake.

For the characteristic safety values of the SEW-EURODRIVE components, refer to the product-related documentation as well as the library for the SISTEMA software available for download at www.sew-eurodrive.com.

2.8 Project planning

When using a brake, the drive must always be planned for the applicative application. Follow the applicable project planning specifications. Effects of the application on the projected drive beyond the project planning limits may lead to damage to the drive. The user is responsible for these aspects of the drive.

When dimensioning the brake, observe the valid project planning specifications of SEW-EURODRIVE and the resulting application limits. If the applicative requirements or technical properties of the brake change, the brake project planning process and a check of the application limits must be performed again.

If requested, SEW-EURODRIVE may assist you with the dimensioning of the safety system, the project planning and the calculation of the performance level. Contact SEW-EURODRIVE if required.

2.9 Acceptance

The system manufacturer has to perform an overall evaluation for determining the safety of a machine.

The effectiveness of each risk minimization must be checked. It must also be checked if the required safety integrity is reached for each implemented safety function.

To validate the safety integrity level you can use the "SISTEMA" calculation tool from the Institut für Arbeitsschutz (Institute for Occupational Safety and Health of the German Social Accident Insurance).

31550835/EN – 08/2024

3 Explosion protection

3.1 Significance of explosion protection

Explosion protection is among the exceptional, safety related areas, because explosions may result in serious personal injury and material damage. It deals with protection from explosions and their effects.

To prevent explosive hazards, many countries have regulations in the form of laws, provisions and standards, which guarantee a high level of safety.

3.2 Certifications and proof of conformity

There are currently 3 important rule sets for explosion-protected products:

1. ATEX for the European Union
2. IECEx system
3. HazLoc-NA® for North America

ATEX

ATEX stands for Atmosphère Explosible and is a synonym for the European Union's ATEX directives.

Directive 2014/34/EU is the rule set that governs explosion-protected devices within the EU. It is based on the EN 60079 and EN 80079 series of standards.

Directive 1999/92/EC defines the minimum regulations for improving health and safety protection and the safety of employees who may be placed at risk by a potentially explosive atmosphere.

The EU declaration of conformity certifies that the introduced motor complies with the basic health and safety requirements of all relevant European guidelines. It is a part of the operating instructions that are included with the motor upon delivery.

IECEx system

IECEx is a certification system from the IEC (International Electrotechnical Commission) for explosion-protected devices for use in potentially explosive atmospheres. It is based on the IEC 60079 series of standards and ISO/IEC 80079.

The Certificate of Conformity (CoC) certifies that the motor meets current IEC standards and that a tested quality assurance system is used during production. The Certificate of Conformity can be viewed on and downloaded from the IECEx website (www.iecex.com).

HazLoc-NA®

HazLoc-NA® is a term defined by SEW-EURODRIVE that stands for "Hazardous Locations – North America". In North America, areas exposed to explosion hazards are called "hazardous locations". In the USA, the "hazardous locations" are described in the National Electrical Code (NFPA 70) and in the Canadian Electrical Code (C22.1) in Canada. A distinction is made between two different classification systems (division and zone system).

The division system is described in NEC 500 and C22.1-15 (Appendix J) and the zone system in NEC 505, NEC 506 and C22.1 – 15 (Section 18).

31550835/EN – 08/2024

The motors are certified by the CSA, the "Canadian Standards Association". The test mark offers visible proof that the product has been tested and certified according to North American standards. The certificate of conformity is available from SEW-EURODRIVE upon request.

3.3 Applications

The following brake versions are available for explosion-protected motors belonging to the EDR.. and EDRN.. series:

- BE.. brake
- BE.. brake for explosion-protected motors
- BE.. safety brake for explosion-protected motors

Available brakes

Application	ATEX	IECEx	HazLoc-NA®
Working brake	• BE.. brake for explosion-protected motors		BE.. brake
Holding brake with emergency stop function	• BE.. brake for explosion-protected motors • BE.. safety brake for explosion-protected motors		BE.. brake for explosion-protected motors
EDR..BE..	3D, 3GD	Not certified	CID2, CIID2, CICIID2
EDRN..BE..	3G, 3D, 3GD	3G-c, 3D-c, 3GD-c	
3G(-c)	T3 (200 °C)	–	
3D(-c)	–	T120 °C or T140 °C	
CID2	T3 (200 °C)	–	
CIID2	–	T3C (160 °C)	

Limitation: The BE62 and BE122 double disk brakes are only available for the 3D, 3D-c, and CIID2 designs.

While drives without explosion protection are primarily focused on compliance with the insulation classes of the motor or brake winding, due to the explosion protection a broader view is required.

The maximum surface temperature is determined by all components of the gearmotor. All of the project steps specified in this manual must be followed so that the brake does not exceed the confirmed maximum surface temperature.

31550835/EN – 08/2024

4 Product description and differentiation

4.1 Possible applications

The BE.. modular brake system is specially optimized for the asynchronous motor portfolio (DR.., DRN.., DRU.., DR2.., EDR.., and EDRN..) by SEW-EURODRIVE.

The electromechanical BE.. brakes are used in horizontal and vertical applications where it is necessary to mechanically stop or hold the drive in various situations. Due to their high work capacity, the BE.. brakes can be used both as a working brake and a holding brake with emergency stop functionality.

BE.. brakes are suitable for both line-operated motors (non-controlled applications) and inverter-operated motors (controlled applications). The BE.. safety brakes are only suitable for inverter-operated motors (controlled applications).

Working brake

With line-operated motors, the brake is used for stopping the motor during normal operation. Brake application from the operating speed is the normal case here.

Holding brake

With inverter-operated motors, it is assumed that the brake will primarily be used for holding when in the idle state. In this context, we refer to the brake as a "holding brake". Brake application from a speed only takes place in the event of emergency stop braking (non-controlled stopping of the drive, comparable with stop category 0 in accordance with EN 60204-1). Normally, the brake is activated after controlled stopping (stop category 1 in accordance with EN 60204-1) at speeds of < 20 min^{-1}.

The type of use must be taken into account during the selection and dimensioning of the brake.

The modular brake system produces many different applications for the BE.. brake:

- Working brake or holding brake with emergency stop features in horizontal and vertical applications
- Safety brake in its function as a holding brake with emergency stop features
- Working brake or holding brake with emergency stop features in applications in areas with a risk of explosion
- Safety brake in its function as a holding brake with emergency stop features in applications in areas with a risk of explosion

31550835/EN – 08/2024

4.2 General description

BE.. brakes from SEW-EURODRIVE are DC-operated electromagnetic disk brakes. They open electrically and brake using spring force. The brake is installed on the B-side and integrated into the motor. The advantage is that brakemotors from SEW-EURODRIVE are very short and robust. Furthermore, SEW-EURODRIVE brakemotors are especially low-noise. This means they are especially suited for environments sensitive to noise.

The brake coil can be adapted to different connection voltages. It is powered via a brake control which is either placed in the terminal box of the motor or in the control cabinet.

The brake is applied in the event of a power failure. It is therefore suited for basic safety requirements in horizontal and vertical applications (e.g. according to EN 115).

Due to the high overload capacity during emergency stops, the BE.. brake is ideally suited as a holding brake in controlled applications. The working capacity is available for emergency stop braking operations.

DRN.. motors with BE.. brake can be used in ambient temperature ranges of -40 °C to +100 °C. They can be delivered in degrees of protection IP54, IP55, IP65, and IP66.

4.2.1 With optional manual brake release

The brake can also be released without voltage supply if equipped with a manual brake release. This enables, for example, manual lowering of hoists or "weathervane" mode for cranes.

Two options are available for manual brake release:

1. With automatic manual brake release (option designation /HR), a hand lever is included in the delivery.
2. For the lockable manual brake release (option designation /HF), a set screw is included in the delivery.

4.2.2 With patented two-coil system

The BE.. brake is a DC-operated electromagnetic spring-loaded brake. It is equipped with the patented two-coil system from SEW-EURODRIVE. It works particularly rapid and wear-free in supply system startup in combination with brake controls from SEW-EURODRIVE with acceleration function.

When using the two-coil system, BE.. brakes are suitable for high switching frequencies as they are required for fast cycle applications for example.

While operation of the brake is also possible without acceleration function or with a direct DC voltage supply without SEW-EURODRIVE brake control for sizes up to BE2, all brakes of sizes BE5 and higher are optimized for using the two-coil system.

This allows for particularly energy-efficient operation as the power loss can be reduced in stop state. For brakes without two-coil system, the magnetic circuit has to be dimensioned larger for implementing the same braking torque and wear distance.

31550835/EN – 08/2024

4.2.3 With SEW-EURODRIVE brake control in the terminal box or control cabinet

Usually, the brake is controlled by a brake control that is installed in either the motor terminal box or the control cabinet. You can choose from a wide range of brake controls. In addition to various connection voltages, brake controls for specific application requirements are available as well:

- With acceleration function for high switching frequency (by using the patented two-coil system, e.g. BGE../BME../BSG..)
- With rapid cut-off function for high stopping accuracy (with integrated or additional high-speed relays, e.g. BMP../BSR../BUR..)
- With integrated heating function (BMH..)
- With additional DC 24 V control inputs for PLC or inverter (e.g. BMK.. or BMV..)
- As safety-related component for functionally safe interruption of the energy supply to the brake (e.g. BST.., SBM..)
- BG1Z integrated brake control with condition monitoring of the brake wear (determination of the lining reserve) and AC 200 – 500 V wide range voltage supply in connection with MOVILINK® DDI

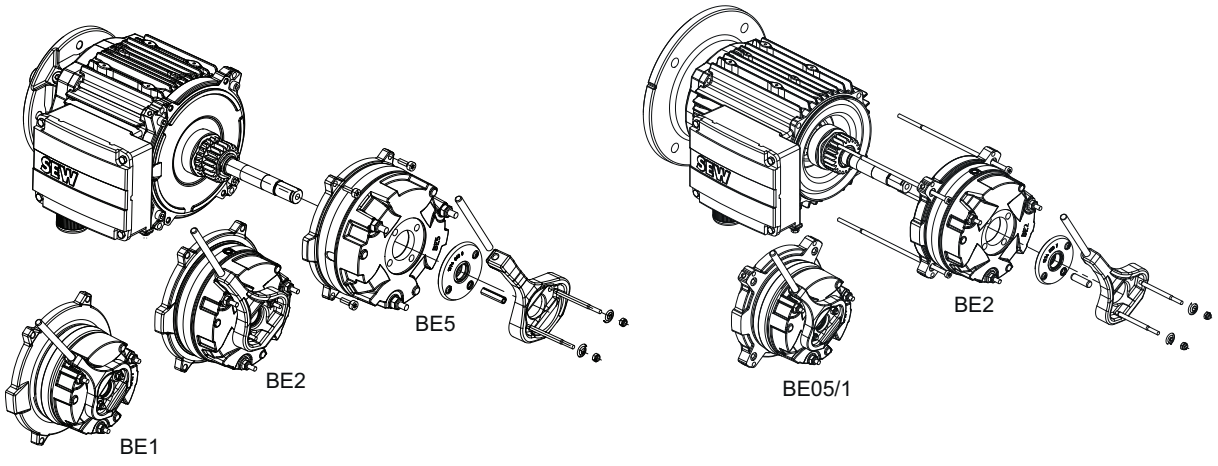
Brakes up to BE2 can optionally also be delivered for operation at an external DC voltage source without additional brake control.

4.2.4 Maintenance-friendly and suitable for condition monitoring

A difference is made between integral and modular design when BE.. brakes and motors from SEW-EURODRIVE are connected.

- Integrated design of the brake for motors of size 56 – 80 with BE02 – BE2 brake means the B-side endshield of the motor is an integral part of the brake with a friction surface.
- The modular design of the BE03 brake for motors of sizes 63 – 71 and all BE.. brakes for motors from size 90 means the brake has a separate friction disk. The complete bearing of the motor is maintained even when the brake is removed.

The modular design allows for mounting of up to 4 brake sizes to one motor, especially for motors of size 90 and higher. The B-side endshield is to be regarded like a connecting flange, which accommodates the BE.. brake pre-mounted on a friction disk. When it comes to maintenance of the drive, the modular structure has the particular advantage that the brake can be removed without having to remove the entire drive from the system or disassembling it.



20493017739

31550835/EN – 08/2024

Adjustability

Brakes from BE05 upward allow you to adjust the working air gap quickly and easily as standard. This makes it possible to use the asbestos-free brake linings over a long period of time, even in wear-intensive applications.

In contrast, the BE02 and BE03 brakes cannot be adjusted. However, they are equipped with a considerably higher wear limit and thus provide a long service life, even without adjustment.

Internal brake plug connector from BE20 – BE122

Brakemotors from SEW-EURODRIVE equipped with a brake of size BE20 or higher have an internal brake plug connector. The plug connector makes it possible to maintain the brake without having to loosen the wiring in the terminal box of the motor.

Optional with air gap monitoring

For predictive planning of the service intervals, BE1 – BE122 brakes on motors of sizes 80 – 315 can optionally be designed with air gap monitoring.

The diagnostic unit /DUE (Diagnostic Unit Eddy Current) is used for monitoring the working air gap. The diagnostic unit /DUE consists of the following components:

- An evaluation unit in the motor terminal box that is supplied via a DC 24 V voltage.
- A sensor, integrated in the magnet body of the brake

The diagnostic unit /DUE monitors the switching status of the brake and the wear on the basis of the current air gap. This information is output as digital or analog signals.

31550835/EN – 08/2024

4.2.5 Characteristics of the BE.. safety brake

BE.. brakes are optionally available as safety brakes. These are identical to BE.. brakes with regard to the general design and the basic operating principle.

Safety brakes are developed by SEW-EURODRIVE for use in functional safety and are certified by TÜV NORD as a safety-related component of category 1 according to EN ISO 13849-1. As such, motor options and drive combinations are available to a limited degree, where applicable.

When they are suitably incorporated into a safe braking system (SBS), you can realize numerous safety concepts up to PL e with the safety brakes.

The use of a safety brake allows for safety functions which force the motor to enter idle state and hold it safely in its position:

- SBA (Safe Brake Actuation) – Safe deceleration
- SBH (Safe Brake Hold) – Safe hold

At SEW-EURODRIVE, the entire drive with safety brake is manufactured with high production quality. Safety brakes are subjected to production monitoring with 100% final inspection. The traceability of the safety brake to the end customer allows us to inform our customers, if necessary. Included documents already fulfill the normative requirements of EN ISO 13849 and round off the product.

BE.. safety brakes are certified by TÜV-Nord Systems GmbH & Co. KG and fulfill the requirements according to EN ISO 13849.

4.2.6 Characteristics of the BE.. brake for EDR.. and EDRN.. explosion-protected motors

With regard to the general design and the basic functional principle, the BE.. brakes for EDR.. and EDRN.. explosion-protected motors are identical to the BE.. brakes and the BE.. safety brakes for the DR.., DRN.. and DR2... standard motors.

The EDR.. and EDRN.. explosion-protected brakemotors are available for the following rule sets:

- ATEX: Equipment category 3G and 3D
- IECEx: EPL protection level "Gc", "Dc"
- HazLoc-NA®: Class I Division 2 and Class II Division 2

They fulfill the following standards:

Rule set	EDR..	EDRN..
ATEX	EN 60079-0 EN 60079-15 EN 60079-31	EN 60079-0 EN 60079-7 EN 60079-31
IECEx	No brakemotor available	IEC 60079-0 IEC 60079-7 IEC 60079-31
HazLoc-NA®	**EDR.. < 0.75 kW** NEC500 C22.1	**EDRN ≥ 0.75 kW** NEC500 C22.1

31550835/EN – 08/2024

Depending on the individual requirements, the ex labels differ in terms of gas group, dust group, temperature class or the maximum surface temperature:

Rule set	EDR..	EDRN..
ATEX	II3G Ex ec **IIB** T3 Gc II3G Ex ec **IIC** T3 Gc II3D Ex tc **IIIB T120°C** Dc II3D Ex tc **IIIC T120°C** Dc II3D Ex tc **IIIB T140°C** Dc II3D Ex tc **IIIC T140°C** Dc	
IECEx	No brakemotor available	Ex ec **IIB** T3 Gc Ex ec **IIC** T3 Gc Ex tc **IIIB T120°C** Dc Ex tc **IIIC T120°C** Dc Ex tc **IIIB T140°C** Dc Ex tc **IIIC T140°C** Dc
HazLoc-NA®	CLI, DIV2 GP A, B, C & D **T3** CLI, DIV2 GP A, B, C & D **T3B** CLI, DIV2 GP A, B, C & D **T3C** CLII, DIV2 GP F & G **T4A**	CLI, DIV2 GP A, B, C & D **T3** CLI, DIV2 GP A, B, C & D **T3B** CLI, DIV2 GP A, B, C & D **T3C** CLII, DIV2 GP F & G **T4A** CLII, DIV2 GP F & G **T3C**

4.2.7 Differences between the BE.. brake and the BE.. brake/safety brake for EDR.. and EDRN.. explosion-protected motors

Depending on the design, the EDR.. and EDRN.. explosion-protected brakemotors fulfill the requirements for protection type "device protection by increased safety e" and "device dust ignition protection by housing t".

This ensures that the brakemotor neither sparks nor overheats in an unapproved manner during normal operation. To prevent the utilized brakemotor from becoming a source of ignition, several modifications have been made to the BE.. brakes.

Design changes:

- Operation of the brake coil at reduced power
- Design with reduced maximum braking torque
- Use of a modified seal system

Technical data for project planning:

- Reduced no-load starting frequency Z_0
- Reduced braking work for use as a working and holding brake
- Reduced limit speeds

31550835/EN – 08/2024

Brake control:

- You must install the brake control in the control cabinet on the 3G, 3GD, 3G-c and 3GD-c designs.
- On the 3D, 3D-c, CID2, CIID2 and CICIID2 designs, the brake control can be located in the motor's terminal box.

Comparing the designs

The following table compares the different designs using the BE2 brake for a EDRN90M4 motor as an example with regard to explosion protection.

		BE.. brake		BE.. brake for explosion-protected motors
Application		Working brake and holding brake	Working brake (HazLoc-NA®)[1)]	- Working brake (ATEX, IECEx) - Holding brake (ATEX, HazLoc-NA®, IECEx)
Electric power consumption of the brake coil P_B		43 W	43 W	34 W
Maximum braking torque		20 Nm	20 Nm	14 Nm
No-load starting frequency	Size	2200 h^{-1}	460 h^{-1}	460 h^{-1}
	BGE	5800 h^{-1}	1200 h^{-1}	1200 h^{-1}
Maximum braking work of working brake at …		Brake application speed: 1500 min^{-1} 13260 J	Brake application speed: 1800 min^{-1} 3432 J	Brake application speed: 1500 min^{-1} 3822 J
Maximum braking work of holding brake at 1800 min^{-1}		10400 J	Not available as a holding brake	3360 J

1) Observe the reduced values for the no-load starting frequency and the maximum braking work.

For additional technical data, refer to chapter "Technical data" (→ 🗎 103).

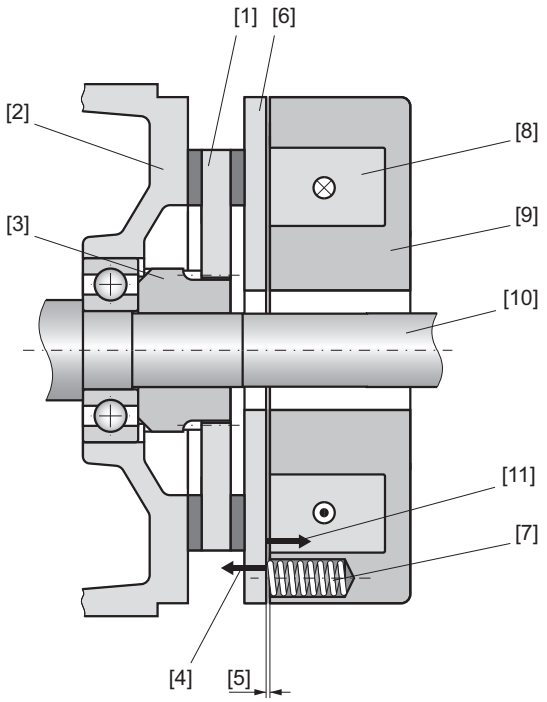
31550835/EN – 08/2024

4.3 Technical details

4.3.1 Basic design and functional principle

The essential parts of the brake system are the mobile pressure plate [6], the brake springs [7], the brake lining carrier [1], the brake endshield [2] and the brake coil [8] (accelerator coil BS + coil section TS = holding coil HS). The magnet body consists of the magnet body housing [9] with cast winding and a tapping.

The pressure plate is forced against the brake disk by the brake springs when the electromagnet is de-energized. The brake is applied to the motor. The number and type of brake springs determine the braking torque. When the brake coil is connected to the corresponding DC voltage, the force of the brake springs [4] is overcome by magnetic force [11], thereby bringing the pressure plate into contact with the magnet body. The brake lining carrier moves clear and the rotor can turn.



3985157259

[1] Brake lining carrier
[2] Brake endshield
[3] Driver
[4] Spring force
[5] Working air gap
[6] Pressure plate
[7] Brake spring
[8] Brake coil
[9] Magnet body housing
[10] Motor shaft
[11] Electromagnetic force

31550835/EN – 08/2024

4.3.2 Braking torque definition

The braking torques of the BE.. brakes are defined on the basis of DIN VDE 0580. A distinction is made between the following braking torques here:

Abbreviation according to DIN VDE 0580	Designation	Description
M_1	Dynamic braking torque	Torque acting upon the motor shaft with a slipping brake (brake safely disconnected). The torque depends on the current operating temperature and the current friction speed/motor speed.
M_2	Virtually static braking torque (= nominal braking torque M_B)	Braking torque with slowly slipping brake (relative speed between the friction components: 1 m/s) at 20 °C
M_4	Static braking torque	Breakaway torque that is necessary to rotate the motor shaft from an idle state with the brake closed.

The nominal braking torque M_B of the brakes is subjected to 100% final testing in the factory at SEW-EURODRIVE within the scope of quality control and is within a tolerance range of -10% and +50% in the delivery state.

This nominal value M_B is used both during brake selection and also during project planning. The differences between M_1 (dynamic braking torque) and M_4 (static braking torque) and the nominal braking torque are taken into account by SEW-EURODRIVE with the formulas and the calculation coefficients that are used when doing this.

The characteristic values M_1 and M_4 are therefore not relevant within the scope of the project planning and selection of the brake.

INFORMATION

The characteristic values M_1 and M_4 can differ significantly from the nominal braking torque M_B depending on the wear and operating state of the brake in some cases, and can particularly be outside the above-mentioned tolerance range for M_B.

Should specific requirements of the application require more precise knowledge, please contact SEW-EURODRIVE.

31550835/EN – 08/2024

4.4 Motor combinations

4.4.1 Motor combinations with BE.. brake

Different brake sizes and braking torque steps are available for the various motor series.

DRN../DRU../DR2.. motors with BE.. safety brake are also available in combination with MOVILINK® DDI. Note that in this combination, only brake controls in the control cabinet are permitted for the safety brake (see chapter "Combination of safety brake and brake control").

The following tables show the possible combinations of motor and brakes as well as the available braking torque graduations:

(E)DR..	–	–	71	80	–	90 100	112 132	160	180	200 225	250 280	315
(E)DRN../DRU../DR2..	56	63	71	80	90	100	112 132S	132M 132L	160 180	200 225	250 280	315
BE02	✓											
BE03		✓	✓									
BE05			✓	✓	✓							
BE1			✓	✓	✓	✓						
BE2				✓	✓	✓						
BE5					✓	✓	✓					
BE11							✓	✓				
BE20								✓	✓			
BE30									✓	✓		
BE32									✓	✓		
BE60										✓	✓	
BE62										✓	✓	
BE120											✓	✓
BE122											✓	✓

✓ Combination available

✓ Combination available, optionally available as safety brake

31550835/EN – 08/2024

4.4.2 Braking torque graduations

Depending on the demands placed on the brake, different braking torque graduations are available depending on the brake sizes.

The following table shows the maximum braking torque (M_{Bmax}) as well as the available braking torque graduations (M_B) in Nm.

Available stages for M_B	Brake (M_{Bmax})							
	BE02 (1.2 Nm)	BE03 (3.4 Nm)	BE05 (5 Nm)	BE1 (10 Nm)	BE2 (20 Nm)	BE5 (55 Nm)	BE11 (110 Nm)	BE20 (200 Nm)
0.8	✓							
0.9		✓						
1.2	✓							
1.3		✓						
1.7		✓						
1.8[1)]			✓					
2.1		✓						
2.5[1)]			✓					
2.7		✓						
3.4		✓						
3.5			✓					
5			✓	✓	✓			
7				✓	✓			
10				✓	✓			
14					✓	✓		
20					✓	✓	✓	
28						✓	✓	
40						✓	✓	✓
55						✓	✓	✓
80							✓	✓
110							✓	✓
150								✓
200								✓

1) Not available for BE.. safety brakes.

Available stages for M_B	Brake (M_{Bmax})					
	BE30 (300 Nm)	BE32 (600 Nm)	BE60 (600 Nm)	BE62 (1200 Nm)	BE120 (1000 Nm)	BE122 (2000 Nm)
75	✓					
100	✓	✓				
150	✓	✓				

31550835/EN – 08/2024

Available stages for M_B	Brake (M_{Bmax})					
	BE30 (300 Nm)	BE32 (600 Nm)	BE60 (600 Nm)	BE62 (1200 Nm)	BE120 (1000 Nm)	BE122 (2000 Nm)
200	✓	✓	✓			
300	✓	✓	✓			
400		✓	✓	✓	✓	
500		✓	✓			
600		✓	✓	✓	✓	
800				✓	✓	✓
1000				✓	✓	
1200				✓		✓
1600						✓
2000						✓

Legend

✓	Available
✓	For EDR../EDRN.. HazLoc-NA® (inverter operation), ATEX and IECEx not available

INFORMATION

Note that there may be limitations for the braking torques M_B to be selected depending on the motor design, especially for:

- AC motors for ambient temperatures above +60 °C.
- AC motors with BE safety brake in combination with the manual brake release option.

→ Consult SEW-EURODRIVE in these cases.

31550835/EN – 08/2024

4.5 Comparing the characteristics and restrictions

4.5.1 General

Depending on the use of the BE.. brake, conditions and restrictions, which are listed in the following tables, exist both for the brake itself as well as for the other drive components.

Observe these conditions and restrictions when configuring and ordering the overall drive.

A distinction is made between the following designs of the brake:

- BE.. brake
- BE.. safety brake
- BE.. brake for explosion-protected motors
- BE.. safety brake for explosion-protected motors

Brakes	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Available sizes	BE02 – BE122	BE03 – BE32	BE03 – BE122	BE03 – BE32
Usage	Working brake or holding brake with emergency stop function	Holding brake with emergency stop function	Working brake or holding brake with emergency stop function	Holding brake with emergency stop function
Safety architecture, category (EN ISO 13849-1)	B	1	B	1

Brake options	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Manual brake release	/HR or /HF	/HR	/HR or /HF	/HR
Condition monitoring Brake	BE1 – BE122: **/DUE**[1)] BE2 – BE122: **/DUB**[2)]	BE1 – BE32: **/DUE**[1)] BE2 – BE32: **/DUB**[2)]	Not available	Not available

1) /DUE for DR.. and DRN.. motors
2) /DUB for DR.. motors

Brake control	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Installation in terminal box	Available	Available	Available to a limited degree	Available to a limited degree
Installation in the control cabinet	Available	Available	Available	Available
Voltage supply from the motor terminal board	Available to a limited degree	Not available	Available to a limited degree	Not available

31550835/EN – 08/2024

Brake control	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Direct DC voltage supply	Available for BE02 – BE2, upon request for BE5 – BE11	Not available	Available for BE03 – BE2	Not available
Integrated brake control for MOVILINK® DDI	Available for BE03 – BE62	Not available	Not available	Not available

4.5.2 Combination options and combination restrictions, motors and motor options

Motors	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Available motor series	DRS.., DRE.., DRN.., DRU.., DRL.., DRM.., DRK.., DR..J (LSPM), DR2..	DRS.., DRE.., DRN.., DRU.., DRL.., DR2S.., DR2L.., DR2C..A	EDRS.., EDRE.., EDRN..	EDRS.., EDRN..
Number of poles	All	2, 4, 6[1].	4	4

1) Only with fixed number of poled (single-speed)

Installation and ambient conditions	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Ambient temperature of -20 °C to +40 °C	Available	Available	Available	Available
Additional ambient temperatures up to -40 °C or +100 °C	Available to a limited degree	Not available	Available to a limited degree up to +60 °C	Not available
Installation altitude < 1000 m above sea level	Available	Available	Available	Available
Installation altitude > 1000 m above sea level	Available	Not available	Available to a limited degree up to +60 °C	Not available

Output designs[1]	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
F.A/F.B universal foot-mounted version	Available	Available to a limited degree	Available	Available to a limited degree
/FI IEC foot-mounted motor with specification of the shaft height	Available	Available to a limited degree	Available	Available to a limited degree
/FG 7-series integral motor	Available	Available to a limited degree	Available	Available to a limited degree

31550835/EN – 08/2024

Output designs[1)]	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
/2W Second shaft end on the brakemotor	Available	Available to a limited degree	Available to a limited degree	Available to a limited degree
/FF IEC flange-mounted motor with bore	Available	Available	Available	Available
/FT IEC flange-mounted motor with threads	Available	Available	Available	Available
/FL general flange-mounted motor (deviating from IEC)	Available	Available to a limited degree	Available	Available to a limited degree
/FM 7-series integral motor with IEC feet, specification of shaft height, if necessary	Available	Not available	Available	Not available
/FE IEC flange-mounted motor with bore and IEC feet, specification of the shaft height, if necessary	Available	Available to a limited degree	Available	Available to a limited degree
/FY IEC flange-mounted motor with thread and IEC feet, specification of shaft height, if necessary	Available	Available	Available	Available
/FK general flange-mounted motor (deviating from IEC) with feet, specification of shaft height, if necessary	Available	Available to a limited degree	Available	Available to a limited degree
/FC C-face flange-mounted motor, dimensions in inch	Available	Not available	Available for HazLoc-NA®	Not available

1) Gear unit - motor combinations with the pinion bore/pinion shaft end affect the permitted braking torque!

Thermal monitoring	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
/TF Temperature sensor (PTC thermistor or PTC resistor)	Available	Available[1)]	Included as standard	Available[1)]
/TH Thermostat (bimetallic switch)	Available	Available	Available to a limited degree	Not available
/Pt1 1 Pt100 sensor	Available	Available[1)]	Available	Available[1)]

31550835/EN – 08/2024

Thermal monitoring	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
/Pt3 3 Pt100 sensors	Available	Available[1)]	Available	Available[1)]
/PK 1 Pt1000 sensor	Available	Available[1)]	Available	Available[1)]
/PI 1 Pt1000 sensor Motor protection for MOVILINK® DDI	Available	Available[1)]	Not available	Not available

1) At least one monitoring function of the group /TF, /KY, /PT, /PK or /PI must be selected.

Ventilation	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
/V or /VE Forced cooling fan	Available	Available	Available	Available
/Z Additional flywheel mass (flywheel fan)	Available	Available to a limited degree	Not available	Not available
/AL Metal fan	Available	Available	Included as standard with dust explosion protection	Included as standard with dust explosion protection
/U or /OL Non-ventilated	Available	Available	Not available	Not available
/C Canopy for the fan guard	Available	Available	Available	Available
/LN Noise-reduced fan guard	Available	Available	Available to a limited degree	Available to a limited degree

IP degrees of protection of the motor	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
IP54/55/65	Available	Available	Available	Available
IP56/66	Available	Available	Available	Available
Other degrees of protection	On request	Not available	Not available	Not available

Storage	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
/NS relubrication device	Available	Available	Available	Available

31550835/EN – 08/2024

Storage	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
/ERF Reinforced bearing on A-side with roller bearing	Available	Not available	Available	Not available
/NIB Insulated bearing B-side	Available	Available	Available	Available
Preparation for accommodating SPM measuring nipples	Available	Not available	Not available	Not available

Winding of the motor	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Thermal class B	Available	Available	Not available	Not available
Thermal class F	Available	Available	Available	Available
Thermal class H	Available	Available	Not available	Not available
Strip heater	Available	Available	Available to a limited degree	Available to a limited degree
/RI Reinforced winding insulation	Available	Available	Not available	Not available
/RI2 Reinforced winding insulation with increased resistance against partial discharge	Available	Available	Not available	Not available

Motor connection	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Terminal board design	Available	Available	Available to a limited degree	Available to a limited degree
Cage clamp terminals	Available	Available	Available	Available
Plug connectors	Available	Available	Not available	Not available

Painting and corrosion protection	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Painting	Standard: RAL 7031 Optional: - Special colors - Surface protection (OS) - ECO2	Standard: RAL 7031 Optional: - Special colors - Surface protection (OS)	Standard: RAL 7031 Optional: - Special colors - Surface protection (OS)	Standard: RAL 7031 Optional: - Special colors - Surface protection (OS)
Corrosion protection (KS)	Available	Available	Available	Available

31550835/EN – 08/2024

Painting and corrosion protection	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
/DH Condensation drain hole	Available	Available	Not available	Not available

Encoders	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Encoder or encoder mounting adapter	Available	Available to a limited degree	Available to a limited degree	Available to a limited degree
Safety encoders	Available	Available	Available to a limited degree	Available to a limited degree
Mounted third-party encoders	On request	On request	On request	On request

Decentralized technology	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
/MSW MOVI-SWITCH®	Available	Not available	Available to a limited degree	Not available
/MM MOVIMOT®	Available	Not available	Available to a limited degree	Not available
/MMA MOVIMOT® advanced	Available	Not available	Available to a limited degree	Not available
/MMF MOVIMOT® flexible	Available	Not available	Available to a limited degree	Not available

MOVILINK® DDI	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
/DI Code → DI0x00 → with external brake control or /MMF	Available	Available to a limited degree	Not available	Not available
/DI DI1x00 design with BS1Z brake control	Not available	Not available	Not available	Not available
/DI DI2x00 design with BG1Z brake control	Available	Not available	Not available	Not available

31550835/EN – 08/2024

4.5.3 Combination options and combination restrictions, gear unit

Gear unit	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Helical gear unit	Available	Available: RX, RXF, R27-R167, R27F-R87F, RF27-RF167, RZ27-RZ87	Available: RX, RXF, R, R..F, RF, RZ, RM	Available: RX, RXF, R27-R167, R27F-R87F, RF27-RF167, RZ27-RZ87
Parallel-shaft helical gear unit	Available	Available: F, FA..B, FH..B, FV..B, FF, FAF, FHF, FVF, FA, FH, FV, FAZ, FHZ, FVZ	Available: F, FA..B, FV..B, FF, FAF, FVF, FA, FV, FAZ, FVZ Available to a limited degree: FH..B, FHF, FH, FT, FHZ	Available: F, FA..B, FV..B, FF, FAF, FVF, FA, FV, FAZ, FVZ Available to a limited degree: FH..B, FHF, FH, FHZ
Helical-bevel gear unit	Available	Available: K, KA..B, KH..B, KV..B, KF, KAF, KHF, KVF, KA, KH, KV, KAZ, KHZ, KVZ	Available: K, KA..B, KV..B, KF, KAF, KVF, KA, KV, KAZ, KVZ Available to a limited degree: KH, KH..B, KHF, KHZ, KT, K.9	Available: K, KA..B, KV..B, KF, KAF, KVF, KA, KV, KAZ, KVZ Available to a limited degree: KH, KH..B, KHF, KHZ
Helical-worm gear unit	Available	Available to a limited degree: S, SF, SAF, SHF, SA, SH, SAZ, SHZ	Available: S, SF, SAF, SA, SAZ Available to a limited degree: SH, SHF, SHZ, ST	Available to a limited degree: S, SF, SAF, SHF, SA, SH, SAZ, SHZ
SPIROPLAN® gear units	Available	Available: W37/47, WF37/47, WAF37/47, WA37/47, WA37/47B, WH37/47B, WHF37/47, WH37/47, W.19 – W.59	Available: W..20, W..30, W37/47, WF37/47, WAF37/47, WA37/47, WA37/47B Available to a limited degree: WH37/47, WH37/47B, WHF37/47	Available: W37/47, WF37/47, WAF37/47, WA37/47, WA37/47B Available to a limited degree: WH37/47, WH37/47B, WHF37/47
Electrified monorail drive HS.., HW.., HK..	Available	Not available	Not available	Not available

31550835/EN – 08/2024

Gear unit options	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
/R reduced backlash	Available	Available	Available	Available
/T with torque arm	Available	Available	Available	Available
/G with rubber buffer	Available	Available	Available	Available
/DUV condition monitoring	Available	Available	Not available	Not available

Adapter	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Adapter	Available: AM.., AD.., AR.., AL.., AT.., AMS..	Not available	Available: AM.., AM../RS AD.., AD../P, AD../RS, AD../ZR, AR.., AR../W, AR../WS, AL..,	Not available

Variablespeed gear unit	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
VU/VZ VARIBLOC®	Available	Not available	Available	Not available
VARIMOT®	Available	Not available	Available	Not available

Other designs	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors
Compound gear unit	Available	Not available	Available	Not available
IG mounting	Available	Not available	Available to a limited degree	Not available

4.5.4 Combination options and combination restrictions, frequency inverter

Drives with BE.. electromechanical brakes/safety brakes can be operated on frequency inverters from SEW-EURODRIVE and on third-party inverters. To do so, observe the documentation for the respective product.

INFORMATION

With regard to safety-related applications, there may be more requirements for BE.. brakes or safety brakes in the entire system, which limit the selection of suitable frequency inverters, e.g. safe torque off (STO), safe brake control (SBC), brake test, etc. Make sure that the selected frequency inverter is suitable for the requirements.

31550835/EN – 08/2024

5 Mechanical project planning

5.1 Introduction

Plan BE.. brakes from SEW-EURODRIVE for their applicative use case according to defined guidelines. Project planning guidelines differ from each other according to how the brake is used. A distinction is particularly made among the following project planning guidelines:

- Project planning for BE.. brakes as a working brake or BE.. as a working brake for ATEX, IECEx and HazLoc-NA® (→ 🗎 49),
- Project planning for BE.. brakes and BE.. safety brakes as a holding brake (→ 🗎 60),
- Project planning for BE.. brakes and BE.. safety brakes as a holding brake for ATEX, IECEx and HazLoc-NA® (→ 🗎 70).

When selecting and designing the BE.. brake, you must follow the appropriate project planning procedure and the project formulas in this chapter.

You may use the SEW-Workbench project planning tool for computer-aided project planning and selecting the gearmotors with the different designs of the BE.. brake from SEW-EURODRIVE.

If you have any questions on project planning, contact your SEW-EURODRIVE contact person.

5.2 General information

5.2.1 Key to the project planning procedures

Formula symbol	Unit	Description	Source
a_{Bmax}	$m \times s^{-2}$	Maximum deceleration when braking	
d_0	mm	Diameter of the output shaft transmission element	Application
ED	%	Relative cyclic duration factor	Motor project planning
f_A	–	Application factor for checking the brake functions "Hold" and "Brake"	Chapters "Braking torques" (→ 🗎 37) and "Application factor fA" (→ 🗎 108)
$f_{Brake,\ output}$	–	Design-dependent output factor	Chapters "Variables for determining the output load when braking" (→ 🗎 42) and "Output factor fbrake,output" (→ 🗎 136)
f_{Mmax}	–	Transmission element factor, braking torque, determination in relation to the used load range for braking work	Chapters "Application of load ranges" (→ 🗎 135) and "Braking torques" (→ 🗎 37) and "Load ranges for horizontal and vertical applications" (→ 🗎 40)

31550835/EN – 08/2024

Formula symbol	Unit	Description	Source
f_{Mmin}	–	Braking torque reduction factor, determination in relation to the used load range for braking work	Chapters "Application of load ranges" (→ 🗎 135) and "Braking torques" (→ 🗎 37) and "Load ranges for horizontal and vertical applications" (→ 🗎 40)
$f_{EmergOff}$	–	Factor for determining $M_{aEmergOff}$ depending on the gear unit	Chapter "Variables for determining the output load when braking" (→ 🗎 42)
$F_{R,brake}$	N	Resulting gear unit utilization via created radial load	
F_{Ra}	N	The permitted overhung load on the output end for M_{amax} applies to the point of force application located in the middle of the shaft end or end of the hollow shaft	Product documentation
$F_{RaEmergOff}$	N	Maximum permitted emergency stop overhung load for output shaft in combination with the BE.. brake/safety brake; applies to point of force application located in the middle of the shaft end or end of the hollow shaft	Product documentation and chapter "Variables for determining the output load when braking" (→ 🗎 42)
F_{RP}	N	Buffer overhung load	Chapter "Variables for determining the output load when braking" (→ 🗎 42)
f_V	–	Wear factor; determination in relation to the used load range for braking work	Chapters "Application of load ranges" (→ 🗎 135) and "Load ranges for horizontal and vertical applications" (→ 🗎 40)
f_Z	–	Transmission element factor for overhung load	Product documentation
i	–	Gear unit ratio	Product documentation
i_V	–	Gear ratio of optional customer's additional transmission	Application
J_{Int}	kgm²	Motor mass moment of inertia (incl. mount-on components), based on the motor shaft	Product documentation
J_X	kgm²	Mass moment of inertia of application and gear unit based on the motor shaft	Application and product documentation
K_J	–	Factor for external mass moment of inertia	Product documentation
K_M	–	Factor for load torque	Product documentation
K_P	–	Factor for static power and relative cyclic duration factor	Product documentation
L_B	h	Brake service life	
M_{amax}	Nm	Limit value of the gear unit load capacity: maximum permitted output torque	Product documentation
$M_{aEmergOff}$	Nm	Limit value of the gear unit load capacity: maximum permitted emergency stop torque in combination with BE.. brake/safety brake	Product documentation
M_B	Nm	Nominal braking torque for the BE.. brake/safety brake.	Product documentation

31550835/EN – 08/2024

Formula symbol	Unit	Description	Source
$M_{brake,\ output}$	Nm	Resulting gear unit load from the braking torque, based on gear unit output shaft	Product documentation
M_L	Nm	Static load torque at the motor shaft • Horizontally and vertically upwards: Application and gear unit efficiency are considered as "aggravating". • Vertically downwards: Application and gear unit efficiency are considered as "helpful".	
$M_{L,a}$	Nm	Static load torque value at the output shaft, efficiency not considered	Application
M_n	Nm	Nominal motor torque	Product documentation
M_P	Nm	Buffer torque	Chapter "Variables for determining the output load when braking" (→ 🗎 42)
N_{B1}	–	Number of cycles until brake maintenance in working brake operation	
N_{B2}	–	Number of permitted emergency stop braking operations until brake maintenance	Chapter "Consideration of mechanical service life limits" (→ 🗎 44)
N_{B2max}	–	Number of permitted emergency stop braking operations until end of service life	Chapter "Consideration of mechanical service life limits" (→ 🗎 44)
n_{Brake}	min^{-1}	Real brake application speed, relevant for check	
n_D	min^{-1}	Change of motor speed until brake application	
n_m	min^{-1}	Relevant speed of the application based on the motor shaft	Application
$n_{max,0}$	min^{-1}	Maximum permitted operating speed of the brakemotor	Chapters "Limit speeds for brakes" (→ 🗎 39) and "Limit speeds nmax,0 and nmax,1" (→ 🗎 111)
$n_{max,1}$	min^{-1}	Maximum permitted speed for brake application depending on application	Chapters "Limit speeds nmax,0 and nmax,1" (→ 🗎 111) and "Limit speeds for brakes" (→ 🗎 39)
$n_{emergStop}$	min^{-1}	Real emergency stop speed relevant for check	
η_G	–	Gear unit efficiency	Product documentation
η_G'	–	Retrodriving gear unit efficiency (SPIROPLAN® gear units and helical-worm gear units)	
η_L	–	Efficiency of the application	Application
P_N	kW	Nominal power	Product documentation
P_{stat}	kW	Static power	Motor project planning

31550835/EN – 08/2024

Formula symbol	Unit	Description	Source
s_{Bmax}	m	Maximum stopping distance	
t_2	s	Brake application time. Depending on the brake connection type, use $t_{2,I}$ or $t_{2,II}$	Chapters "Pulse frequencies" (→ 🗎 108) and "Pulse frequencies of the brakes" (→ 🗎 38)
$t_{2,I}$	s	Brake application time for cut-off in the AC circuit (AC shutdown)	Chapters "Pulse frequencies" (→ 🗎 108) and "Pulse frequencies of the brakes" (→ 🗎 38)
$t_{2,II}$	s	Brake application time for cut-off in the DC and AC circuit (AC/DC cut-off) and cut-off in the DC circuit (DC cut-off)	Chapters "Pulse frequencies" (→ 🗎 108) and "Pulse frequencies of the brakes" (→ 🗎 38)
t_{Bmax}	s	Maximum braking time	
t_{Bmin}	s	Minimum braking time	
t_{signal}	s	Plant signal transmit time	Application
t_{cycle}	s	Cycle time	Application
v_L	$m \times s^{-1}$	Relevant speed of the load or application at the point in time when the emergency stop is triggered	Application
v_{Brake}	$m \times s^{-1}$	Real speed of the load or application when the service braking operation begins	
$v_{emergStop}$	$m \times s^{-1}$	Real speed of the load or application when the emergency stop begins	
W_1	J	Maximum occurring braking work in case of emergency stop	
W_{tot}	J	Total braking work of all braking operations in the driving cycle	
W_{Insp}	J	Permitted work until brake inspection	Chapters "Consideration of mechanical service life limits" (→ 🗎 44) and "Braking work until maintenance" (→ 🗎 134)
W_{max}	J	Maximum value of W_n braking work from all cycles n = 1, 2, 3, …	
W_n	J	Occurring braking work in normal braking operations (in cycles n = 1, 2, 3, … , n)	
$W_{per,n}$	J	Maximum permitted braking work for emergency stop depending on the brake application speed	Chapter "Permitted emergency stop braking work Wper, n" (→ 🗎 112)
$W_{per,Z}$	J	Permitted braking work depending on the number of braking operations per hour	Chapter "Characteristic safety values" (→ 🗎 141)
X_B	–	Repeatability of braking distance in line operation	Chapter "Application of load ranges" (→ 🗎 135)
Z	h^{-1}	Required cycle switching frequency	Application

Formula symbol	Unit	Description	Source
Z_0	h^{-1}	No-load starting frequency of the motor	Product documentation
Z_{B0}	h^{-1}	Maximum permitted no-load starting frequency of the brake (without considering the motor)	Chapters "No-load starting frequency for holding brakes" (→ 🗎 38) and "No-load starting frequency and switching intervals for holding brakes" (→ 🗎 110)
Z_{B1max}	h^{-1}	Maximum emergency stop frequency	Chapter "Load ranges for horizontal and vertical applications" (→ 🗎 40)
Z_M	h^{-1}	Permitted starting frequency of the motor	Chapter "Permitted starting frequency of the motor" (→ 🗎 58)
$Z_{M,n}$	h^{-1}	Permitted switching frequencies of the individual acceleration phases	
$Z_{M,cycle,per}$	h^{-1}	Permitted cycle switching frequency	

31550835/EN – 08/2024

5.2.2 Braking torques

Braking torque definition

Project planning of brakes and safety brakes is to be carried out based on the braking torque defined by SEW-EURODRIVE.

The nominal braking torque M_B is used. By definition, this is the quasi-static braking torque M_2 according to DIN VDE0580, i.e. the braking torque with a slowly slipping brake (brake closed, relative velocity between the friction components: 1 m/s) at 20 °C.

The nominal value M_B is used both during brake selection and also during planning. The differences between M_1 (dynamic braking torque) and M_4 (static braking torque) and the nominal braking torque are taken into account by SEW-EURODRIVE with the formulas and the calculation coefficients that are used when doing this.

The characteristic values M_1 and M_4 are therefore not relevant within the scope of the project planning and selection of the brake. For more extensive applicative requirements of the brake, such as carrying out a brake test, the characteristic values M_1 and M_4 may possibly need to be examined and evaluated separately.

In the application, the nominal value M_B is combined to allow for various test and calculation steps:

- Application factor f_A for combined test of the holding and braking function
- Output factor $f_{brake,output}$ for checking the output load during emergency stop
- Reduction factor f_{Mmin} and transmission element factor f_{Mmax} for determining braking time, stopping distance, and deceleration

Application factor

The ratio of braking torque and load torque of the application, which is important for ensuring the brake function, is defined for brakes of the BE.. series by means of the application factor f_A:

The factor forms the ratio between the nominal braking torque M_B and the static load torque M_L in relation to the motor shaft.

By definition, the factor f_A always has a value > 1 and describes the 2 following limit states at the same time:

- Limit state that is necessary to hold a static load reliably in the idle state
- Limit state that is necessary to bring a moving application with a defined dynamic load reliably to the idle state.

The concept "reliably" is to be understood in the statistical sense. The intended use of the brakes requires compliance with the required minimum factor f_A as well as all other conditions specified in the project planning instructions and operating instructions.

Application factor f_A is not a safety factor in the true sense. This definition would require the failure limit to be 1. In contrast, the factor f_A is to be viewed as a binding dimensioning factor, meaning a functional failure can begin to occur even at values > 1.

INFORMATION

If the specified minimum values for f_A are undershot, the characteristic safety values B_{10D} also lose their validity for the application.

31550835/EN – 08/2024

5.2.3 Pulse frequencies of the brakes

In the case of brakes operated with AC voltage, make sure the connection type designated by the manufacturer is applied correctly during the brake connection. The following types are distinguished:

- Cut-off in the AC circuit (AC cut-off) with normal application time
- Cut-off in the AC circuit and the DC circuit (AC/DC cut-off) with shortened application time

The correct switch-off type must be ensured through appropriate wiring. Certain brake control systems from SEW-EURODRIVE realize the same cut-off in the DC circuit and in the AC circuit via integrated switching relays (e.g. BMP1.5), or via mounted switching relays (e.g. BSR or BUR).

To prevent delayed brake application or unintentional ongoing brake release, you must observe the following:

- During project planning, consider the required cut-off type and the effects on the expected stopping distance in particular.
- Only use the faster cut-off in the DC and AC circuit for hoists and hoist-like applications.
- If it is unclear whether the application is a hoist-like application, contact SEW-EURODRIVE.
- Make sure that the configured connection type (AC or AC/DC) is implemented correctly during startup, regardless of the type of application.

The connection type is specified on the included wiring diagrams by a pictogram.

For brakes operated with a DC voltage, a cut-off only in the DC circuit (DC cut-off) is always performed due to the operating principle. This has the same application time as the AC-DC cut-off method. The selected connection type must be taken into account in the project planning using the variable t_2 according to chapter "Mechanical project planning" (→ 🗎 32).

5.2.4 No-load starting frequency for holding brakes

Inverter-operated drives are often able to handle very dynamic motion requirements and very short travel cycles. For drives with brakes, 3 important limit conditions must be observed in the cycle design:

- The magnet system of the brake requires sufficient time to execute the requested switching command (close or open).
- The brake control requires sufficient time to enable the electronic components involved to perform their state changes completely, e.g. charging capacitors.
- Brakes that are operated with rapid excitation, e.g. with BME. series brake controls, are loaded with a higher mean rms current at a higher no-load starting frequency than would be the case with a lower no-load starting frequency. The reason for this is the higher time proportion of the inrush currents. The result is greater heating and higher load on the brake coil.

For the reasons mentioned, the following 3 design requirements must be observed for cycle design:

- The permitted no-load starting frequency Z_{B0} of the brake must not be exceeded (formula 2.2 and 3.2). The permitted values depending on the size and control mode are listed in chapter "Maximum permitted no-load starting frequencies" (→ 🗎 110).

31550835/EN – 08/2024

- The intervals between switch-on, switch-off and subsequent restart must be designed so that the brake can convert the respective electrical switching command into a mechanical response (application or release). Observe the switching times t_1 and t_2 of the brakes according to chapter "Pulse frequencies" (→ 🗎 108) and the response and signal runtimes of the application.
- Adhere to the minimum pause times before switching on again depending on the type of brake control. The minimum pause times are defined in chapter "Minimum pause times before switching on again" (→ 🗎 110).

5.2.5 Limit speeds for brakes

Within the project planning procedure, the required operating speeds of the application are checked against characteristic values of the brake or the brake motor in 2 steps:

- Maximum permitted emergency stop speed $n_{max,1}$

  This characteristic value marks the upper limit of the speed range in which by definition the brake may be applied in compliance with the permitted braking work $W_{per,n}$ during an emergency stop for the load range being used.

- Maximum permitted operating speed $n_{max,0}$

  This characteristic value marks the upper limit of the speed range in which the brakemotor may be operated in compliance with the mechanical strength in usual holding brake operation (meaning without an emergency stop).

Operating points at which it cannot be guaranteed on the application side that the brake will not be applied from speed must be within the speed range < $n_{max,1}$.

Operating points for which a brake application can be prevented on the application side by motor-independent measures (e.g. by additional external brake systems) may also be within the speed range between $n_{Max,1}$ and > $n_{max,0}$.

Exceeding the maximum permitted emergency stop speed $n_{max,1}$ (even once) or the maximum operating speed $n_{max,0}$ (even for a short time) is not permitted.

31550835/EN – 08/2024

5.2.6 Load ranges for horizontal and vertical applications

The following table shows the guidelines and restrictions when using the respective load ranges.

Range	Reduced R	Standard S	Overload range A	Overload range B	Overload range C	Overload range D	Overload range H
Permitted for	all applications	all applications	horizontal applications	horizontal applications	horizontal applications	horizontal applications	vertical applications
Max. permitted braking torque level	All levels[1)]	All levels[1)]	max. 75% M_{Bmax}	max. 75% M_{Bmax}	max. 75% M_{Bmax}	max. 75% M_{Bmax}	All levels[1)]
Wear factor f_V	Normal	Normal	Normal	Slightly increased	Significantly increased	Massively increased	Massively increased
Effective range of the dynamic braking torque Min. (f_{Mmin}) max. (f_{Mmax})	Normal	Normal	Normal	Slightly expanded	Significantly expanded	Extremely expanded	Significantly expanded
Maximum emergency stop frequency Z_{B1max}	10 h^{-1}	10 h^{-1}	5 h^{-1}	5 h^{-1}	5 h^{-1}	5 h^{-1}	5 h^{-1}

1) All levels that are permitted for the respective motor-brake combination.

The following pause time must be observed between two emergency stop braking operations:

- At least 6 minutes for load ranges R and S
- At least 12 minutes for load ranges A – H

You must use the limit values of load range R for explosion-protected drives.

31550835/EN – 08/2024

5.2.7 Assignment of the load ranges

Not all load ranges are available for every brake size in the BE series. The table shows the current correlations to the brakes and use cases.

Brake		Load ranges						
		Reduced R	Standard S	Overload range A	Overload range B	Overload range C	Overload range D	Overload range H
BE02	Standard		X					
BE03 – BE5	Standard		X					
	FS		X					
	Explosion protection	X						
	Ex-FS	X						
BE11 – BE32	Standard		X	X	X	X	X	X[1)]
	FS		X	X	X	X	X	
	Explosion protection	X						
	Ex-FS	X						
BE60 – BE122	Standard		X				X	
	Explosion protection	X						

1) Only for BE30/32

Legend	
Standard	BE.. brake
FS	BE.. safety brake
Explosion protection	BE.. brake for explosion-protected motors
Ex-FS	BE.. safety brake for explosion-protected motors

The following characteristic values depend on the load range:

- Maximum permitted speed $n_{Max,1}$
- Permitted braking work for emergency stop braking $W_{zul,n}$
- Specific wear factor f_V
- Reduction and transmission element factors f_{Mmin} and f_{Mmax}

The size-dependent values of these variables can be found in chapters "Limit speeds nmax,0 and nmax,1" (→ 🗎 111), "Permitted emergency stop braking work Wper, n" (→ 🗎 112) and "Application of load ranges" (→ 🗎 135).

You must use the limit values of load range R for explosion-protected drives.

31550835/EN – 08/2024

5.2.8 Variables for determining the output load when braking

To check the mechanical load on the drive in the motor-gear unit combination caused by braking, the following values are used:

- Design-dependent output factor $f_{brake,output}$
- Torque limit value M_{amax} and $M_{aEmergOff}$
- Overhung load limit value F_{Ramax} and $F_{RaEmergOff}$

Definition of $M_{aEmergOff}$ and $F_{RaEmergOff}$

The $M_{aEmergOff}$ and $F_{RaEmergOff}$ values correspond to the permitted buffer torques M_P and buffer forces F_{RP} of the gear unit.

The buffer torque M_P is defined as follows:

For service factors $\leq 2.5 \times \frac{1.7}{f_{eso}}$: $M_P = M_{a_eso} = f_{eso} \times M_{amax}$

For service factors $> 2.5 \times \frac{1.7}{f_{eso}}$: $M_P = M_{a_eso} = 1.7 \times i \times 2.5 \times M_n$

The buffer force F_{RP} is defined as follows:

$F_{RP} = F_{Ra_eso} = 1.7 \times F_{Ra}$

Both the buffer torque M_P as well as the buffer force F_{RP} are limited to 1000 events.

Gear unit design	$f_{EmergOff}$
R..7, F..7, K..7, S..7	1.7
K..9	1.7
S..7p	Gear ratio-dependent on request
W10	1.3
W20/30	1.5
W..7	1.4
W..9	Gear ratio-dependent on request

Design-dependent output factor $f_{brake,output}$

To determine the output load during an emergency stop braking operation, the characteristic value M_B is used for the calculations. However, due to its definition as nominal braking torque, this does not represent the decisive load of the output.

Therefore, an additional factor is also used when determining the output load. This takes into consideration:

- Differences between the characteristic value M_B and the real occurring dynamic braking torque
- Different definitions of the load limit values for emergency stop braking operations A differentiation must be made regarding whether a gear unit is used and, if so, which design.

The values according to chapter "Output factor fbrake,output" (→ 🖹 136) apply.

31550835/EN – 08/2024

5.2.9 Establishing the maintenance intervals

Abrasion buildup on the friction linings

Brakes are subject to different kinds of wear according to the application. As such, planning regular inspections and maintenance is an important aspect of drive project planning.

The expected service life of the friction lining is calculated as a main size (using the characteristic value W_{Insp}) when establishing the maintenance intervals.

Apart from this apparent wear criterion, there are additional influencing factors that can lead to wear effects on brake linings and mechanical guiding elements. It also applies for applications in which the brakes are only used in emergency stop situations (holding brakes).

These special wear factors include:

- No-load wear

  As a matter of principle, this is mainly formed by the existing residual friction in the brake.
- Mounting positions that lead to a vertical alignment of the motor longitudinal axis.

  Due to the weight of the brake's lining carrier, larger brakes (BE20 and larger) particularly undergo greater wear, especially on the bottom of the lining.
- Double disk brakes

  Increased wear, mainly in the pivoted mounting position by supporting the brake plate.
- Performing activation processes

  Friction work is used in every process. The number of activation processes and the friction work used per process must be taken into account when determining the lining service life.

All listed factors can additionally reduce the calculated service life. The /DUE option and the integrated BG1Z brake control enable wear monitoring.

Mechanical wear on guiding elements

In addition to the described wear on the friction linings, the wear on mechanical gaskets and guiding elements must also be taken into account, particularly in rapid-cycle applications.

This also applies for brakes that are used in environments with heavy soiling or high thawing stress.

31550835/EN – 08/2024

Consideration of mechanical service life limits

In addition to this approach, the total number N_{B2max} of possible emergency stop braking operations is limited to the following values depending on the load range and the degree of gear unit utilization, regardless of the calculated numerical value from the related project planning procedure:

Application	Load range	Gear unit utilization	N_{B2max}	Relevant limit
Working brake	R and S	$\leq M_{amax}$	Not limited	–
Holding brake	All	$\leq M_{amax}$	2000	Mechanical service life of the brake
		$\leq M_{aEmergOff}$	1000	Mechanical service life of the gear unit

31550835/EN – 08/2024

5.2.10 Project planning measures

BE.. brakes as a working brake and BE.. as a working brake for ATEX, IECEx and HazLoc-NA®

If the result of the respective checks in the project planning procedure is negative, the following table describes the possible project planning measures for an alternative drive.

Checks	For-mula	Possible measures
Is the braking torque sufficient?	1.1	• Select a greater braking torque • Select a larger brake size (adhere to feasibility) • Select a larger motor, in case a larger brake could not be mounted previously • Select a larger gear ratio • Reduce the load in the application
Is the permitted switching frequency sufficient?	1.6	• Select a rectifier with high-speed excitation • Select a larger motor • Extend the application's cycle time and reduce the required switching frequency
Is the vertical/horizontal braking work sufficient?	1.8	• Reduce brake application speed – Select brake control with AC/DC cut-off – Select a smaller gear ratio – Reduce the application speed – Use a motor with a greater number of poles[1)] • Select a greater braking torque • Select a larger brake size (adhere to feasibility)
Is the brake service life sufficient?	1.11	• Select a larger brake size (adhere to feasibility) • Reduce braking work (see "Is the vertical/horizontal braking work sufficient?")
Final drive check: Calculation of the drive considering the selected components and their characteristic values (such as inertia) For detailed project planning criteria and procedures, refer to the SEW-EURODRIVE project planning guidelines.	---	• Select a new gearmotor
Is the braking load of the gear unit (torque) permitted?	1.14	• Select a lower braking torque • Select larger gear unit • Select a different gear unit ratio
Is the braking load of the gear unit (overhung load) permitted?	1.16	• Select a lower braking torque • Select larger gear unit • Select a different gear unit ratio • Select a different gear unit design
Does the stopping distance correspond to the applicative requirement?	1.19	• Select a greater braking torque

31550835/EN – 08/2024

Checks	For-mula	Possible measures
Does the deceleration correspond to the applicative requirement?	1.22	• Select a lower braking torque • Select an additional flywheel mass

BE.. brakes and BE.. safety brakes as a holding brake

If the result of the respective tests in the project planning procedure is negative, the following table describes the possible project planning measures for an alternative drive.

Tests	For-mula	Possible measures
Is the braking torque sufficient?	2.1	• Select a higher braking torque • Select a larger brake size (adhere to feasibility) • Select a larger motor if a larger brake could not be mounted prior • Select a larger gear ratio • Reduce the load in the application
Is the permitted no-load starting frequency of the brake sufficient?	2.2	• Change brake type • Change the type of brake control • Reduce the application's no-load starting frequency
Is the emergency stop speed permitted?	2.6	• Select a brake control with AC/DC cut-off • Select a smaller gear ratio • Reduce the load movement speed in the application
Is the vertical/horizontal emergency stop braking work sufficient?	2.8	• Reduce the emergency stop speed • Change the braking torque • Select a larger brake size (adhere to feasibility)
Number of emergency stop braking functions sufficient?	2.9	• Reduce the braking work for emergency stop • Reduce the emergency stop speed
Final drive check: Calculating the drive considering the selected components and their characteristic values (such as inertia). For detailed project planning criteria and procedures, refer to the SEW-EURODRIVE project planning guidelines.	–	• Select new gearmotor
Is the emergency stop load for the gear unit (torque) permitted?	2.12	• Select a lower braking torque • Select a larger gear unit • Select a different gear unit ratio
Is the emergency stop load for the gear unit (overhung load) permitted?	2.14	• Select a lower braking torque • Select a larger gear unit • Select a different gear unit ratio • Select a different gear unit design

31550835/EN – 08/2024

Tests	For-mula	Possible measures
Is the braking distance sufficient?	2.17	• Select a higher braking torque • Reduce the emergency stop speed
Is the deceleration permitted?	2.19	• Change the braking torque

BE.. brakes and BE.. safety brakes functioning as holding brake for ATEX, IECEx, and HazLoc-NA®

If the result of the respective tests in the project planning procedure is negative, the following table describes the possible project planning measures for an alternative drive.

Tests	For-mula	Possible measures
Is the braking torque sufficient?	3.1	• Select a higher braking torque • Select a larger brake size (adhere to feasibility) • Select a larger motor if a larger brake could not be mounted prior • Select a larger gear ratio • Reduce the load in the application
Is the permitted no-load starting frequency of the brake sufficient?	3.2	• Change brake type • Change the type of brake control • Reduce the application's no-load starting frequency
Is the emergency stop speed permitted?	3.6	• Select a brake control with AC/DC cut-off • Select a smaller gear ratio • Reduce the load movement speed in the application
Is the vertical/horizontal emergency stop braking work sufficient?	3.8	• Reduce the emergency stop speed • Change the braking torque • Select a larger brake size (adhere to feasibility)
Number of emergency stop braking functions sufficient?	3.9	• Reduce the braking work for emergency stop • Reduce the emergency stop speed
Final drive check: Calculating the drive considering the selected components and their characteristic values (such as inertia). For detailed project planning criteria and procedures, refer to the SEW-EURODRIVE project planning guidelines.	–	• Select new gearmotor
Is the emergency stop load for the gear unit (torque) permitted?	3.12	• Select a lower braking torque • Select a larger gear unit • Select a different gear unit ratio
Is the emergency stop load for the gear unit (overhung load) permitted?	3.14	• Select a larger gear unit • Select a different gear unit ratio • Select a different gear unit design

31550835/EN – 08/2024

Tests	For-mula	Possible measures
Is the braking distance sufficient?	3.17	• Select a higher braking torque • Reduce the emergency stop speed
Is the deceleration permitted?	3.19	• Change the braking torque

31550835/EN – 08/2024

5.3 Working brake, also for ATEX, IECEx, HazLoc-NA®

5.3.1 General information

The project planning procedure in this chapter describes the procedure for the project planning of a drive with a BE.. brake as a working brake or a BE.. brake as a working brake for ATEX, IECEx, or HazLoc-NA® requirements.

The following project planning procedures are described together in chapter "Project planning procedure for BE.. brake as a working brake" (→ 🗎 50):

- BE.. brake as a working brake
- BE.. brake as a working brake for ATEX, IECEx, and HazLoc-NA® requirements as an option of the EDR../EDRN.. type series.

These procedures are to be generally applied line-operated applications.

The following project planning procedure thoroughly describes the procedure during project planning of a drive with a BE.. brake as a working brake. The project planning procedure partially refers to calculation formulas. At relevant points in the project planning procedure, a formula number stands for the matching calculation formulas. The formulas are listed in a table following the project planning procedure.

The variables used in the formulas, including their definitions, are listed in a table in chapter "Key to the project planning procedures" (→ 🗎 32).

Checks against product characteristics whose testing turns out negative are required in some parts of the project planning procedure. Information on additional steps in the case of a negative test result is summarized in chapter "Project planning measures" (→ 🗎 45).

Observe the following notes in addition to the project planning procedures:

- For vertical applications with a counterweight, it may be necessary to calculate the upward travel after the downward travel has completed and vice versa, depending on the load situation.
- All applications with non-horizontal direction of movement, thus inclining, must be calculated as vertical applications. This also includes further applications with off-center load distribution, such as vertical rotary tables.
- Horizontal applications that are stressed by outside forces, e.g. wind load and pressing forces, among other things, must also be planned like hoists.
- For special applications, e.g. vertical rotary tables with eccentric load distribution, you cannot readily use the project planning process, since you mostly need to follow additional framework conditions. You must discuss these with the applicant for the respective case and include them in an amended or separate calculation.

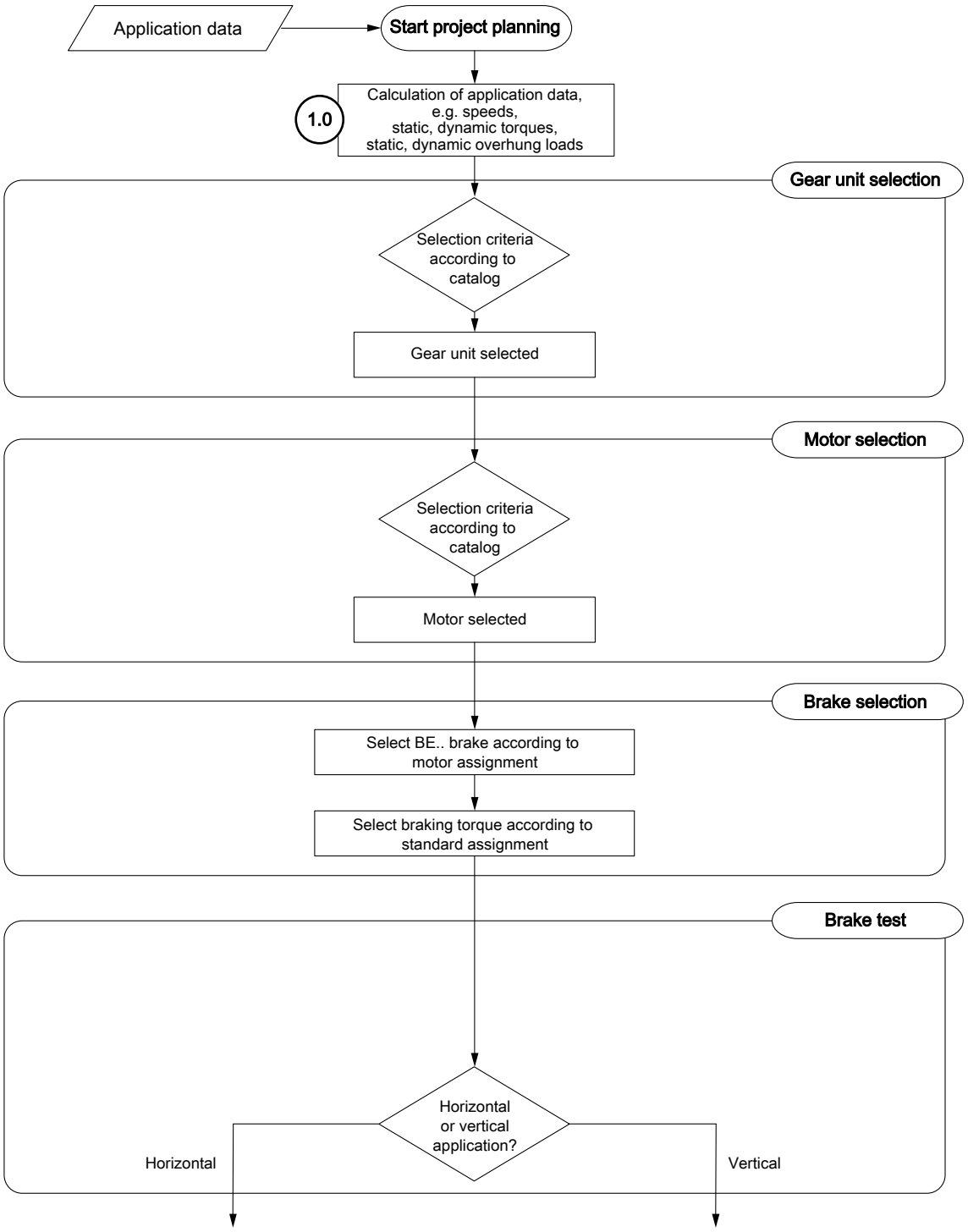
Peculiarities during the project planning of special applications in the SEW-Workbench

- Vertical rotary table

  Since no vertical rotary tables with eccentric masses can be calculated, only the calculation for horizontal applications is performed when calculating the brake.

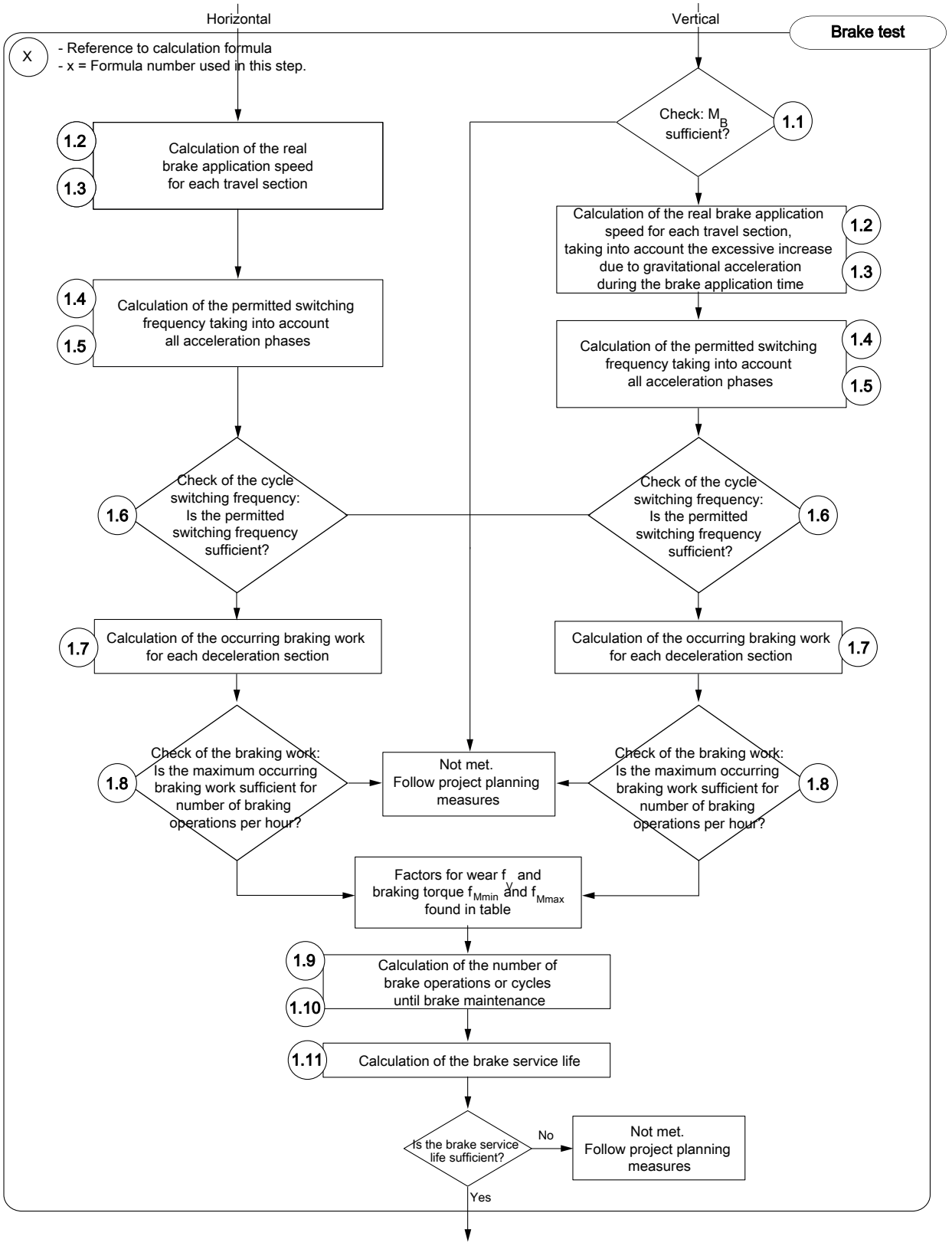
31550835/EN – 08/2024

5.3.2 Project planning procedure for BE.. brake as a working brake

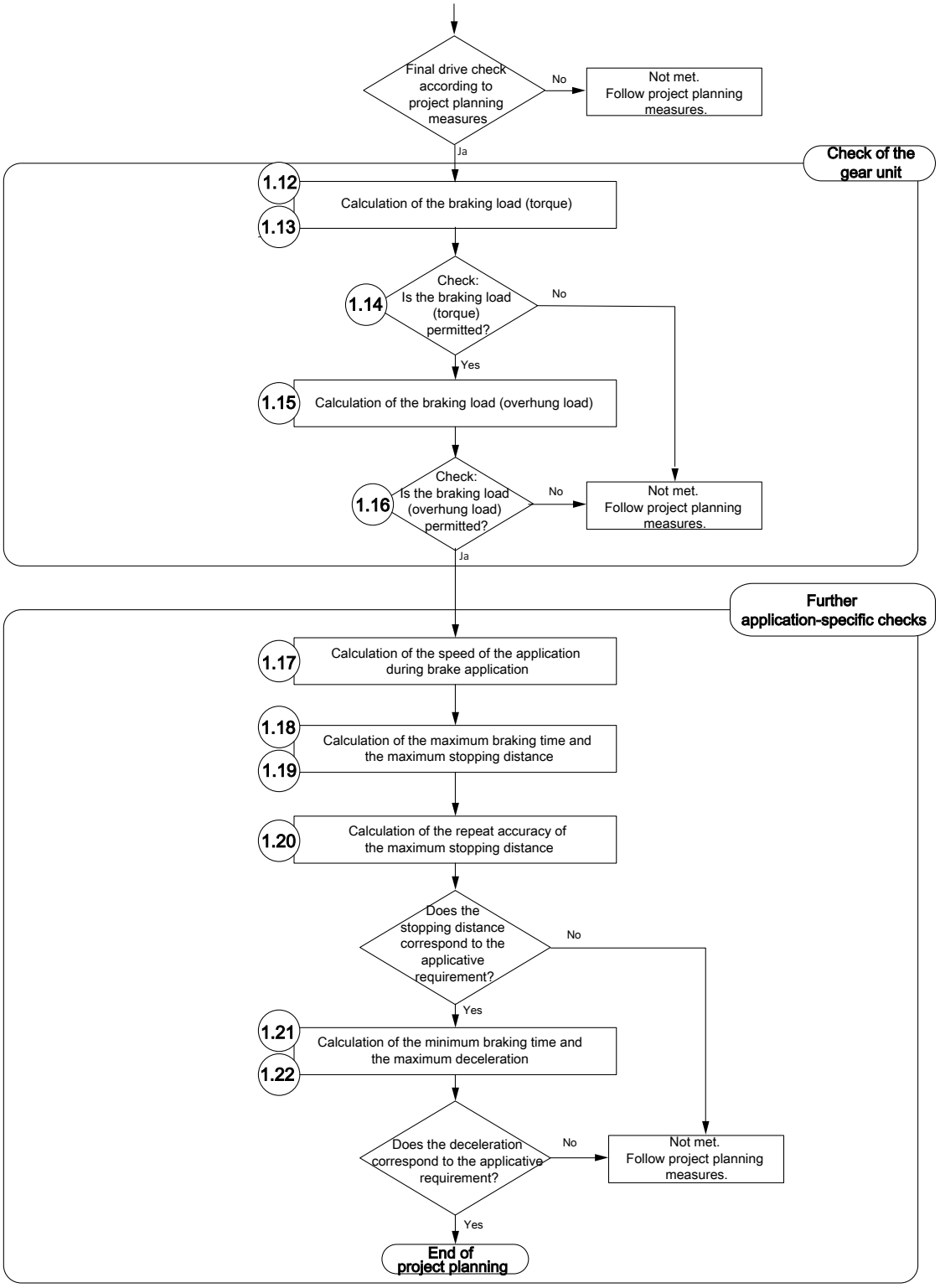


9007237423465867

31550835/EN – 08/2024



9007237424384139



38175977739

5.3.3 Calculation formulas for BE.. brake as a working brake

Formula 1.0: Static load torque at the motor shaft

Horizontally and vertically upwards		Vertically downwards	
$M_L = \frac{M_{L,a}}{i \times \eta_L \times \eta_G}$		$M_L = M_{L,a} \times \frac{\eta_L \times \eta_G}{i}$	
$[M_L]$ = Nm	Static load torque at the motor shaft. Application and gear unit efficiency are considered as **aggravating**.	$[M_L]$ = Nm	Static load torque at the motor shaft. Application and gear unit efficiency are considered as **helpful**.
$[M_{L,a}]$ = Nm	Static load torque value at the output shaft, efficiency not considered		
$[\eta_L]$ = 1	Efficiency of the application		
$[\eta_G]$ = 1	Efficiency of the gear unit		
[i] = 1	Gear unit ratio		

Formula 1.1: Check of the braking torque

Horizontally and vertically upwards	Vertically downwards	
–	$M_B \geq f_A \times M_L$	
	$[f_A]$ = 1	Application factor
	$[M_B]$ = Nm	Nominal braking torque

Formula 1.2: Speed difference during brake application

Horizontally and vertically upwards	Vertically downwards
$n_D = \frac{9.55 \times M_L \times t_2}{J_{Int} + J_x \times \eta_L \times \eta_G}$	
$[n_D]$ = min^{-1}	Change of motor speed until brake application
$[t_2]$ = s	Brake application time; depending on connection type, $t_{2,I}$ or $t_{2,II}$ must be used
$[J_{Int}]$ = kgm^2	Motor mass moment of inertia with mount-on components, based on the motor shaft
$[J_x]$ = kgm^2	Mass moment of inertia of application with gear unit based on the motor shaft

Formula 1.3: Calculation of the real brake application speed

Horizontally and vertically upwards	Vertically downwards
$n_{Brake} = n_m - n_D$	$n_{Brake} = n_m + n_D$
$[n_{Brake}]$ = min^{-1}	For testing the relevant, real brake application speed
$[n_m]$ = min^{-1}	Relevant motor speed of the application

31550835/EN – 08/2024

Formula 1.4: Calculation of the permitted starting frequency of the motor for an acceleration phase

Horizontally and vertically upwards	Vertically downwards
$Z_M = Z_0 \times K_J \times K_M \times K_P$	
$[Z_M] = h^{-1}$	For the permitted starting frequency of the motor, see chapter "Permitted starting frequency of the motor" (→ 🗎 58)
$[Z_0] = h^{-1}$	No-load starting frequency of the motor
$[K_J] = 1$	Factor for external mass moment of inertia
$[K_M] = 1$	Factor for load torque
$[K_P] = 1$	Factor for static power and relative cyclic duration factor

Formula 1.5: Calculation of the permitted cycle switching frequency of the motor while considering all acceleration phases

Horizontally and vertically upwards	Vertically downwards
$Z_{M,Cycle,per} = \frac{1}{(\frac{1}{Z_{M,1}} + \frac{1}{Z_{M,2}} + ... + \frac{1}{Z_{M,n}})}$	
$[Z_{M,Cycle,per}] = h^{-1}$	Permitted cycle switching frequency
$[Z_{M,n}] = h^{-1}$	Permitted switching frequencies of the individual acceleration phases

Formula 1.6: Check of the motor's cycle switching frequency

Horizontally and vertically upwards	Vertically downwards
$Z \leq Z_{M,cycle,per}$	
$[Z] = h^{-1}$	Required cycle switching frequency

Formula 1.7: Calculation of the occurring braking work

Horizontally and vertically upwards	Vertically downwards
$W_n = \frac{M_B}{M_B + M_L} \times \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Brake}^2}{182.5}$	$W_n = \frac{M_B}{M_B - M_L} \times \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Brake}^2}{182.5}$
$[W_n] = J$	Occurring braking work in normal braking operations (in cycles n = 1, 2, 3, …, n)

Formula 1.8: Check of the maximum occurring braking work against permitted braking work

Horizontally and vertically upwards	Vertically downwards
$W_{max} \leq W_{per,Z}$	
$[W_{per,Z}] = J$	Permitted braking work depending on the number of braking operations per hour
$[W_{max}] = J$	Maximum value of W_n braking work from all braking operations

31550835/EN – 08/2024

Formula 1.9: Calculation of the total braking work of all braking operations in one driving cycle

Horizontally and vertically upwards	Vertically downwards
$W_{ges} = W_1 + W_2 + ... + W_n$	
$[W_{tot}] = J$	Total braking work of all braking operations in the driving cycle

Formula 1.10: Calculation of the number of cycles until brake maintenance

Horizontally and vertically upwards	Vertically downwards
$N_{B1} = \frac{W_{Insp}}{W_{ges}}$	
N_{B1}	Number of cycles until brake inspection in working brake operation. Observe the project planning notes.
$[W_{Insp}] = J$	Permitted work until brake inspection

Formula 1.11: Calculation of the brake service life

Horizontally and vertically upwards	Vertically downwards
$L_B = \frac{N_{B1} x\, t_{cycle}}{3600}$	
$[L_W] = h$	Brake service life
$[t_{Cycle}] = s$	Cycle time

Formula 1.12: Calculation of the braking load (torque) when braking (gear unit output side)

Horizontally and vertically upwards	Vertically downwards
$M_{Brake,\,Output} = \frac{i}{\eta_G}\left[\left(M_B \times f_{Brake,\,Output} + M_L\right) \times \frac{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}}{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}} + 1}\right] - M_{L,a} \times \eta_L$	$M_{Brake\,,Output} = \frac{i}{\eta_G}\left[\left(M_B \times f_{Brake,\,Output} - M_L\right) \times \frac{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}}{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}} + 1}\right] + M_{L,a} \times \eta_L$
$[M_{brake,output}] = Nm$	Resulting gear unit load from the braking torque, based on gear unit output shaft
$[f_{brake,output}] = 1$	Factor for output design of the selected brake or gear unit combination
$[\eta_G] = 1$	Gear unit efficiency; for SPIROPLAN® or helical-worm gear units, the retrodriving efficiency n_G‘ must be used (see formula 1.14)

Formula 1.13: Retrodriving efficiency for SPIROPLAN® or helical-worm gear unit

Horizontally and vertically upwards	Vertically downwards
$\eta'_G = 2 - \frac{1}{\eta_G}$	
$[\eta_G‘] = 1$	Gear unit efficiency of SPIROPLAN® or helical-worm gear unit (retrodriving)
$[\eta_G] = 1$	Gear unit efficiency of SPIROPLAN® or helical-worm gear unit

Formula 1.14: Check of the braking load (torque)

Horizontally and vertically upwards	Vertically downwards
$M_{Brake,output} \leq M_{amax}$	
$[M_{amax}]$ = Nm	Maximum permitted output torque

Formula 1.15: Calculation of the braking load (gear unit overhung load) when braking

Horizontally and vertically upwards	Vertically downwards
$F_{R,brake} = \frac{M_{brake,output} \times 2000}{d_0} \times f_Z$	
$[F_{R,\,brake}]$ = N	Resulting gear unit utilization via created radial load
$[d_0]$ = mm	Diameter of the output shaft transmission element
$[f_Z]$ = 1	Transmission element factor for overhung load
→ observe additional overhung load by application if necessary	

Formula 1.16: Check of the braking load (overhung load)

Horizontally and vertically upwards	Vertically downwards
$F_{R,brake} \leq F_{Ramax}$	
$[F_{Ramax}]$ = N	Maximum permitted overhung load for output shaft; applies to points of force application located in the middle of the shaft end or end of the hollow shaft

Formula 1.17: Calculation of the speed of the application during brake application

Horizontally and vertically upwards	Vertically downwards
$v_{Brake} = \frac{n_{Brake}}{n_m} \times v_L$	
$[v_{Brake}]$ = m × s^{-1}	Real speed of the load in the application during brake application
$[v_L]$ = m × s^{-1}	Relevant speed of the load in the application at the point in time when the emergency stop is triggered

Formula 1.18: Calculation of the maximum braking time

Horizontally and vertically upwards	Vertically downwards
$t_{B\max} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Brake}}{9.55 \times (M_B \times f_{M\min} + M_L)}$	$t_{B\max} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Brake}}{9.55 \times (M_B \times f_{M\min} - M_L)}$
$[t_{Bmax}]$ = s	Maximum braking time
$[f_{Mmin}]$ = 1	Braking torque reduction factor, determination in relation to the used load range for braking work

31550835/EN – 08/2024

Formula 1.19: Calculation of the maximum stopping distance

Horizontally and vertically upwards	Vertically downwards
$$S_{Bmax} = v_L \times t_{Signal} + v_{Brake} \times \left(t_2 + \frac{1}{2} \times t_{Bmax} \right)$$	
$[S_{Bmax}]$ = m	Maximum stopping distance
$[t_{signal}]$ = s	Plant signal transmit time

Formula 1.20: Calculation of the repeat accuracy of the maximum stopping distance

Horizontally and vertically upwards	Vertically downwards
$$X_B = \pm 0.12 \times s_{Bmax}$$	
$[X_B]$ = m	Variation of the stopping distance

Formula 1.21a: Calculation of the minimum braking time (for gear units with $n_G \geq 90\%$)

Horizontally and vertically upwards	Vertically downwards
$$t_{Bmin} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Brake}}{9.55 \times (M_B \times f_{Mmax} + M_L)}$$	$$t_{Bmin} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Brake}}{9.55 \times (M_B \times f_{Mmax} - M_L)}$$
$[t_{Bmin}]$ = s	Minimum braking time
$[f_{Mmax}]$ = 1	Braking torque transmission element factor, determination in relation to the used load range for braking work

Formula 1.21b: Calculation of the minimum braking time (for gear units with $n_G < 90\%$)

Horizontally and vertically upwards	Vertically downwards
$$t_{Bmin} = \frac{(J_{Int} + J_x \times \eta_L \times \eta'_G) \times n_{EmergStop}}{9.55 \times \left(M_B \times f_{Mmax} + M_L \times \frac{\eta_G}{\eta'_G} \right)}$$	$$t_{Bmin} = \frac{(J_{Int} + J_x \times \eta_L \times \eta'_G) \times n_{EmergStop}}{9.55 \times \left(M_B \times f_{Mmax} - M_L \times \frac{\eta_G}{\eta'_G} \right)}$$
$[t_{Bmin}]$ = s	Minimum braking time
$[f_{Mmax}]$ = 1	Braking torque transmission element factor, determination in relation to the used load range for braking work

Formula 1.22: Calculation of the maximum deceleration when braking

Horizontally and vertically upwards	Vertically downwards
$$a_{Bmax} = \frac{v_{Brake}}{t_{Bmin}}$$	
$[a_{Bmax}]$ = m × s^{-2}	Maximum deceleration when braking

5.3.4 Permitted starting frequency of the motor

You can determine the Z_M permitted switching frequency of the motor in cycles/per hour by using the following formula:

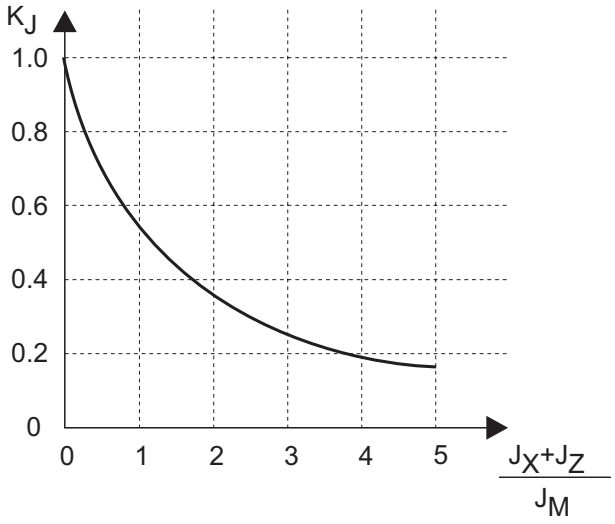
$$\mathbf{Z_M = Z_0 \times K_J \times K_M \times K_P}$$

INFORMATION

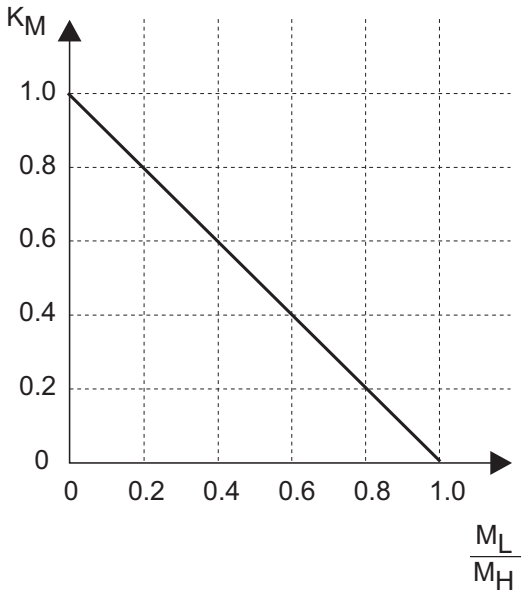
When using the additional flywheel mass/Z option, you must multiply the no-load starting frequency Z_0 by the factor **0.8**.

You determine the factors $_J$, K_M, and K_P using the following diagrams:

Factor K_J depending on the additional mass moment of inertia

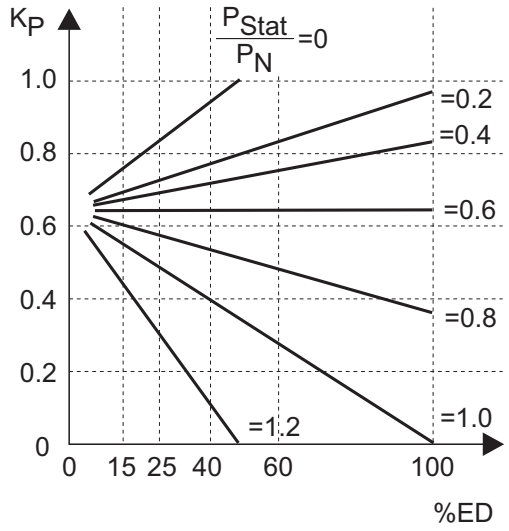


Factor K_M depending on the external load during run-up



31550835/EN – 08/2024

Factor K_P depending on the static power and the relative cyclic duration factor cdf



J_X: Total of all external mass moments of inertia in relation to the motor axis
J_Z: Mass moment of inertia flywheel fan
J_M: Motor mass moment of inertia
M_L: Counter-torque during startup
M_H: Acceleration torque of the motor
P_{stat}: Power demand after run-up (static power)
P_N: Rated motor power
%cdf: Relative cyclic duration factor

Example

Brakemotor: DRN80M4 with BE1 brake as line-powered drive

No-load starting frequency Z_0 with BGE brake rectifier = 8200 h^{-1}

1. $(J_X + J_Z) / J_M = 3.5 \rightarrow K_J = 0.2$
2. $M_L / M_H = 0.6 \rightarrow K_M = 0.4$
3. $P_{stat} / P_N = 0.6$ and 60% cdf $\rightarrow K_P = 0.65$

$Z = Z_0 \times K_J \times K_M \times K_P = 8200\ h^{-1} \times 0.2 \times 0.4 \times 0.65 = 426\ h^{-1}$

The cycle duration is 8.45 s.

The switch-on time is 5.07 s.

31550835/EN – 08/2024

5.4 Holding brake/safety brake

5.4.1 General information

The project planning procedure in this chapter describes the procedure for the project planning of a drive with a BE.. brake or a BE.. safety brake as a holding brake.

The following project planning procedures are described together in chapter "Project planning procedure, BE.. brake and BE.. safety brake as a holding brake" (→ 🗎 62):

- BE.. brake as a holding brake with emergency stop features
- BE.. safety brake as a holding brake with emergency stop features

You must generally use these procedures in controlled applications (drive is operated on a frequency inverter) outside of explosion-protected areas.

The following project planning procedures thoroughly describe the procedure during project planning of a drive with a BE.. brake or a BE.. safety brake. The following project planning procedures partially refer to calculation formulas. At relevant points in the project planning procedure, a formula number stands for the matching calculation formulas. The formulas are listed in a table following the project planning procedure.

The variables used in the formulas, including their definitions, are listed in a table in chapter "Key to the project planning procedures" (→ 🗎 32).

Checks against product characteristics that may turn out negative are required in some parts of the project planning procedure. Information on additional steps is summarized in chapter "Project planning measures" (→ 🗎 45).

You must also consider the following information regarding the project planning procedures:

- For vertical applications with a counterweight, it may be necessary to calculate the upward travel after the downward travel has completed and vice versa, depending on the load situation.
- All applications with non-horizontal direction of movement, thus inclining, must be calculated as vertical applications. This also includes further applications with off-center load distribution, such as vertical rotary tables.
- Horizontal applications that are stressed by outside forces, e.g. wind load and pressing forces, among other things, must also be planned like hoists.
- For special applications, e.g. winders, calenders, applications with crank drives, vertical rotary tables with off-center load distribution, etc., the project planning procedure cannot be used readily, since it will usually be necessary to follow additional framework conditions. You must discuss these with the applicant for the respective case and, if necessary, include them in an amended or separate calculation.
- Project planning for stand-alone motors is performed analogously to the procedure for gearmotors, with the difference being that limit values and checks specific to the gear unit are not considered and carried out. Consult SEW-EURODRIVE for the limit values of IEC motor shafts.

31550835/EN – 08/2024

Peculiarities during the project planning of special applications in the SEW-Workbench

- Winder

  In winding drives, the calculation of the brake in the SEW-Workbench is always performed under the assumption of a free-running winder. Effects due to the tensions of the winding material remain unconsidered.

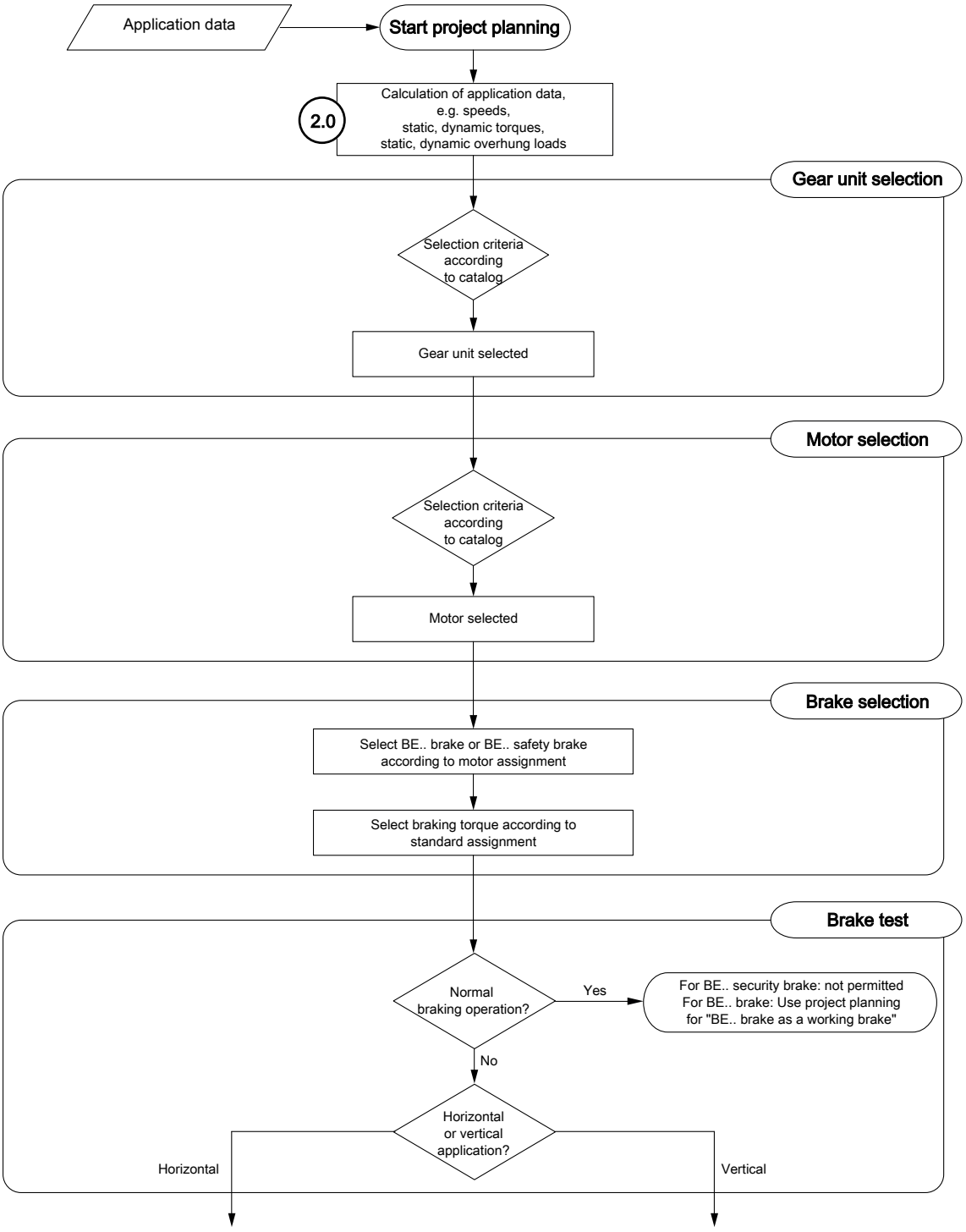
  Coordinate with the customer the precise framework conditions of the emergency stop braking operation and the cause variables to be considered and evaluate it in a separate calculation, if necessary.

- Vertical rotary table

  Since no vertical rotary tables with eccentric masses can be calculated, only the calculation for horizontal applications is performed when calculating the brake.

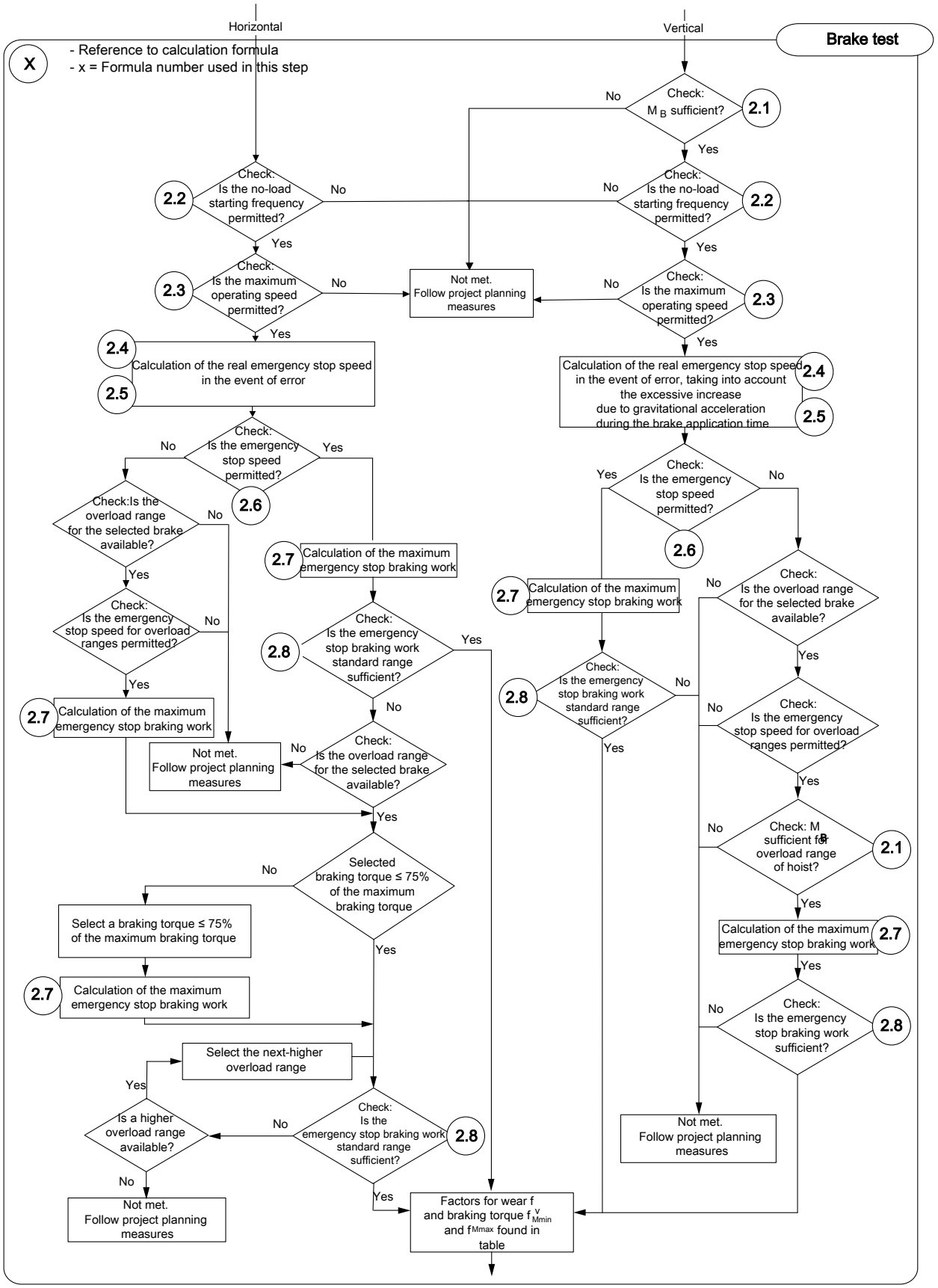
31550835/EN – 08/2024

5.4.2 Project planning procedure, BE.. brake and BE.. safety brake as a holding brake

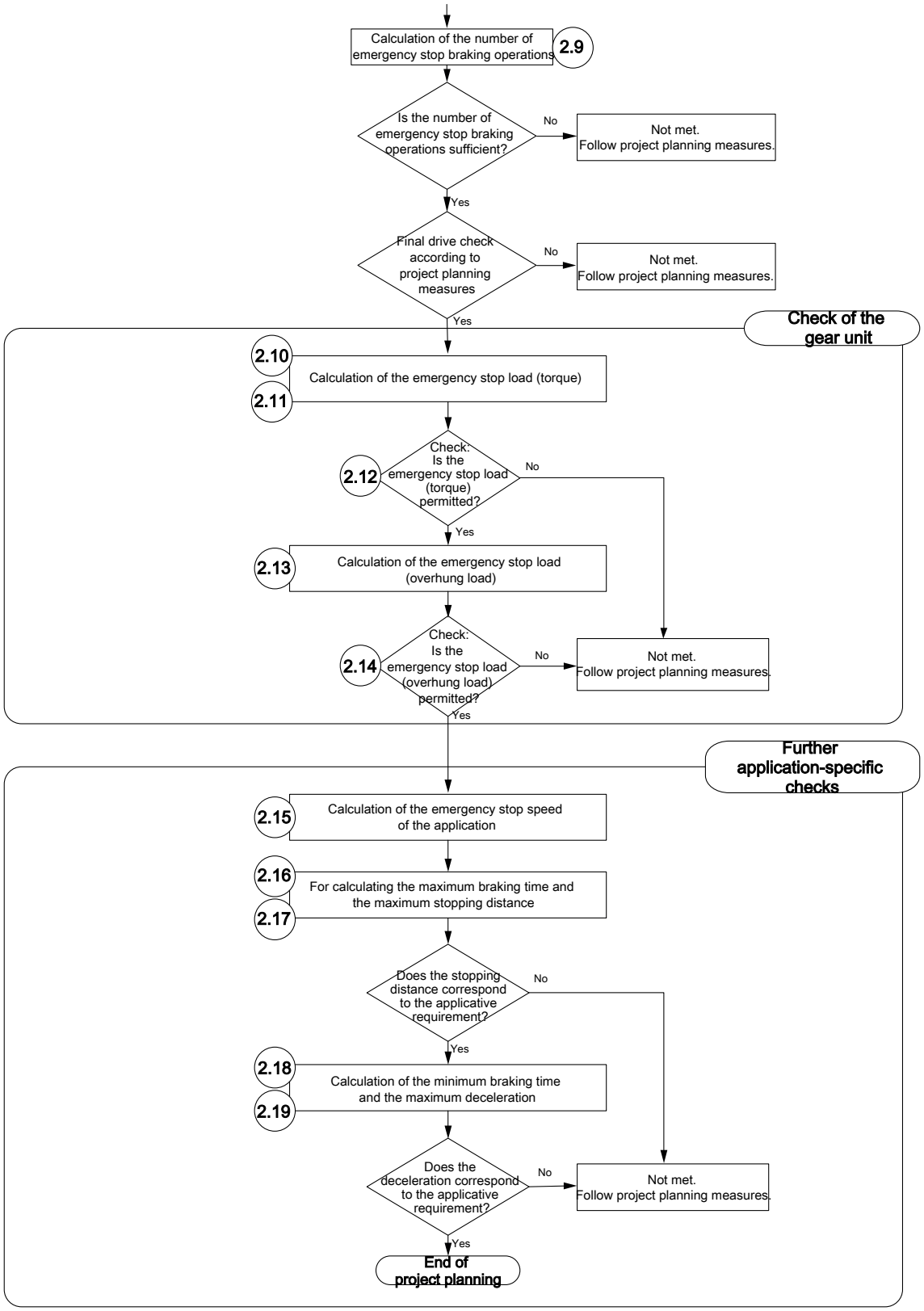


9007237379482379

31550835/EN – 08/2024



9007237443505291



38446289035

31550835/EN – 08/2024

5.4.3 Calculation formulas, BE.. brake and BE.. safety brake as a holding brake

Formula 2.0: Static load torque at the motor shaft

Horizontally and vertically upwards		Vertically downwards	
$M_L = \frac{M_{L,a}}{i \times \eta_L \times \eta_G}$		$M_L = M_{L,a} \times \frac{\eta_L \times \eta_G}{i}$	
$[M_L]$ = Nm	Static load torque at the motor shaft. Application and gear unit efficiency are considered as **aggravating**.	$[M_L]$ = Nm	Static load torque at the motor shaft. Application and gear unit efficiency are considered as **helpful**.
$[M_{L,a}]$ = Nm	Static load torque value at the output shaft, efficiency not considered		
$[\eta_L]$ = 1	Efficiency of the application		
$[\eta_G]$ = 1	Efficiency of the gear unit		
[i] = 1	Gear unit ratio		

Formula 2.1: Check of the braking torque

Horizontally and vertically upwards	Vertically downwards	
–	$M_B \geq f_A \times M_L$	
	$[f_A]$ = 1	Application factor
	$[M_B]$ = Nm	Nominal braking torque

Formula 2.2: Check of the no-load starting frequency

Horizontally and vertically upwards	Vertically downwards
$Z \leq Z_{B0}$	
$[Z] = h^{-1}$	Required cycle switching frequency
$[Z_{B0}] = h^{-1}$	Maximum permitted no-load starting frequency of the brake

Formula 2.3: Check of the maximum operating speed

Horizontally and vertically upwards	Vertically downwards
$n_{m,1}, n_{m,2}, \ldots \leq n_{Max,0}$	
$[n_{max,0}] = min^{-1}$	Maximum permitted operating speed of the brakemotor

31550835/EN – 08/2024

Formula 2.4: Speed difference during brake application

Horizontally and vertically upwards	Vertically downwards
$$n_D = \frac{9.55 \times M_L \times t_2}{J_{Int} + J_x \times \eta_L \times \eta_G}$$	
$[n_D] = min^{-1}$	Change of motor speed until brake application
$[t_2] = s$	Brake application time; depending on connection type, $t_{2,I}$ or $t_{2,II}$ must be used
$[J_{Int}] = kgm^2$	Motor mass moment of inertia with mount-on components, based on the motor shaft
$[J_x] = kgm^2$	Mass moment of inertia of application with gear unit based on the motor shaft

Formula 2.5: Calculation of the real emergency stop speed

Horizontally and vertically upwards	Vertically downwards
$n_{em.stop} = n_m - n_D$	$n_{em.stop} = n_m + n_D$
$[n_{EmergStop}] = min^{-1}$	Real emergency stop speed relevant for check
$[n_m] = min^{-1}$	Relevant motor speed of the application

Formula 2.6: Check of the maximum emergency stop speed

Horizontally and vertically upwards	Vertically downwards
$n_{EmergStop} \leq n_{Max,1}$	
$[n_{max,1}] = min^{-1}$	Maximum permitted speed for brake application depending on application

Formula 2.7: Calculation of the maximum emergency stop braking work

Horizontally and vertically upwards	Vertically downwards
$W_1 = \frac{M_B}{M_B + M_L} \times \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Emergency\ stop}{}^2}{182.5}$	$W_1 = \frac{M_B}{M_B - M_L} \times \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Emergency\ stop}{}^2}{182.5}$
$[W_1] = J$	Maximum occurring braking work during emergency stop

Formula 2.8: Check if the emergency stop braking work is within the maximum permitted braking work

Horizontally and vertically upwards	Vertically downwards
$W_1 \leq W_{per,n}$	
$[W_{per,n}] = J$	Maximum permitted braking work for emergency stop depending on the brake application speed

31550835/EN – 08/2024

Formula 2.9: Calculation of the number of permitted emergency stop braking operations until brake maintenance

Horizontally and vertically upwards	Vertically downwards
$$N_{B2} \le \frac{W_{Insp}}{W_1 \times f_V}$$ $$N_{B2} \le N_{B2max}$$	
$[N_{B2}] = 1$	Number of permitted emergency stop braking operations until brake maintenance
$[N_{B2max}] = 1$	Maximum permitted number of emergency stop braking operations until end of service life
$[W_{Insp}] = J$	Permitted work until maintenance of the brake
$[f_v] = 1$	Wear factor; determination in relation to the used load range for braking work

Formula 2.10: Calculation of the emergency stop load (torque) when braking (gear unit output side)

Horizontally and vertically upwards	Vertically downwards
$$M_{Brake,\ Output} = \frac{i}{\eta_G}\left[\left(M_B \times f_{Brake,\ Output} + M_L\right) \times \frac{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}}{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}} + 1}\right] - M_{L,a} \times \eta_L$$	$$M_{Brake\ ,Output} = \frac{i}{\eta_G}\left[\left(M_B \times f_{Brake,\ Output} - M_L\right) \times \frac{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}}{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}} + 1}\right] + M_{L,a} \times \eta_L$$
$[M_{brake,output}] = Nm$	Resulting gear unit load from the braking torque, based on gear unit output shaft
$[\eta_G] = 1$	Gear unit efficiency; for SPIROPLAN® or helical-worm gear units, the retrodriving efficiency n_G‘ must be used (see formula 2.10)
$[f_{brake,output}] = 1$	Factor for output design of the selected brake or gear unit combination

Formula 2.11: Retrodriving efficiency for SPIROPLAN® or helical-worm gear unit

Horizontally and vertically upwards	Vertically downwards
$$\eta'_G = 2 - \frac{1}{\eta_G}$$	
$[\eta_G‘] = 1$	Gear unit efficiency of SPIROPLAN® or helical-worm gear unit (retrodriving)
$[\eta_G] = 1$	Gear unit efficiency of SPIROPLAN® or helical-worm gear unit

Formula 2.12: Check of the emergency stop load (torque)

Horizontally and vertically upwards	Vertically downwards
$$M_{Brake,Output} \le M_{aEmerg.off}$$	
$[M_{aEmergOff}] = Nm$	Maximum permitted emergency stop torque in combination with BE.. brake or BE.. safety brake.

31550835/EN – 08/2024

Formula 2.13: Calculation of the emergency stop load (gear unit overhung load) when braking

Horizontally and vertically upwards	Vertically downwards
$$F_{R,brake} = \frac{M_{brake,output} \times 2000}{d_0} \times f_Z$$	
$[F_{R,\,brake}]$ = N	Resulting gear unit load from the braking torque, based on gear unit output shaft
$[d_0]$ = mm	Gear unit efficiency; for SPIROPLAN® or helical-worm gear units, the retrodriving efficiency n_G‘ must be used (see formula 2.10)
$[f_Z]$ = 1	Factor for output design of the selected brake or gear unit combination
→ observe additional overhung load by application if necessary	

Formula 2.14: Check of the emergency stop load (overhung load)

Horizontally and vertically upwards	Vertically downwards
$$F_{R,Brake} \leq F_{RaEmerg.off}$$	
$[F_{RaEmergOff}]$ = N	Maximum permitted emergency stop overhung load for output shaft in combination with the BE.. brake or BE.. safety brake; applies to point of force application located in the middle of the shaft end or end of the hollow shaft

Formula 2.15: Calculation of the emergency stop speed of the application

Horizontally and vertically upwards	Vertically downwards
$$v_{EmergStop} = \frac{n_{EmergStop}}{n_m} \times v_L$$	
$[v_{EmergStop}]$ = m × s^{-1}	Real speed of the load in the application during brake application
$[v_L]$ = m × s^{-1}	Relevant speed of the load in the application at the point in time when the emergency stop is triggered

Formula 2.16: Calculation of the maximum braking time

Horizontally and vertically upwards	Vertically downwards
$$t_{Bmax} = \frac{\left(J_{Int} + J_x \times \eta_L \times \eta_G\right) \times n_{EmergStop}}{9.55 \times \left(M_B \times f_{Mmin} + M_L\right)}$$	$$t_{Bmax} = \frac{\left(J_{Int} + J_x \times \eta_L \times \eta_G\right) \times n_{EmergStop}}{9.55 \times \left(M_B \times f_{M\,min} - M_L\right)}$$
$[t_{Bmax}]$ = s	Maximum braking time
$[f_{Mmin}]$ = 1	Braking torque reduction factor, determination in relation to the used load range for braking work

31550835/EN – 08/2024

Formula 2.17: Calculation of the maximum stopping distance

Horizontally and vertically upwards	Vertically downwards
$$S_{B\max} = v_L \times t_{Signal} + v_{EmergStop} \times \left(t_2 + \frac{1}{2} \times t_{B\max} \right)$$	
$[S_{Bmax}]$ = m	Maximum stopping distance
$[t_{signal}]$ = s	Plant signal transmit time

Formula 2.18a: Calculation of the minimum braking time (for gear units with $n_G \geq 90\%$)

Horizontally and vertically upwards	Vertically downwards
$$t_{B\min} = \frac{\left(J_{Int} + J_x \times \eta_L \times \eta_G\right) \times n_{EmergStop}}{9.55 \times \left(M_B \times f_{M\max} + M_L\right)}$$	$$t_{B\min} = \frac{\left(J_{Int} + J_x \times \eta_L \times \eta_G\right) \times n_{EmergStop}}{9.55 \times \left(M_B \times f_{M\max} - M_L\right)}$$
$[t_{Bmin}]$ = s	Minimum braking time
$[f_{Mmax}]$ = 1	Transmission element factor, braking torque, determination in relation to the used load range for braking work

Formula 2.18b: Calculation of the minimum braking time (for gear units with $n_G < 90\%$)

Horizontally and vertically upwards	Vertically downwards
$$t_{B\min} = \frac{\left(J_{Int} + J_x \times \eta_L \times \eta'_G\right) \times n_{EmergStop}}{9.55 \times \left(M_B \times f_{M\max} + M_L \times \frac{\eta_G}{\eta'_G} \right)}$$	$$t_{B\min} = \frac{\left(J_{Int} + J_x \times \eta_L \times \eta'_G\right) \times n_{EmergStop}}{9.55 \times \left(M_B \times f_{M\max} - M_L \times \frac{\eta_G}{\eta'_G} \right)}$$
$[t_{Bmin}]$ = s	Minimum braking time
$[f_{Mmax}]$ = 1	Transmission element factor, braking torque, determination in relation to the used load range for braking work

Formula 2.19: Calculation of the maximum deceleration when braking

Horizontally and vertically upwards	Vertically downwards
$$a_{B\max} = \frac{v_{Emerg.stop}}{t_{B\min}}$$	
$[a_{Bmax}]$ = m × s^{-2}	Maximum deceleration when braking

31550835/EN – 08/2024

5.5 Holding brake/safety brake for ATEX, IECEx, HazLoc-NA®

5.5.1 General information

The project planning procedure in this chapter describes the procedure for the project planning of a drive with a BE.. brake or a BE.. safety brake as a holding brake for ATEX, IECEx, and HazLoc-NA®.

The following project planning procedure is described in chapter "Project planning procedure BE.. brake and BE.. safety brake as a holding brake for ATEX, IECEx, and HazLoc-NA®" (→ 🗎 72):

- BE.. brake as a holding brake with emergency stop features for ATEX, IECEx, and HazLoc-NA® as an option of the EDR../EDRN.. type series
- BE.. safety brake as a holding brake with emergency stop features for ATEX and IECEx as an option of the EDR../EDRN.. type series

You must use this procedure in controlled applications (drive is operated on a frequency inverter) in of explosion-protected areas.

The subsequent project planning procedures thoroughly describe the procedure during project planning of a drive with a BE.. brake or BE.. safety brake as a holding brake for ATEX, IECEx, and HazLoc-NA®. The following project planning procedure partially refers to calculation formulas. At relevant points in the project planning procedure, a formula number stands for the matching calculation formulas. The formulas are listed in a table following the project planning procedure.

The variables used in the formulas, including their definitions, are listed in a table in chapter "Key to the project planning procedures" (→ 🗎 32).

Checks against product characteristics that may turn out negative are required in some parts of the project planning procedure. Information on additional steps is summarized in chapter "Project planning measures" (→ 🗎 45).

Observe the following notes in addition to the project planning procedures:

- For vertical applications with a counterweight, it may be necessary to calculate the upward travel after the downward travel has completed and vice versa, depending on the load situation.
- All applications with non-horizontal direction of movement, thus inclining, must be calculated as vertical applications. This also includes further applications with off-center load distribution, such as vertical rotary tables.
- Horizontal applications that are stressed by outside forces, e.g. wind load, pressing forces, etc., must also be planned like hoists.
- For special applications, e.g. winders, calenders, applications with crank drives, vertical rotary tables with off-center load distribution, etc., you cannot readily use the project planning procedure, since you will usually need to follow additional framework conditions. You must discuss these with the applicant for the respective case and, if necessary, include them in an amended or separate calculation.
- Project planning for stand-alone motors is performed analogously to the procedure for gearmotors, with the difference being that limit values and checks specific to the gear unit are not considered and carried out. Consult SEW-EURODRIVE for the limit values of IEC motor shafts.

31550835/EN – 08/2024

Peculiarities during the project planning of special applications in the SEW-Workbench

- Winder

  In winding drives, the calculation of the brake in the SEW-Workbench is always performed under the assumption of a free-running winder. Effects due to the tensions of the winding material remain unconsidered.

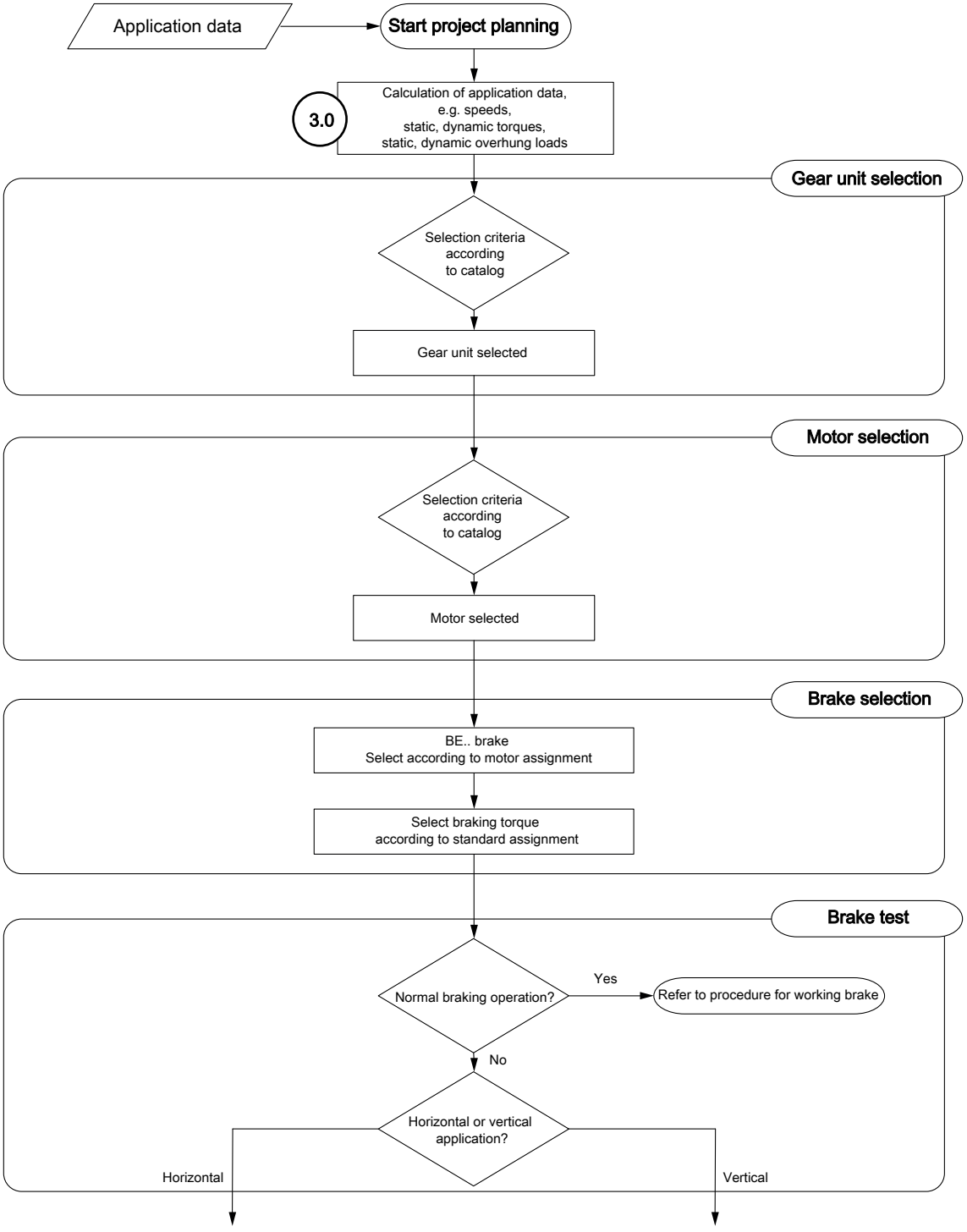
  Coordinate with the customer the precise framework conditions of the emergency stop braking operation and the cause variables to be considered and evaluate it in a separate calculation, if necessary.

- Vertical rotary table

  Since no vertical rotary tables with eccentric masses can be calculated, only the calculation for horizontal applications is performed when calculating the brake.

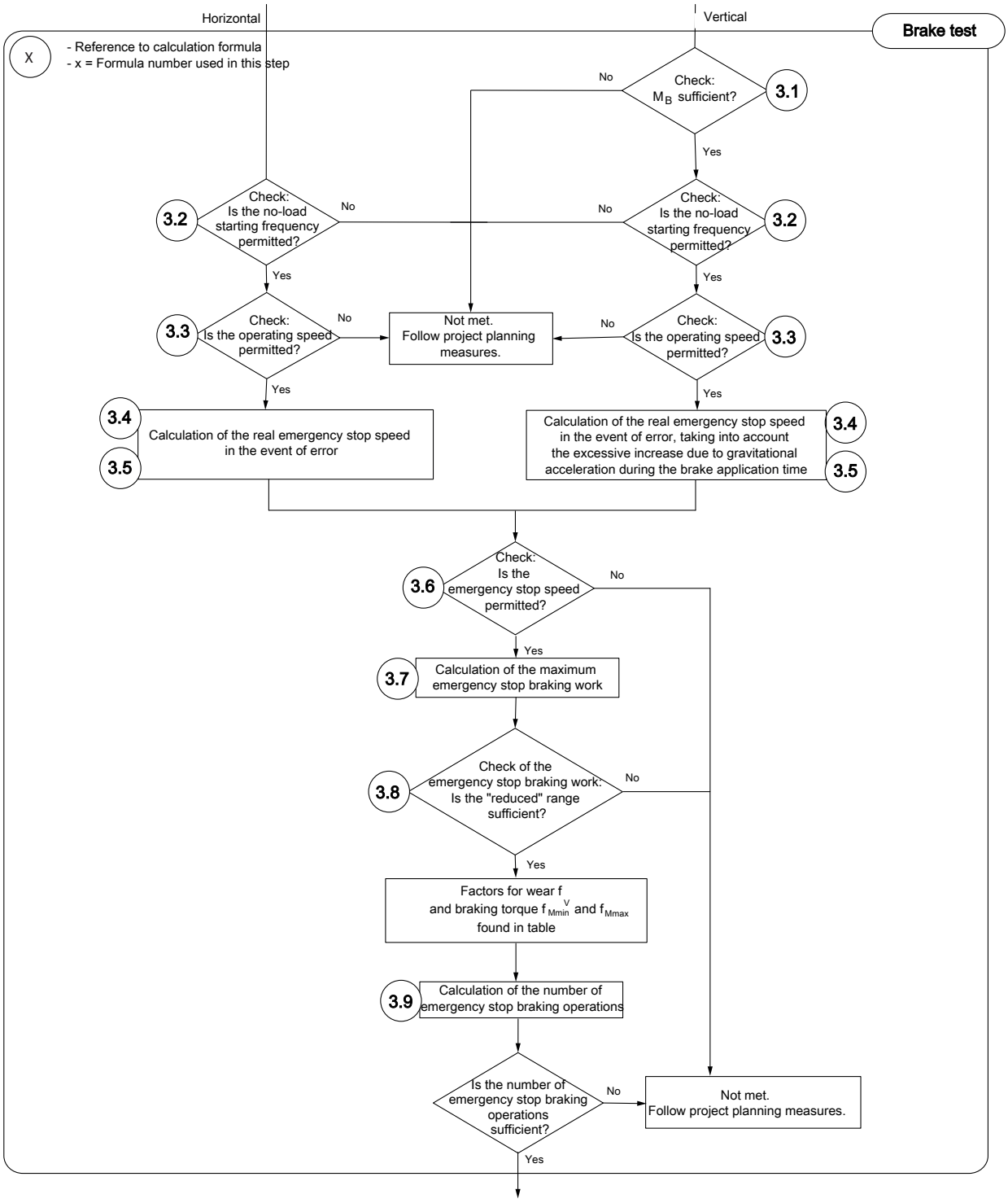
31550835/EN – 08/2024

5.5.2 Project planning procedure BE.. brake and BE.. safety brake as a holding brake for ATEX, IECEx, and HazLoc-NA®

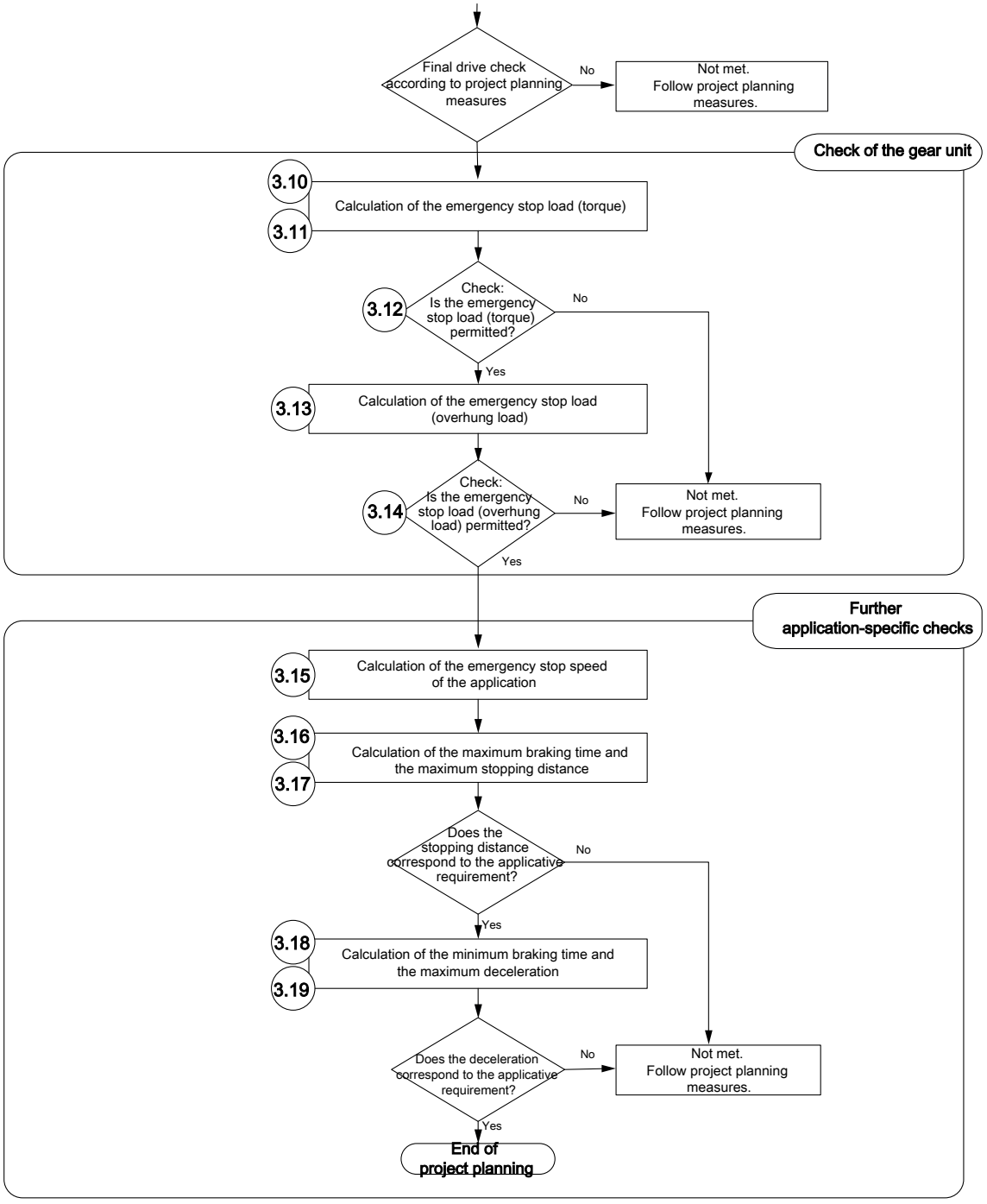


9007237701261323

31550835/EN – 08/2024



9007237701602955



38446872459

5.5.3 Calculation formulas BE.. brake and BE.. safety brake as a holding brake for ATEX, IECEx, and HazLoc-NA®

Formula 3.0: Static load torque at the motor shaft

Horizontally and vertically upwards		Vertically downwards	
$M_L = \frac{M_{L,a}}{i \times \eta_L \times \eta_G}$		$M_L = M_{L,a} \times \frac{\eta_L \times \eta_G}{i}$	
$[M_L]$ = Nm	Static load torque at the motor shaft. Application and gear unit efficiency are considered as **aggravating**.	$[M_L]$ = Nm	Static load torque at the motor shaft. Application and gear unit efficiency are considered as **helpful**.
$[M_{L,a}]$ = Nm	Static load torque value at the output shaft, efficiency not considered		
$[\eta_L]$ = 1	Efficiency of the application		
$[\eta_G]$ = 1	Efficiency of the gear unit		
[i] = 1	Gear unit ratio		

Formula 3.1: Check of the braking torque

Horizontally and vertically upwards	Vertically downwards	
	$M_B \geq f_A \times M_L$	
–	$[f_A]$ = 1	Application factor
	$[M_B]$ = Nm	Nominal braking torque

Formula 3.2: Check of the no-load starting frequency

Horizontally and vertically upwards	Vertically downwards
$Z \leq Z_{B0}$	
$[Z] = h^{-1}$	Required cycle switching frequency
$[Z_{B0}] = h^{-1}$	Maximum permitted no-load starting frequency of the brake

Formula 3.3: Check of the maximum operating speed

Horizontally and vertically upwards	Vertically downwards
$n_{m,1}, n_{m,2}, \ldots \leq n_{Max,0}$	
$[n_{max,0}] = min^{-1}$	Maximum permitted operating speed of the brakemotor

31550835/EN – 08/2024

Formula 3.4: Speed difference during brake application

Horizontally and vertically upwards	Vertically downwards
$$n_D = \frac{9.55 \times M_L \times t_2}{J_{Int} + J_x \times \eta_L \times \eta_G}$$	
$[n_D]$ = min^{-1}	Change of motor speed until brake application
$[t_2]$ = s	Brake application time; depending on connection type, $t_{2,I}$ or $t_{2,II}$ must be used
$[J_{Int}]$ = kgm^2	Motor mass moment of inertia with mount-on components, based on the motor shaft
$[J_x]$ = kgm^2	Mass moment of inertia of application with gear unit based on the motor shaft

Formula 3.5: Calculation of the emergency stop speed

Horizontally and vertically upwards	Vertically downwards
$n_{em.stop} = n_m - n_D$	$n_{em.stop} = n_m + n_D$
$[n_{EmergStop}]$ = min^{-1}	Real emergency stop speed relevant for check
$[n_m]$ = min^{-1}	Relevant motor speed of the application

Formula 3.6: Check of the maximum emergency stop speed

Horizontally and vertically upwards	Vertically downwards
$n_{EmergStop} \leq n_{Max,1}$	
$[n_{max,1}]$ = min^{-1}	Maximum permitted speed for brake application depending on application

Formula 3.7: Calculation of the maximum occurring braking work

Horizontally and vertically upwards	Vertically downwards
$$W_1 = \frac{M_B}{M_B + M_L} \times \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Emergency\ stop}{}^2}{182.5}$$	$$W_1 = \frac{M_B}{M_B - M_L} \times \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Emergency\ stop}{}^2}{182.5}$$
$[W_1]$ = J	Maximum occurring braking work during emergency stop

Formula 3.8: Check if the emergency stop braking work is within the maximum permitted braking work

Horizontally and vertically upwards	Vertically downwards
$W_1 \leq W_{per,n}$	
$[W_{per,n}]$ = J	Maximum permitted braking work for emergency stop depending on the brake application speed

31550835/EN – 08/2024

Formula 3.9: Calculation of the number of permitted emergency stop braking operations until brake maintenance

Horizontally and vertically upwards	Vertically downwards
$$N_{B2} \le \frac{W_{Insp}}{W_1 \times f_V}$$ $$N_{B2} \le N_{B2max}$$	
$[N_{B2}] = 1$	Number of permitted emergency stop braking operations until brake maintenance
$[N_{B2max}] = 1$	Maximum permitted number of emergency stop braking operations until end of service life
$[W_{Insp}] = J$	Permitted work until maintenance of the brake
$[f_v] = 1$	Wear factor; determination in relation to the used load range for braking work

Formula 3.10: Calculation of the emergency stop load (torque) when braking (gear unit output side)

Horizontally and vertically upwards	Vertically downwards
$$M_{Brake,\ Output} = \frac{i}{\eta_G}\left[\left(M_B \times f_{Brake,\ Output} + M_L\right) \times \frac{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}}{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}} + 1}\right] - M_{L,a} \times \eta_L$$	$$M_{Brake\ ,Output} = \frac{i}{\eta_G}\left[\left(M_B \times f_{Brake,\ Output} - M_L\right) \times \frac{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}}{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}} + 1}\right] + M_{L,a} \times \eta_L$$
$[M_{brake,output}] = Nm$	Resulting gear unit load from the braking torque, based on gear unit output shaft
$[\eta_G] = 1$	Gear unit efficiency; for SPIROPLAN® or helical-worm gear units, the retrodriving efficiency n_G‘ must be used (see formula 2.10)
$[f_{brake,output}] = 1$	Factor for output design of the selected brake or gear unit combination

Formula 3.11: Retrodriving efficiency for SPIROPLAN® or helical-worm gear unit

Horizontally and vertically upwards	Vertically downwards
$$\eta'_G = 2 - \frac{1}{\eta_G}$$	
$[\eta_G‘] = 1$	Gear unit efficiency of SPIROPLAN® or helical-worm gear unit (retrodriving)
$[\eta_G] = 1$	Gear unit efficiency of SPIROPLAN® or helical-worm gear unit

Formula 3.12: Check of the emergency stop load (torque)

Horizontally and vertically upwards	Vertically downwards
$$M_{Brake,Output} \le M_{aEmerg.off}$$	
$[M_{aEmergOff}] = Nm$	Maximum permitted emergency stop torque in combination with BE.. brake or BE.. safety brake.

Formula 3.13: Calculation of the emergency stop load (gear unit overhung load) when braking

Horizontally and vertically upwards	Vertically downwards
Calculation of the effective gear unit overhung load during braking	
$$F_{R,brake} = \frac{M_{brake,output} \times 2000}{d_0} \times f_Z$$	
$[F_{R,EmergOff}]$ = N	Resulting gear unit utilization via created radial load
$[d_0]$ = mm	Diameter of the output shaft transmission element
$[f_Z]$ = 1	Transmission element factor for overhung load
→ observe additional overhung load by application if necessary	

Formula 3.14: Check of the emergency stop load (gear unit overhung load)

Horizontally and vertically upwards	Vertically downwards
$$F_{R,Brake} \leq F_{RaEmerg.off}$$	
$[F_{RaEmergOff}]$ = N	Maximum permitted emergency stop overhung load for output shaft in combination with the BE.. brake or BE.. safety brake; applies to point of force application located in the middle of the shaft end or end of the hollow shaft

Formula 3.15: Calculation of the emergency stop speed of the application

Horizontally and vertically upwards	Vertically downwards
$$v_{EmergStop} = \frac{n_{EmergStop}}{n_m} \times v_L$$	
$[v_{EmergStop}]$ = m × s^{-1}	Real speed of the load in the application during brake application
$[v_L]$ = m × s^{-1}	Relevant speed of the load in the application at the point in time when the emergency stop is triggered

Formula 3.16: Calculation of the maximum braking time

Horizontally and vertically upwards	Vertically downwards
$$t_{Bmax} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{EmergStop}}{9.55 \times (M_B \times f_{Mmin} + M_L)}$$	$$t_{Bmax} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{EmergStop}}{9.55 \times (M_B \times f_{M\,min} - M_L)}$$
$[t_{Bmax}]$ = s	Maximum braking time
$[f_{Mmin}]$ = 1	Braking torque reduction factor, determination in relation to the used load range for braking work

31550835/EN – 08/2024

Formula 3.17: Calculation of the maximum stopping distance

Horizontally and vertically upwards	Vertically downwards
$$S_{B\max} = v_L \times t_{Signal} + v_{EmergStop} \times \left(t_2 + \frac{1}{2} \times t_{B\max} \right)$$	
$[S_{Bmax}]$ = m	Maximum stopping distance
$[t_{signal}]$ = s	Plant signal transmit time

Formula 3.18a: Calculation of the minimum braking time (for gear units with nG ≥ 90%)

Horizontally and vertically upwards	Vertically downwards
$$t_{B\min} = \frac{\left(J_{Int} + J_x \times \eta_L \times \eta_G \right) \times n_{EmergStop}}{9.55 \times \left(M_B \times f_{M\max} + M_L \right)}$$	$$t_{B\min} = \frac{\left(J_{Int} + J_x \times \eta_L \times \eta_G \right) \times n_{EmergStop}}{9.55 \times \left(M_B \times f_{M\max} - M_L \right)}$$
$[t_{Bmin}]$ = s	Minimum braking time
$[f_{Mmax}]$ = 1	Transmission element factor, braking torque, determination in relation to the used load range for braking work

Formula 3.18b: Calculation of the minimum braking time (for gear units with nG < 90%)

Horizontally and vertically upwards	Vertically downwards
$$t_{B\min} = \frac{\left(J_{Int} + J_x \times \eta_L \times \eta'_G \right) \times n_{EmergStop}}{9.55 \times \left(M_B \times f_{M\max} + M_L \times \frac{\eta_G}{\eta'_G} \right)}$$	$$t_{B\min} = \frac{\left(J_{Int} + J_x \times \eta_L \times \eta'_G \right) \times n_{EmergStop}}{9.55 \times \left(M_B \times f_{M\max} - M_L \times \frac{\eta_G}{\eta'_G} \right)}$$
$[t_{Bmin}]$ = s	Minimum braking time
$[f_{Mmax}]$ = 1	Transmission element factor, braking torque, determination in relation to the used load range for braking work

Formula 3.19: Calculation of the maximum deceleration when braking

Horizontally and vertically upwards	Vertically downwards
$$a_{B\max} = \frac{v_{Emerg.stop}}{t_{B\min}}$$	
$[a_{Bmax}]$ = m × s^{-2}	Maximum deceleration when braking

31550835/EN – 08/2024

6 Thermal project planning

6.1 Introduction

BE.. brakes from SEW-EURODRIVE must be planned for their applicative use case according to defined guidelines. Project planning guidelines differ from each other according to how the brake is used. For applications with speed-variable operation (frequency inverter operation) the brake could be operated in a speed range that does not comply with the specified temperature limit of the brake. For this reason, thermal project planning of the brake must be carried out, see chapter "Project planning" (→ 🗎 89).

If you have any questions about project planning, contact your SEW-EURODRIVE contact person.

6.2 General information

6.2.1 Key to the project planning procedures

Formula symbol	Unit	Description
cdf_B	%	Cyclic duration factor of the brake
cdf_{B_per}	%	Permitted cyclic duration factor of the brake
n_{B_m}	min^{-1}	Effective rotational speed of the brake (as mean value "m")
$n_{B_th_k}$	min^{-1}	Thermal breakpoint speed of the brake
n_{M_n}	min^{-1}	Motor speed of the individual travel sections with released brake
t_n	s	Duration of the individual travel sections with released brake
t_{tot}	s	Duration of the entire travel cycle
f_{B_AH}	1	Correction factor for the installation altitude of the brakemotor above sea level

31550835/EN – 08/2024

6.2.2 Operating modes according to IEC 60034

The rated power is always related to an operating mode and a cyclic duration factor.

According to the standard IEC 60034-1 "Rotating electrical machines – Part 1: Rating and performance" the electrical operating modes are defined in terms of time, load, and temperatures as follows:

S1 continuous duty

Operation at a constant load, with a duration long enough for the machine to reach a thermal steady-state condition.

S2 short-time duty

Operation at a constant load for a time which is less than the time required for reaching a thermal steady-state condition. The subsequent time in idle state when the windings are de-energized is long enough for the machine temperature to deviate less than 2 K from the temperature of the coolant.

S3 intermittent duty

Operation consisting of a sequence of identical duty cycles, with each cycle including a period of operation at constant load and an idling time with de-energized windings. The starting current does not have any significant effect on the overtemperature.

S9 operation with non-periodic load and rotational speed changes

Operation with usually non-periodic changes in load and speed within the permitted operating range. In this operation, overloads often occur that significantly exceed the reference load.

6.2.3 Line operation

In line operation the motor is operated at a constant speed relative to the line frequency and number of poles. The permitted period of operation of the motor is defined by the data on the nameplate. The speed of the motor is constant during operation and thereby so is the cooling, so no separate thermal project planning of the brake is required for ventilated drives. The prerequisite for this is that the brake is that the voltage is switched off when the motor is switched off.

31550835/EN – 08/2024

6.2.4 Frequency inverter operation

The use of a frequency inverter makes adjustable speed operation possible. A fan-cooled motor (IC411[1)]) can thereby be operated in speed ranges in which it is no longer possible to comply with the specified temperature limits of the break in continuous duty. For this reason, thermal project planning of the brake must be carried out, see chapter "Project planning" (→ 🗎 89).

When a forced cooling fan (IC416[1)]) is used, the cooling capacity is constant irrespective of the motor speed. It is thereby possible to forgo thermal project planning analogously to line operation.

There are speed-variable drives for various control modes, e.g. V/f, VFC, VFC^{PLUS}, or CFC, that can have different characteristics with regard to the control quality and the thermal load of the motor winding.

The control mode of the motor is of lesser importance for the brake and the temperature development of the brake, in contrast, and can therefore be disregarded.

1) IEC 60034-6 Rotating electrical machines – Part 6: Methods of Cooling (IC Code)

6.2.5 Ventilation types

The thermally permitted load torque of the motor depends very heavily on the type of cooling in addition to the motor size and operating mode, particularly in the case of operation on a frequency inverter. A distinction is made between self-cooling and external cooling.

Self-cooling

Asynchronous motors from SEW-EURODRIVE are fan-cooled as standard. In doing so, the impellers of the fan wheels generate the same air flow irrespective of the direction of rotation. The intensity of the air flow depends on the motor speed. This means that the cooling capacity of the motor fan decreases with lower motor speeds (e.g. FI-controlled drives). For this reason, you cannot keep the brake open permanently during continuous duty at low speeds without additional measures.

External cooling

The /V or /VE forced cooling fan option is available as another ventilation type. For this option, the fan wheel is removed from the rotor shaft and replaced by a cover with an integrated active fan. The forced cooling fan is supplied externally, which means it is operated irrespective of the motor speed. Therefore no further measures are required at low speeds.

Available fan options

Code in the type designation	Description	Sizes
None	Standard fan (plastic)	63MS – 315H
/V and /VE	Forced cooling fan	71MS – 315H
/AL	Aluminum fan	63MS – 315H
/U	Non-ventilated (without fan)	63MS – 315H
/OL	Non-ventilated (closed B-side)	63MS – 132S
/Z	Additional flywheel mass	63MS – 132L

31550835/EN – 08/2024

6.2.6 Motor series with associated operating modes

The following table shows a variety of single-speed AC motors that can also be operated on frequency inverters and/or are explicitly designed for frequency inverter option (FI operation). With regard to brakemotors, make sure that sufficient cooling of the brakes can be ensured, especially in the lower speed range during project planning.

Motor series	Approvals	Number of poles / speed class in min^{-1}	Nameplate data	Nameplate data for FI operation
DRS.. **DRE..** **DR2S..** **DRN..** **DRU**..	e.g. IEC or combined approvals	4 (2, 6, 8)	Line operation except for DR2S for operating mode S9	None
	e.g. UR or combined approvals	4 (2, 6, 8)	Line operation	CT setting range
	e.g. IEC or combined approvals	4	FI operation MOVIMOT-D, MOVIMOT® advanced	CT setting range
DRE...J **DRP...J** **DRU...J**		4	Line operation and FI operation	Supplemental table sticker
DRM.. **DR2M..**		8, 12	Line operation	None
DRL.. **DR2L..**	IEC, UR, CSA	1200, 1700, 2100, 3000	FI operation	None
EDRS.. **EDRE..** **EDRN..**	ATEX	4	Line nameplate	Supplemental table sticker
	IECEx	4	Line nameplate	Supplemental table sticker
	HazLoc-NA®	4	Line nameplate	CT setting range
DR2C..		2000, 3000	FI operation	

31550835/EN – 08/2024

DRS.. / DRE.. / DR2S.. / DRN.. / DRU..

These are normally 4-pole drives with fan cooling that are designed for a line frequency of 50 Hz at a synchronous speed of 1500 min^{-1} or 60 Hz at a synchronous speed of 1800 min^{-1}. In rare cases even drives with a different number of poles are operated on a frequency inverter (e.g. 2-pole or 6-pole drives).

The motors are designed with various nominal powers for the operating modes S1 "continuous duty", S2 "short-time duty", S3 "intermittent duty", or S9 exclusively "frequency inverter operation". As a rule, merely the rating data for line operation is specified on the nameplate of the drive, whereby the operating mode specification also relates explicitly to this rating point.

Even if the nameplate does not contain any data about inverter operation, the drives can also be operated on a frequency inverter in compliance with the project planning specifications of SEW-EURODRIVE (thermal and dynamic limit characteristics for inverter operation).

MOVIMOT® (DRN..)

MOVIMOT® drives are a combination of 4-pole fan-cooled AC motors and the MOVIMOT® frequency inverter series.

There is a distinction between two different setting ranges that are based on a fixed combination of motor and inverter power. Because the inverter is integrated into the motor connection box, the rated motor voltage of 230/400 V 50 Hz is not specified on the nameplate, but rather the possible input voltage of the frequency inverter and the nominal frequency of the supply voltage.

For MOVIMOT® motors a setting range and a CT value are listed on the motor nameplate. The CT value relates to the lower speed point here.

MOVIMOT® undertakes the brake control as standard. Therefore no external supply voltage is required for the brake. The nominal voltage of the brake is selected according to the MOVIMOT® size because with MOVIMOT® the brake coil also absorbs the regenerative energy at the same time.

31550835/EN – 08/2024

DRE...J / DRP...J / DRU...J

The DR...J motors with LSPM (Line Start Permanent Magnet) technology are AC motors with squirrel-cage motors that contain permanent magnets in the rotor.

The LSPM motors are available exclusively in 4-pole variants and are capable of line operation as well as frequency inverter operation.

In line operation the 4-pole motors run asynchronously, synchronize to the operating frequency after startup, and finally run in synchronous mode at 1500 1/min.

In frequency inverter operation the motors, which are design for the operating mode V/f, synchronize with the operating frequency of the frequency inverter.

Depending on the "star" or "delta" operating mode there are LSPM motors for frequency inverter operation in the speed classes 1500 min^{-1} or 50 Hz and 2610 min^{-1} or 87 Hz.

In frequency inverter operation it must also be noted that LSPM motors prescribe a minimum speed for continuous operation. This is 300 min^{-1} for MOVITRAC® B, MOVIMOT®, and MOVIFIT® inverters and 150 min^{-1} for MOVITRAC® LTE-B and LTP-B inverters.

Due to the operating principle, LSPM motors do not have any rotor losses. The result is a very high efficiency in a very compact design.

The DR...J motors are available exclusively in operating mode S1.

The nameplate is oriented to the standard asynchronous motor, though it lists additional LSPM-specific elements. In addition, the LSPM motors receive a supplemental sticker on which various operating points are indicated.

The DRP...J motors are no longer actively marketed. The DRE...J and DRU...J motors are available as an alternative. The DR2...J motors are planned as a successor to the current DR...J motors.

DRM.. / DR2M..

The DRM and DRM2 torque motors are 8- or 12-pole AC motors that are designed for operation with rated torque in an idle state. They are comparable with springs with endless spring travel.

The synchronous speeds range from 500 – 750 min^{-1}.

The DRM. motors are available in the operating modes S1 an S3 (15%).

The DRM. motors are primarily line-operated and only rarely frequency inverter-operated. In line operation the motors travel against a block at nominal speed and thereby hold the application in position at a speed of 0.

A thermal check of the brake is not required for these motors because the brake was already developed for this application.

DRL.. / DR2L..

The DRL. and DR2L. motors are asynchronous servomotors based on the DRS. and DRN. asynchronous motor series with squirrel-cage rotor and 4-pole winding.

They are operated in combination with an encoder and thermal protection and in the "Thermal class F" design exclusively on the SEW-EURODRIVE frequency inverter in CFC control mode and are available in 4 speed classes (1200/1700/2100/3000 min^{-1}). The 4 speed classes are realized via 2 winding calculations in star and delta connection respectively. In frequency inverter operation, field weakening begins at the rated speed. Below the rated speed the DRL./DR2L. motors can be operated continuously with the limit torques defined in the thermal S1 characteristic curve.

31550835/EN – 08/2024

The nameplate of the DRL./DR2L. motors does not list any power rating but rather exclusively the nominal torque and the maximum possible motor torque.

However, the actual maximum torque depends on the inverter power used. With high inverter powers the maximum motor torque exceeds the torque transferable via the standard pinion shaft end (dynamics package 1). The DRL./DR2L. motors offer a reinforced pinion shaft end (dynamics package 2) for these applications with servo-like dynamics.

EDRS.. / EDRE.. / EDRN..

The 4-pole EDR../EDRN. motors are designed for the operating mode S1 (continuous duty). The suitable for line operation as well as frequency inverter operation and are available in the 50 Hz or 60 Hz variants.

ATEX/IECEx

An explosion-protected gearmotor receives 2 nameplates, one nameplate on the gear unit and one nameplate on the motor. For operation on a frequency inverter a supplemental sticker is applied to the terminal box on which the permitted motor data are listed in table form.

For brakemotors the cyclic duration factor of the brake is listed on the supplemental sticker. The linear sequence of the permitted cyclic duration factor of the brake cannot be shown on the nameplate for space reasons. For this reason the permitted cyclic duration factor of the brake as a 2-stage model is specified. Below the thermal cutoff frequency the cyclic duration factor of the brake is reduced. Above the thermal cutoff frequency the cyclic duration factor is 100%. For the permitted values and linear sequence, refer to the limit characteristics in chapter "Permitted cyclic duration factor and thermal breakpoint speed" (→ 🗎 136).

HazLoc-NA®

An explosion-protected gearmotor receives 2 nameplates, one nameplate on the gear unit and one nameplate on the motor. For operation on a frequency inverter the setting range is additionally listed on the motor nameplate. For brakemotors there is no additional specification of the cyclic duration factor of the brake outside of the motor setting range.

DR2C..

DR2C. motors are IPM (integrated permanent magnet) motors. They consist of adapted stators of the asynchronous motors and permanent magnet-excited rotors without asynchronous cage.

DR2C. are available in sizes 71 – 132S in speed classes 2000 and 3000 min^{-1}. Energy efficiency classes up to IE5 are possible with IPM motors. DR2C. motors can be operated exclusively on a frequency inverter.

31550835/EN – 08/2024

6.2.7 Definition of characteristic variables

Effective speed of the brake n_{B_m}

In frequency inverter operation there are individual travel sections of different duration and different speed. To make the thermal significance of this travel profile conceivable, the concept of the thermal effective speed of the brake n_{B_m} is introduced.

The thermal effective speed of the brake represents the time-weighted and thereby effective motor speed of the travel profile that is effective for the cooling of the brake.

This analysis is always applied when there is an overwhelming portion of time within a travel profile during which the motor is operated below the thermal breakpoint speed of the brake. All travel sections of the cycle during which the brake is electrically released are included in the determination of the thermal effective speed. The travel sections with applied brake are not analyzed.

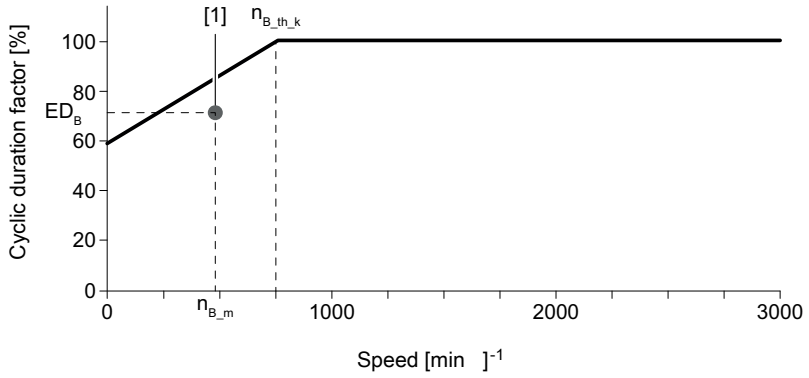
Cyclic duration factor of the brake cdf_B

In principle the cyclic duration factor is the ratio of time under load to cycle duration (10 minutes maximum) and is specified as a percentage.

During the thermal project planning a distinction is to be made between the respective cyclic duration factor of the motor and the cyclic duration factor of the brake cdf_B. All travel sections of the cycle during which the brake is electrically released are included in the determination of the cyclic duration factor of the brake. The travel sections with applied brake are not analyzed.

Limit characteristics for the permitted cyclic duration factor of the brake

The permitted cyclic duration factor of the brake according to speed is shown in the following diagram. The effective operating point of the brake must lie below the characteristic curve.



35731884299

[1] Effective operating point of the brake

For the characteristics of the individual brake sizes, refer to chapter "Permitted cyclic duration factor and thermal breakpoint speed" (→ 🗎 136).

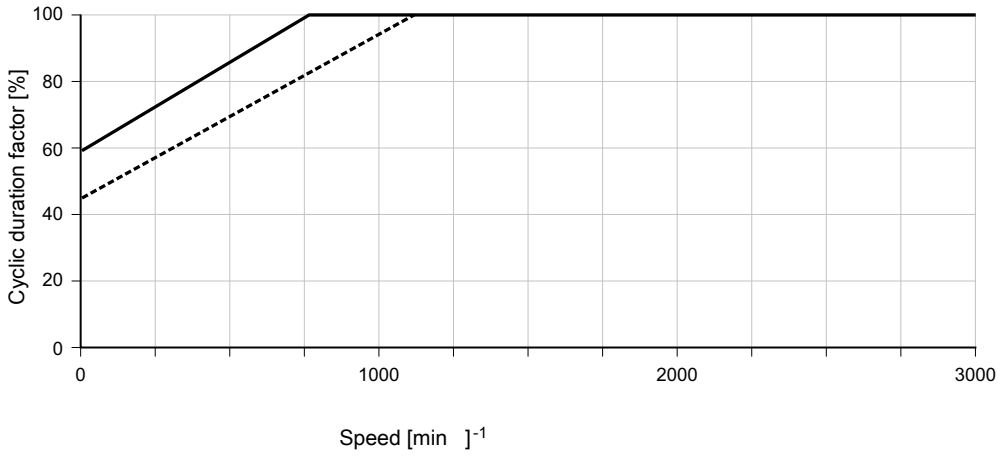
Ambient temperature

The permitted temperature range of the motor is specified on the nameplate. The rating data of the motor and the cyclic duration factor of the brake always relate to this temperature range. If the motor is operated at a lower temperature range then there is the possibility of realizing a higher cyclic duration factor even at low motor speeds. Contact SEW-EURODRIVE in such cases.

Installation altitude

Another factor influencing the effective cooling effect is the installation altitude of the drive and the associated ambient air density. As altitude increases, the density decreases and thereby also leads to an increasingly reduced cooling effect of the ventilation current on the motor side of the brake. This effect is taken into account within the framework of the project planning in the form of a correction factor that reduces the permitted cyclic duration factor of the brake and increases the thermal breakpoint speed of the brakemotor for installation altitudes > 1000 m above sea level. The application factor f_{B_AH} is shown below and is based on the IEC 60034-1 motor standard.

The following diagram shows the permitted cyclic duration factor of the brake according to the installation altitude.



9007238420200459

— cdf curve for installation altitudes < 1000 m above sea level
---- cdf curve for installation altitudes up to 4000 m above sea level

31550835/EN – 08/2024

6.3 Project planning

6.3.1 General information

The project planning procedure contained in this chapter described the procedure for the thermal project planning of a BE.. brake on drives that are operated on a frequency inverter.

Calculation formulas

The following project planning procedure thoroughly describes the procedure during the thermal project planning of a BE.. brake. The following project planning procedure partially refers to calculation formulas.

At relevant points in the project planning procedure, formula numbers refer to the matching calculation formulas. The formulas are listed in a table following the project planning procedure.

Checks against product characteristics that may turn out negative are required in some parts of the project planning procedure.

For further information about how to proceed further, refer to chapter "Project planning measures" (→ 🗎 89).

Product characteristics

For the values according to size and design, see chapter "Permitted cyclic duration factor and thermal breakpoint speed" (→ 🗎 136).

Only values for explosion-protected brakemotors are available in this documentation. For values for other brakemotors, contact SEW-EURODRIVE.

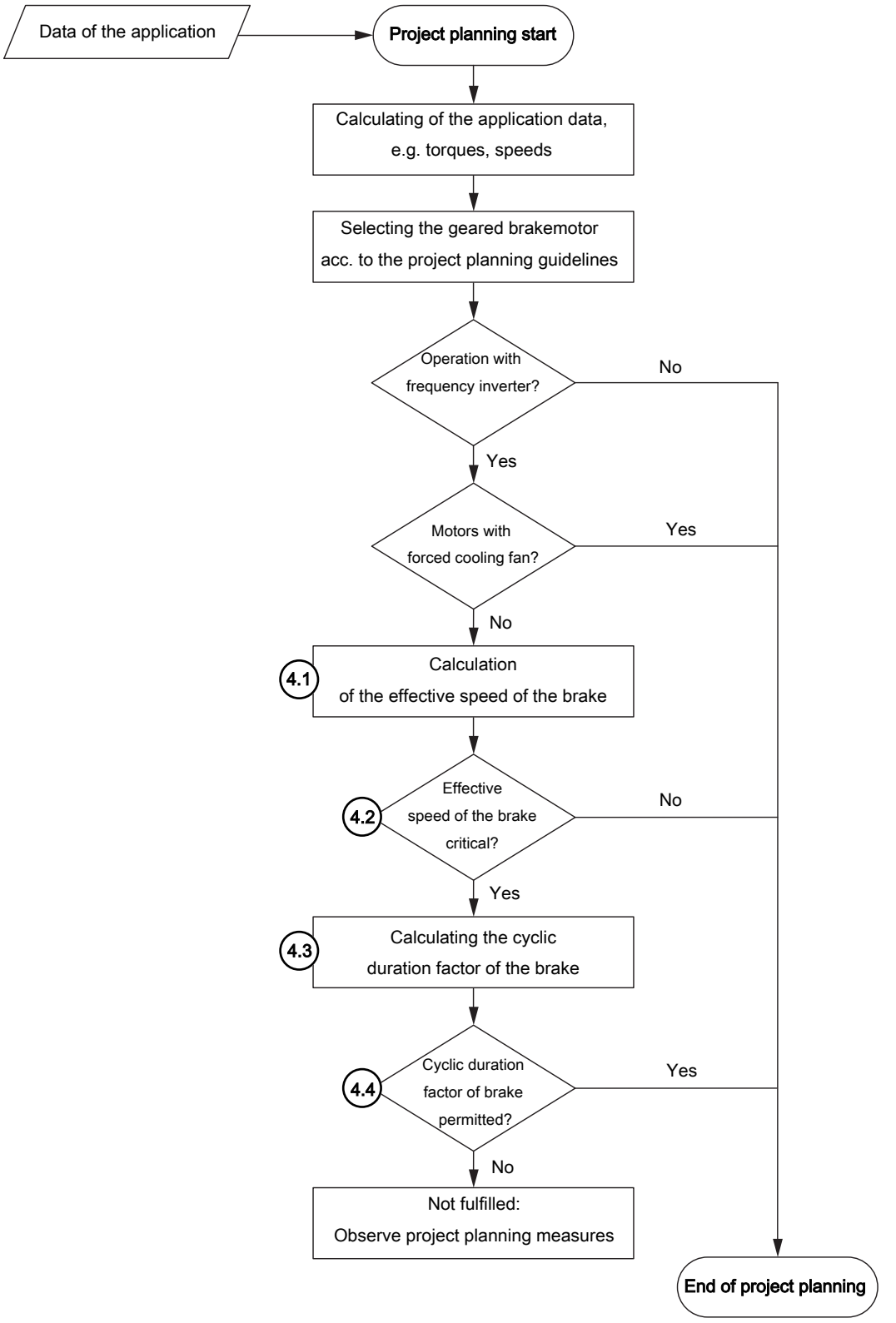
6.3.2 Project planning measures

The following table gives points of reference for finding a solution during the thermal project planning of the BE.. brakes or BE.. brake for ATEX, IECEx, and HazLoc-NA® in case the result of the respective checks in the course of the project planning is negative.

Checks	Formula	Possible measures
Is the effective speed of the brake critical?	4.2	• Apply the brake for pause sections with position control • Increase the motor speed through a higher gear unit ratio • Use a forced cooling fan
Is the cyclic duration factor of the brake permitted?	4.4	• Apply the brake for pause sections with position control • Adjust the travel cycle to achieve shorter pause times with released brake • Use a forced cooling fan

31550835/EN – 08/2024

6.3.3 Project planning procedure



9007234986446859

6.3.4 Calculation formulas

No.	Formula
4.1	**Calculation of the effective speed of the brake** $n_{B_m} = \frac{n_{M_1} \times t_1 + ... + n_{M_n} \times t_n}{t_1 + ... + t_n}$
	$[n_{B_m}] = min^{-1}$ Effective speed of the brake
	$[t_n] = s$ Duration of the individual travel sections with released brake
	$[n_{M_n}] = min^{-1}$ Motor speed of the individual travel sections with released brake
4.2	**Check of the effective speed of the brake** $n_{B_m} \leq \frac{n_{B_th_k}}{f_{B_AH}}$
	$[n_{B_th_k}] = min^{-1}$ Thermal breakpoint speed of the brake, see chapter "Permitted cyclic duration factor and thermal breakpoint speed" (→ 🖹 136)
	$[f_{B_AH}]$ Application factor for taking into account the installation altitude of the brakemotor above sea level
4.3	**Calculation of the cyclic duration factor of the brake** $cdf_B = \frac{t_1 + ... + t_n}{t_{tot}} \times 100$
	$[cdf_B] = \%$ Cyclic duration factor of the brake
	$[t_n] = s$ Duration of the individual travel sections with released brake
	$[t_{tot}] = s$ Duration of the entire travel cycle
4.4	**Check of the cyclic duration factor of the brake** $cdf_B \leq cdf_{B_per} \times f_{B_IA}$
	$[cdf_{B_per}] = \%$ Permitted cyclic duration factor of the brake, see chapter "Permitted cyclic duration factor and thermal breakpoint speed" (→ 🖹 136)

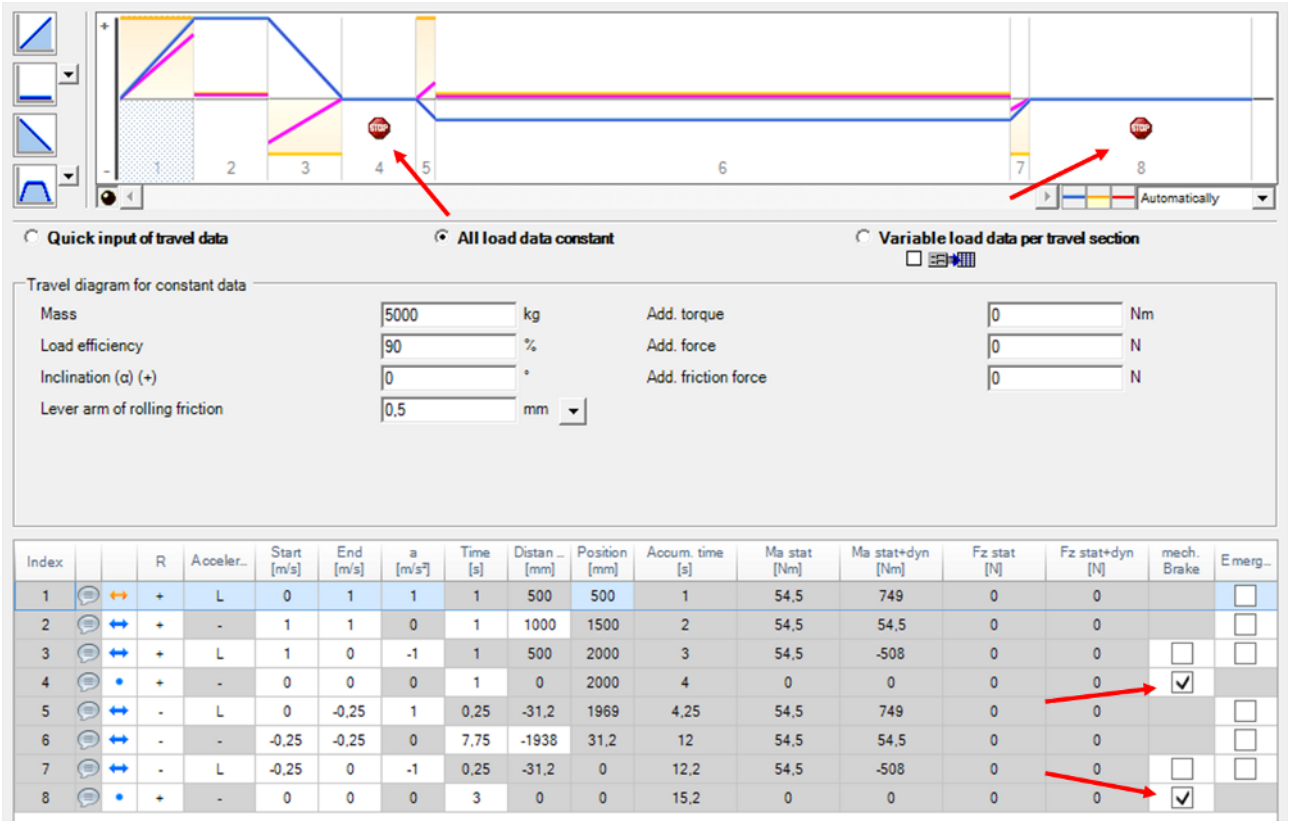
31550835/EN – 08/2024

6.3.5 Configuration example

With this project planning example the determination of the cyclic duration factor of the brake cdf_B and the effective speed of the brake n_{B_m} is illustrated and limited at the corresponding values of the motor.

A horizontal drive with 2 different speeds in the travel cycle whereby the brake is applied (case 1) or remains released (case 2) during the pause serves as an example.

Case 1: Brake is applied during the pause



Index	R	Acceler...	Start [m/s]	End [m/s]	a [m/s²]	Time [s]	Distan... [mm]	Position [mm]	Accum. time [s]	Ma stat [Nm]	Ma stat+dyn [Nm]	Fz stat [N]	Fz stat+dyn [N]	mech. Brake	Emerg...
1	+	L	0	1	1	1	500	500	1	54,5	749	0	0		
2	+	-	1	1	0	1	1000	1500	2	54,5	54,5	0	0		
3	+	L	1	0	-1	1	500	2000	3	54,5	-508	0	0	☐	☐
4	+	-	0	0	0	1	0	2000	4	0	0	0	0	☑	
5	-	L	0	-0,25	1	0,25	-31,2	1969	4,25	54,5	749	0	0		☐
6	-	-	-0,25	-0,25	0	7,75	-1938	31,2	12	54,5	54,5	0	0		☐
7	-	L	-0,25	0	-1	0,25	-31,2	0	12,2	54,5	-508	0	0	☐	☐
8	+	-	0	0	0	3	0	0	15,2	0	0	0	0	☑	

35705403275

It is apparent from the stop icons in the diagram as well as the check marks in the table for travel sections 4 and 8 that the brake is applied in these break sections.

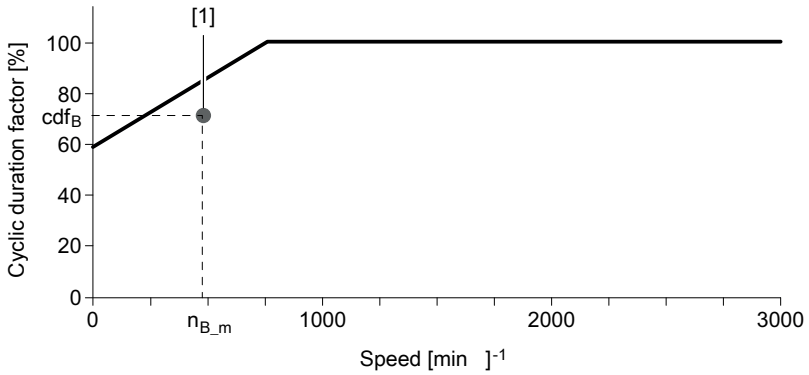
The brake is not energized in these sections and thereby does not experience any heating, so these sections are not taken into account for the effective speed n_{B_m} or the cyclic duration factor cdf_B.

With an application diameter of d_0 = 250 mm, for example, and a gear unit ratio of i = 17.87, for example, the following values result:

- Effective speed of the brake n_{B_m} = 497.6 min^{-1}, see formula 4.1 (→ 🗎 91)
- Cyclic duration factor of the brake cdf_B = 74%, see formula 4.3 (→ 🗎 91)
- Installation altitude ≤ 1000 m above sea level → f_{B_AH} = 1 (→ 🗎 141)

31550835/EN – 08/2024

The following operating point of the brake results:

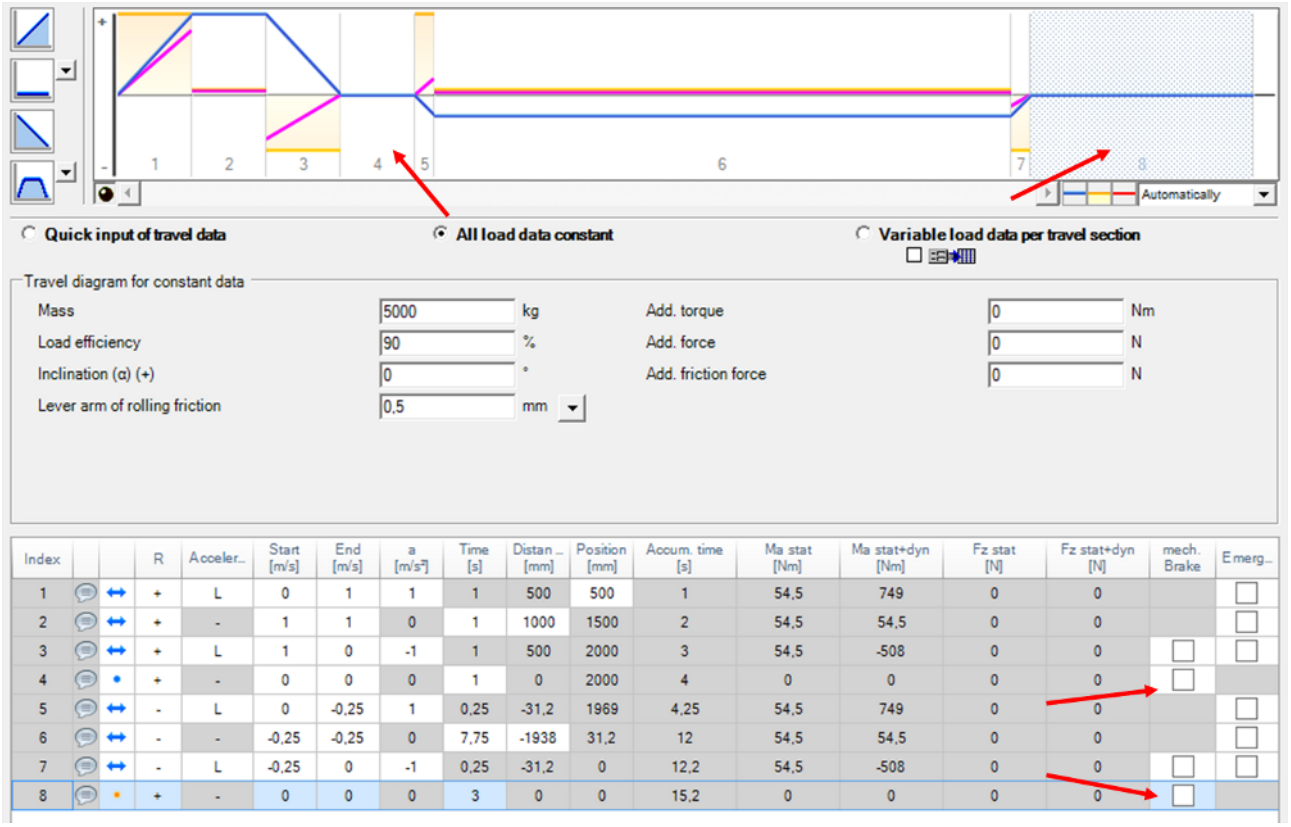


9007234986555019

— Permitted cyclic duration factor cdf_{B_per} at 40 °C, 50 °C
[1] Operating point with applied brake

The thermal properties of the brake are thereby non-critical. To that effect, the brake-motor can be used without further measures.

Case 2: Brake remains released during the pause (e.g. position control)



Index	R	Acceler..	Start [m/s]	End [m/s]	a [m/s²]	Time [s]	Distan .. [mm]	Position [mm]	Accum. time [s]	Ma stat [Nm]	Ma stat+dyn [Nm]	Fz stat [N]	Fz stat+dyn [N]	mech. Brake	Emerg..
1	+	L	0	1	1	1	500	500	1	54,5	749	0	0		
2	+	-	1	1	0	1	1000	1500	2	54,5	54,5	0	0		
3	+	L	1	0	-1	1	500	2000	3	54,5	-508	0	0	☐	☐
4	+	-	0	0	0	1	0	2000	4	0	0	0	0	☐	
5	-	L	0	-0,25	1	0,25	-31,2	1969	4,25	54,5	749	0	0		☐
6	-	-	-0,25	-0,25	0	7,75	-1938	31,2	12	54,5	54,5	0	0		☐
7	-	L	-0,25	0	-1	0,25	-31,2	0	12,2	54,5	-508	0	0	☐	☐
8	+	-	0	0	0	3	0	0	15,2	0	0	0	0	☐	

35705406603

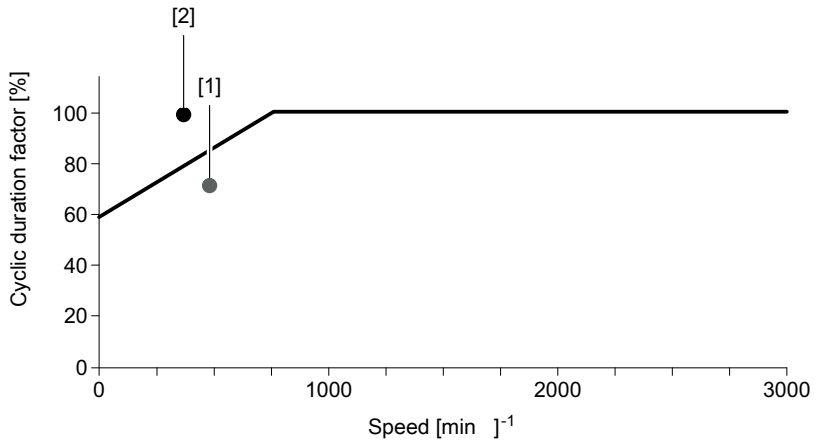
If no check mark is placed in the pause sections, the brake remains released in these sections. This is also apparent from the lack of stop icons in the diagram.

The brake is energized in these sections, so they result in further heating of the brake and must therefore be taken into account for the effective speed n_{B_m} and the cyclic duration factor cdf_B.

This results in the following values:

- Effective speed of the brake n_{B_m} = 359.3 min^{-1}, see formula 4.1 (→ 🗎 91)
- Cyclic duration factor of the brake cdf_B = 100%, see formula 4.3 (→ 🗎 91)

The following operating point of the brake results:



35731881355

— Permitted cyclic duration factor cdf_{B_per} at 40 °C, 50 °C
[1] Operating point with applied brake (case 1)
[2] Operating point with released brake

The brake is thermally overloaded. Additional measures must therefore be taken such as the use of a forced cooling fan or the reduction of the cyclic duration factor of the brake through the forgoing of the position hold control, for example.

31550835/EN – 08/2024

7 Brake test

7.1 General information

In applications with brakes, the braking torque represents an important criterion for the functional and performance capability of the brake. If the braking torque is reduced or lost, the functionality of the application, the safety of the machine, and/or personal safety can be limited. To check the functioning and performance of a brake, you can integrate a brake test to check the switching state and switching capability of the brake into the overall system. The checking of the applied brake with a defined torque also shows whether the brake still has sufficient braking torque available for the application.

Especially for safety-related applications in which the brake performs a safety sub-function, a brake test for the brake may be required by one or more standards, e.g. by EN ISO 13849-1. The brake test is not typically an independent safety sub-function but supplements a higher-level safety system for brake testing which is required by the standards. The overall system must meet the diagnostic coverage (DC) required by the standards.

A brake test provides you with information about the functional and performance capability of the brake. Potential faults or functional limitations can be detected at an early stage, allowing the necessary maintenance and repair work to be initiated. In a brake system with multiple brakes, each brake must be tested separately. This ensures that the safety sub-function is maintained even if one brake fails.

The functional and performance capability of a brake can be adversely affected by a multitude of potential faults. To summarize, the potential faults can appear in one of the following fault patterns:

Fault pattern	Effect of fault
Brake remains applied	Safe state
Brake remains open	Dangerous state
Insufficient braking torque	Dangerous state
Brake does not release fully	Dangerous state

SEW-EURODRIVE offers various types of brake tests. These tests allow safety functions to be implemented with brakes in horizontal and vertical applications up to the most demanding requirement PL e.

31550835/EN – 08/2024

7.2 Explanation of terms

In relation to a brake test, the terms "brake test" and "brake diagnostics" are used with the same meaning as the state-of-the-art. SEW-EURODRIVE prefers the term "brake test" and uses this term in the following chapters.

7.3 Performing a brake test

A brake test is generally understood to mean a test function that checks the functioning and performance of one or more brakes. The test function is usually implemented as a software function. However, testing methods without software are also known.

Testing is intended to check if the brake is still able to open and close. You must also test whether the brake still has a sufficient braking torque. To test the torque, the brake is preferably tested with a static load. For this purpose, the closed brake in the idle state is loaded with a defined torque that the brake must be able to hold. The defined torque can be generated, for example, as a motor torque or by a testing weight. The testing causes no wear on the brake and can therefore be performed frequently.

In addition to the static test, you can also perform a dynamic test. In this case, the machine is brought from motion to the idle state by the brakes. The braking distance expected for the test conditions should be achieved by the brake. A dynamic test causes wear on the brake, which must be considered when dimensioning the brake. In machines with multiple brakes working on the same axis, a separate dynamic test of each brake usually leads to stress within the mechanical structure of the machine and to a longer braking distance. Alternatively, all the brakes can be tested simultaneously, but this is not in compliance with separate testing required by the standards. Dynamic testing is rather unsuitable to be used as the only testing method in a machine.

INFORMATION



In machines with more than one brake, each brake is tested individually (e.g. group drives or a motor brake in combination with another brake on the same drive axis). Any mechanical stress during the separate testing must be taken into consideration in the design of the machine or must be avoided using suitable automation.

7.4 Areas of application

A brake test is used, first and foremost, to meet the requirements of functional safety. In a safety system, standards require testing of the brakes when the brakes are used in a safety-related manner. In a brake systems with multiple brakes, a brake test must be carried out separately for each brake.

Outside of functional safety, a brake test is used to detect a failure in the overall system, if possible before it occurs. This can be due, e.g., to preventive maintenance, increasing availability, or even protecting investments.

7.5 Standards and state-of-the-art

The standard EN ISO 13849-1 contains explanations of safety concepts and the required tests. It does not contain detailed information about designing a brake test for safety-related brake systems.

31550835/EN – 08/2024

Various publications such as the German Social Accident Insurance or the Institute for Occupational Safety of the German Social Accident Insurance, among others, describe options for implementing a safety-related brake system as well as a brake test.

7.6 Test rate

The test rate defines the frequency with which a brake test is performed. It is defined by the user for a specific machine. Applicative and standards requirements must be taken into consideration when doing so. A brake test is called up via a higher-level controller and must be ensured by the user. SEW-EURODRIVE recommends calling up the brake test using a safety controller.

Regular call-up of a brake test

In IFA report 04/2018 "Safe drive controls with frequency inverters," the Institute for Occupational Safety and Health recommends regularly performing a brake test after approx. 8 hours or one shift. The same applies to system structures in category 2 and 3.

Special feature for machines with access regulation

In machines where access to the hazard zone is safely prevented, e.g. via security doors with an active guard locking device, a brake test can be performed immediately before accessing the hazard zone. Access to the hazard zone may be granted only after a positive test result.

One-off call-up of a brake test

In addition to regular call-ups, it is advisable to execute a brake test after the following events:

- Initial startup of a machine
- After emergency stop braking
- After voltage failure
- After the machine is switched on
- After inspection, maintenance, or repair of the machine

31550835/EN – 08/2024

7.7 Diagnostic coverage

In a safety-related use of the brake in a safe brake system, the diagnostic coverage (DC) is relevant for the final determination of the safety integrity, e.g. performance level (PL). The DC value is a characteristic value for the brake test. This value is determined as a ratio of the number of detectable hazardous failures of a brake to the number of all hazardous failures of a brake. The DC value is a indicator for which hazardous faults on a brake are detected by the brake test. A brake test is required from a system architecture of category 2 and higher in accordance with EN ISO 13849-1.

The originator of a brake test determines the DC value that is valid for the test, which is then used as part of the determination of the performance level (PL) achieved for the safe brake system.

7.8 Avoiding erroneous test results

In order to avoid erroneous test results, particular attention must be paid to the following:

- Before starting a static brake test, SEW-EURODRIVE recommends moving the axes that are to be tested slightly, for example, by moving a short distance forward or moving to a specific position at which the brake test will be performed. The motion ensures that the axis being tested can move freely and that the devices involved in the test are available and functioning properly. The motion can be performed by the machine's automation system or as part of the brake test.
- A software-based brake test usually cannot directly determine the braking torque that is present at the brake. In addition to the braking torque, a torque determined by the test also includes applicative torques, such as friction. Measuring tolerances of the measuring equipment that is used and a temperature-dependent torque characteristic of the motor can also lead to measurement deviations.

  These applicative torques and the different meaning of the braking torques M_2 and $M_{4100\ °C}$ can lead to the brake slipping, even significantly outside the tolerance range for the nominal braking torque M_{br}.
- Because of possible measurement deviations and the different meaning of the nominal braking torque M_{br} and the static braking torque $M_{4100\ °C}$, brake slippage can and may occur, even significantly outside the tolerance range for the nominal braking torque M_{br}.

Temperature-dependent torque characteristic of the motor

For frequency inverters from SEW-EURODRIVE, the control mode with encoder feedback assumes a drive that is warm from operation. With an increasing deviation of the motor's operating temperature from this assumption, a difference develops between the torque assumed by the control system and the torque actually generated by the motor. This is especially true for applications in low ambient temperatures and can have significant effects (e.g. in cold storage applications at less than 0 °C). This effect also occurs in drives with a lower thermal load than normal ambient temperature.

In such use cases, the motor must be equipped with a temperature sensor, e.g. Pt1000 or KTY, and evaluated via the frequency inverter. Through the temperature sensor, the frequency inverter takes into consideration the real temperature of the drive and compensates for the temperature-dependent torque characteristic using the control system.

31550835/EN – 08/2024

7.9 Test torque for the brake

A suitable torque for testing the brake is selected according to the application. When making this selection, in particular the application and the torque of the brake used must be taken into consideration. The test torque is always below the nominal torque of the brake.

7.9.1 Gravity-loaded axis

In this document, the term gravity-loaded axes includes all applications that, due to an external force, can independently perform a hazardous motion. An external force is typically gravity. However, other forces that act upon the axis from outside and can cause a hazardous motion must be taken into consideration, e.g. spring force (applications that are pretensioned with a spring).

For gravity-loaded applications, the IFA Report recommends testing the brake in relation to the applicative limits.

M_{test} = 1.3 × the maximum static load torque of the application

The test torque includes a safety margin of +30%. According to the IFA Report, this safety margin can be omitted in redundant brake systems (with 2 brakes). In addition to this, standards or other institutions may make other declarations regarding a test torque which must additionally be taken into consideration by the user.

31550835/EN – 08/2024

7.9.2 More axes

For axes that are not gravity-loaded, e.g. horizontal drives with a horizontal direction of movement, a comparable recommendation has not been made thus far in the IFA Report or by other institutions. SEW-EURODRIVE therefore recommends a test torque related to the nominal braking torque M_B. This corresponds to the maximum static torque that the brake must be able to hold.

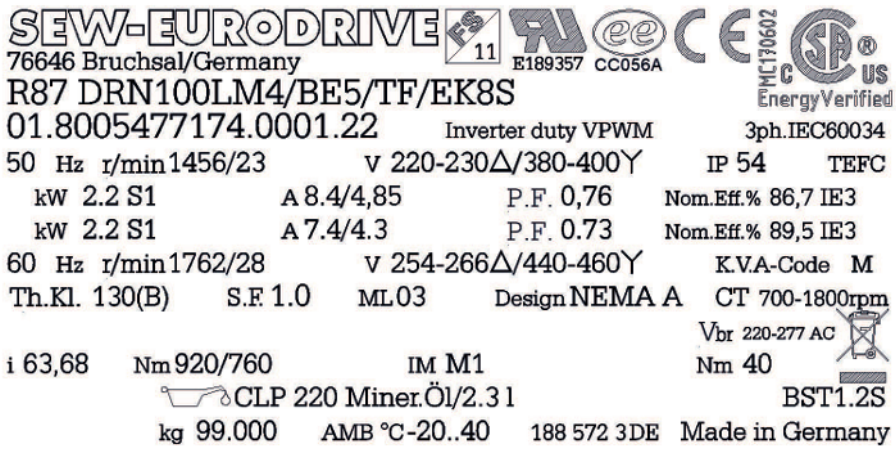
The maximum test torque M_{test} can be determined based on the nominal braking torque M_B indicated on the motor nameplate or according to the technical data in the documentation.

Brake type	Maximum test torque	
	Determination via M_B on the motor nameplate	Determination via characteristic values in the documentation
BE.. brake	$M_{test} = 0.6 \times M_B$	$M_{test} = 0.6 \times M_B$

Example of a BE5 brake

Determining the maximum test torque for the BE5 brake with a nominal braking torque of 40 Nm.

- Determination using the motor nameplate:



9007237703233035

$$M_{test} = 0.6 \times M_B = 0.6 \times 40\ Nm = 24\ Nm$$

- Determination using the documentation

  $$M_{test} = 0.6 \times M_B = 0.6 \times 40\ Nm = 24\ Nm$$

  Table section from the operating instructions of the motor:

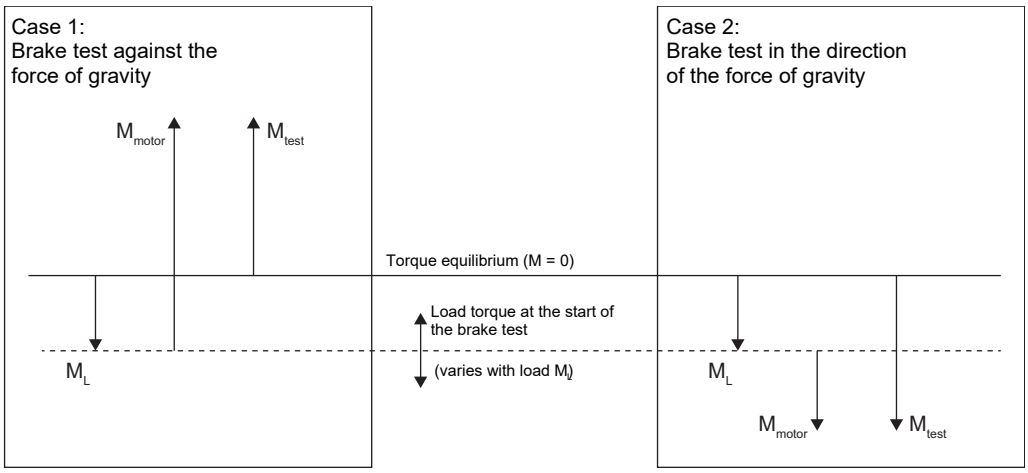
Motor size	Brake size	Braking torque level M_B [Nm]
DRN100LM4	BE5	55
		40
		28
		20
		14

7.9.3 Effect of load torque on the hoist

In a gravity-loaded axis, the test torque is composed of the motor torque and the load torque. To ensure that a brake is tested correctly with the desired test torque, the existing load torque of the application must be taken into consideration when integrating a brake test. Otherwise, the brake may be tested with a torque that is too high or too low. A test torque that is too high can cause undesired slippage of the closed brake, despite the brake being free of faults. The fault response that this triggers in the brake test can cause the machine to come to an undesired standstill and necessitate subsequent inspection and maintenance work. A test torque that is too high can also lead to an undesired load on the machine structure.

By contrast, a brake with a test torque that is too low will not be sufficiently tested. Potential faults could go undetected and lead to loss or limitation of the desired safety.

The following figure shows a simplified representation of the torques on the hoist with a load torque in the direction of gravity. The representation of the torques is idealized, e.g. without friction forces or rolling resistance.



33205903243

M_{test} Total torque used to test the brake
M_L Portion of M_{test} made up of load torque
M_{motor} Portion of M_{test} made up of motor torque

The portion of the desired test torque made up of the motor torque amounts to:

Case 1: $M_{motor} = M_{test} + M_L$

Case 2: $M_{motor} = M_{test} - M_L$

To test the brake, the axis can also be loaded with a defined testing weight. The mass of the testing weight corresponds to the equivalent motor torque. The load torque is assumed to be constant or must be determined and taken into consideration each time the brake test is performed. In applications with variable load torques, a brake test with integrated load determination is recommended.

7.10 Activating the friction surfaces

When a brake is used as a holding brake, it is not usually subjected to dynamic loading. This can cause a gradual reduction in the static braking torque. As compensation, the friction surfaces can be reactivated by a targeted dynamic load. The activation process regenerates the top layer of the friction linings.

31550835/EN – 08/2024

SEW-EURODRIVE recommends paying attention to the following during activation procedures such as this:

- Activating the friction surfaces causes wear on the brake. Perform friction surface activation as infrequently as possible in order not to reduce the service life of the lining too much.
- The friction surfaces should preferably be activated using a brake application at a significantly reduced motor speed (<750 min^{-1}).
- Activation of the friction surfaces by means of controlled start-up of the motor against the applied brake is only permissible if the motor speed does not exceed a value of 100 min^{-1} and the activation time does not exceed 5 seconds.

In the event of questions with regard to the design of activation of the friction surfaces, contact SEW-EURODRIVE.

7.11 Diagnostic unit /DUE

The diagnostic unit /DUE for function and wear monitoring of the BE.. brake detects the switching status of the brake and its wear status by means of continuous measurement of the air gap. The diagnostic unit /DUE detects whether the magnetic circuit of the brake - including the brake control - essentially works (brake opens and closes). Furthermore, the /DUE option makes it possible to detect a change to the air gap of the brake via a continuous air gap measurement. In this manner, wear-related function restrictions can be detected and rectified by means of maintenance.

INFORMATION

The diagnostic unit /DUE detects the switching status and the degree of wear of the brake by interpreting the air gap. However, the /DUE option cannot determine the available braking torque. Additional applicative measures may be needed to check the braking torque.

31550835/EN – 08/2024

8 Technical data

8.1 Operating currents

8.1.1 General information on determining operating currents

The tables in this chapter list the operating currents of the brakes at different voltages.

The acceleration current I_B (= inrush current) flows for a short time when releasing the brake (approx. 160 ms for BE02 – BE62, 400 ms for BE60 – BE122 in connection with BMP3.1 brake control). No increased inrush current occurs when using BG, BS24 or BMS brake control and direct DC voltage supply without control unit (only possible with brake size BE02 – BE2).

The values for the holding currents I_H are effective values. Only use current measurement units that are designed to measure effective values.

INFORMATION

The following operating currents and power consumption values are nominal values. They refer to a coil temperature of +20 °C.

Operating currents and power consumption usually decrease during normal operation due to heating of the brake coil.

However, note that the actual operating currents can be higher by up to 25% when the coil temperatures are below +20 °C.

Legend

The following tables list the operating currents of the brakes at different voltages.

The following values are specified:

P_B	Nominal value of the electric power consumption in the brake coil in watt
U_N	Nominal voltage (rated voltage range) of the brake in V (AC or DC)
I_H	Nominal holding current in A (AC). Effective value of the braking current in the supply cable to the SEW-EURODRIVE brake control
I_G	Nominal holding current in A (DC) in the brake cable with direct DC voltage supply or Nominal holding current in A (DC) in the brake cable with DC 24 V supply via BS24, BSG, or BMV
I_B	Acceleration current in A (AC or DC) when operated with SEW-EURODRIVE brake control for high-speed excitation
I_B/I_H	Inrush current ratio ESV
I_B/I_G	Inrush current ratio ESV for DC 24 V supply with BSG or BMV

31550835/EN – 08/2024

Calculation rules for nominal operating currents and nominal coil power

Depending on the drive design, SEW-EURODRIVE may reduce the power of the brake coil to achieve lower self-heating. The following table gives an overview of possible designs. The nominal power applicable for the application and the resulting nominal currents can be calculated using the table values for rated operation and the specified adjustment factors.

Brake coil design	Adjustment factor for power and current	DR../DRN../DRU../DR2..	EDR../EDRN..
Rated power	Table values for currents and power without adjustment	Drives for ambient temperatures up to a max of +60 °C	Explosion-protected drives according to HazLoc-NA® (line operation)
1st reduced power	Table values for currents and power × 0.79	Drives for ambient temperatures up to a max of +80 °C	Explosion-protected drives according to ATEX, IECEx, or HazLoc-NA® (inverter operation)
2nd reduced power	Table values for currents and power × 0.63	Drives for ambient temperatures up to a max of +100 °C	–

BE02, BE03, BE05, BE1, BE2 brakes

	BE02	BE03	BE05, BE1	BE2
Nominal power brake coil in W	25	25	30	41
Inrush current ratio ESV	4	4	4	4

Nominal voltage (rated voltage range) V_N		BE02		BE03		BE05, BE1		BE2	
		I_H	I_{DC}	I_H	I_{DC}	I_H	I_{DC}	I_H	I_{DC}
AC V	DC V	AC A	DC A	AC A	DC A	AC A	DC A	AC A	DC A
24 (23–26)	10	-	–	2.20	2.55	2.25	2.90	2.95	3.80
60 (57-63)	24	-	0.72	0.87	1.02	0.90	1.17	1.18	1.53
120 (111-123)	48	-	–	0.44	0.51	0.45	0.59	0.59	0.77
184 (174-193)	80	-	–	0.28	0.32	0.29	0.37	0.38	0.49
208 (194-217)	90	-	–	0.25	0.29	0.26	0.33	0.34	0.43
230 (218-243)	96	0.14	0.18	0.22	0.26	0.23	0.30	0.30	0.39
254 (244-273)	110	-	–	0.19	0.23	0.20	0.27	0.27	0.35
290 (274-306)	125	-	–	0.17	0.21	0.18	0.24	0.24	0.31
330 (307-343)	140	-	–	0.15	0.18	0.16	0.21	0.21	0.28
360 (344-379)	160	-	–	0.14	0.16	0.14	0.19	0.19	0.25
400 (380-431)	180	0.08	0.1	0.12	0.14	0.13	0.17	0.17	0.22
460 (432-484)	200	0.07	0.09	0.11	0.13	0.11	0.15	0.15	0.19
500 (485-542)	220	-	–	0.10	0.11	0.10	0.13	0.14	0.18
575 (543-600)	250	-	–	0.09	0.10	0.09	0.12	0.12	0.16

31550835/EN – 08/2024

Brakes BE5, BE11, BE20, BE30, BE32, BE60, BE62

	BE5	BE11	BE20	BE30, BE32	BE60, BE62
Nominal power brake coil in W	50	70	95	120	195
Inrush current ratio ESV	5.9	6.6	7.5	8.5	9.2

Nominal voltage (rated voltage range) V_N		BE5	BE11	BE20	BE30, BE32	BE60, BE62
		I_H	I_H	I_H	I_H	I_H
AC V	DC V	AC A	AC A	AC A	AC A	AC A
60 (57 – 63)	24	1.28	2.05	2.55	–	–
120 (111 – 123)	–	0.64	1.04	1.28	1.66	–
184 (174 – 193)	–	0.41	0.66	0.81	1.05	–
208 (194 – 217)	–	0.37	0.59	0.72	0.94	1.50
230 (218 – 243)	–	0.33	0.52	0.65	0.84	1.35
254 (244 – 273)	–	0.29	0.47	0.58	0.75	1.20
290 (274 – 306)	–	0.26	0.42	0.51	0.67	1.12
330 (307 – 343)	–	0.23	0.37	0.46	0.59	0.97
360 (344 – 379)	–	0.21	0.33	0.41	0.53	0.86
400 (380 – 431)	–	0.18	0.30	0.37	0.47	0.77
460 (432 – 484)	–	0.16	0.27	0.33	0.42	0.68
500 (485 – 542)	–	0.15	0.24	0.29	0.38	0.60
575 (543 – 600)	–	0.13	0.22	0.26	0.34	0.54

31550835/EN – 08/2024

Brake BE120, BE122

	BE120, BE122
Nominal power brake coil in W	220
Inrush current ratio ESV	6

Nominal voltage (rated voltage range) V_N	BE120, BE122
	I_H
AC V	AC A
230 (218 – 243)	1.45
254 (244 – 273)	1.30
290 (274 – 306)	1.16
360 (344 – 379)	0.92
400 (380 – 431)	0.82
460 (432 – 484)	0.73
500 (485 – 542)	0.65
575 (543 – 600)	0.58

31550835/EN – 08/2024

8.1.2 Operating currents with BG1Z

The tables in this chapter show the operating currents of BE.. brakes when supplied from the local AC supply system with BG1Z brake control.

The acceleration current I_B (= inrush current) flows only for a short time (depending on brake sizes between 100 – 500 ms) when the brake is released.

The values for the holding currents I_H are effective values. Only use devices for the current measurement that are suitable for the measurement of effective values.

The operating currents specified below are nominal values. They relate to a coil temperature of +20 °C. If the heat rises above a coil temperature of +20 °C, the operating current increases because the closed loop system integrated into the BG1Z or BS1Z must compensate for the rise in winding resistance due to the temperature.

Key

The following tables list the operating currents of the brakes at different voltages. The following values are specified:

- V_N Nominal voltage (rated voltage range) of the brake in V (AC or DC).
- I_H Nominal holding current in A (AC or DC). Effective value of the braking current in the supply cable to the SEW-EURODRIVE brake control.
- I_B Acceleration current in A (AC or DC) when operated with SEW-EURODRIVE brake control for high-speed excitation.
- I_B/I_H Inrush current ratio ESV.

	BE03	BE05	BE1	BE2	BE5	BE11	BE20	BE30	BE32	BE60	BE62
Inrush current ratio ESV	3.9	3.4	4.2	4.5	2.9	3.6	3.5	3.9	3.9	3.0	3.0

Nominal voltage (rated voltage range) V_N	**BE03**	**BE05**	**BE1**	**BE2**	**BE5**	**BE11**	**BE20**	**BE30**	**BE32**	**BE60**	**BE62**
	Nominal holding current I_H										
V AC	**AC A**	**AC A**	**AC A**	**AC A**	**AC A**	**AC A**	**AC A**	**AC A**	**AC A**	**AC A**	**AC A**
200 V to 500 V	0.06	0.08	0.08	0.09	0.15	0.35	0.40	0.48	0.48	0.52	0.52

31550835/EN – 08/2024

8.2 Application factor f_A

The following table defines the application factors for the checking of the stop and emergency stop function for vertical drives and other axes under static load in the load range R, S, and H in use as working brakes and holding brakes.

No factors are defined for load ranges A to D because the application is not permitted for axes under static load.

Brake	Use as	Load range	f_A
BE	Working brake	R and S	2
	Holding brake	R and S	2.5
		H	3

8.3 Pulse frequencies

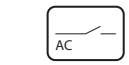
The switching times of the brake generally depend on many factors, e.g. on the operating temperature of the brakes, the wear condition and the tolerances of the components used. A particular factor determining the switching times is the braking torque set.

The following table gives us guide values for the following switching times:

- Response time $t_{1,I}$ for standard excitation

  When operating with the BG., BMS., BS24 brake controls or direct supply with DC voltage without brake control
- Response time $t_{1,II}$ for high-speed excitation

  For operation with the brake controls BGE., BG1Z, BME., BMP., BMK./BMKB., BMH., BSG, or BMV



- Application time $t_{2,I}$ with pure cut-off in the AC circuit (AC)



- Application time $t_{2,II}$ with cut-off in the AC and DC circuit (AC/DC) or disconnection only in the DC circuit (DC)

The pulse frequencies are identical for the BE.. brake and the BE.. safety brake.

Brake	t_1 in 10^{-3} s		t_2 in 10^{-3} s	
	$t_{1,I}$	$t_{1,II}$	$t_{2,I}$	$t_{2,II}$
BE02	30	25	100	10
BE03	60	23	73	15
BE05	34	15	42	10
BE1	55	10	76	12
BE2	73	17	68	10
BE5	–	35	70	10
BE11	–	41	82	15
BE20	–	57	88	20
BE30	–	60	80	16
BE32	–	60	80	16
BE60	–	90	120	25

31550835/EN – 08/2024

Brake	t_1 in 10^{-3} s		t_2 in 10^{-3} s	
	$t_{1,I}$	$t_{1,II}$	$t_{2,I}$	$t_{2,II}$
BE62	–	90	120	25
BE120	–	120	130	40
BE122	–	120	130	40

$t_{1,I}$ = Response time for standard excitation

$t_{1,II}$ = Response time for high-speed excitation

$t_{2,I}$ = Brake application time for cut-off in the AC circuit

$t_{2,II}$ = Brake application time for cut-off in the DC and AC circuit

INFORMATION

The times stated are guide values which were determined with the brakes at operating temperature. These may vary under real application conditions.

31550835/EN – 08/2024

8.4 No-load starting frequency and switching intervals for holding brakes

8.4.1 Maximum permitted no-load starting frequencies

Brake	Maximum permitted no-load starting frequency [h^{-1}]	
	$Z_{B0,I}$ with normal control	$Z_{B0,II}$ with rapid control
BE02	6000	4000
BE03	6000	4000
BE05	6000	4000
BE1	6000	4000
BE2	6000	4000
BE5	–	2000
BE11	–	2000
BE20	–	2000
BE30	–	1000
BE32		
BE60	–	1000
BE62		
BE120	–	1000
BE122		

8.4.2 Minimum pause times before switching on again

Brake control	Minimum pause time before switching on again in ms
BMS.	50
BME.	100
BMH.	100
BMP.	100
BMP3.1	300
BMV.	100
BMK., BMKB.	100
BG.	50
BGE.	100
BUR.	100
BS.	50
BSG.	100
BG1Z.	–

For the pause times of the safe brake controls BST. and SBM., refer to the operating instructions "Safety-Related BST Brake Module (as from Build Status 12.11) for Control Cabinet Installation" and "SBM Brake Module for Control Cabinet Installation".

31550835/EN – 08/2024

8.5 Limit speeds $n_{max,0}$ and $n_{max,1}$

The following speed limits apply to all brake designs:

Brake		Max. permitted emergency stop speed $n_{max,1}$ in min^{-1}				Max. permitted operating speed $n_{max,0}$ in min^{-1}
		Reduced R	Standard S	Overload ranges A-D	Overload range H	
BE02	Standard	–	3600	–	–	4500
BE03 – BE2	Standard	–	3600	–	–	4500
	FS	–	3600	–	–	4500
	Ex	3000	–	–	–	3600
	Ex-FS	3000	–	–	–	3600
BE5	Standard	–	3600	3600	–	3600
	FS	–	3600	3600	–	3600
	Ex	3000	–	–	–	3600
	Ex-FS	3000	–	–	–	3600
BE11 – BE20	Standard	–	3600	3600	–	3600
	FS	–	3600	3600	–	3600
	Ex	3000	–	–	–	3600
	Ex-FS	3000	–	–	–	3600
BE30 – BE32	Standard	–	1800	3600	3000	3600
	FS	–	1800	3600	–	3600
	Ex	1800	–	–	–	1800
	Ex-FS	1800	–	–	–	1800
BE60 – BE122	Standard	–	1800	2500	–	2500
	Ex	1800	–	–	–	1800

31550835/EN – 08/2024

8.6 Permitted emergency stop braking work $W_{zul,n}$

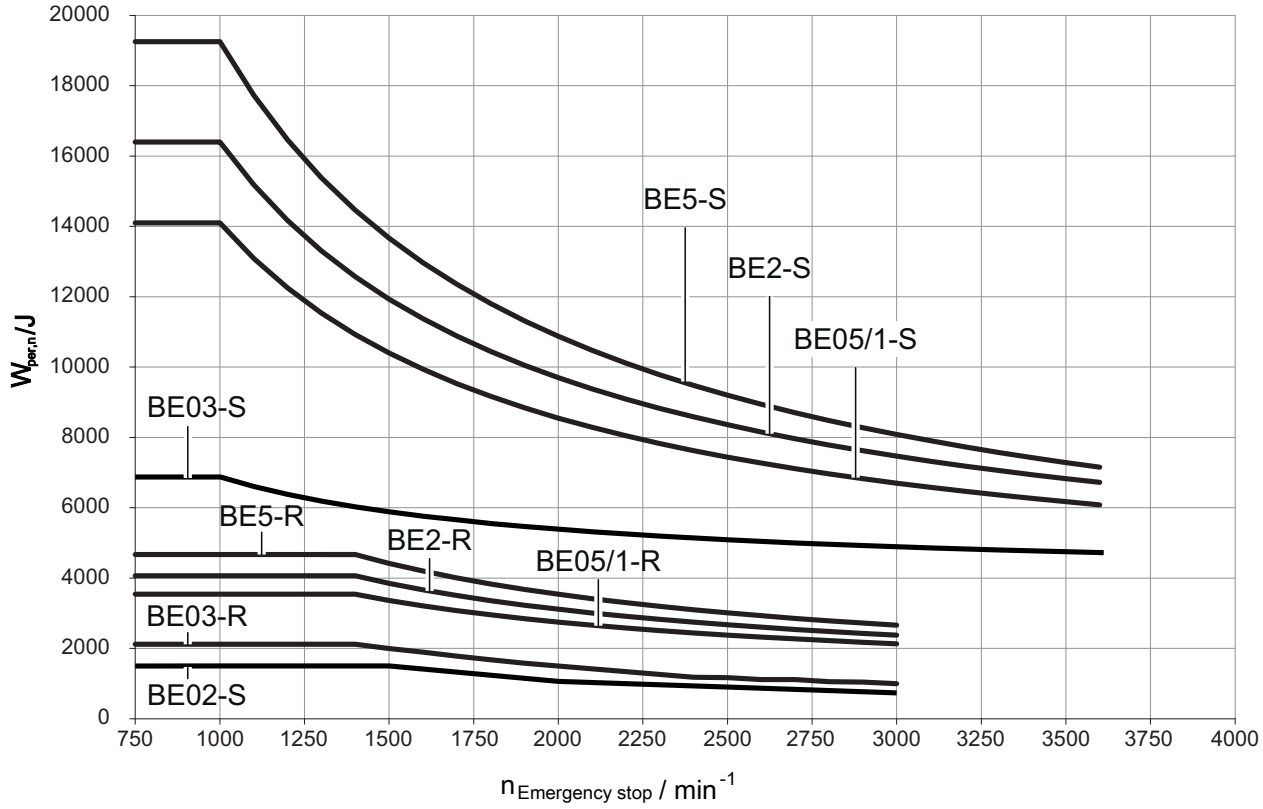
The permitted braking work for emergency stop braking operations $W_{per,n}$ for BE.. brakes and BE.. safety brakes is specified below. Information is provided for each brake size in a common chart for different load levels.

Brake types	Load ranges	Section
BE02	S	(→ 🗎 113)
BE03 – BE5	R, S	(→ 🗎 113)
BE11	R, S, A, B, C, D	(→ 🗎 115)
BE20	R, S, A, B, C, D	(→ 🗎 117)
BE30 – BE32	R, S, A, B, C, D, H	(→ 🗎 119) and (→ 🗎 121)
BE60 – BE62	R, S, D	(→ 🗎 123)
BE120 – BE122	R, S, D	(→ 🗎 124)

If you require increased braking work that goes beyond the limits of the aforementioned load ranges, contact SEW-EURODRIVE.

31550835/EN – 08/2024

8.6.1 BE02 – BE5 (load ranges R and S)



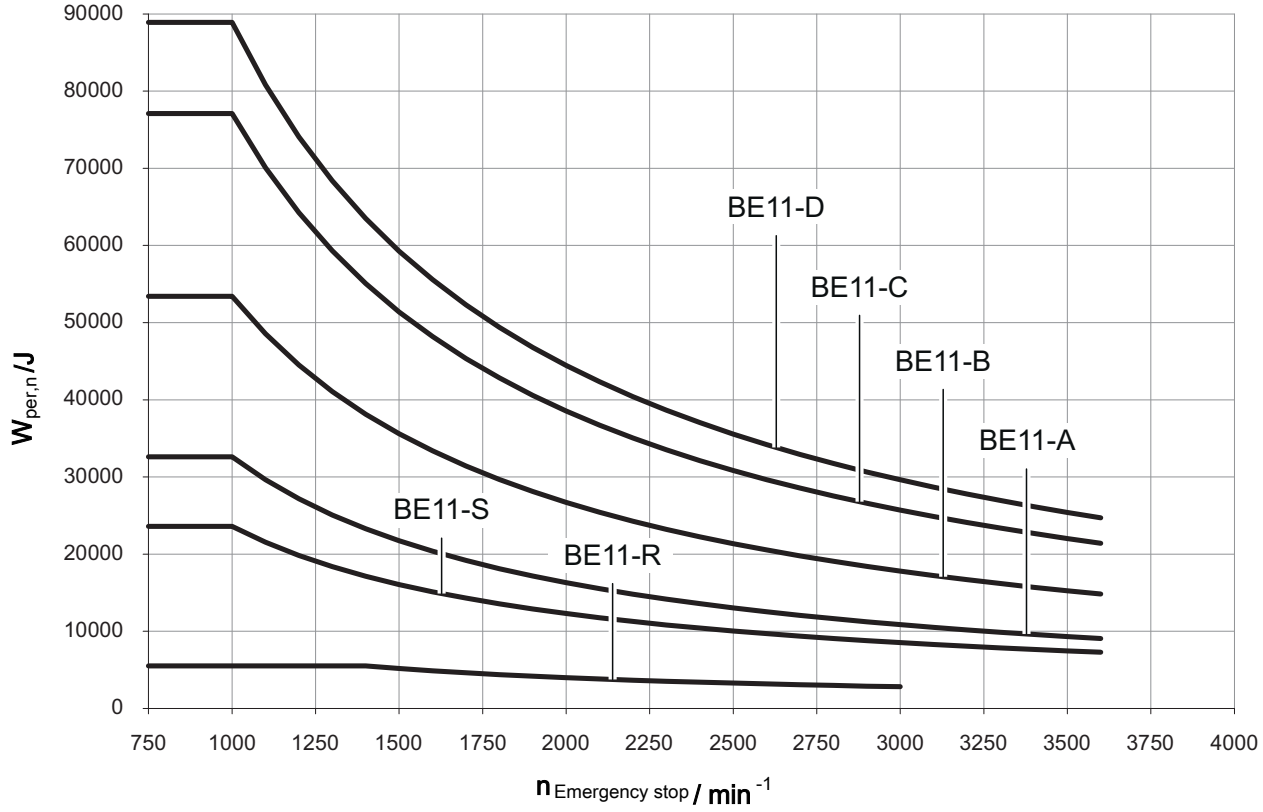
27021620488371083

$n_{EmergStop}$	BE02	BE03	BE05/1	BE2	BE5	BE03	BE05/1	BE2	BE5
	Load range S	Load range R				Load range S			
min^{-1}	$W_{per,n}$ /J								
750	1500	2143	3450	3910	4480	6880	14100	16400	19300
900	1500	2143	3450	3910	4480	6880	14100	16400	19300
1000	1500	2143	3450	3910	4480	6880	14100	16400	19300
1100	1500	2143	3450	3910	4480	6609	13100	15200	17700
1200	1500	2143	3450	3910	4480	6383	12300	14200	16500
1300	1500	2143	3450	3910	4480	6192	11500	13300	15400
1400	1500	2143	3450	3910	4480	6029	10900	12600	14500
1500	1500	2000	3290	3720	4240	5887	10400	11900	13700
1600	1410	1875	3150	3560	4030	5763	9940	11400	13000
1700	1320	1765	3020	3410	3840	5653	9530	10900	12400
1800	1250	1667	2910	3280	3680	5556	9170	10400	11800
1900	1180	1579	2820	3170	3530	5468	8840	10100	11300
2000	1130	1500	2730	3070	3390	5390	8550	9700	10900
2100	1070	1429	2650	2970	3270	5319	8290	9380	10500
2200	1020	1364	2580	2890	3160	5255	8050	9090	10100

$n_{EmergStop}$	BE02	BE03	BE05/1	BE2	BE5	BE03	BE05/1	BE2	BE5
	Load range S	Load range R				Load range S			
min^{-1}	$W_{per,n}$ /J								
2300	980	1304	2510	2810	3060	5196	7830	8830	9780
2400	940	1250	2450	2740	2970	5142	7630	8580	9480
2500	900	1200	2390	2670	2880	5092	7440	8360	9200
2600	870	1154	2340	2610	2810	5046	7270	8150	8940
2700	830	1111	2290	2560	2730	5004	7110	7960	8700
2800	800	1071	2250	2500	2670	4964	6960	7790	8480
2900	780	1034	2210	2460	2600	4928	6830	7620	8280
3000	750	1000	2170	2410	2550	4893	6700	7470	8080
3100	–	–	–	–	–	4861	6580	7320	7900
3200	–	–	–	–	–	4831	6470	7190	7730
3300	–	–	–	–	–	4803	6360	7060	7580
3400	–	–	–	–	–	4776	6260	6940	7430
3500	–	–	–	–	–	4751	6170	6830	7290
3600	–	–	–	–	–	4728	6080	6720	7150

31550835/EN – 08/2024

8.6.2 BE11 (load ranges R, S, A, B, C, D)



9007221973370123

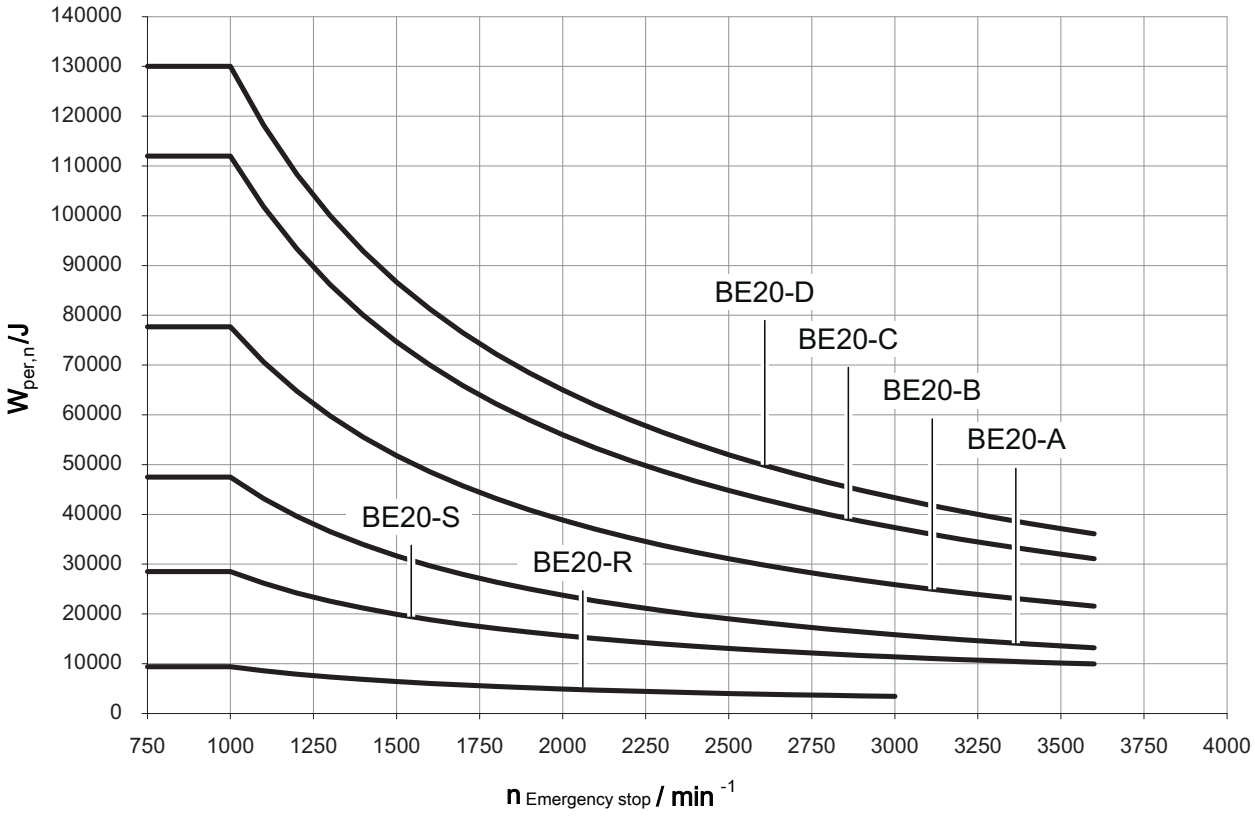
$n_{EmergStop}$	BE11					
min^{-1}	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D
	$W_{per,n}$ /J					
750	5360	23600	32600	53400	77100	88900
900	5360	23600	32600	53400	77100	88900
1000	5360	23600	32600	53400	77100	88900
1100	5360	21500	29600	48500	70100	80800
1200	5360	19800	27200	44500	64300	74100
1300	5360	18400	25100	41100	59300	68400
1400	5360	17100	23300	38100	55100	63500
1500	5030	16100	21700	35600	51400	59300
1600	4740	15100	20400	33400	48200	55600
1700	4480	14300	19200	31400	45400	52300
1800	4260	13600	18100	29700	42800	49400
1900	4050	12900	17200	28100	40600	46800
2000	3870	12300	16300	26700	38600	44500
2100	3700	11800	15500	25400	36700	42300
2200	3550	11300	14800	24300	35000	40400

31550835/EN – 08/2024

$n_{EmergStop}$	BE11					
min^{-1}	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D
	$W_{per,n}$ /J					
2300	3420	10800	14200	23200	33500	38700
2400	3290	10400	13600	22300	32100	37000
2500	3180	10000	13000	21400	30800	35600
2600	3070	9690	12500	20500	29700	34200
2700	2970	9370	12100	19800	28600	32900
2800	2880	9070	11600	19100	27500	31800
2900	2790	8790	11200	18400	26600	30700
3000	2710	8530	10900	17800	25700	29600
3100	–	8290	10500	17200	24900	28700
3200	–	8060	10200	16700	24100	27800
3300	–	7850	9880	16200	23400	26900
3400	–	7650	9590	15700	22700	26100
3500	–	7460	9310	15300	22000	25400
3600	–	7280	9060	14800	21400	24700

31550835/EN – 08/2024

8.6.3 BE20 (load ranges R, S, A, B, C, D)



9007221974801931

$n_{EmergStop}$	BE20					
min^{-1}	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D
	$W_{per,n}$ /J					
750	9240	28500	47500	77700	112000	130000
900	9240	28500	47500	77700	112000	130000
1000	9240	28500	47500	77700	112000	130000
1100	8460	26200	43200	70600	102000	118000
1200	7820	24200	39600	64800	93300	108000
1300	7270	22600	36500	59800	86200	100000
1400	6800	21200	33900	55500	80000	92900
1500	6390	19900	31700	51800	74700	86700
1600	6040	18900	29700	48600	70000	81300
1700	5720	17900	27900	45700	65900	76500
1800	5440	17100	26400	43200	62200	72200
1900	5190	16300	25000	40900	58900	68400
2000	4970	15700	23800	38900	56000	65000
2100	4770	15000	22600	37000	53300	61900
2200	4580	14500	21600	35300	50900	59100

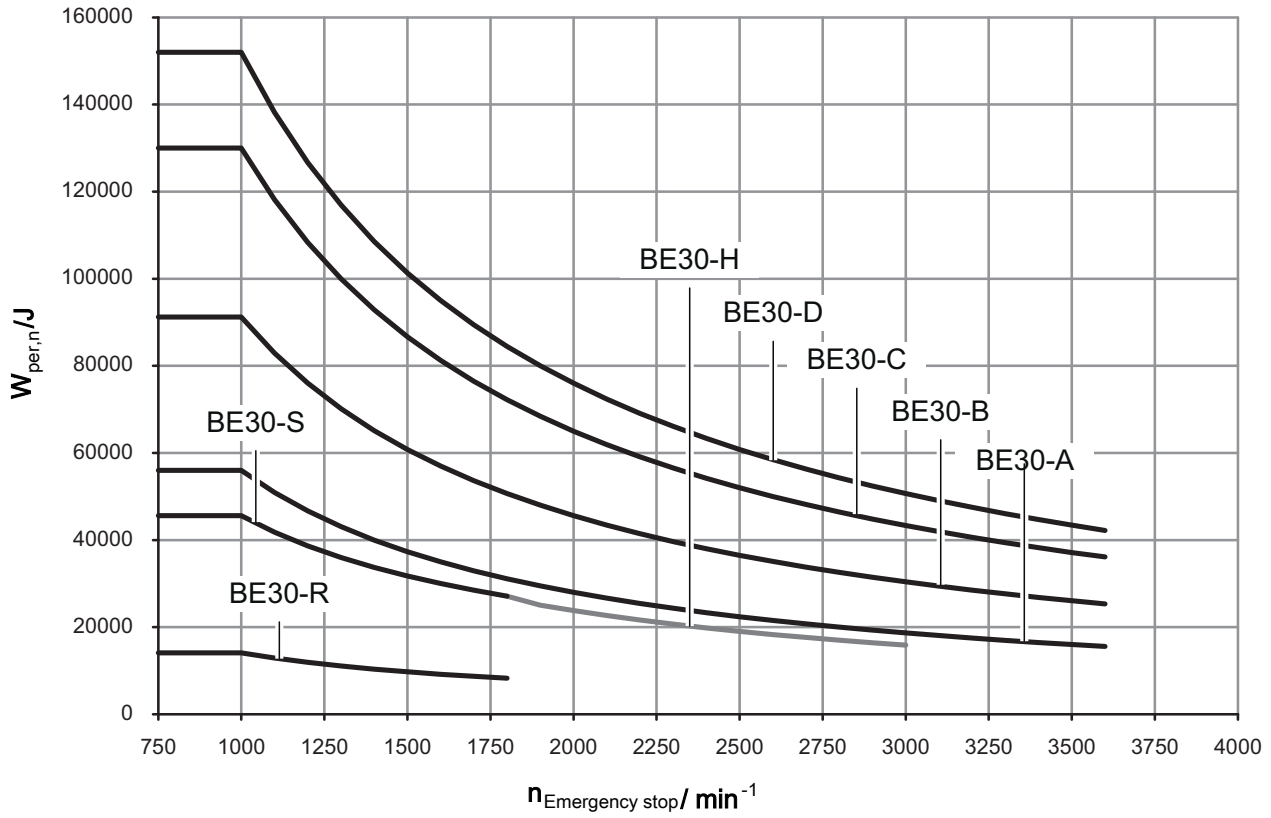
$n_{EmergStop}$	BE20					
min^{-1}	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D
	$W_{per,n}$ /J					
2300	4410	14000	20700	33800	48700	56500
2400	4260	13500	19800	32400	46700	54200
2500	4120	13100	19000	31100	44800	52000
2600	3980	12700	18300	29900	43100	50000
2700	3860	12300	17600	28800	41500	48100
2800	3750	12000	17000	27800	40000	46400
2900	3640	11700	16400	26800	38600	44800
3000	3550	11400	15800	25900	37300	43300
3100	–	11100	15300	25100	36100	41900
3200	–	10800	14800	24300	35000	40600
3300	–	10600	14400	23500	33900	39400
3400	–	10400	14000	22900	32900	38200
3500	–	10100	13600	22200	32000	37100
3600	–	9940	13200	21600	31100	36100

31550835/EN – 08/2024

8.6.4 BE30 (load ranges R, S, A, B, C, D, H)

INFORMATION

Observe that during capacity utilization of the load range H in the speed range from 1800 – 3000 min^{-1} for hoists and hoist-like applications, a greater nominal braking torque may be necessary to meet the project planning requirements (see formula 2.1).



9007221974805003

$n_{EmergStop}$	BE30						
min^{-1}	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D	Load range H
	$W_{per,n}$ /J						
750	14100	45600	56000	91200	130000	152000	–
900	14100	45600	56000	91200	130000	152000	–
1000	14100	45600	56000	91200	130000	152000	–
1100	12800	41800	50900	82900	118000	138000	–
1200	11800	38700	46700	76000	108000	127000	–
1300	10900	36000	43100	70200	100000	117000	–
1400	10100	33700	40000	65100	92900	109000	–
1500	9470	31700	37300	60800	86700	101000	–
1600	8890	30000	35000	57000	81300	95000	–
1700	8380	28500	32900	53600	76500	89400	-

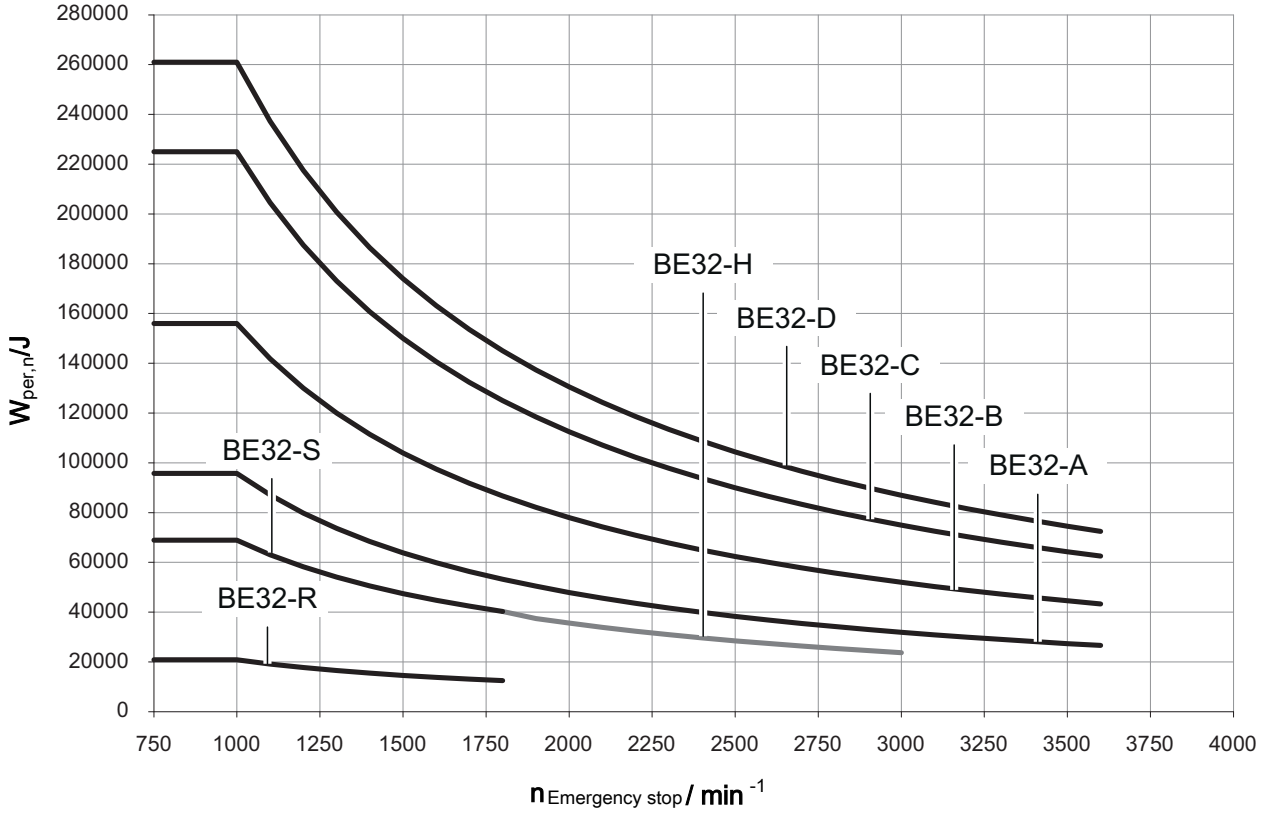
$n_{EmergStop}$	BE30						
min^{-1}	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D	Load range H
	$W_{per,n}$ /J						
1800	7920	27100	31100	50700	72200	84400	27100
1900	–	–	29500	48000	68400	80000	25700
2000	–	–	28000	45600	65000	76000	24400
2100	–	–	26700	43400	61900	72400	23200
2200	–	–	25500	41500	59100	69100	22200
2300	–	–	24300	39700	56500	66100	21200
2400	–	–	23300	38000	54200	63300	20300
2500	–	–	22400	36500	52000	60800	19500
2600	–	–	21500	35100	50000	58500	18800
2700	–	–	20700	33800	48100	56300	18100
2800	–	–	20000	32600	46400	54300	17400
2900	–	–	19300	31400	44800	52400	16800
3000	–	–	18700	30400	43300	50700	16300
3100	–	–	18100	29400	41900	49000	–
3200	–	–	17500	28500	40600	47500	–
3300	–	–	17000	27600	39400	46100	–
3400	–	–	16500	26800	38200	44700	–
3500	–	–	16000	26100	37100	43400	–
3600	–	–	15600	25300	36100	42200	–

31550835/EN – 08/2024

8.6.5 BE32 (load ranges R, S, A, B, C, D, H)

INFORMATION

Observe that during capacity utilization of the load range H in the speed range from 1800 – 3000 min^{-1} for hoists and hoist-like applications, a greater nominal braking torque may be necessary to meet the project planning requirements (see formula 2.1).



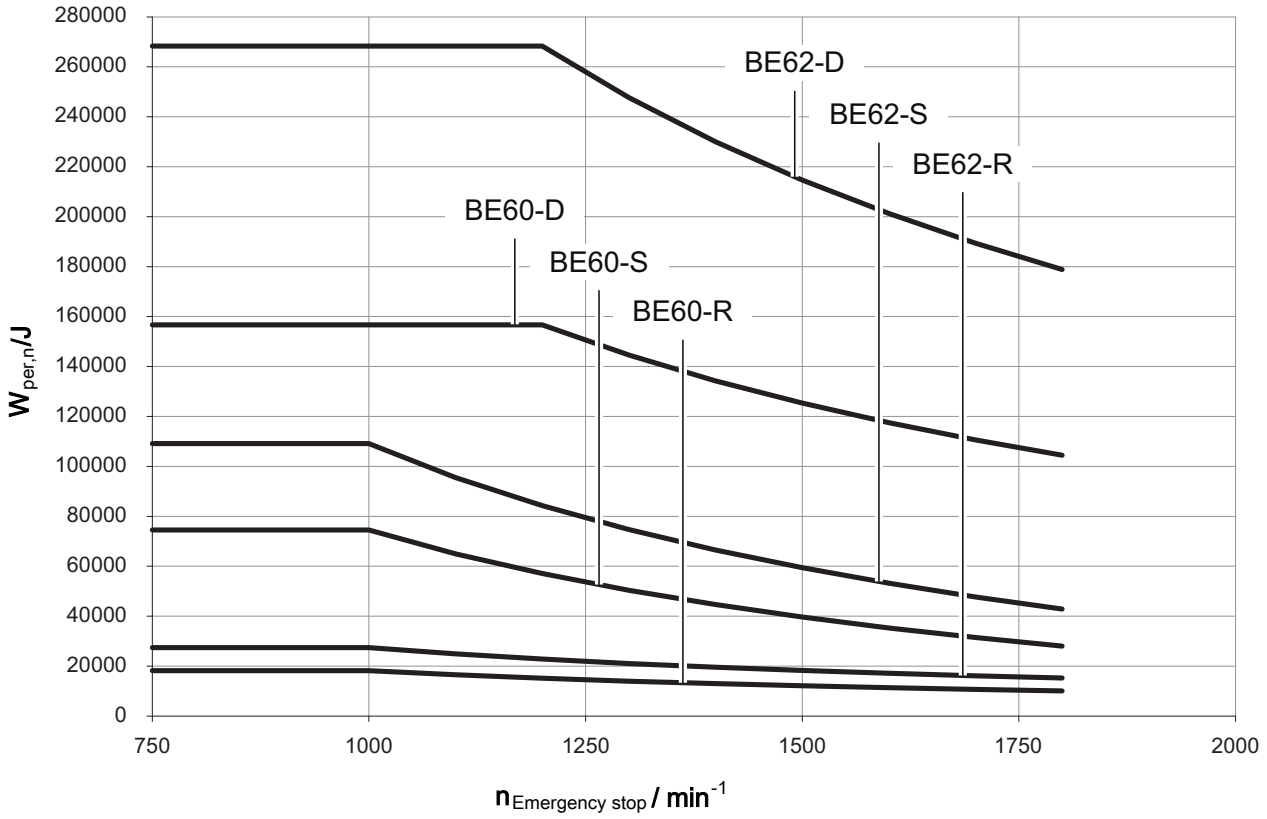
9007221974808075

$n_{EmergStop}$	BE32						
min^{-1}	**Load range R**	**Load range S**	**Load range A**	**Load range B**	**Load range C**	**Load range D**	**Load range H**
	$W_{per,n}$ /J						
750	21300	69000	95800	156000	225000	261000	–
900	21300	69000	95800	156000	225000	261000	–
1000	21300	69000	95800	156000	225000	261000	–
1100	19400	63100	87100	142000	205000	237000	–
1200	17800	58200	79800	130000	188000	218000	–
1300	16400	54100	73700	120000	173000	201000	–
1400	15300	50500	68400	111000	161000	186000	–
1500	14300	47500	63900	104000	150000	174000	–
1600	13400	44800	59900	97500	141000	163000	–
1700	12600	42400	56400	91800	132000	154000	-

$n_{EmergStop}$	BE32						
min^{-1}	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D	Load range H
	$W_{per,n}$ /J						
1800	11900	40300	53200	86700	125000	145000	40300
1900	–	–	50400	82100	118000	137000	38200
2000	–	–	47900	78000	113000	131000	36300
2100	–	–	45600	74300	107000	124000	34500
2200	–	–	43500	70900	102000	119000	33000
2300	–	–	41700	67800	97800	113000	31500
2400	–	–	39900	65000	93800	109000	30200
2500	–	–	38300	62400	90000	104000	29000
2600	–	–	36800	60000	86500	100000	27900
2700	–	–	35500	57800	83300	96700	26900
2800	–	–	34200	55700	80400	93200	25900
2900	–	–	33000	53800	77600	90000	25000
3000	–	–	31900	52000	75000	87000	24200
3100	–	–	30900	50300	72600	84200	–
3200	–	–	29900	48800	70300	81600	–
3300	–	–	29000	47300	68200	79100	–
3400	–	–	28200	45900	66200	76800	–
3500	–	–	27400	44600	64300	74600	–
3600	–	–	26600	43300	62500	72500	–

31550835/EN – 08/2024

8.6.6 BE60 – BE62 (load ranges R, S, D)

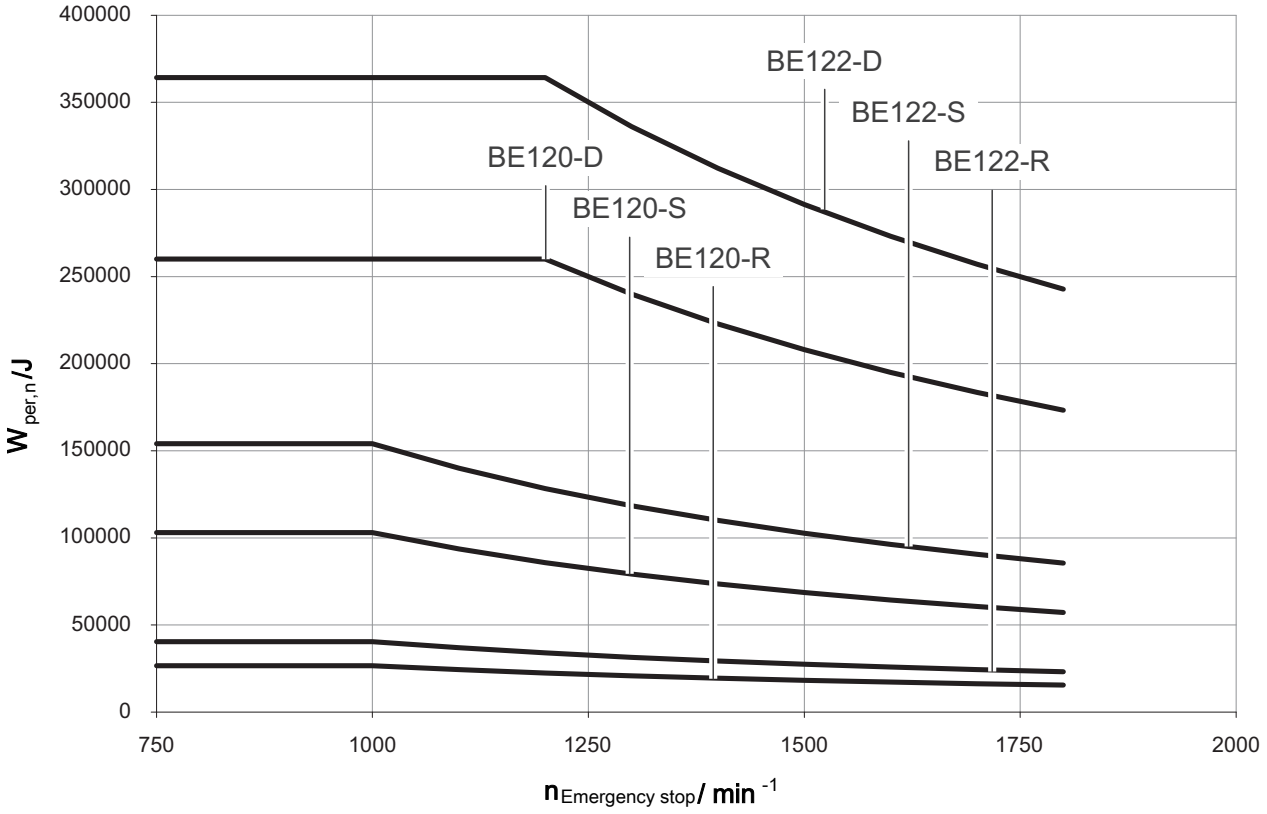


9007221975211019

$n_{EmergStop}$	BE60			BE62		
min^{-1}	Load range R	Load range S	Load range D	Load range R	Load range S	Load range D
	$W_{per,n}$ /J					
750	17800	74500	157000	26700	109000	268000
900	17800	74500	157000	26700	109000	268000
1000	17800	74500	157000	26700	109000	268000
1100	16200	65000	157000	24300	95500	268000
1200	14900	57100	157000	22300	84300	268000
1300	13700	50400	145000	20600	74700	248000
1400	12800	44600	134000	19100	66500	230000
1500	11900	39700	125000	17900	59400	215000
1600	11200	35300	118000	16800	53200	201000
1700	10600	31500	111000	15800	47700	189000
1800	9980	28100	104000	14900	42800	179000

31550835/EN – 08/2024

8.6.7 BE120 – BE122 (load ranges R, S, D)



9007221974811147

$n_{EmergStop}$	BE120			BE122		
min^{-1}	Load range R	Load range S	Load range D	Load range R	Load range S	Load range D
	$W_{per,n}$ /J					
750	26400	103000	260000	39700	154000	364000
900	26400	103000	260000	39700	154000	364000
1000	26400	103000	260000	39700	154000	364000
1100	24000	93600	260000	36200	140000	364000
1200	22100	85800	260000	33200	128000	364000
1300	20400	79200	240000	30700	119000	336000
1400	19000	73600	223000	28600	110000	312000
1500	17700	68700	208000	26700	103000	291000
1600	16700	64400	195000	25100	96300	273000
1700	15700	60600	184000	23700	90600	257000
1800	14800	57200	173000	22400	85600	243000

31550835/EN – 08/2024

8.7 Permitted braking work for service braking operations $W_{per,Z}$

The permitted braking work for service braking operations $W_{zul,Z}$ for BE.. brakes is specified below. Information is provided for all respective brake sizes in a common chart for different reference speeds.

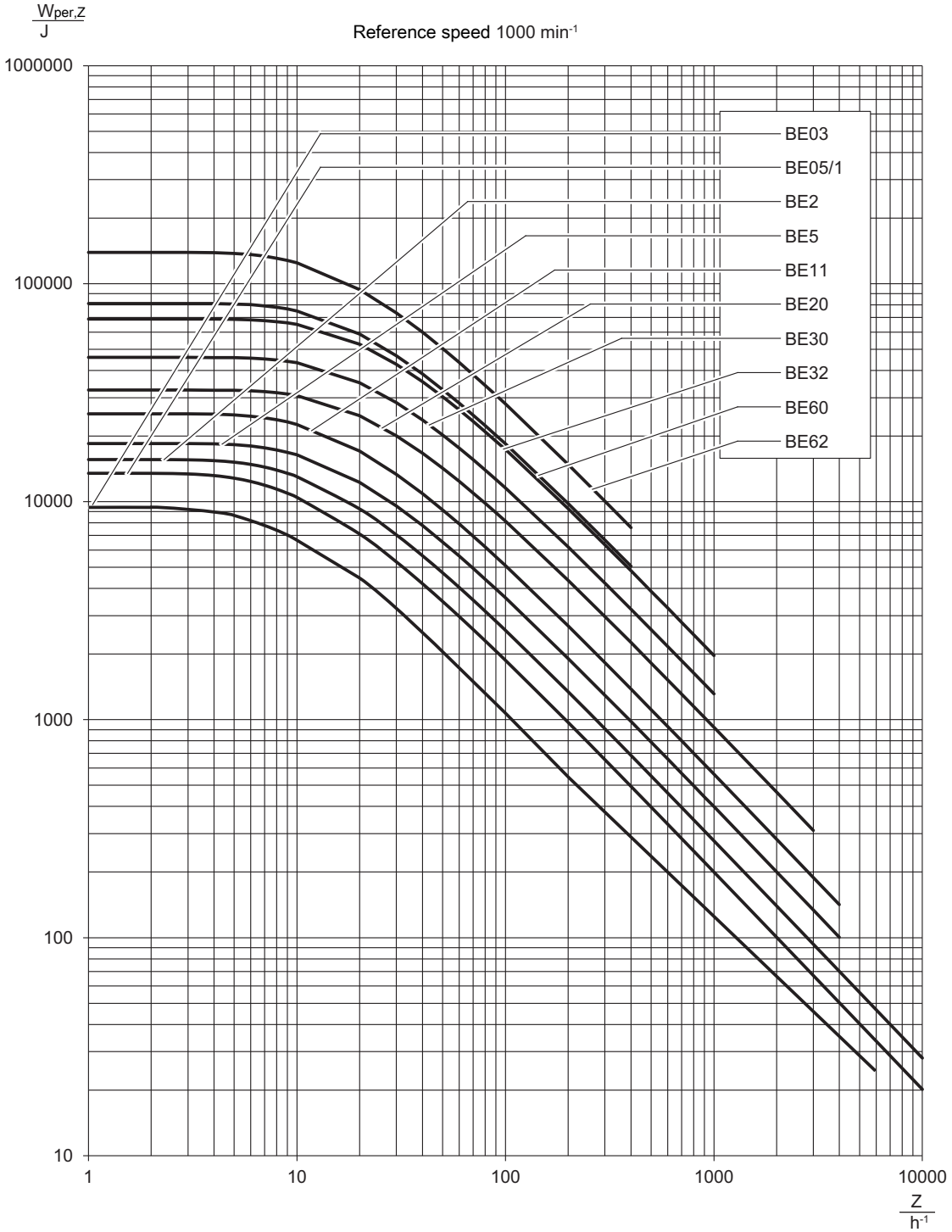
Load range	Reference speed min^{-1}	Application	Section
S	1000	Braking operation from operating speed with 6 motor poles, 50 Hz operation	(→ 🗎 126)
S	1200	Braking operation from operating speed with 6 motor poles, 60 Hz operation	(→ 🗎 127)
S	1500	Braking operation from operating speed with 4 motor poles, 50 Hz operation	(→ 🗎 128)
S	1800	Braking operation from operating speed with 4 motor poles, 60 Hz operation	(→ 🗎 129)
S	3000	Braking operation from operating speed with 2 motor poles, 50 Hz operation	(→ 🗎 130)
S	3600	Braking operation from operating speed with 2 motor poles, 60 Hz operation	(→ 🗎 131)
R	1500	Braking operation from operating speed with 4 motor poles, 50 Hz operation	(→ 🗎 132)
R	1800	Braking operation from operating speed with 4 motor poles, 60 Hz operation	(→ 🗎 133)

INFORMATION

- No standalone limit values are defined for braking operations of motors with ≥ 8 poles in load range S (50 Hz or 60 Hz). Use the chart of the 1000 min^{-1} reference speed for load range S.

31550835/EN – 08/2024

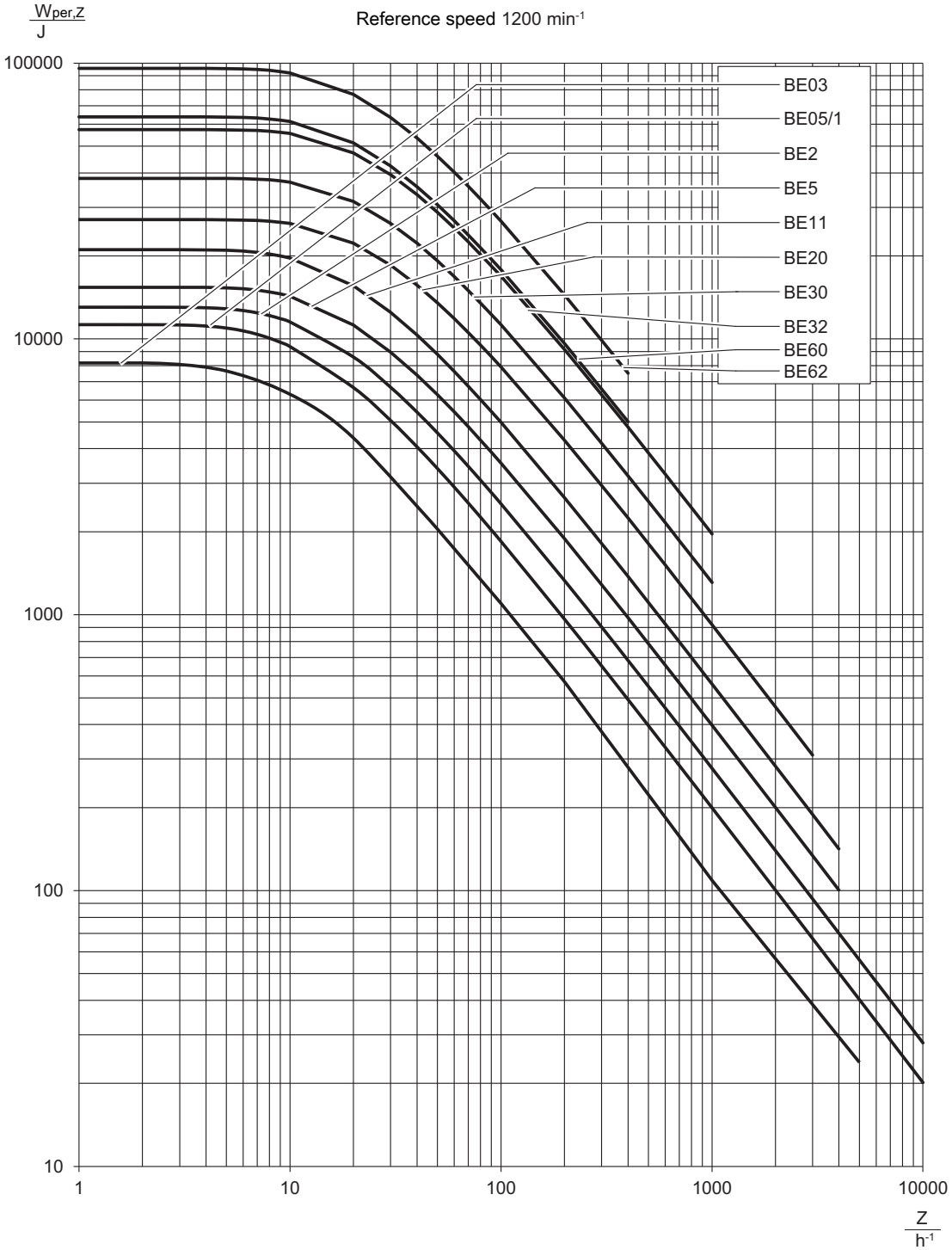
8.7.1 Braking operation from operating speed, load range S, 6 motor poles, 50 Hz



18014421240204427

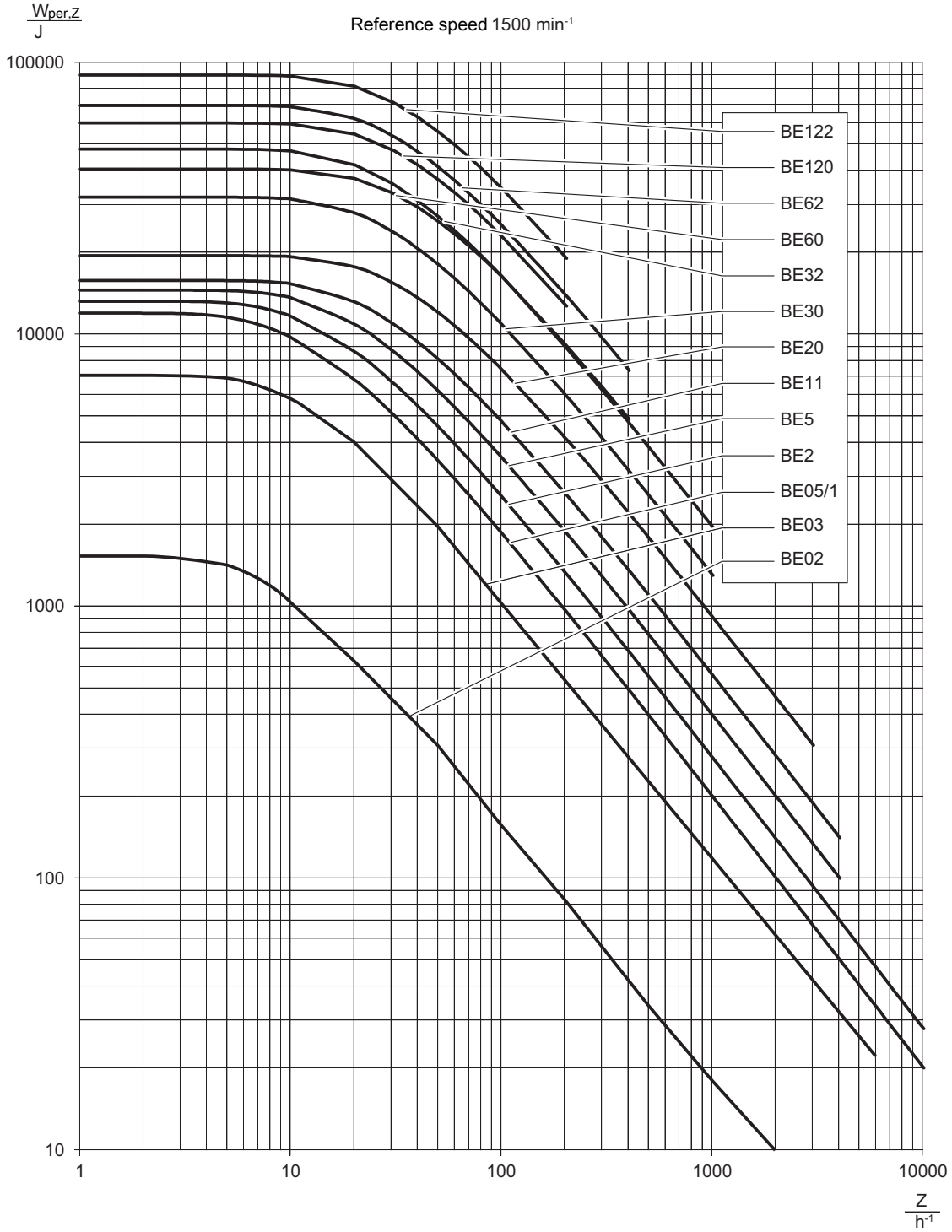
31550835/EN – 08/2024

8.7.2 Braking operation from operating speed, load range S, 6 motor poles, 60 Hz



18014421240207115

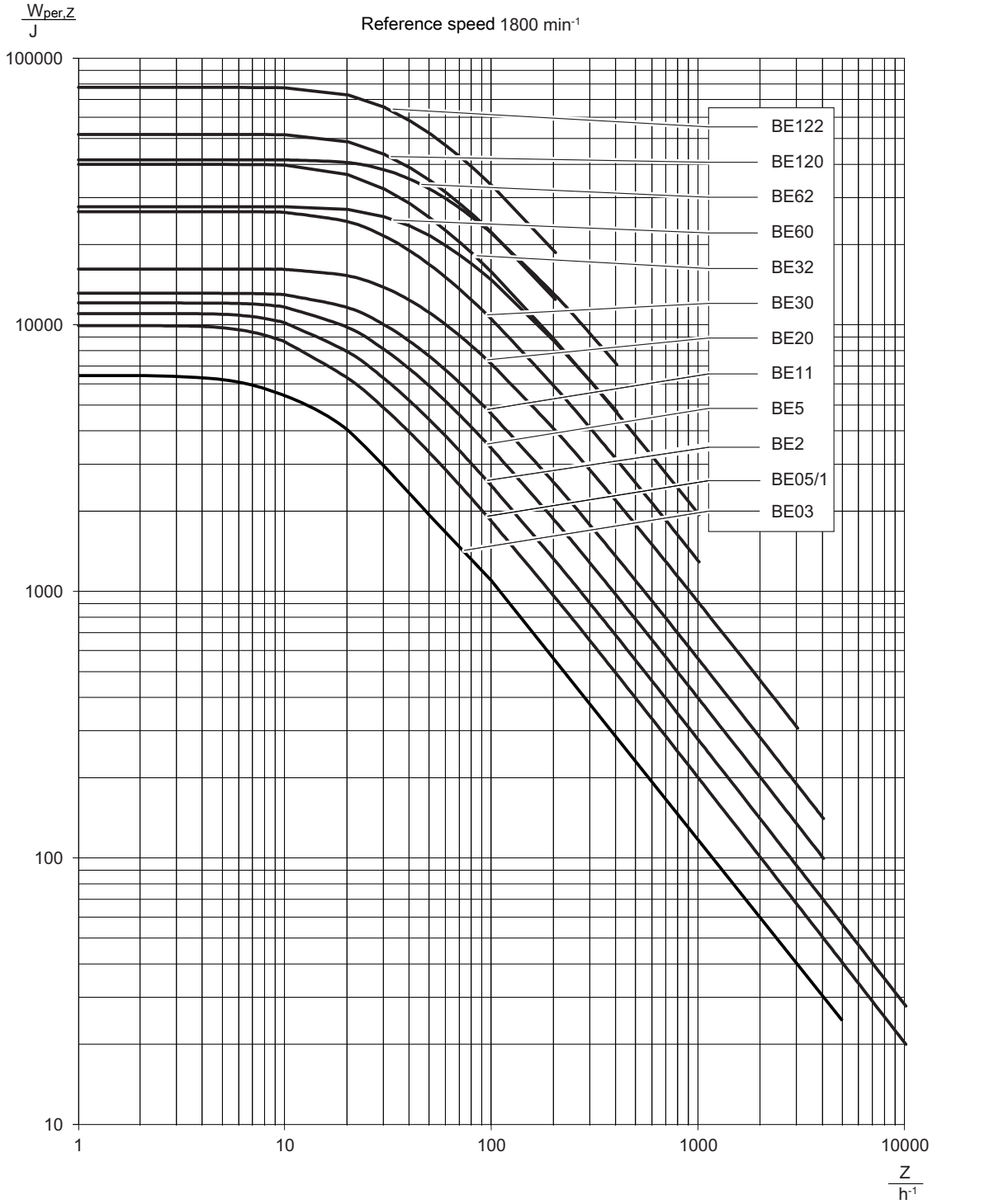
8.7.3 Braking operation from operating speed, load range S, 4 motor poles, 50 Hz



27021620494950795

31550835/EN – 08/2024

8.7.4 Braking operation from operating speed, load range S, 4 motor poles, 60 Hz

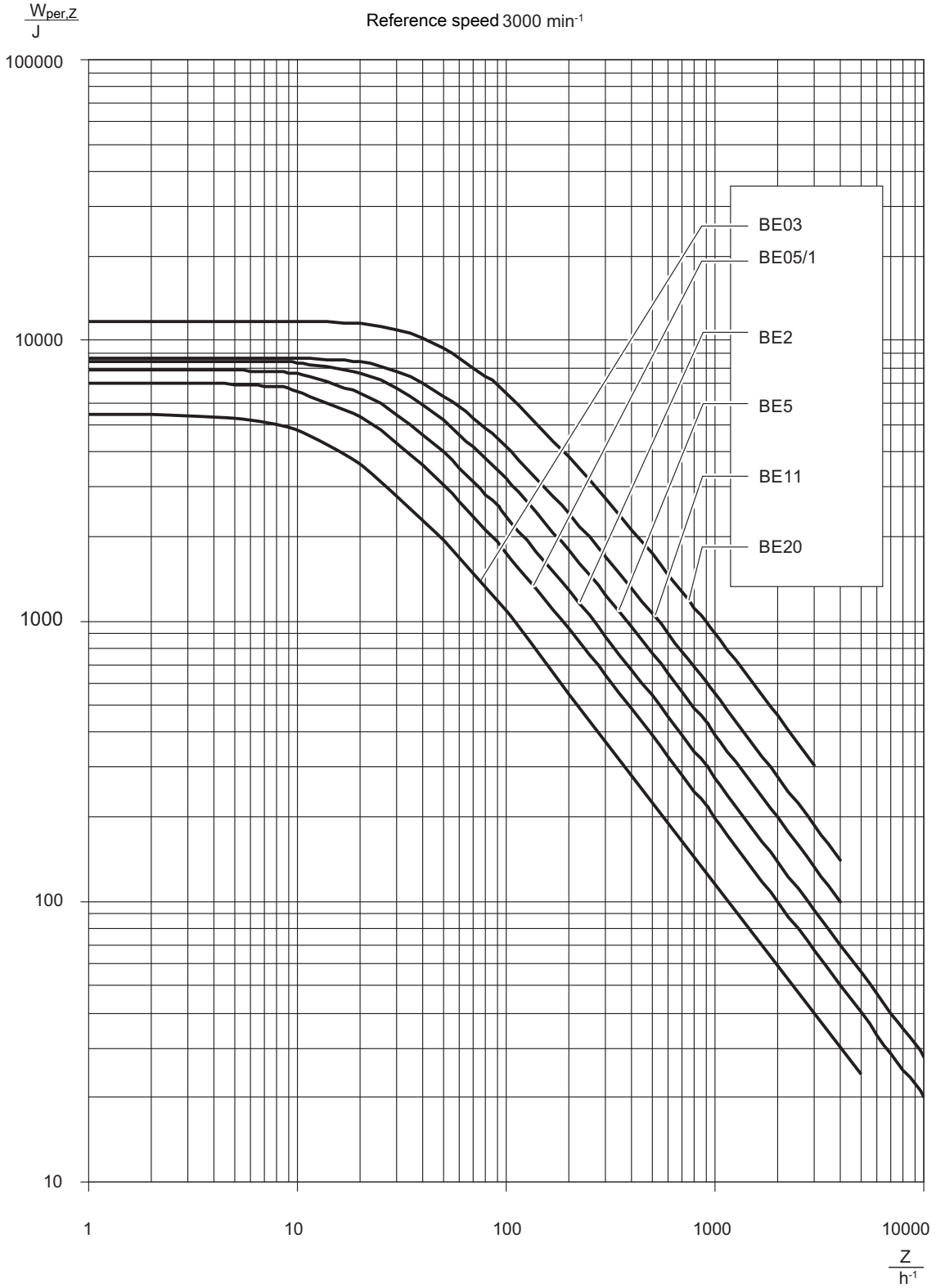


18014421240212491

8.7.5 Braking operation from operating speed, load range S, 2 motor poles, 50 Hz

INFORMATION

No braking operations are allowed for motors with 2 poles for brake sizes BE30 – BE122.

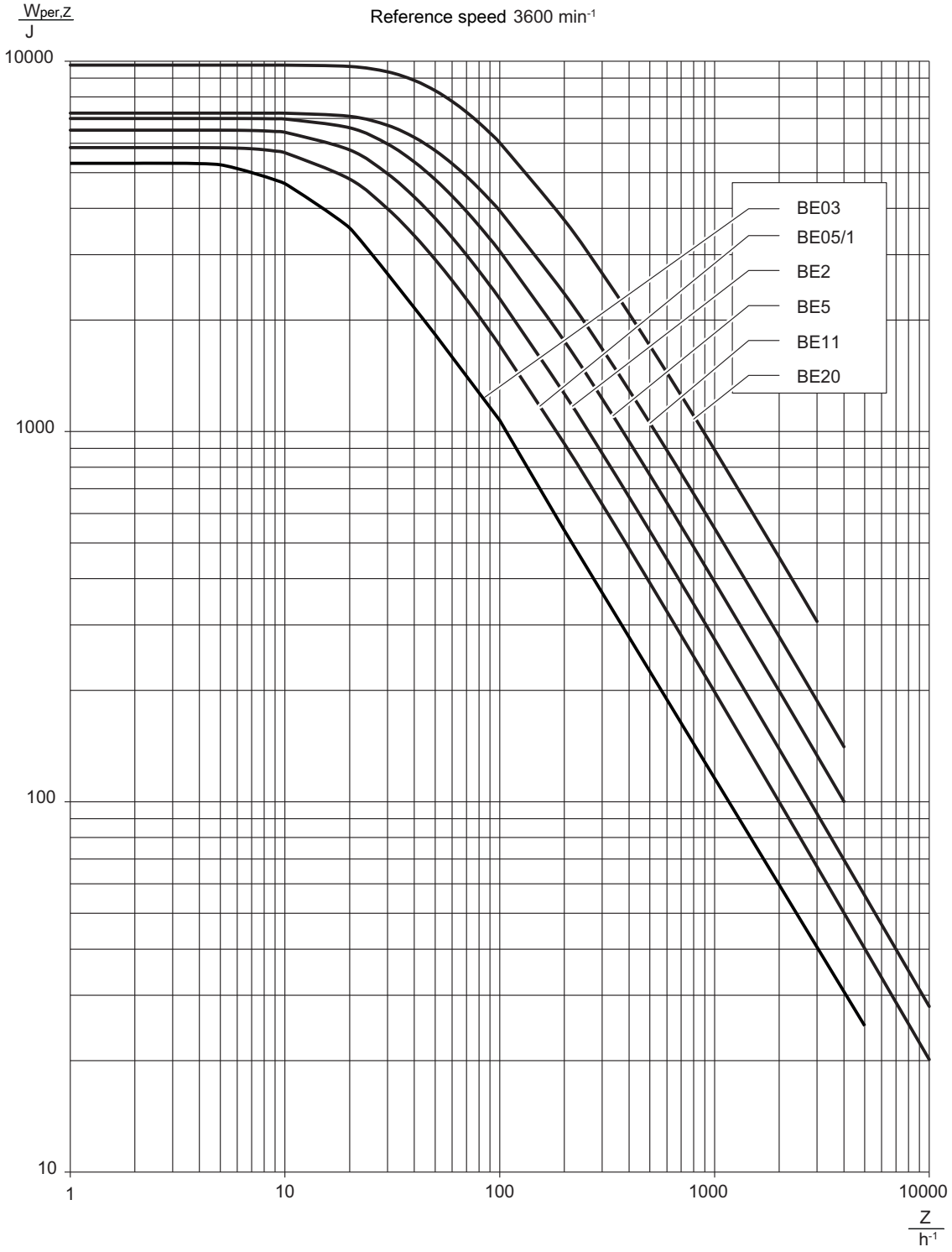


31550835/EN – 08/2024

8.7.6 Braking operation from operating speed, load range S, 2 motor poles, 60 Hz

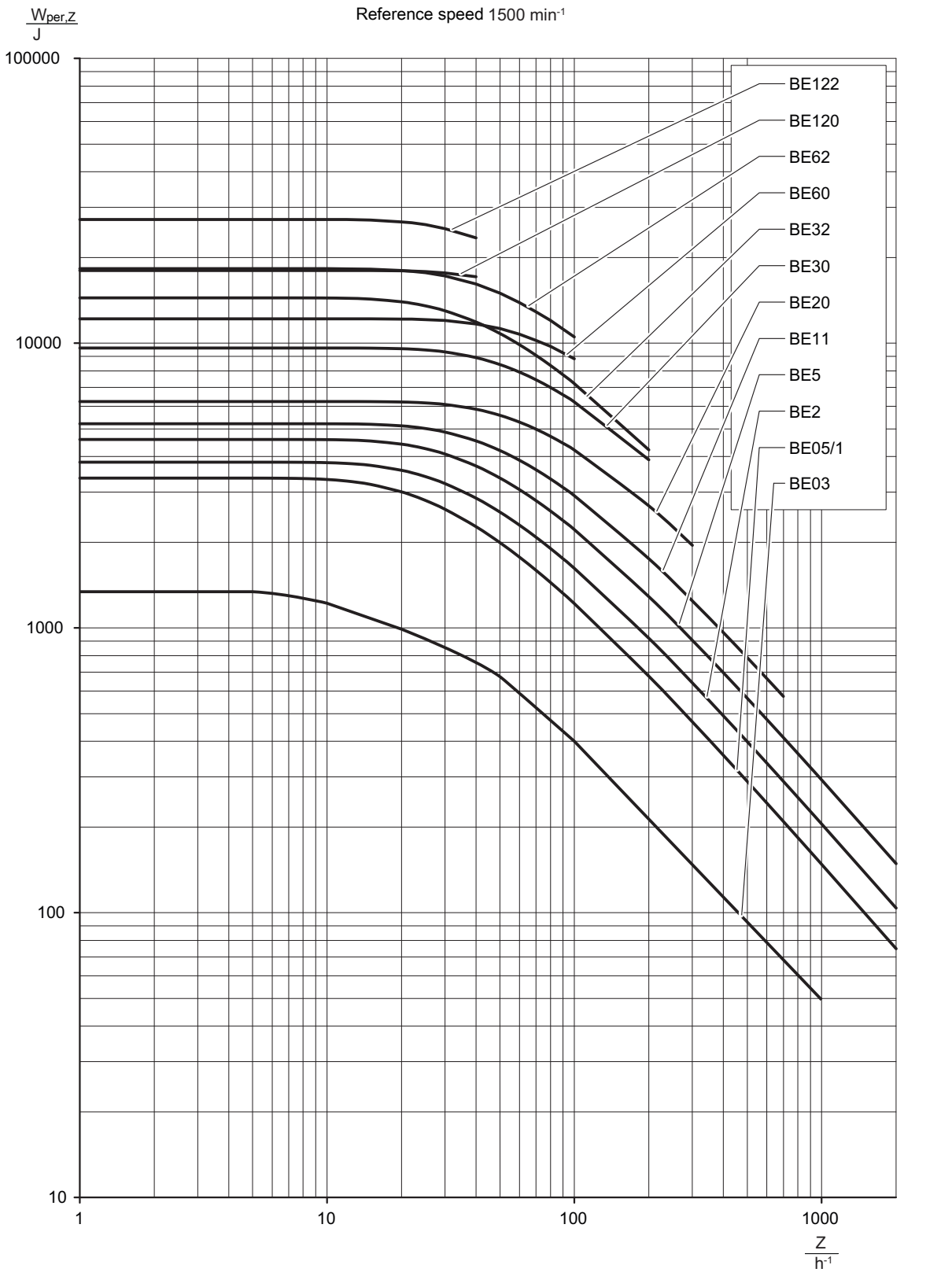
INFORMATION

No braking operations are allowed for motors with 2 poles for brake sizes BE30 – BE122.



31550835/EN – 08/2024

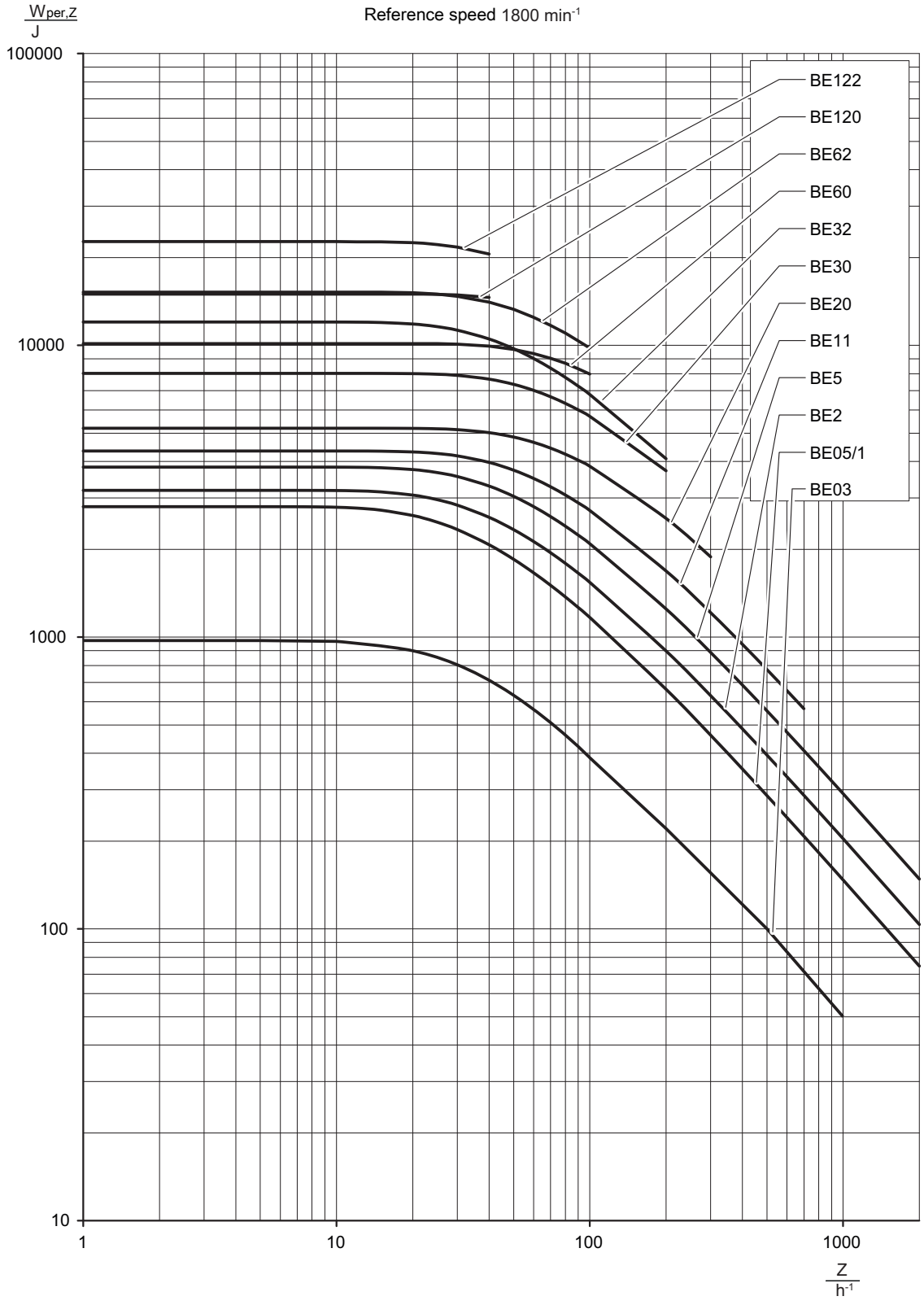
8.7.7 Braking operation from operating speed, load range R, 4 motor poles, 50 Hz



18014421240233355

31550835/EN – 08/2024

8.7.8 Braking operation from operating speed, load range R, 4 motor poles, 60 Hz



18014421240236043

8.8 Braking work until maintenance

When using a brake as safety brake, the braking work until maintenance is reduced according to the following table.

Brake size	**Braking work until maintenance (W_{insp}) × 10^6 J**			
FS code	–	**FS04/FS07**	**FS02**	**FS11**
	Brake	Brake in combination with safety encoder	Safety brake	Safety brake in combination with safety encoder
BE02	15	–	–	–
BE03	200	200	200	200
BE05	120	120	120	120
BE1	120	120	120	120
BE2	180	180	180	180
BE5	390	390	270	270
BE11	640	640	285	285
BE20	1000	1000	445	445
BE30	1500	1500	670	670
BE32	1500	1500	670	670
BE60	2500	2500	–	–
BE62	2500	2500	–	–
BE120	390	390	–	–
BE122	300	300	–	–

31550835/EN – 08/2024

8.9 Application of load ranges

Default values	BE.. brake as a holding brake		BE.. brake as a safety brake		BE.. brake as a working brake	
f_{Mmax} To calculate the minimum braking time and the maximum deceleration	1.5		1.5		1.5	
f_{Mmin} To calculate the maximum braking time and the maximum braking distance	Reduced	0.9	Reduced	0.9	Reduced	0.9
	Standard	0.9	Standard	0.9	Standard	0.9
	Overload A	0.9	Overload A	0.9	Overload A	-
	Overload B	0.8	Overload B	0.8	Overload B	-
	Overload C	0.7	Overload C	0.7	Overload C	-
	Overload D	0.6	Overload D	0.6	Overload D	-
	Overload H	0.7	Overload H	-	Overload H	-
f_V To calculate the number of permitted emergency stop braking operations until brake maintenance	Reduced	1	Reduced	1	Reduced	1
	Standard	1	Standard	1	Standard	1
	Overload A	1	Overload A	1	Overload A	-
	Overload B	10	Overload B	10	Overload B	-
	Overload C	50	Overload C	50	Overload C	-
	Overload D	100	Overload D	100	Overload D	-
	Overload H	100	Overload H	-	Overload H	-
X_B Calculation of the repeat accuracy of the braking distance in line operation	-		-		+/- 0.12	
Number of permitted emergency stop braking operations per hour	Reduced/ standard	10	Reduced/ standard	10	–	
	Overload A – H	5	Overload A – H	5		

INFORMATION

For brakes on **explosion-protected** motors, the factors for the "reduced" load range are always used according to project planning procedures.

31550835/EN – 08/2024

8.10 Output factor $f_{brake,output}$

The following table shows the drive factors $f_{brake,drive}$.

Output design	BE..
F..7, K..7, R..7, S..7, W..7	1
K..9, W.9	1
S..7p	1
Industrial gear units (all series)	1.5
Third-party gear unit	1.5
No gear unit (stand-alone motor)	1.5

8.11 Permitted cyclic duration factor and thermal breakpoint speed

The current values of the technical data and characteristic values used for project planning are compiled in this chapter.

The permitted cyclic duration factor of the brake cdf_{B_per} is shown relative to the speed and/or frequency and ambient temperature. Above the thermal breakpoint speed $n_{B_th_k}$ the permitted cyclic duration factor is 100%.

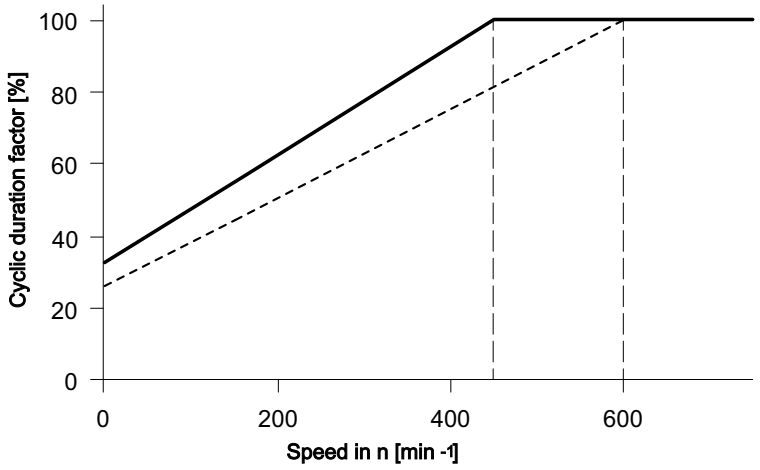
31550835/EN – 08/2024

8.11.1 BE03 – BE5 brake for explosion-protected motors

Thermal breakpoint speed $n_{B_th_k}$

Thermal breakpoint speed $n_{B_th_k}$ [min^{-1}]	
40 °C, 50 °C	**60 °C**
450	600

Permitted cyclic duration factor cdf_{B_per}



35732107915

Permitted cyclic duration factor cdf_{B_per} at 40 °C
Permitted cyclic duration factor cdf_{B_per} at 60 °C
Thermal breakpoint speed $n_{B_th_k}$

Speed n in min^{-1}	Frequency f in Hz	Permitted cyclic duration factor cdf_{B_per} in %	
		40 °C, 50 °C	**60 °C**
0	0	30	25
75	2.5	42	34
150	5	53	44
225	7.5	65	53
300	10	77	63
375	12.5	88	72
450	15	100	81
525	17.5	100	91
≥ 600	20	100	100

Nameplate data

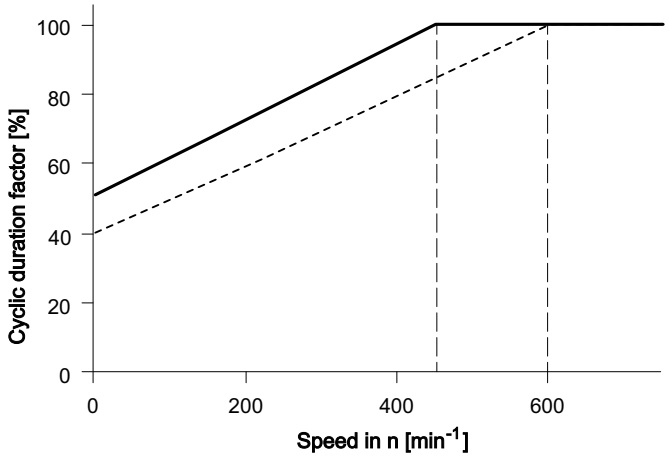
VFC operating data				VFCe operating data			
40 °C, 50 °C		**60 °C**		**40 °C, 50 °C**		**60 °C**	
f in Hz	**cdf_{max} in %**	**f in Hz**	**cdf_{max} in %**	**f in Hz**	**cdf_{max} in %**	**f in Hz**	**cdf_{max} in %**
< 15	50	< 20	45	< 15	30	< 20	25

8.11.2 BE11 – BE32 brake for explosion-protected motors

Thermal breakpoint speed $n_{B_th_k}$

Thermal breakpoint speed $n_{B_th_k}$ [min^{-1}]	
40 °C, 50 °C	**60 °C**
450	600

Permitted cyclic duration factor cdf_{B_per}



35732418059

Permitted cyclic duration factor cdf_{B_per} at 40 °C
Permitted cyclic duration factor cdf_{B_per} at 60 °C
Thermal breakpoint speed $n_{B_th_k}$

Speed n in min^{-1}	Frequency f in Hz	Permitted cyclic duration factor cdf_{B_per} in %	
		40 °C, 50 °C	**60 °C**
0	0	50	40
75	2.5	58	48
150	5	67	55
225	7.5	75	63
300	10	83	70
375	12.5	92	78
450	15	100	85
525	17.5	100	93
≥ 600	20	100	100

Nameplate data

VFC operating data				VFCe operating data			
40 °C, 50 °C		**60 °C**		**40 °C, 50 °C**		**60 °C**	
f in Hz	**cdf_{max} in %**	**f in Hz**	**cdf_{max} in %**	**f in Hz**	**cdf_{max} in %**	**f in Hz**	**cdf_{max} in %**
< 15	65	< 20	55	< 15	50	< 20	40

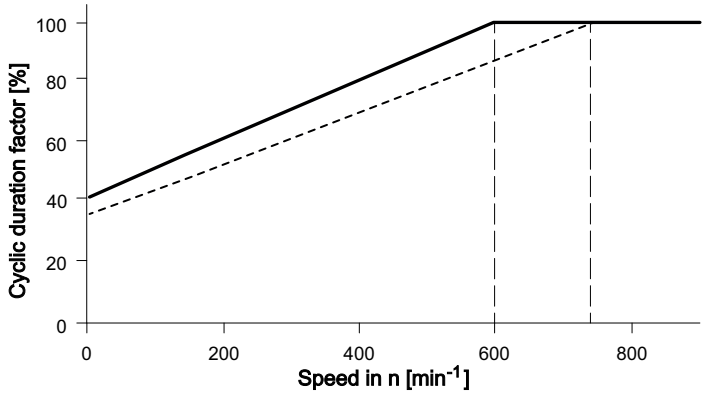
31550835/EN – 08/2024

8.11.3 BE60 – BE122 brake for explosion-protected motors

Thermal breakpoint speed $n_{B_th_k}$

Thermal breakpoint speed $n_{B_th_k}$ in min^{-1}	
40 °C, 50 °C	**60 °C**
600	750

Permitted cyclic duration factor cdf_{B_per}



35732421003

Permitted cyclic duration factor cdf_{B_per} at 40 °C
Permitted cyclic duration factor cdf_{B_per} at 60 °C
Thermal breakpoint speed $n_{B_th_k}$

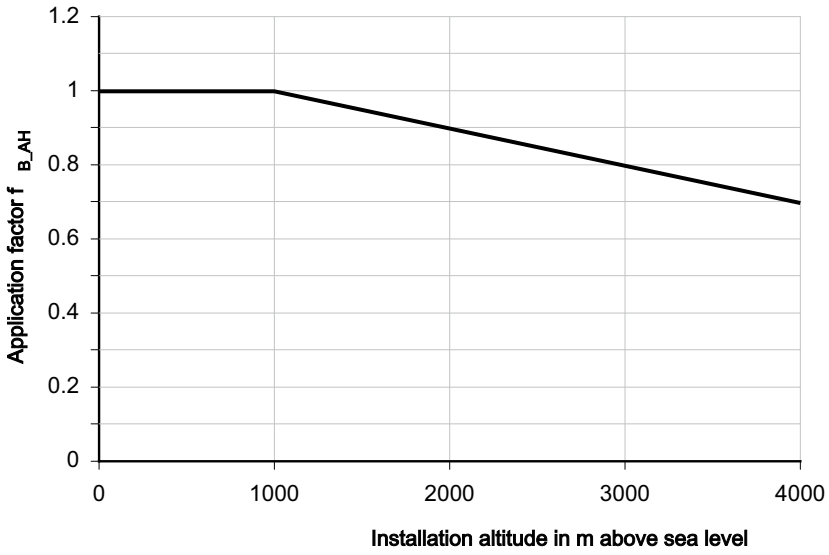
Speed n in min^{-1}	Frequency f in Hz	Permitted cyclic duration factor cdf_{B_per} in %	
		40 °C, 50 °C	**60 °C**
0	0	40	35
75	2.5	48	42
150	5	55	48
225	7.5	63	55
300	10	70	61
375	12.5	78	68
450	15	85	74
525	17.5	93	81
600	20	100	87
675	22.5	100	94
≥ 750	25	100	100

Nameplate data

VFC operating data			
40 °C, 50 °C		**60 °C**	
f in Hz	**cdf_{max} %**	**f in Hz**	**cdf_{max} in %**
< 20	55	< 25	45

31550835/EN – 08/2024

8.12 Application factor for installation altitude f_{B_AH}



9007238298141067

31550835/EN – 08/2024

8.13 Characteristic safety values

INFORMATION

In addition to the documentation, you can also obtain the characteristic safety values of components by SEW-EURODRIVE in the SEW-EURODRIVE library for the SISTEMA software tool. The documentation and the library are available for download from www.sew-eurodrive.de.

8.13.1 Characteristic safety values for BE.. brakes

The values specified in the following table apply to BE.. brakes in standard applications.

	Characteristic safety values according to EN ISO 13849-1	
Classification	Category B	
System structure	1-channel (Cat. B)	
$MTTF_d$ value	Calculation via B_{10D} value	
B_{10D} value	BE02	1.5×10^6
	BE03	20×10^6
	BE05	16×10^6
	BE1	12×10^6
	BE2	8×10^6
	BE5	6×10^6
	BE11	3×10^6
	BE20	2×10^6
	BE30	1.5×10^6
	BE32	1.5×10^6
	BE60	1×10^6
	BE62	1×10^6
	BE120	0.25×10^6
	BE122	0.25×10^6

SEW-EURODRIVE offers BE03 to BE32 brakes also as safety brakes. For more information, refer to the addendum to the operating instructions Safety Brakes – AC Motors DR.., DRN.., DRU.., DR2.., EDR.., EDRN.. – Functional Safety".

31550835/EN – 08/2024

8.13.2 Characteristic safety values for BE.. safety brake

	Characteristic safety values in accordance with EN ISO 13849-1	
Classification	Category 1	
System structure	1-channel (Cat. 1)	
Operating mode	High demand	
Safe state	The brake is applied	
Safety sub-functions	Safe brake actuation (SBA)	
	Safe brake hold (SBH)	
Service life	20 years or T_{10d} value (depending on which value occurs first)	
T_{10D}-value	0.1 × $MTTF_D$	
$MTTF_d$ value	Calculation via B_{10D} value	
B_{10D} value	BE03	$24×10^6$
	BE05	$20×10^6$
	BE1	$16×10^6$
	BE2	$12×10^6$
	BE5	$10×10^6$
	BE11	$8×10^6$
	BE20	$5×10^6$
	BE30	$3×10^6$
	BE32	$3×10^6$

31550835/EN – 08/2024

9 Contacting SEW-EURODRIVE

You can find the worldwide contact data and locations on the **SEW-EURODRIVE website** via the following link or the QR code shown below.

https://www.sew-eurodrive.de/contacts-worldwide



31550835/EN – 08/2024

Index

A

ATEX 10, 16

B

BE.. brake
- Braking torque graduations 22
- Combinations and restrictions 24
- Description 13
- Motor combinations. 21
- Motor/brake assignment 21
- Operating currents 103
- Pulse frequencies of the BE brake 108

BE.. brake for explosion-protected motors
- Comparing the designs 18
- Differences from BE.. brake 17
- Features 16

Brake
- Basic structure 19
- Function 19

Braking torque graduations 22
Braking work until maintenance 134

C

Calculation formulas
- BE.. as a holding brake for explosion-protected motors 75
- BE.. brake and BE.. safety brake as a holding brake 65
- BE.. brake as a working brake 53
- Mechanical project planning 91

Calculation rules
- Nominal coil power 104
- Nominal operating currents 104

Configuration example 92
Copyright notice 5

D

Definition
- FRaEmergOff 42
- MaEmergOff 42

E

Emergency stop 12
Emergency stop braking operations
- Until end of service life 44

End of service life 44
Explosion protection 10
- ATEX 10
- Available brakes 11
- HazLoc-NA® 10
- IECEx 10

F

Formula symbol
- Mechanical project planning 32
- Thermal project planning 80

FRaEmergOff 42

G

Emergency stop braking operations 44

H

HazLoc-NA® 10, 16
Holding brake 12

I

IECEx 10, 16

K

Key
- Mechanical project planning 32

L

Legend
- Thermal project planning 80

Limit speeds 39
Line operation 81
Load ranges
- Application 135
- Assignment 41
- For horizontal and vertical applications 40

M

MaEmergOff 42
Maintenance interval 43
Motor/brake assignment 21

N

No-load starting frequency 38
Nominal coil power 104
Nominal operating currents 104

31550835/EN – 08/24

SEW EURODRIVE

O

Output factor, design-dependent 42

P

Permitted switching frequency of the motor 58
Possible combinations
- Frequency inverter 31
- Gear unit 30
- Motors and motor options 25

Product names 5
Project planning 9
Project planning measures
- BE.. brake as a holding brake for explosion-protected motors 47
- BE.. brake as a working brake 45
- BE.. brake as a working brake for explosion-protected motors 45
- BE.. brakes and BE.. safety brakes as a holding brake 46

Project planning procedure
- BE.. as a holding brake for explosion-protected motors 72
- BE.. brake and BE.. safety brake as a holding brake 62
- BE.. brake as a working brake 50
- Thermal project planning 90

S

Safety brake 12, 16
SBA (Safe Brake Actuation) 16
SBH (Safe Brake Hold) 16
SBS 16
SEW-Workbench 49, 61, 71
Switching frequency 58
Switching intervals 110

T

Technical data of the BE brake
- Operating currents of the BE.. brake. 103
- Pulse frequencies of the BE brake 108

Test torque 99
Trademarks 5

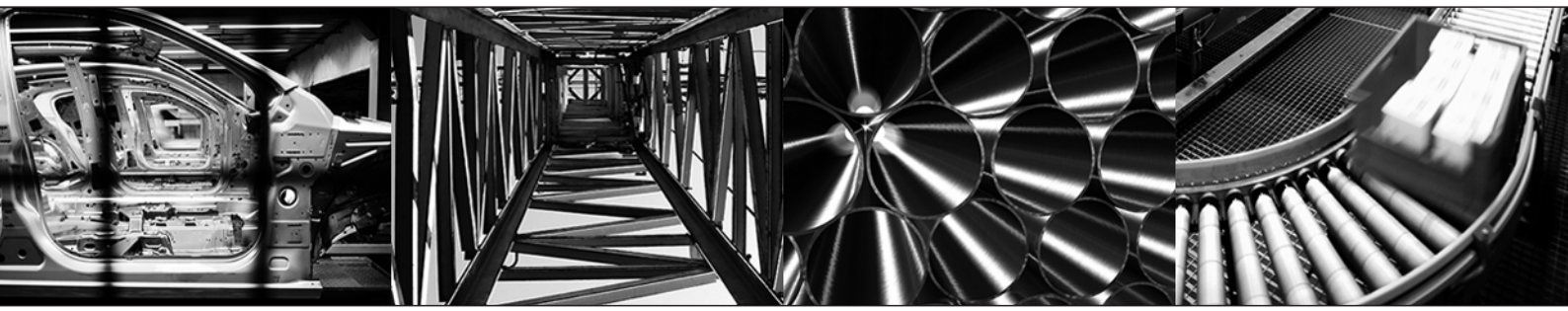
V

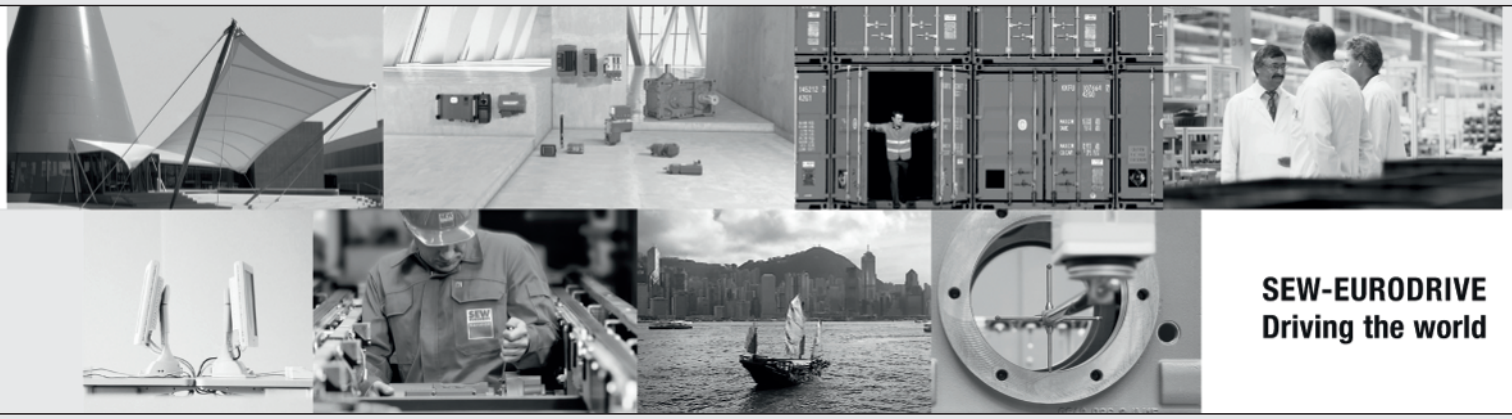
Vertical rotary table 49, 61, 71

W

Wear factors 43
Winder 61, 71
Working brake 12

31550835/EN – 08/24





SEW-EURODRIVE
Driving the world

SEW-EURODRIVE GmbH & Co KG
Ernst-Blickle-Str. 42
76646 BRUCHSAL
GERMANY
Tel. +49 7251 75-0
Fax +49 7251 75-1970
sew@sew-eurodrive.com
➞ **www.sew-eurodrive.com**