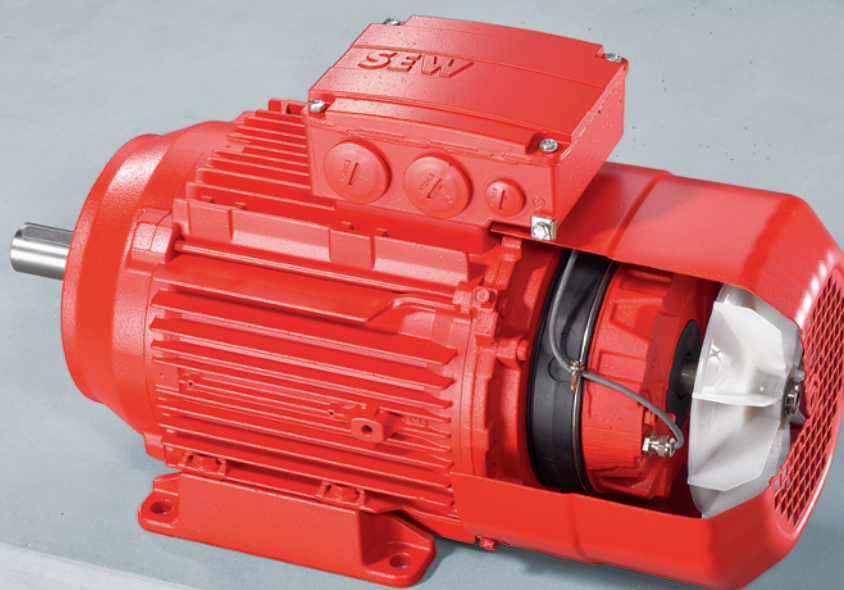




Manual



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

Project Planning for BE.. Brakes

Working brake/holding brake/safety brake



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1 General information

1.1 Contents and purpose of this documentation

This manual describes the dimensioning of the following brakes:

- BE.. brake
- BE.. brake for explosion-protected motors
- BE.H holding brake with increased braking torque
- BE.. safety brake
- BE.. safety brake for explosion-protected motors

The project planning procedures described apply to the listed brakes in combination with the associated motor series.

Make sure you always use the latest edition of the documentation. The SEW-EURODRIVE website (www.sew-eurodrive.com) provides a broad selection of technical documentation downloads in various languages. You can also order printed copies of the 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

All brake data required for project planning can be found in this manual. Refer to the following SEW-EURODRIVE catalogs for the required gear unit and motor data:

- DRN63 – 315, DR2S56 – 225, DR2L71 – 225 AC motors
- DR.71 – 315, DT56, DR63 AC motors
- DRN.. gearmotors (IE3)
- DRE.. gearmotors (IE2)
- DRS../DR2S.. gearmotors (IE1)
- Asynchronous servo gearmotors
- Explosion-protected AC motors
- Explosion-protected drives
- DRC2.. AC motor
- DR2C..A gearmotors (IE5)
- DR2C..U gearmotors (IE5)

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

1.3 Rights to claim under limited warranty

Read the information in this documentation. This is essential for fault-free operation and fulfillment of any rights to claim under limited warranty. Read the documentation before you start working with the product.

1.4 Product names and trademarks

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

1.5 Decimal separator in numerical values

In this document, a period is used to indicate the decimal separator.

Example: 30.5 kg

1.6 Copyright notice

© 2026 SEW-EURODRIVE. All rights reserved. Copyright law prohibits the unauthorized reproduction, modification, distribution, and use of this document – in whole or in part.

1.7 Recycling, reprocessing, reuse

When manufacturing products, SEW-EURODRIVE makes sure to keep the use of new natural resources to a minimum in the interests of the circular economy. Key aspects here are the recycling of materials as well as the inspection and/or processing of returned components and their reuse in new products. These processes are only used at SEW-EURODRIVE if the resulting materials and components correspond to the quality of new products.

1.8 General Terms and Conditions (T&Cs)

You can find an overview of SEW-EURODRIVE's General Terms and Conditions (GTC) under the following links.

- [General Terms and Conditions \(GTC\) in German](#)
- [General Terms and Conditions \(GTC\) in English](#)

For transactions with customers and suppliers of subsidiaries and representatives of SEW-EURODRIVE outside Germany, the respective local terms and conditions, including delivery conditions, shall apply.

- [SEW-EURODRIVE worldwide in German](#)
- [SEW-EURODRIVE worldwide in English](#)

2 Functional safety (FS)

2.1 Functionally safe motor options

Motors from SEW-EURODRIVE are also available with the following functionally safe motor options:

- Safety brake
- Safety encoder
- Integrated STO (decentralized inverters)

Functionally safe motor options are designed for implementing safety functions.

SEW-EURODRIVE assumes responsibility for the delivered motor 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 designed with a manipulation indicator and marked as follows:

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

If these markings are damaged, there is a deviation from the delivery state.

2.2 Safety brake

SEW-EURODRIVE safety brakes combine exceptional reliability with high electrical and mechanical durability.

Safety brakes allow you to increase the safety in your machines by implementing safety functions for deceleration and stopping. The safety brake represents the safety-relevant actuator in the intelligent interaction of sensor, control, and actuator.

The safety brakes cannot trigger a safe state at the machine autonomously. The brakes must be augmented in the overall system with suitable brake control and monitored by means of a brake test, if necessary. The overall system triggers a suitable fault response, e.g. the safe state, on request.

2.3 General information on functionally safe motor options

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.

2.4 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.

2.5 Retraceability

Functionally safe motor options can be retraced by SEW-EURODRIVE with the motor serial number and thus have a unique assignment to the motor.

If a safety encoder or safety brake is replaced by SEW-EURODRIVE Service, traceability is ensured.

If you replace a functionally safe motor option on your own, you revoke this assignment. To continue the assignment, document the replacement yourself.

2.6 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.

2.7 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.

2.8 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)

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.

2.9 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.

2.10 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.

2.11 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).

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).



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 Brakes for explosion-protected motors

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

Rule sets

Motor type	ATEX	IECEX	HazLoc-NA®
EDR..BE..	3D, 3GD	Not certified	CID2, CIID2, CICIID2
EDRN..BE..	3G, 3D, 3GD	3G-c, 3D-c, 3GD-c	

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

Temperature class, maximum surface temperature

Design	Operating mode	Brake control installation location	Temperature class (gas)	Max. surface temperature (dust)
3G(-c)	Line operation or FI operation	Control cabinet	T3 (200 °C)	–
3D(-c)		Control cabinet or terminal box	–	T120 °C or T140 °C
CID2	Line operation	Control cabinet	T3C (160 °C)	–
		Terminal box	T3B (165 °C)	–
	FI operation	Control cabinet or terminal box	T3 (200 °C)	–
CIID2	Line operation	Control cabinet or terminal box	–	T4A (120 °C)
	FI operation	Control cabinet or terminal box	–	T3C (160 °C)

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.

4 Product description

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. In addition, the brakes of the BE.. modular brake system can also be used in combination with the synchronous motors of the DR.. modular motor system (DR2C.., DRE..J, DRU..J).

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.. and BE.H brakes with increased holding torque 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 $< 20 \text{ min}^{-1}$.

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
- The BE.. and BE.H brakes with increased braking torque are only suitable for inverter-operated motors (controlled applications).
- Working brake or holding brake with emergency stop features in areas with a risk of explosion
- Safety brake in its function as a holding brake with emergency stop features in areas with a risk of explosion

4.2 General description

BE.. brakes of 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 of SEW-EURODRIVE are very short and robust. Furthermore, SEW-EURODRIVE brake-motors 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 if the current supply is interrupted. It is therefore suitable for basic safety requirements in travel and lifting 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.

The BE.H holding brake with increased braking torque is specially designed for motors that are only approved for inverter operation. These include the DR2C.. and DR2L.. motor types. These motors have a higher power density. The BE.H brakes are adapted to their power rating with regard to the braking torque.

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.

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

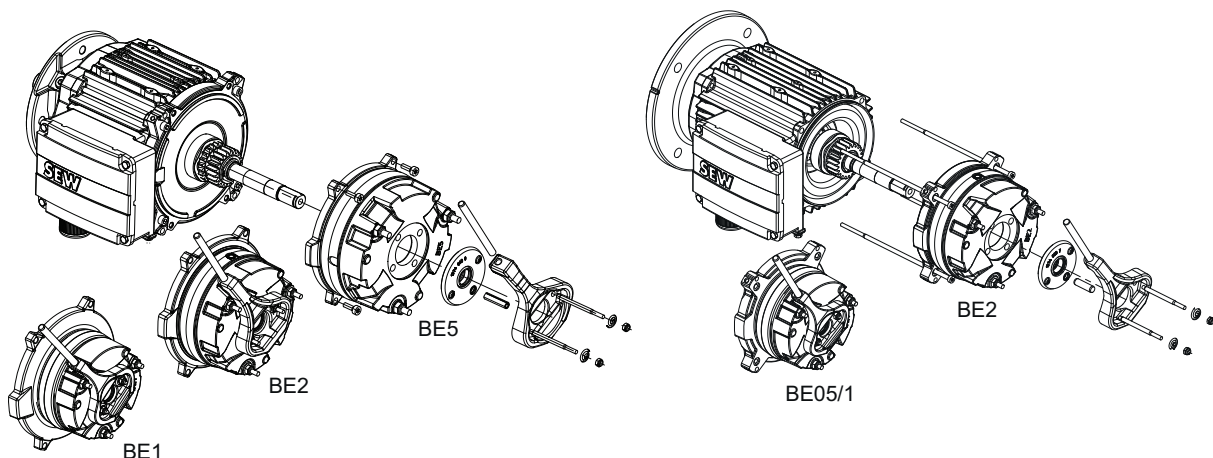
Brakes up to BE2 can optionally also be delivered for operation at an external DC voltage source without additional brake control.

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 to 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.



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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.

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 EDNR.. explosion-protected motors

With regard to the general design and the basic functional principle, the BE.. brakes for EDR.. and EDNR.. 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 EDNR.. explosion-protected brakemotors are available for the following rule sets:

- ATEX: Equipment categories 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..	EDNR..
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. < 0.75kW NEC500 C22.1	EDNR ≥ 0.75 kW NEC500 C22.1

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 II B T3 Gc II3G Ex ec II C T3 Gc II3D Ex tc II B T120°C Dc II3D Ex tc II C T120°C Dc II3D Ex tc II B T140°C Dc II3D Ex tc II C T140°C Dc	
IECEX	No brakemotor available	Ex ec II B T3 Gc Ex ec II C T3 Gc Ex tc II B T120°C Dc Ex tc II C T120°C Dc Ex tc II B T140°C Dc Ex tc II C 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

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.

Application	BE.. brake		BE.. brake for explosion-protected motors
	Working brake and holding brake	Working brake (HazLoc-NA®) ¹⁾	Working brake (ATEX, IECEx) and 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
	BGE	5800 h ⁻¹	1200 h ⁻¹
Maximum braking work of working brake at brake application speed	1500 min ⁻¹ : 13260 J	1800 min ⁻¹ : 3432 J	1500 min ⁻¹ : 3822 J
Maximum braking work of holding brake at 1800 min ⁻¹	10400 J	—	3360 J

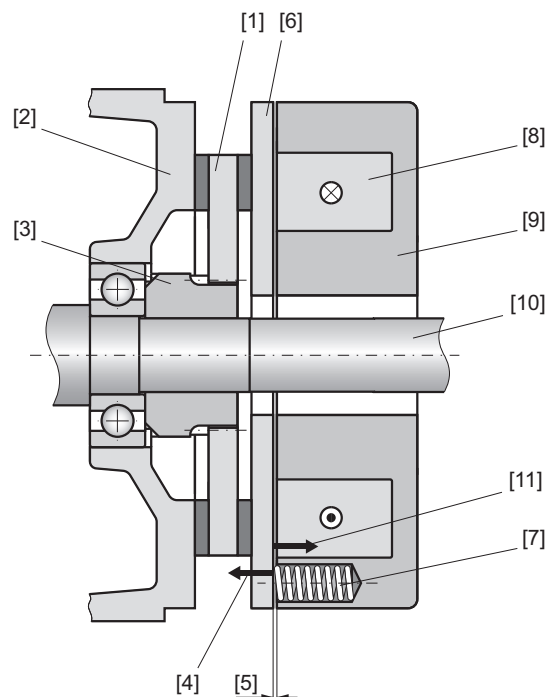
1) Observe the reduced values for the no-load starting frequency and for the maximum braking work.

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.



9007203239898251

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

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 final testing in the factory at SEW-EURODRIVE within the scope of quality inspection and is within a tolerance range of -10% and +50% in the delivery state.

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

That is why the characteristic values M_1 and M_4 are not relevant during project planning and the selection process of the brake.

Note: 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 of M_B .

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

5 Selection tables for brakes

5.1 Motor combinations with BE.. brake

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

DRN.., DRU.., and 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.

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

DR.., EDR..	–	–	71	80	–	90 100	112 132	160	180	200 225	250 280	315
DRN.., EDRN.., DRU.., DR2..	56	63	71	80	90	100	112 132S	132M 132L	160 180	200 225	250 280	315
BE02	✓											
BE03		✓	✓									
BE05			✓	✓	✓							
BE1			✓	✓	✓	✓						
BE1H			✓									
BE2				✓	✓	✓						
BE2H				✓								
BE5					✓	✓	✓					
BE11							✓	✓				
BE20								✓	✓			
BE30									✓	✓		
BE32									✓	✓		
BE60										✓	✓	
BE62										✓	✓	
BE120											✓	✓
BE122											✓	✓

✓ Combination available

✓ Combination available, optionally as safety brake

5.2 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	BE1H 14 Nm	BE2 20 Nm	BE2H 28 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					✓ ²⁾	✓		✓		
20						✓		✓	✓	
28							✓ ²⁾	✓	✓	
40								✓	✓	✓
55								✓	✓	✓
80									✓	✓
110									✓	✓
150										✓
200										✓

1) Not available for BE.. safety brakes.

2) Braking torque is only available as holding torque.

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	✓	✓				

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)
150	✓	✓				
200	✓	✓	✓			
300	✓	✓	✓			
400		✓	✓	✓	✓	
500		✓	✓			
600		✓	✓	✓	✓	
800				✓	✓	✓
1000				✓	✓	
1200				✓		✓
1600						✓
2000						✓

✓ Available

✓ Not available for EDR.., EDRN.. motors according to HazLoc-NA® (inverter operation), ATEX and IECEX

Note that there may be limitations for the selectable braking torques M_B 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.

5.3 Comparing the characteristics and restrictions

5.3.1 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
- Holding brake with increased braking torque for inverter-operated motors

Brake	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
Available sizes	BE02 – BE122	BE03 – BE32	BE03 – BE122	BE03 – BE32	BE1H, BE2H
Use	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	Holding brake with emergency stop function
Safety architecture, category (EN ISO 13849-1)	B	1	B	1	B

Brake options	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
Manual brake release	/HR or /HF	/HR	/HR or /HF	/HR	/HR or /HF
Condition monitoring Brake	BE1 – BE122: /DUE ¹⁾ BE2 – BE122: /DUB ²⁾	BE1 – BE32: /DUE ¹⁾ BE2 – BE32: /DUB ²⁾	–	–	BE1H - BE2H: /DUE ¹⁾

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	BE.H holding brake for inverter-operated motors
Installation in terminal box	✓	✓	Available to a limited degree	Available to a limited degree	Available only for external control
Installation in the control cabinet	✓	✓	✓	✓	✓
Voltage supply from the motor terminal board	Available to a limited degree	–	Available to a limited degree	–	–
Direct DC voltage supply	Available for BE02 – BE2 On request for BE5 – BE11	–	Available for BE03 – BE2	–	✓
Integrated brake control for MOVILINK® DDI	Available for BE03 – BE62	–	–	–	–

✓ Available
– Not available

5.3.2 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	BE.H holding brake for inverter-operated motors
Available motor series	DRS.., DRE.., DRN.., DRU.., DRL.., DRM.., DRK.., DR..J (LSPM), DR2C..	DRS.., DRE.., DRN.., DRU.., DRL.., DR2S.., DR2L.., DR2C..	EDRS.., EDRE.., EDRN..	EDRS.., EDRN..	DR2C..A., DR2L..
Number of poles	All	2, 4, 6 ¹⁾	4	4	4, 6

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

Installation and ambient conditions	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
Ambient temperature of -20 °C to +40 °C	✓	✓	✓	✓	✓
Additional ambient temperatures up to -40 °C or +100 °C	Available to a limited degree	–	Available to a limited degree up to +60 °C	–	Available to a limited degree
Installation altitude < 1000 m above sea level	✓	✓	✓	✓	✓
Installation altitude > 1000 m above sea level	✓	–	Available to a limited degree up to +60 °C	–	✓

Output designs ¹⁾	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
F.A/F.B Universal foot-mounted design	✓	Available to a limited degree	✓	Available to a limited degree	✓
/FI IEC foot-mounted motor with specification of the shaft height	✓	Available to a limited degree	✓	Available to a limited degree	✓
/FG 7-series integral motor	✓	Available to a limited degree	✓	Available to a limited degree	✓

Output designs ¹⁾	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
/2W Second shaft end on the brakemotor	✓	Available to a limited degree	Available to a limited degree	Available to a limited degree	✓
/FF IEC flange-mounted motor with bore	✓	✓	✓	✓	✓
/FT IEC flange-mounted motor with threads	✓	✓	✓	✓	✓
/FL General flange-mounted motor (other than IEC)	✓	Available to a limited degree	✓	Available to a limited degree	✓
/FM 7-series integral motor with IEC feet, specification of shaft height, if necessary	✓	–	✓	–	✓
/FE IEC flange-mounted motor with bore and IEC feet, specification of the shaft height, if necessary	✓	Available to a limited degree	✓	Available to a limited degree	✓
/FY IEC flange-mounted motor with thread and IEC feet, specification of shaft height, if necessary	✓	✓	✓	✓	✓
/FK general flange-mounted motor (deviating from IEC) with feet, specification of shaft height, if necessary	✓	Available to a limited degree	✓	Available to a limited degree	✓

Output designs ¹⁾	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
/FC C-face flange-mounted motor; dimensions in inches	✓	–	Available for HazLoc-NA®	–	✓

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	BE.H holding brake for inverter-operated motors
/TF Temperature sensor (PTC thermistor or PTC resistor)	✓	✓ ¹⁾	Included as standard	✓ ¹⁾	✓
/TH Thermostat (bimetallic switch)	✓	✓	Available to a limited degree	–	✓
/Pt1 1 Pt100 sensor	✓	✓ ¹⁾	✓	✓ ¹⁾	✓
/Pt3 3 Pt100 sensors	✓	✓ ¹⁾	✓	✓ ¹⁾	✓
/PK 1 Pt1000 sensor	✓	✓ ¹⁾	✓	✓ ¹⁾	✓
/PI 1 Pt1000 sensor Motor protection for MOVILINK® DDI	✓	✓ ¹⁾	–	–	✓

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	BE.H holding brake for inverter-operated motors
/V or /VE Forced cooling fan	✓	✓	✓	✓	✓
/Z Additional flywheel mass (flywheel fan)	✓	Available to a limited degree	–	–	✓

Ventilation	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
/AL Metal fan	✓	✓	Included as standard with dust explosion protection	Included as standard with dust explosion protection	✓
/U or /OL Non-ventilated	✓	✓	–	–	✓
/C Canopy for the fan guard	✓	✓	✓	✓	✓
/LN Noise-reduced fan guard	✓	✓	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	BE.H holding brake for inverter-operated motors
IP54/55/65	✓	✓	✓	✓	✓
IP56/66	✓	✓	✓	✓	✓
Other degrees of protection	On request	–	–	–	On request

Bearing arrangement	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
/NS Relubrication device	✓	✓	✓	✓	✓
/ERF Reinforced bearing on A-side with roller bearing	✓	–	✓	–	✓
/NIB Insulated bearing B-side	✓	✓	✓	✓	✓
Preparation for accommodating SPM measuring nipples	✓	–	–	–	✓

Winding of the motor	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
Thermal class B	✓	✓	–	–	–
Thermal class F	✓	✓	✓	✓	✓
Thermal class H	✓	✓	–	–	–
Strip heater	✓	✓	Available to a limited degree	Available to a limited degree	✓
/RI Reinforced winding insulation	✓	✓	–	–	–
/RI2 Reinforced winding insulation with increased resistance against partial discharge	✓	✓	–	–	–

Motor connection	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
Terminal board design	✓	✓	Available to a limited degree	Available to a limited degree	✓
Spring-loaded terminals	✓	✓	✓	✓	✓
Connector	✓	✓	–	–	✓

Painting and corrosion protection	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated 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)	Standard: RAL 7031 Optional: - Special colors - Surface protection (OS) - ECO2
Corrosion protection (KS)	✓	✓	✓	✓	✓
/DH Condensation drain hole	✓	✓	–	–	✓

Encoder	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
Encoder or encoder mounting adapter	✓	Available	Available to a limited degree	Available to a limited degree	✓
Safety encoder	✓	✓	Available to a limited degree	Available to a limited degree	✓
Mounted third-party encoders	On request	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	BE.H holding brake for inverter-operated motors
/MSW MOVI-SWITCH®	✓	–	Available to a limited degree	–	–
/MM MOVIMOT®	✓	–	Available to a limited degree	–	–
/MMA MOVIMOT® advanced	✓	–	Available to a limited degree	–	✓
/MMF MOVIMOT® flexible	✓	–	Available to a limited degree	–	✓

MOVILINK® DDI	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
/DI Code → DI0x00 → with external brake control or /MMF	✓	Available to a limited degree	–	–	✓
/DI DI1x00 design with BS1Z brake control	–	–	–	–	–
/DI DI2x00 design with BG1Z brake control	✓	–	–	–	✓

✓ Available
– Not available

5.3.3 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	BE.H holding brake for inverter-operated motors
Helical gear unit	✓	RX, RXF, R27-R167, R27F-R87F, RF27-RF167, RZ27-RZ87	RX, RXF, R, R..F, RF, RZ, RM	RX, RXF, R27-R167, R27F-R87F, RF27-RF167, RZ27-RZ87	✓
Parallel-shaft helical gear units	✓	F, FA..B, FH..B, FV..B, FF, FAF, FHF, FVF, FA, FH, FV, FAZ, FHZ, FVZ	F, FA..B, FV..B, FF, FAF, FVF, FA, FV, FAZ, FVZ Available to a limited degree: FH..B, FHF, FH, FT, FHZ	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	✓	K, KA..B, KH..B, KV..B, KF, KAF, KHF, KVF, KA, KH, KV, KAZ, KHZ, KVZ	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	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 to a limited degree: S, SF, SAF, SHF, SA, SH, SAZ, SHZ	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	✓	W37/47, WF37/47, WAF37/47, WA37/47, WA37/47B, WH37/47B, WHF37/47, WH37/47, W.19 – W.59	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	W37/47, WF37/47, WAF37/47, WA37/47, WA37/47B Available to a limited degree: WH37/47, WH37/47B, WHF37/47	✓
Electrified mono-rail drive HS.., HW.., HK..	✓	–	–	–	✓

Gear unit options	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
/R reduced backlash	✓	✓	✓	✓	✓
/T with torque arm	✓	✓	✓	✓	✓
/G with rubber buffer	✓	✓	✓	✓	✓
/DUV condition monitoring	✓	✓	–	–	✓

Adapter	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
Adapter	AM.., AD.., AR.., AL.., AT.., AMS..	–	AM.., AM../RS AD.., AD../P, AD../RS, AD../ZR, AR.., AR../W, AR../WS, AL..,	–	AM.., AD.., AR.., AL.., AT.., AMS..

Variable-speed gear unit	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
VU/VZ VARIBLOC®	✓	–	✓	–	–
VARIMOT®	✓	–	✓	–	–

Other designs	BE.. brake	BE.. safety brake	BE.. brake for explosion-protected motors	BE.. safety brake for explosion-protected motors	BE.H holding brake for inverter-operated motors
Compound gear units	✓	–	✓	–	✓
IG mounting	✓	–	Available to a limited degree	–	✓

✓ Available
– Not available

5.3.4 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.

As holding brakes with emergency stop properties, BE..H brakes can only be operated on drives with a frequency inverter.

Note: In safety-relevant applications, further requirements might be required for brakes or BE.. safety brakes within the overall system. These requirements, e.g. safe torque off (STO), safe brake control (SBC), or a brake test, can restrict the selection of a suitable frequency inverter. Make sure that the frequency inverter is suitable for the requirements.

6 Mechanical project planning

6.1 Introduction of mechanical project planning

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. The following type of project planning differ in particular:

- Project planning for a BE.. brake as working brake, also for ATEX, IECEx, and HazLoc-NA®
- Project planning of a BE.., BE.H brake or a BE.. safety brake functioning as a holding brake for ATEX, IECEx, and HazLoc-NA®

Observe the relevant project planning procedure and the corresponding calculation formulas when selecting and dimensioning the brake.

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, contact the SEW-EURODRIVE contact person.

6.2 General information

6.2.1 Key to the mechanical project planning procedures

Formula symbol	Unit	Description	Source
a_{Bmax}	$m \times s^{-2}$	Maximum typical deceleration when braking	
d_0	mm	Diameter of the output shaft transmission element	Application
cdf	%	Relative cyclic duration factor	Motor project planning
f_{out}	—	Application factor for checking the brake functions "Hold" and "Brake"	• "Braking torques" (→ 44) • "Application factor f_A" (→ 107)
$f_{Brake, output}$	—	Design-dependent output factor	• "Design-dependent output factor $f_{brake, output}$" (→ 50) • "Output factor $f_{brake, output}$" (→ 135)
f_{Mmax}	—	Transmission element factor, braking torque, determination in relation to the used load range for braking work	• "Load ranges for horizontal and vertical applications" (→ 48) • "Load range-dependent calculation coefficients f_v, f_{Mmin}, f_{Mmax}" (→ 134)

Formula symbol	Unit	Description	Source
f_{Mmin}	—	Braking torque reduction factor, determination in relation to the used load range for braking work	"Load ranges for horizontal and vertical applications" (→ 48) "Load range-dependent calculation coefficients f_v, f_{Mmin}, f_{Mmax}" (→ 134)
f_{Notaus}	—	Factor for determining $M_{aNotaus}$ depending on the gear unit	"Design-dependent output factor $f_{brake,output}$ " (→ 50)
$F_{R,Brems}$	N	Resulting gear unit load due to the radial load generated	
F_{Ra}	N	Permitted overhung load on the output end for M_{amax} . Applies when the point of force application is at the center of the shaft end, or at the face end in the case of hollow shafts#	Product documentation
$F_{RaNotaus}$	N	Maximum permitted emergency off overhung load of the output shaft in combination with brake/BE.. safety brake. Applies when the point of force application is at the center of the shaft end, or at the face end in the case of hollow shafts.	- Product documentation "Design-dependent output factor $f_{brake,output}$" (→ 50)
F_{RP}	N	Emergency off lateral force	"Design-dependent output factor $f_{brake,output}$ " (→ 50)
f_v	—	Wear factor; determined based on the applied load range for braking work	"Load ranges for horizontal and vertical applications" (→ 48) "Load range-dependent calculation coefficients f_v, f_{Mmin}, f_{Mmax}" (→ 134)
f_z	—	Transmission element factor for the overhung load	Product documentation
i	—	Gear unit ratio	Product documentation
J_M	kgm ²	Mass moment of inertia of the motor (incl. mount-on components), based on the motor shaft	Product documentation
J_G	kgm ²	Mass moment of inertia of the gear unit, based on the motor shaft	Product documentation
J_L	kgm ²	Mass moment of inertia of the application, based on the motor shaft	Application
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

Formula symbol	Unit	Description	Source
$M_{aNotaus}$	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
$M_{brake, output}$	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. • Horizontal + vertical upward: The efficiency of the application and the gear unit are taken into account as unfavorable factors. • Vertical downwards: The efficiency of the application and the gear unit are taken into account as favorable factors.	
$M_{L,a}$	Nm	Static load torque value at the output shaft, efficiency not considered	Application
M_n	Nm	Nominal motor torque	Product documentation
M_p	Nm	Emergency off torque	"Design-dependent output factor $f_{brake, output}$ " (→ 50)
N_{B1}	–	Number of cycles until brake maintenance in working brake operation	
N_{B2}	–	Number of permitted emergency-stop braking operations until brake maintenance	
N_{B2max}	–	Number of permitted emergency stop braking operations until end of service life	"Consideration of mechanical service life limits" (→ 53)
n_{brake}	min^{-1}	For testing the relevant, real brake application speed	
n_D	min^{-1}	Change in motor speed until brake application	
n_m	min^{-1}	Relevant speed of the application referenced to the motor shaft	Application
$n_{max,0}$	min^{-1}	Maximum permitted operating speed of the brakemotor	"Limit speeds for brakes" (→ 47) "Limit speeds $n_{max,0}$ and $n_{max,1}$" (→ 110)
$n_{max,1}$	min^{-1}	Maximum permitted speed for brake application depending on application	"Limit speeds for brakes" (→ 47) "Limit speeds $n_{max,0}$ and $n_{max,1}$" (→ 110)
n_{Nohalt}	min^{-1}	Real emergency stop speed relevant for check	
η_G	–	Gear unit efficiency	Product documentation
η_G'	–	Back-driving gear unit efficiency (for gear units with $\eta_G < 90\%$)	

Formula symbol	Unit	Description	Source
η_L	–	Efficiency of the application	Application
P_N	kW	Nominal power	Product documentation
P_{stat}	kW	Static power	Motor project planning
s_{Amax}	m	Maximum typical stopping distance	"Definition of terms" (→ 53)
s_{Bmax}	m	Maximum typical braking distance	"Definition of terms" (→ 53)
t_2	s	Brake application time. Depending on the brake connection type, use $t_{2,I}$ or $t_{2,II}$.	"Pulse frequencies" (→ 107) "Pulse frequencies of the brakes" (→ 46)
$t_{2,I}$	s	Brake application time for cut-off in the AC circuit (AC shutdown)	"Pulse frequencies" (→ 107) "Pulse frequencies of the brakes" (→ 46)
$t_{2,II}$	s	Brake application time for cut-off in the DC and AC circuit (AC/DC shutdown) as well as for DC-side disconnection (DC shutdown)	"Pulse frequencies" (→ 107) "Pulse frequencies of the brakes" (→ 46)
t_{Bmax}	s	Maximum typical braking time	
t_{Bmin}	s	Minimum typical braking time	
t_{signal}	s	System signal propagation 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 requested	Application
v_{Brake}	$m \times s^{-1}$	Real speed of the load or application when the service braking operation begins	
$v_{Nothalt}$	$m \times s^{-1}$	Real speed of the load or application when the emergency stop begins	
W_1	J	Maximum occurring braking work during emergency stop	
W_{tot}	J	Total braking work from all braking operations within the travel cycle	
W_{insp}	J	Permitted work until brake inspection	"Establishing the maintenance intervals" (→ 52) "Permitted braking work until maintenance" (→ 133)
W_{max}	J	Maximum braking work W_n from all braking operations (in cycles $n = 1, 2, 3, \dots, n$)	
W_n	J	Occurring braking work in normal braking operations (in cycles $n = 1, 2, 3, \dots, n$)	

Formula symbol	Unit	Description	Source
$W_{per,n}$	J	Maximum permitted braking work for emergency stop depending on the emergency stop speed	"Permitted emergency stop braking work $W_{per,n}$ " (→ 120)
$W_{per,Z}$	J	Permitted braking work depending on the number of braking operations per hour	"Permitted braking work for service braking operations $W_{per,Z}$ " (→ 111)
X_B	–	Repeat accuracy of the braking and stopping distance in line operation	"Load range-dependent calculation coefficients $f_v, f_{M-min}, f_{M-max}$ " (→ 134)
Z	h^{-1}	Required cycle switching frequency	Application
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)	"No-load starting frequency for holding brakes" (→ 46) "No-load starting frequency and switching intervals for holding brakes" (→ 109)
Z_{B1max}	h^{-1}	Maximum permitted emergency stop frequency of the brake in the selected load range	"Limit speeds for brakes" (→ 47)
Z_M	h^{-1}	Permitted switching frequency of the motor	
$Z_{M,n}$	h^{-1}	Permitted switching frequencies of the individual acceleration phases	
$Z_{M,cycle,per}$	h^{-1}	Permitted cycle switching frequency	

6.2.2 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, the brake moment 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 need to be examined and evaluated separately.

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

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

Application factor f_A

For BE.. series brakes, the application factor f_A is used to define the application's ratio of braking torque to load torque, which is important for ensuring proper brake function:

The factor indicates the ratio of the nominal braking torque M_B to the static load torque M_L in relation to the motor shaft.

By definition, the factor f_A always has values >1 and describes the following two limit states:

- The limit state required to reliably hold a static load at standstill.
- The limit state required to reliably bring a moving application with a defined dynamic load to a standstill.

The term "reliable" 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 mentioned in the project planning regulations and the operating instructions.

Note: The 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 seen as a binding dimensioning factor; in other words, functional failure can also begin to occur with values >1 .

If the actual values fall below the specified minimum values for f_A , the characteristic safety values B_{10D} no longer apply to the use case.

6.2.3 Hoist-like applications

In many applications, the weight must be overcome continuously to move a mass. In such an application, if the weight generates the significant part of the load torque on the motor shaft, it is a "hoist-like application". This applies regardless of the direction of movement.

When dimensioning brakes, this application characteristic is of great importance for the following aspects:

- **Selection of the braking torque**

Compliance with a minimum braking torque to ensure reliable holding and braking performance; see "Braking torques" (→ 44).

- **Type of shutdown**

Use of fast shutdown to limit the speed increase occurring during the response time and to achieve reproducible stopping distances, see "Pulse frequencies of the brakes" (→ 46) and "Basics of stopping distance and braking distance" (→ 53).

- **Limitation of permitted emergency-stop speed**

Avoidance of critical speeds that may impair friction coefficient stability during braking.

- **Limitation of the permitted load ranges/overload range**

Avoidance of high thermal loading of the friction system in order to maintain friction coefficient stability, see "Load ranges for horizontal and vertical applications" (→ 48).

The design procedures assume that "hoist-like applications" are to be evaluated using rules for the "vertical" direction of movement. In addition to the design procedures, the following notes must be observed:

- For **vertical applications with a counterweight**, it may be necessary – depending on the load situation – to calculate the upward travel after the downward travel has been completed, and vice versa.
- **Slewing gear drives with a non-vertical main axis** (horizontal or inclined axes) and eccentric load distributions (e.g. vertical rotary tables) must be evaluated as hoist-like applications.
- **Applications that are subject to external loads**, e.g. wind loads, pressing forces, must also be designed as hoist-like applications.
- For **special applications**, such as winders, calenders, or applications with crank mechanisms, the design process is not directly applicable, as additional boundary conditions must usually be taken into account. These must be considered for the respective case and included in an amended or separate calculation.
- For **winding drives**, the exact boundary conditions for emergency-stop braking as well as the influencing factors to be considered must be evaluated, for example whether tensile forces in the wound material occurring during emergency-stop braking are to be taken into account. Where required, multiple separate calculations are necessary.

6.2.4 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 cut-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).

Observe the following points to prevent a delayed application or an unintended release of the brake:

- When configuring the system, take into account the desired shutdown method and, in particular, the effects on the expected stopping distance.
- For hoists and hoist-like applications, only use the faster AC- and DC-side shutdown.
- 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 shutdown) is always performed due to the operating principle. This DC cut-off 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 the specification in "Mechanical project planning" (→ 39).

6.2.5 No-load starting frequency for holding brakes

Inverter-operated drives are capable of handling dynamic motion requirements and 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 time to execute the requested switching command (close or open).
- The **brake control** requires time for the involved electronic components to execute their state changes, e.g. charging of capacitors.
- Brakes that are operated **with high-speed 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 a higher load on the brake coil.

For the above reasons, you must observe the following three design requirements when designing the cycle:

- The permitted **no-load starting frequency Z_{B0} of the brake** must not be exceeded (formula 2.2 and 3.2). For the permitted values depending on size and control method refer to "Permitted no-load starting frequency of the brake Z_{B0} " (→ 109).

- 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 as specified in chapter "Pulse frequencies" (→ 107) as well as the response times and signal propagation times of the application.
- Adhere to the **minimum pause times** before switching on again, depending on the type of brake control, see "Minimum pause times before switching on again" (→ 109).

6.2.6 Limit speeds for brakes

Within the design process, the required operating speeds of the system are verified in a two-stage check against the characteristic values of the brake or brakemotor:

- **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 $W_{\text{per},n}$ 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, on the application side, brake application from speed cannot be reliably excluded must be within the speed range $\leq n_{\max,1}$.

Operating points at which brake application can be prevented on the application side using measures independent of the motor (e.g. additional external braking systems) may fall in 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 briefly) is not permitted.

Note: The permitted operating speed of the motor may be lower than that of the brake in some cases. This must be strictly observed, particularly for explosion-protected drives, so as not to compromise compliance with the ignition protection type.

6.2.7 Load ranges for horizontal and vertical applications

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

General definition of the load ranges for brakes on AC motors

Brake	Application		Base load range	Permitted over-load range horizontal	Permitted over-load range vertical
	Explosion protection	Functional safety (FS02/11)			
BE02	–	–	S	–	–
BE03	–	✓	S	–	–
BE05		–			
BE1	EX, dust	✓	R	–	–
BE2		–			
BE5	EX, gas	✓	R	–	–
		–			
BE11 BE20	–	✓	S	A, B, C, D	–
		–			
	EX, dust	✓	R	–	–
		–			
BE30 BE32	EX, gas	✓	R	–	–
		–			
	–	✓	S	A, B, C, D	–
		–			
BE60 BE62 BE120 BE122	EX, dust	✓	R	–	–
		–			
	EX, gas	✓	R	–	–
		–			
BE1H BE2H	–	✓	S	D	–
		–			

Only use the basic load ranges for line-operated motors.

Please note: When using drives in potentially explosive atmospheres, the limit values of load range S or the use of overload ranges lead to the risk of explosion. You must use the limit values of load range R for explosion-protected drives.

Depending on the load range, the various brakes exhibit modified operating behavior and, in some cases, restrictions on the application range and the braking torque combinations, as shown in the following tables.

The following characteristic values depend on the load range:

- Maximum permitted speed $n_{\max,0}$ and $n_{\max,1}$
- Permitted braking work for emergency-stop braking operations and service braking operations $W_{\text{zul},n}$ and $W_{\text{zul},T}$
- Specific wear factor f_v
- Reduction factors and correction factors f_{Mmin} and f_{Mmax}

The frame-size-dependent values for these parameters are provided in the following sections: "Limit speeds $n_{\max,0}$ and $n_{\max,1}$ " (→ 110), "Permitted braking work for service braking operations $W_{\text{per},Z}$ " (→ 111), "Permitted emergency stop braking work $W_{\text{per},n}$ " (→ 120) und "Load range-dependent calculation coefficients f_v , f_{Mmin} , f_{Mmax} " (→ 134).

Basic load ranges for working brake and holding brake BE.. or BE.H

Load range	Standard S	Reduced R
Application of the brake	Holding brake / working brake	
Application for explosion-protected drives	–	✓
Application type	All (horizontal/vertical)	
Maximum permitted braking torque level	All levels	
Wear factor f_v	Normal	
Effective range of the dynamic braking torque min. (f_{Mmin}), max. (f_{Mmax})	Normal	
Maximum emergency-stop frequency Z_{B1max}	10 h ⁻¹	
Required minimum pause time between two emergency stop events	10 minutes	

Overload ranges horizontal applications for BE.. holding brake

Load range	Overload A	Overload B	Overload C	Overload D
Application of the brake	Holding brake			
Application for explosion-protected drives	–			
Application type	Only horizontal applications			
Maximum permitted braking torque level	Maximum 75% of the maximum available nominal braking torque stage			
Wear factor f_v	Normal	Slightly increased	Significantly increased	Massively increased
Operating range of the dynamic braking torque min. (f_{Mmin}), max. (f_{Mmax})	Normal	Slightly expanded	Significantly expanded	Extremely expanded
Maximum emergency-stop frequency Z_{B1max}	10 h ⁻¹			
Required minimum pause time between two emergency stop events	10 minutes			

Overload ranges vertical applications for BE.. holding brake

Load range	Overload H
Application of the brake	Holding brake
Application for explosion-protected drives	–
Application type	Only vertical applications
Maximum permitted braking torque level	All levels
Wear factor f_v	Massively increased
Operating range of the dynamic braking torque min. (f_{Mmin}), max. (f_{Mmax})	Significantly expanded
Maximum emergency-stop frequency Z_{B1max}	5 h ⁻¹
Required minimum pause time between two emergency stop events	12 minutes

6.2.8 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 limits M_{amax} and $M_{aNotaus}$
- Radial force limits F_{Ramax} and $F_{RaNotaus}$

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.

When determining the output load, an additional factor is therefore applied. This factor takes into account:

- Differences between the characteristic value M_B and the real occurring dynamic braking torque
- Differing 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 under "Output factor $f_{brake,output}$ " (→ 135) apply.

Limit values for standard gear units (R, F, K, S, W series)

The values $M_{a_{\text{Notalus}}}$ and $F_{Ra_{\text{Notalus}}}$ correspond to the permitted buffer torques M_P and buffer transverse forces F_{RP} of the gear units.

The emergency off torque M_P is defined as follows:

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

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

For the values for factor f_{Notalus} for various gear unit designs, refer to the following table:

Gear unit design	f_{Notalus}
HK., HS., HW.	1.7
R..7, F..7, K..7, S..7	1.7
K..9	1.7
S..7p	Depending on the gear ratio, on request
W10	1.3
W20/30	1.5
W..7	1.4
W..9	Depending on the gear ratio, on request

The emergency off lateral force F_{RP} is defined as follows:

$$F_{RP} = F_{Ra_{\text{eso}}} = 1.7 \times F_{Ra}$$

Both the emergency off torque M_P and the emergency off lateral force F_{RP} are limited to 1000 events.

6.2.9 Establishing the maintenance intervals

Abrasion buildup on the friction linings

Brakes are subject to different kinds of wear depending on 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 determined as a main variable using the characteristic value W_{Insp} .

In addition, there are other influencing factors that can lead to wear effects on brake linings and mechanical guiding elements. This 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**

No-load wear is always caused by the residual friction always present in the brake.

- **Mounting positions** that lead to a vertical alignment of the longitudinal motor axis.

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

- **Double disk brakes**

Double disk brakes have an increased wear, especially in pivoted mounting position, due to the support of 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 offer 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.

Consideration of mechanical service life limits

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
		$\leq M_{aNotaus}$	1000	Mechanical service life of the gear unit

If you require more than the listed maximum number of emergency stop braking operations, contact SEW-EURODRIVE.

6.2.10 Basics of stopping distance and braking distance

Definition of terms

The following definitions are used for brake dimensioning:

The **stopping distance** s_A is defined as the distance that is traveled from the moment braking is triggered (e.g. by actuation of the emergency off switch) to standstill. It comprises:

- Signal travel distance

Distance traveled during the **signal propagation time** t_{signal} . It is assumed that the drive continues to operate at its intended setpoint speed during this time.

- Coasting distance

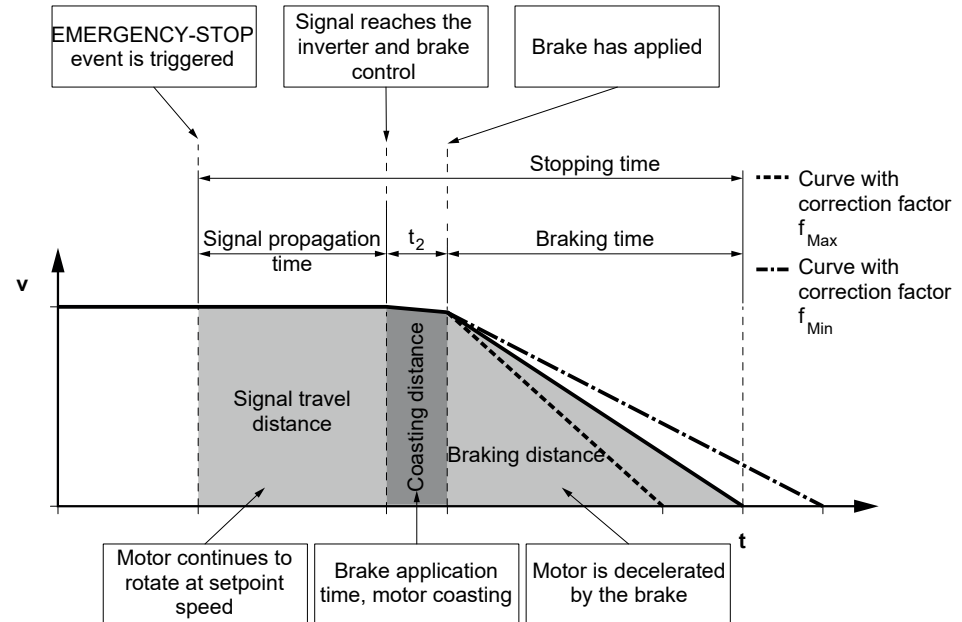
Distance traveled during the **response time t_2 of the brake**. It is assumed that the drive is no longer driven during this time, meaning that it coasts to a stop depending on external loads, friction, direction of movement, and the kinetic energy present. It is also assumed that no braking torque is yet effective during this time period.

- Braking distance s_B

Distance traveled during the **braking time** t_B , measured from the moment of mechanical brake application until standstill. For modeling purposes, a constant mean braking delay is assumed; its variation is represented by the application factors f_{Mmin} and f_{Mmax} .

Application to horizontal motion and vertical upward motion

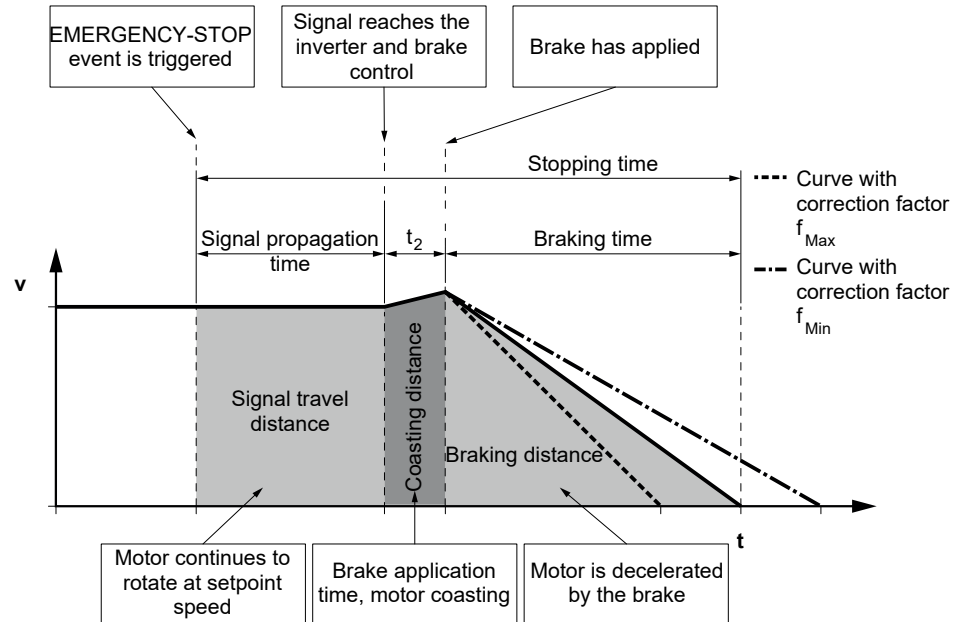
For applications with a horizontal direction of motion or for vertical upward motion, the following figure illustrates the definition applied. As a rule, friction and external forces cause the drive to decelerate already during the time period t_2 .



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Application to vertical downward movement

The following figure illustrates the determined definition for vertical downward motion or comparable types of motion. As a rule, external forces (e.g. gravity) in particular cause the drive to accelerate and to increase its speed during the time period t_2 .



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Information on the limit value assessment of braking distances

During dimensioning for motors with a brake, limit analyses of the stopping distance or the braking deceleration occurring are frequently required. This is driven, for example, by the desire to determine the maximum stopping distance so that it can be used in the context of safety analyses.

In practice, such an assessment involves a high level of effort due to the large number of influencing factors that must be taken into account, or it is often not satisfactorily feasible due to missing/uncertain boundary conditions.

The following shows some example of such influencing factors to be taken into account:

- Time profile of the braking torque
- Actual inertia present in the system
- Friction losses currently occurring in the drive train and the application
- Actual loading condition of the application at the time of braking
- Maintenance condition of the brake or conditioning of the friction system
- Vibration susceptibility of the system

To determine the required brake size, dimensioning usually does not take all operating states and configurations of the application into account; instead, only selected idealized states are considered that appear suitable to represent the most unfavorable load combination.

The calculations presented in the formulas therefore lead to "typical" minimum and maximum values for a discrete model state, which result from statistical assumptions regarding the scattering of the dynamic braking torque. However, the calculated values do not represent absolute maximum and minimum values. These values can be exceeded or undershot.

Repeat accuracy of the stopping distance for line-operated motors

With line-operated motors, the brake is used for stopping the motor during normal operation. In this context we are talking about a "working brake". Brake application from the operating speed is the normal case here.

In such applications, the application factors f_{min} and f_{Mmax} are initially used to determine the stopping distance and its typical scattering across all specimens.

However, the friction system of the brakes is operated in a stationary operating window and therefore, in such applications, a single specimen exhibits good reproducibility of the braking torque within the typical scattering range.

The parameter x_B for determining this repeat accuracy describes how strongly the stopping distance of an specimen typically fluctuates within a specific load situation. This is an empirically determined factor.

6.2.11 Measures for mechanical project planning

Working brake – BE.. 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.

Checks	Formula	Possible measures
Is the braking torque sufficient?	1.1	- Select a greater braking torque. - Select a larger brake size (adhere to feasibility). - Select larger motor, in case a larger brake could not be mounted prior. - 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 the brake application speed. - Select brake control with AC/DC shutdown. - Select a smaller gear ratio. - Reduce the application speed. - Use motor with greater number of poles. - 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: Calculating the drive considering the selected components and their characteristic values (such as inertia) For detailed configuration 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 a 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 a larger gear unit. - Select a different gear unit ratio. - Select a different gear unit design.
Is braking distance/stopping distance sufficient?	1.20 1.21	Select a greater braking torque.

Checks	Formula	Possible measures
Is the deceleration permitted?	1.23	- Select a lower braking torque. - Select an additional flywheel mass.

Holding brake – BE..., BE.H brake or BE.. safety 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.

Checks	Formula	Possible measures
Is the braking torque sufficient?	2.1	- Select a greater braking torque. - Select a larger brake size (adhere to feasibility). - Select larger motor, in case a larger brake could not be mounted prior. - Select a larger gear ratio (results in a higher emergency-stop speed). - 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 no-load starting frequency of the application.
Are the emergency stop speed and operating speeds permitted?	2.6	- Select brake control with AC/DC shutdown. - Select a smaller gear ratio. - Reduce the motion speed of the load in the application.
Is the vertical/horizontal emergency-stop braking work sufficient?	2.8	- Reduce the emergency stop speed. - Changing the braking torque. - Select a larger brake size (adhere to feasibility).
Are the number of emergency stop operations and emergency stop frequency sufficient?	2.9	- Reduce the emergency-stop braking work. - Reduce the emergency stop speed.
Final drive check: Calculating the drive considering the selected components and their characteristic values (such as inertia). For detailed configuration criteria and procedures, refer to the SEW-EURODRIVE project planning guidelines.	–	Select a new gearmotor.
Is the emergency-stop load on the gear unit (torque) permitted?	2.12	- Select a lower braking torque. - Select a larger gear unit. - Select a different gear unit ratio.

Checks	For- mula	Possible measures
Is the emergency stop load on 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.
Is the braking distance sufficient?	2.17 2.18	• Select a greater braking torque. • Reduce the emergency stop speed.
Is the deceleration permitted?	2.20	• Select a different braking torque.

6.3 Working brake – BE.. brake

6.3.1 General information

The project planning procedure in chapter "Project planning procedure for BE.. brake as a working brake" (→ 61) describes the procedure for the project planning of a drive with a BE.. brake as a working brake, also for ATEX, IECEx and HazLoc-NA®.

Notes on the project planning procedure

The following project planning is shown:

- BE.. brake as a working brake

The procedure must be used in line-operated applications.

The process always makes reference to a gearmotor. The design of motors without a gear unit follows the same procedure, except that gear-unit-specific limits and checks are not considered or performed. Strength limit values for each output design of the motors can be requested from SEW-EURODRIVE.

Information on the calculation formulas

At the relevant points in the design process, a formula number refers to the corresponding calculation formula. The formulas in table form can be found after the project planning procedure under "Calculation formulas for BE.. brake as a working brake" (→ 65).

For information on the quantities used in the formulas refer to "Key to the mechanical project planning procedures" (→ 39).

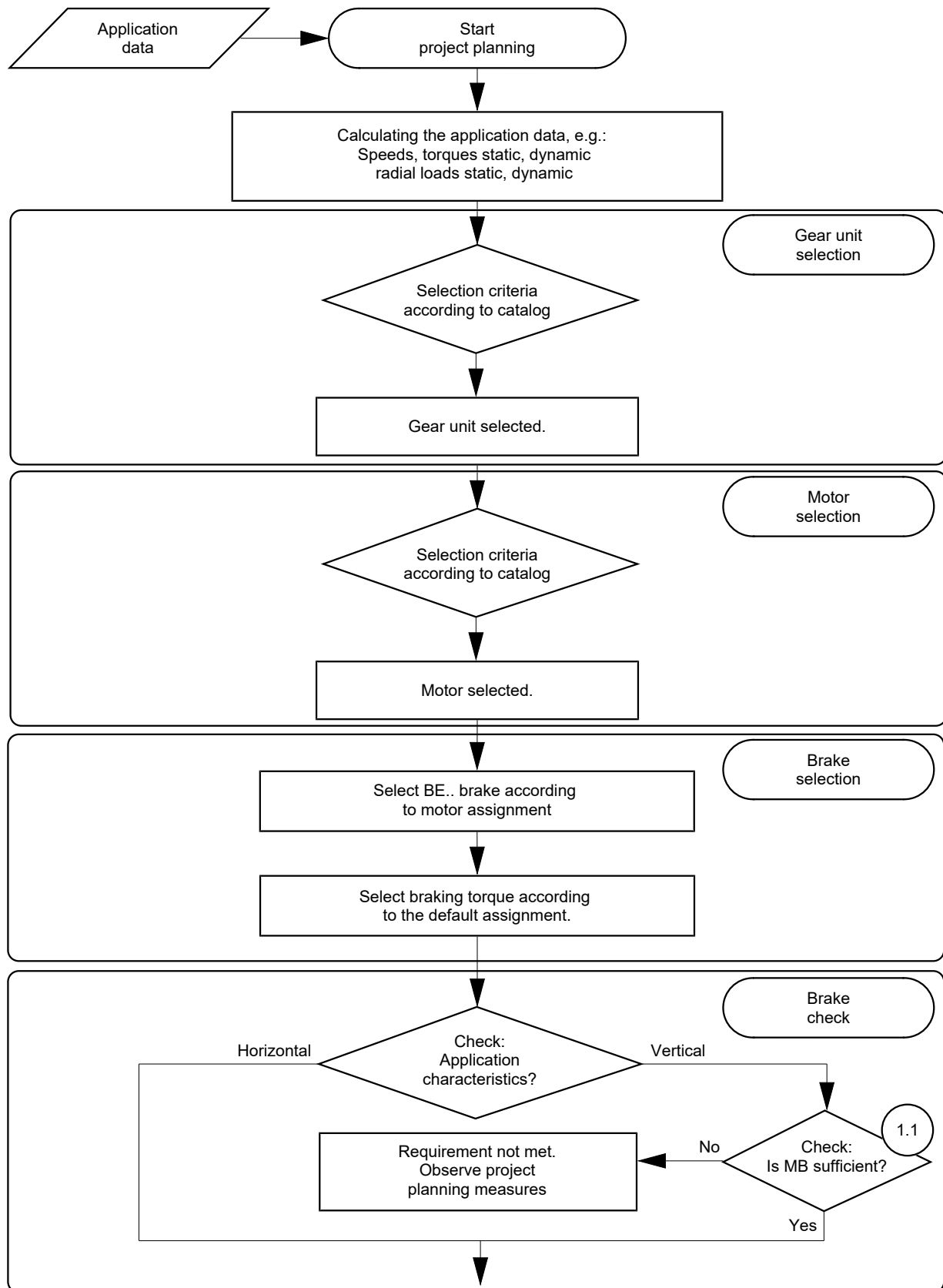
At several points in the configuration process, checks are performed against product-specific characteristic values; these checks may yield a negative result. For information on how to proceed, see "Measures for mechanical project planning" (→ 57).

Notes on calculation coefficients and product characteristic values

The calculation formulas use various calculation coefficients and calculation factors to evaluate, for example, the brake's holding function. For additional information, refer to "General information" (→ 39).

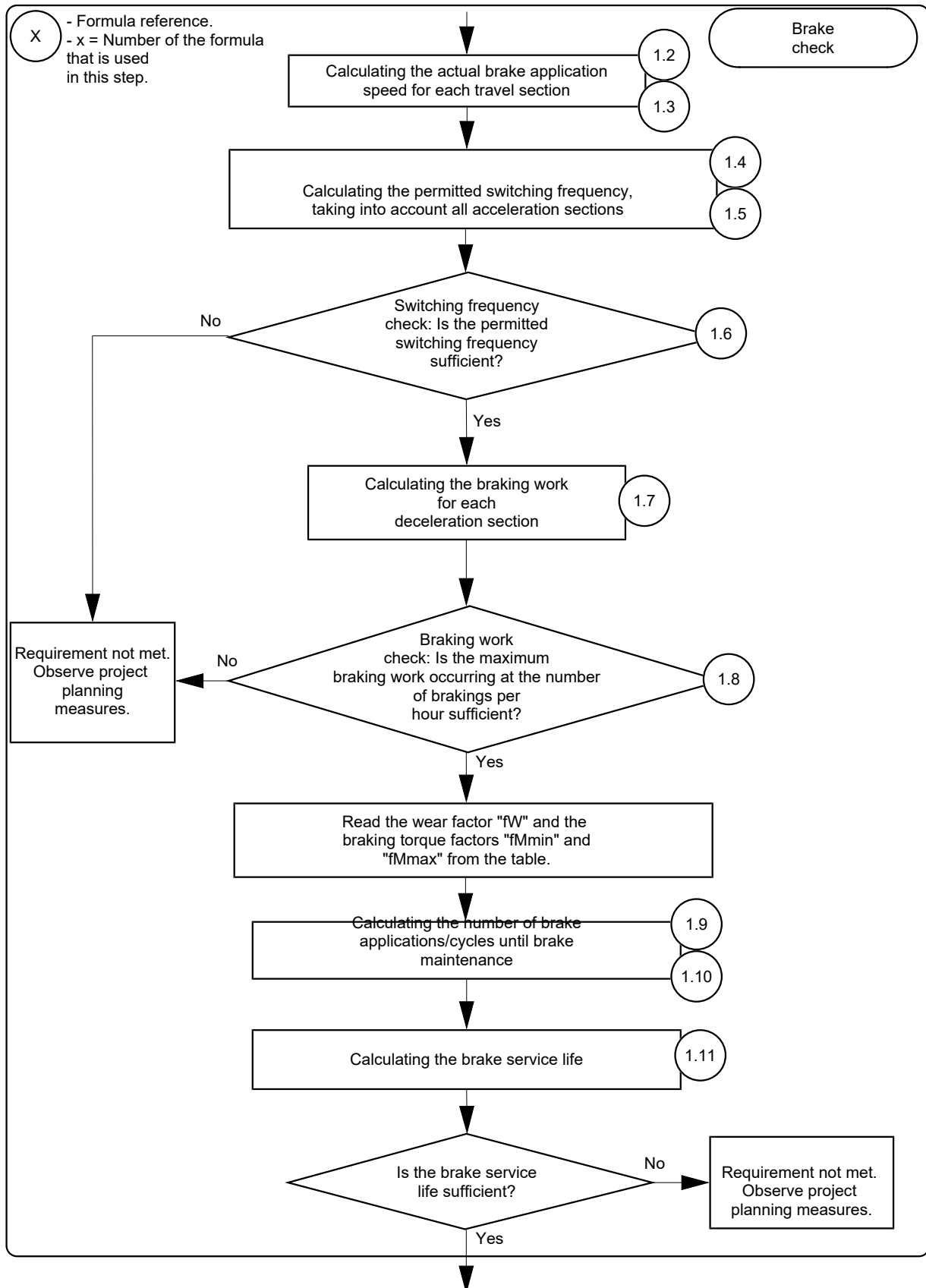
The values dependent on frame size and design variant are presented in tabular form in the technical data. There, you will also find all other product characteristics for the brakes and safety brakes, such as the maximum permitted braking work or the no-load switching frequency.

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



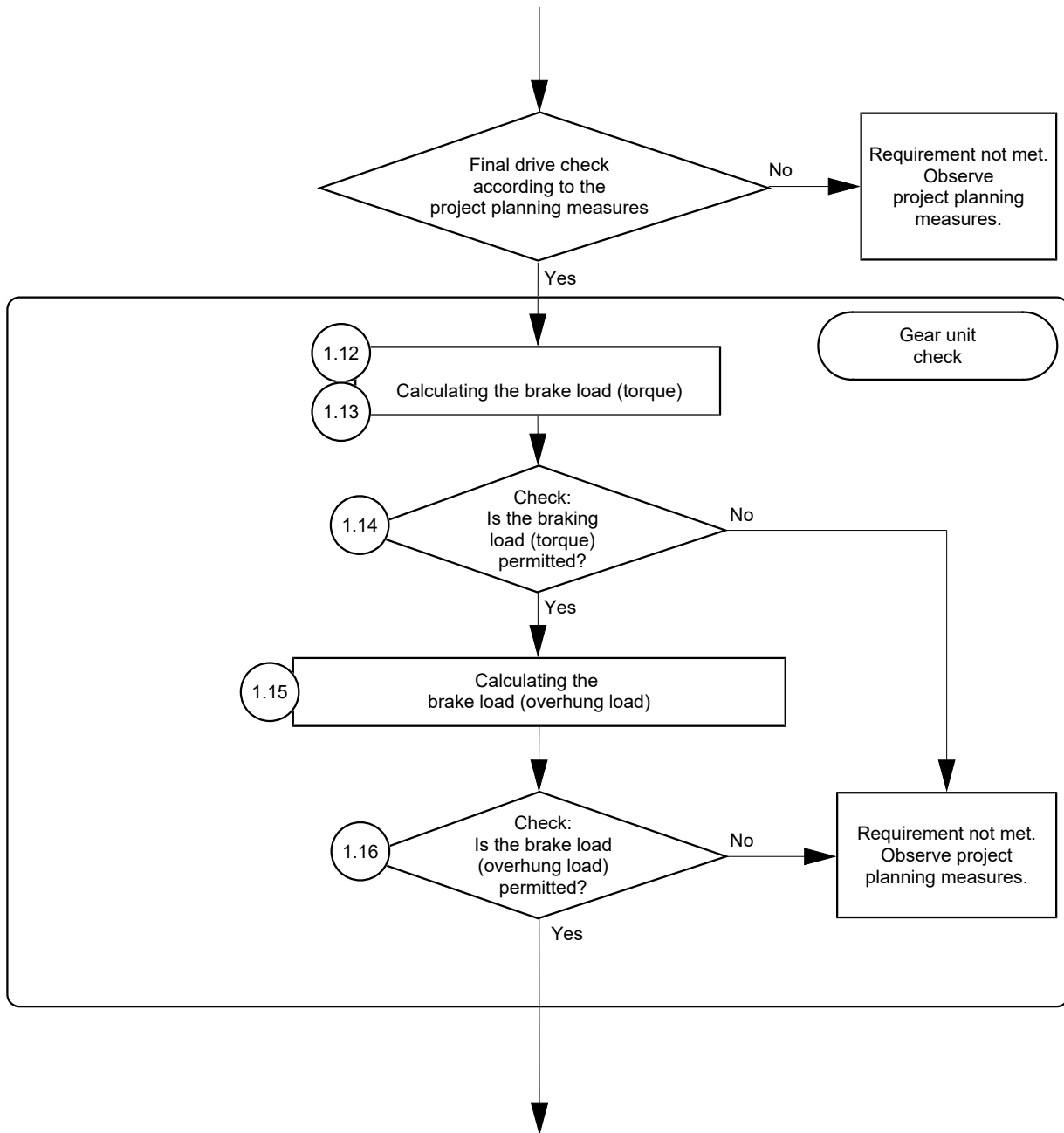
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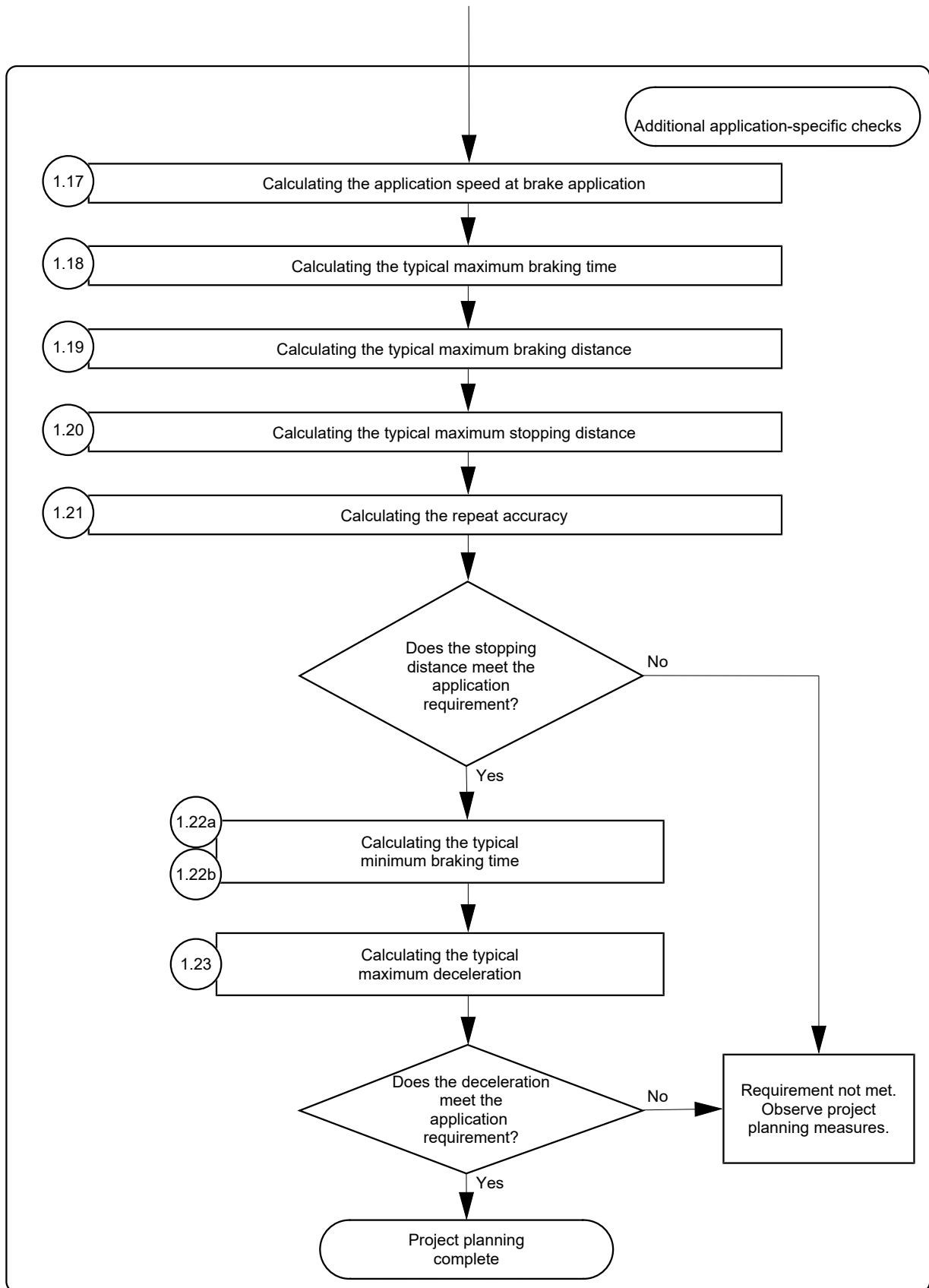
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6.3.3 Calculation formulas for BE.. brake as a working brake

Formula 1.0: Static load torque at the motor shaft

Horizontal and vertical upward		Vertical downward	
$M_L = \frac{M_{L,a}}{i \times \eta_L \times \eta_G}$		$M_L = M_{L,a} \times \frac{\eta_L \times \eta_G}{i}$	
[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		
[η _L] = 1	Efficiency of the application		
[η _G] = 1	Efficiency of the gear unit		
[i] = 1	Gear unit ratio		

Formula 1.1: Checking the braking torque (braking and holding function)

Horizontal and vertical upward		Vertical downward	
–		$M_B \geq f_A \times M_L$	
		[M _B] = Nm	Nominal braking torque
		[f _A] = 1	Application factor

Formula 1.2: Speed difference during brake application

Horizontal and vertical upward		Vertical downward	
$n_D = \frac{9.55 \times M_L \times t_2}{J_M \times \eta_L \times \eta_G + (J_G + J_L) \times \eta_L}$			
[n _D] = min ⁻¹	Change in motor speed until brake application		
[t ₂] = s	Brake application time. Depending on the connection type, use t _{2,I} (AC) or t _{2,II} (AC/DC and DC).		
[J _M] = kgm ²	Motor mass moment of inertia with mount-on components, based on the motor shaft		
[J _G] = kgm ²	Mass moment of inertia of the gear unit, based on the motor shaft		
[J _L] = kgm ²	Mass moment of inertia of the application, based on the motor shaft		

Formula 1.3: Calculating the brake application speed

Horizontal and vertical upward		Vertical downward	
$n_{Brems} = n_m - n_D$		$n_{Brems} = n_m + n_D$	
$[n_{Brake}] = \text{min}^{-1}$	For testing the relevant, real brake application speed		
$[n_m] = \text{min}^{-1}$	Relevant motor speed of the application		

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

Horizontal and vertical upward	Vertical downward
$Z_M = Z_0 \times K_J \times K_M \times K_P$	
$[Z_M] = h^{-1}$	Permitted switching frequency of the motor
$[Z_0] = h^{-1}$	No-load starting frequency of the motor with brake
$[K_J] = 1$	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

Horizontal and vertical upward	Vertical downward
$Z_{M,Zyklus,zul} = \frac{1}{\left(\frac{1}{Z_{M,1}} + \frac{1}{Z_{M,2}} + \dots + \frac{1}{Z_{M,n}}\right)}$	
$[Z_{M,Cycle,per}] = h^{-1}$	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

Horizontal and vertical upward	Vertical downward
$Z \leq Z_{M,Zyklus,zul}$	
$[Z] = h^{-1}$	Required cycle switching frequency

Formula 1.7: Calculating the maximum occurring braking work

Horizontal and vertical upward	Vertical downward
$W_n = \frac{M_B}{M_B + M_L} \times \frac{(J_M + J_G \times \eta_G + J_L \times \eta_L \times \eta_G) \times n_{Brems}^2}{182.5}$	$W_n = \frac{M_B}{M_B + M_L} \times \frac{(J_M + J_G \times \eta_G + J_L \times \eta_L \times \eta_G) \times n_{Brems}^2}{182.5}$
$[W_n] = J$	Occurring braking work in normal braking operations (in cycles $n = 1, 2, 3, \dots, n$)

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

Horizontal and vertical upward	Vertical downward
$W_{max} \leq W_{zul,Z}$	
$[W_{zul,Z}] = J$	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

Formula 1.9: Calculating the total braking work per travel cycle

Horizontal and vertical upward	Vertical downward
$W_{ges} = W_1 + W_2 + \dots + W_n$	
$[W_{tot}] = J$	Total braking work from all braking operations within the travel cycle

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

Horizontal and vertical upward	Vertical downward
$N_{B1} = \frac{W_{Insp}}{W_{ges}}$	
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

Horizontal and vertical upward	Vertical downward
$L_B = \frac{N_{B1} \times t_{Zyklus}}{3600}$	
$[L_B] = h$	Brake service life
$[t_{Cycle}] = s$	Cycle time

Formula 1.12: Calculating the torque effective on the gear unit output during braking

Horizontal and vertical upward	Vertical downward
$M_{Brems, Abtrieb} = \frac{i}{\eta_G} \left[(M_B \times f_{Brems, Abtrieb} + M_L) \times \frac{\frac{J_L \times \eta_L \times \eta_G}{J_M + J_G \times \eta_G}}{\frac{J_L \times \eta_L \times \eta_G}{J_M + J_G \times \eta_G} + 1} - M_{L,a} \times \eta_L \right]$	$M_{Brems, Abtrieb} = \frac{i}{\eta_G} \left[(M_B \times f_{Brems, Abtrieb} - M_L) \times \frac{\frac{J_L \times \eta_L \times \eta_G}{J_M + J_G \times \eta_G}}{\frac{J_L \times \eta_L \times \eta_G}{J_M + J_G \times \eta_G} + 1} + M_{L,a} \times \eta_L \right]$
$[M_{brake, output}] = Nm$	Resulting gear unit load from the braking torque, based on gear unit output shaft
$[\eta_G] = 1$	Gear unit efficiency For gear units with efficiency $\eta_G < 90\%$, back-driving efficiency η_G' must be used.
$[f_{brake, output}] = 1$	Output design factor for the selected brake or gear unit combination

Formula 1.13: Back-driving efficiency for gear units with efficiency $\eta_G < 90\%$

Horizontal and vertical upward	Vertical downward
$\eta_G' = 2 - \frac{1}{\eta_G}$	
$[\eta_G'] = 1$	Gear unit efficiency (back-driving)
$[\eta_G] = 1$	Gear unit efficiency

Formula 1.14: Checking the torque load of the gear unit output

Horizontal and vertical upward	Vertical downward
$M_{Brems, Abtrieb} \leq M_{amax}$	
$[M_{amax}] = \text{Nm}$	Maximum permitted output torque

Formula 1.15: Calculating the effective gear unit radial force during braking

Horizontal and vertical upward	Vertical downward
$F_{R, Brems} = \frac{M_{Brems, Abtrieb} \times 2000}{d_0} \times f_Z$	
$[F_{R, brake}] = \text{N}$	Resulting gear unit load due to the radial load generated
$[d_0] = \text{mm}$	Diameter of the output shaft transmission element
$[f_Z] = 1$	Transmission element factor for the overhung load. Observe additional overhung load by application, if necessary.

Formula 1.16: Checking the overhung load of the gear unit output

Horizontal and vertical upward	Vertical downward
$F_{R, Brems} \leq F_{Rmax}$	
$[F_{Rmax}] = \text{N}$	Maximum permitted overhung load for the output shaft. Applies when the point of force application is at the center of the shaft end, or at the face end in the case of hollow shafts.

Formula 1.17: Calculating the braking speed of the application

Horizontal and vertical upward	Vertical downward
$v_{Brems} = \frac{n_{Brems}}{n_m} \times v_L$	
$[v_{Brake}] = \text{m} \times \text{s}^{-1}$	Actual speed of the load in the application at brake engagement
$[v_L] = \text{m} \times \text{s}^{-1}$	Relevant speed of the load in the application at the point in time when the emergency stop is requested

Formula 1.18: Calculating the typical maximum braking time

Horizontal and vertical upward	Vertical downward
$t_{Bmax} = \frac{(J_M + J_G \times \eta_G + J_L \times \eta_L \times \eta_G) \times n_{Brems}}{9.55 \times (M_B \times f_{Mmin} + M_L)}$	$t_{Bmax} = \frac{(J_M + J_G \times \eta_G + J_L \times \eta_L \times \eta_G) \times n_{Brems}}{9.55 \times (M_B \times f_{Mmin} - M_L)}$
$[t_{Bmax}] = \text{s}$	Maximum typical braking time
$[f_{Mmin}] = 1$	Reduction factor for braking torque

Formula 1.19: Calculating the typical maximum braking distance

Horizontal and vertical upward	Vertical downward
$s_{Bmax} = v_{Brems} \times \left(\frac{1}{2} \times t_{Bmax} \right)$	
$[s_{Bmax}] = m$	Maximum typical braking distance

Formula 1.20: Calculating the typical maximum stopping distance

Horizontal and vertical upward	Vertical downward
$s_{Amax} = v_L \times t_{Signal} + \left(\frac{v_{Brems} + v_L}{2} \right) \times t_2 + s_{Bmax}$	
$[s_{Amax}] = m$	Maximum typical stopping distance
$[t_{Signal}] = s$	System signal propagation time

Formula 1.21: Calculating the repeat accuracy of the typical braking and stopping distance

Horizontal and vertical upward	Vertical downward
$X_B = \pm 0.12 \times s_{Bmax}$	
$[X_B] = m$	Diffusion of braking and stopping distance

Formula 1.22a: Calculating the minimum braking time (for gear units with $n_g \geq 90\%$)

Horizontal and vertical upward	Vertical downward
$t_{Bmin} = \frac{(J_M + J_G \times \eta_G + J_L \times \eta_L \times \eta_G) \times n_{Brems}}{9.55 \times (M_B \times f_{Mmax} + M_L)}$	$t_{Bmin} = \frac{(J_M + J_G \times \eta_G + J_L \times \eta_L \times \eta_G) \times n_{Brems}}{9.55 \times (M_B \times f_{Mmax} - M_L)}$
$[t_{Bmin}] = s$	Minimum typical braking time
$[f_{Mmax}] = 1$	Transmission element factor for braking torque

Formula 1.22b: Calculating the minimum braking time (for gear units with $n_g < 90\%$)

Horizontal and vertical upward	Vertical downward
$t_{Bmin} = \frac{(J_M + J_G \times \eta_G' + J_L \times \eta_L \times \eta_G') \times n_{Brems}}{9.55 \times (M_B \times f_{Mmax} + M_L \times \frac{\eta_G}{\eta_G'})}$	$t_{Bmin} = \frac{(J_M + J_G \times \eta_G' + J_L \times \eta_L \times \eta_G') \times n_{Brems}}{9.55 \times (M_B \times f_{Mmax} - M_L \times \frac{\eta_G'}{\eta_G})}$
$[t_{Bmin}] = s$	Minimum typical braking time
$[f_{Mmax}] = 1$	Transmission element factor for braking torque

Formula 1.23: Calculating the typical maximum deceleration when braking

Horizontal and vertical upward	Vertical downward
$a_{Bmax} = \frac{v_{Brems}}{t_{Bmin}}$	
$[a_{Bmax}] = m \times s^{-2}$ Maximum typical deceleration when braking	

6.3.4 Permitted starting frequency of the motor

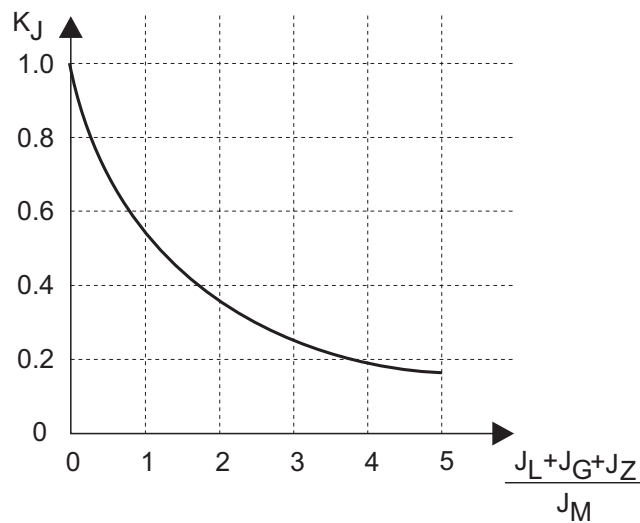
You can determine the permitted switching frequency Z_M of the motor in cycles/per hour by using the following formula:

$$Z_M = Z_0 \times K_J \times K_M \times K_P$$

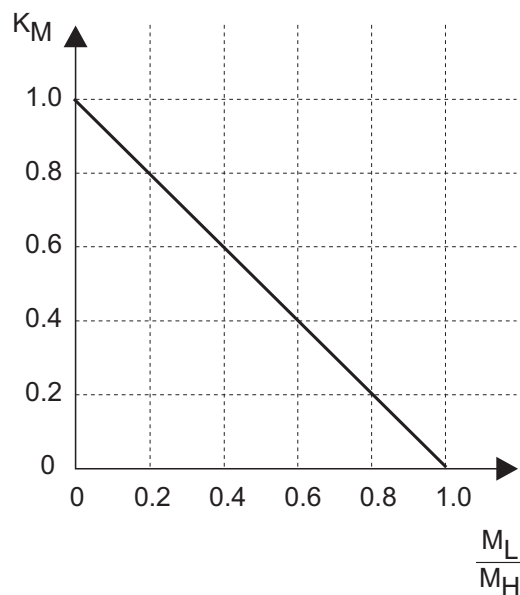
When using the additional flywheel mass/Z option, you must multiply the no-load starting frequency Z_0 by the factor **0.8**.

You can determine the factors K_J , K_M , and K_P using the following diagrams:

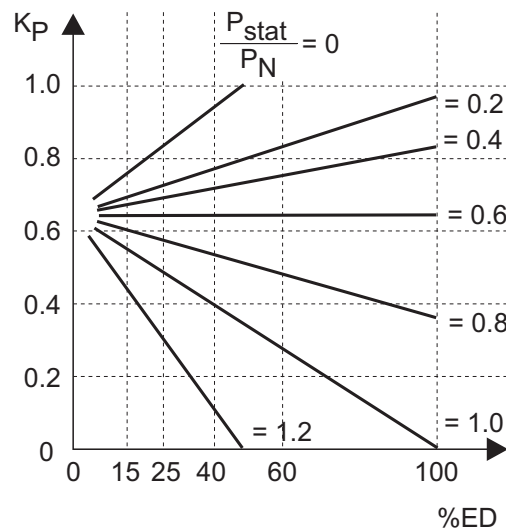
Factor K_J depending on the additional mass moment of inertia



Factor K_M depending on the external load during run-up



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



J_L	Total of all mass moments of inertia on the load end in relation to the motor axis
J_G	Mass moment of inertia of gear unit
J_Z	Mass moment of inertia flywheel fan
J_M	Mass moment of inertia of motor
M_L	Counter-torque during run-up
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. $(J_L + J_G + J_Z) / J_M = 3.5 \rightarrow K_J = 0.2$
2. $M_L / M_H = 0.6 \rightarrow K_M = 0.4$
3. $P_{stat} / P_N = 0.6$ and 60% cdf $\rightarrow K_P = 0.65$

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

The cycle duration is 8.45 s.

The switch-on time amounts to 5.07 s.

6.4 Holding brake – BE.., BE.H brake or BE.. safety brake

6.4.1 General information

The project planning procedure in chapter "Project planning procedure BE.., BE.H brake, or BE.. safety brake as a holding brake" (→ 74) describes the procedure for the project planning of a drive with a BE.., BE.H brake or with BE.. safety brake as a holding brake, also for ATEX, IECEx and HazLoc-NA®.

Notes on the project planning procedure

There is no distinction between brake and safety brake within the processes. Accordingly, the defined rules apply equally to both designs. In specific cases where different limit values apply, this is marked in the relevant tables.

The following project planning procedures are shown together:

- BE.. and BE.H brake as a holding brake with emergency stop characteristics. This procedure is used in controlled applications (drive is operated on a frequency inverter).
- BE.. safety brake as a holding brake with emergency stop characteristics. This procedure must be used in controlled applications (drive is operated on a frequency inverter) with functional safety.

The process always makes reference to a gearmotor. The design of motors without a gear unit follows the same procedure, except that gear-unit-specific limits and checks are not considered or performed. Strength limit values for each output design of the motors can be requested from SEW-EURODRIVE.

Information on the calculation formulas

At the relevant points in the design process, a formula number refers to the corresponding calculation formula. The formulas in table form can be found after the project planning procedure under "Calculation formulas BE.., BE.H brake, or BE.. safety brake as a holding brake" (→ 79).

For information on the quantities used in the formulas refer to "Key to the mechanical project planning procedures" (→ 39).

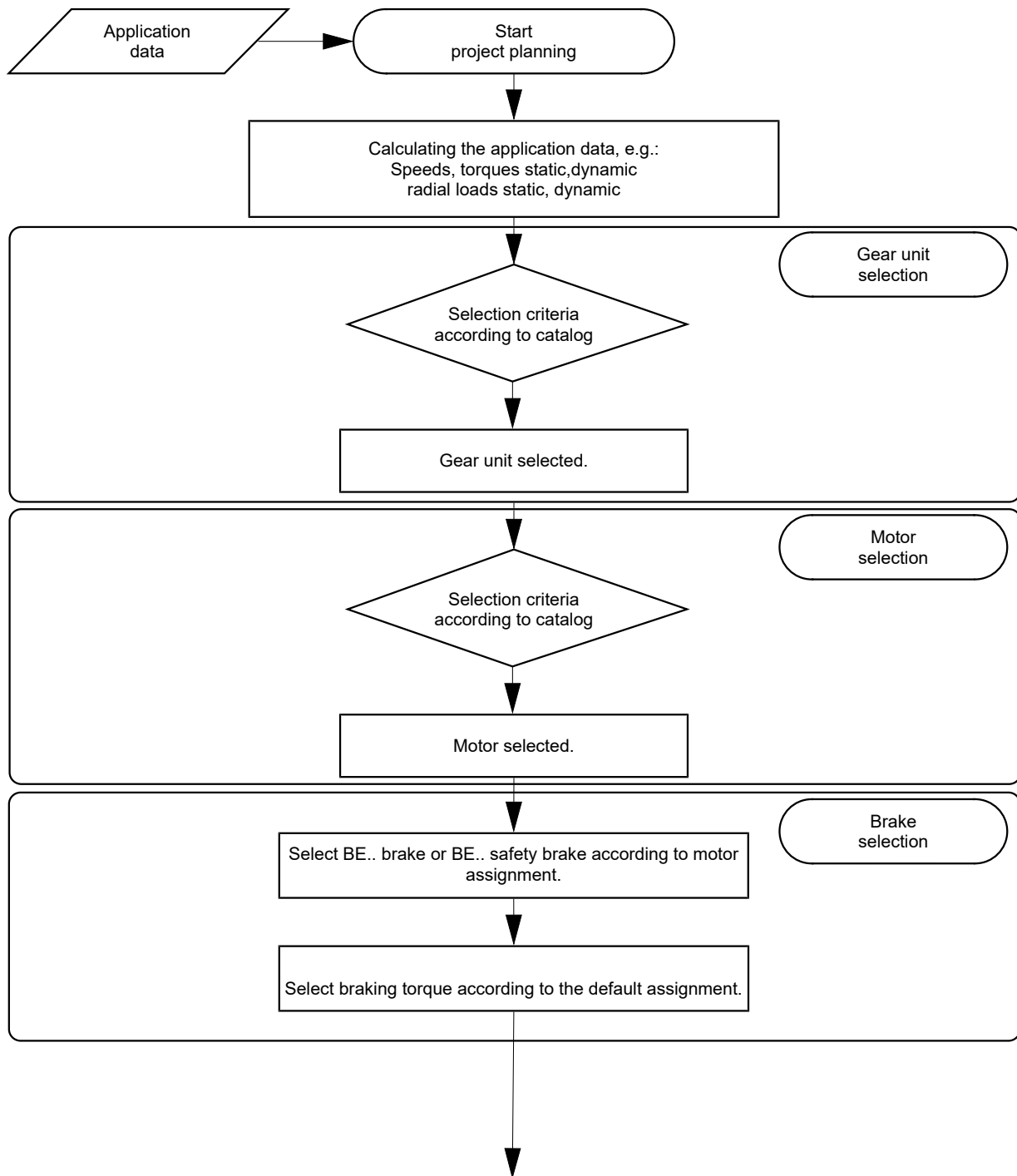
At several points in the configuration process, checks are performed against product-specific characteristic values; these checks may yield a negative result. For information on how to proceed, see "Measures for mechanical project planning" (→ 57).

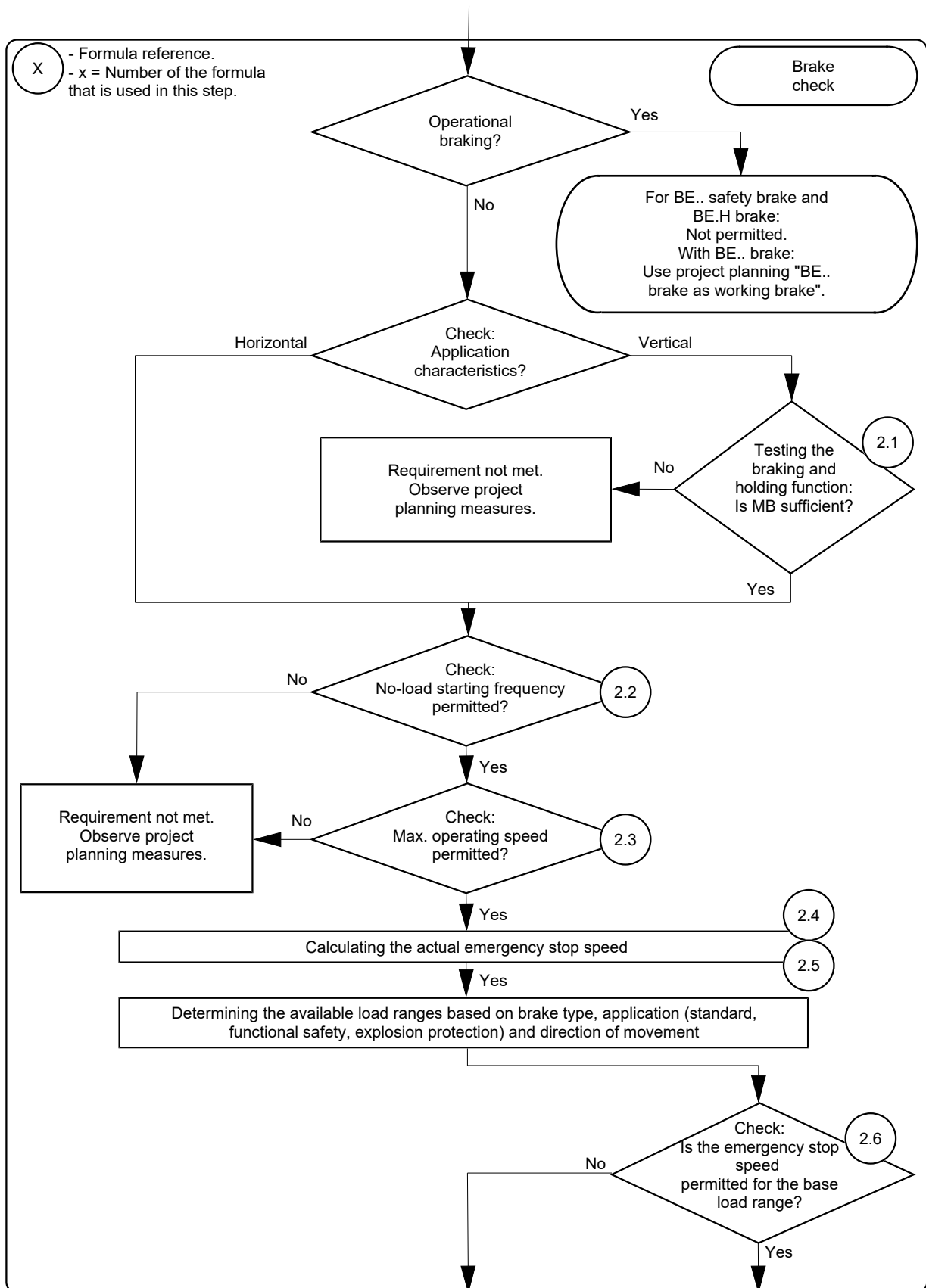
Notes on calculation coefficients and product characteristic values

The calculation formulas use various calculation coefficients and calculation factors to evaluate, for example, the brake's holding function. For additional information, refer to "General information" (→ 39).

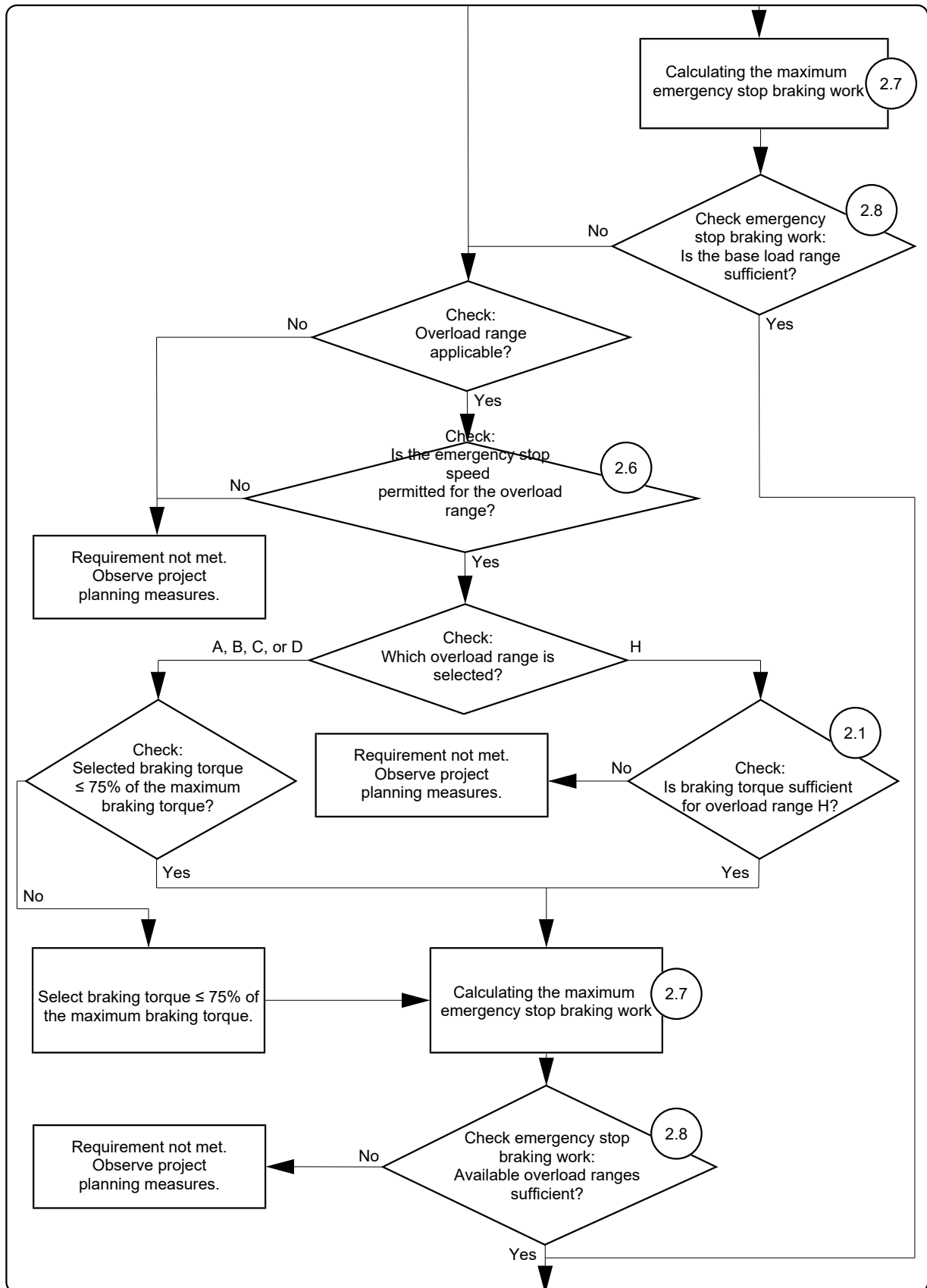
The values dependent on frame size and design variant are presented in tabular form in the technical data. There, you will also find all other product characteristics for the brakes and safety brakes, such as the maximum permitted braking work or the no-load switching frequency.

6.4.2 Project planning procedure BE..., BE.H brake, or BE.. safety brake as a holding brake



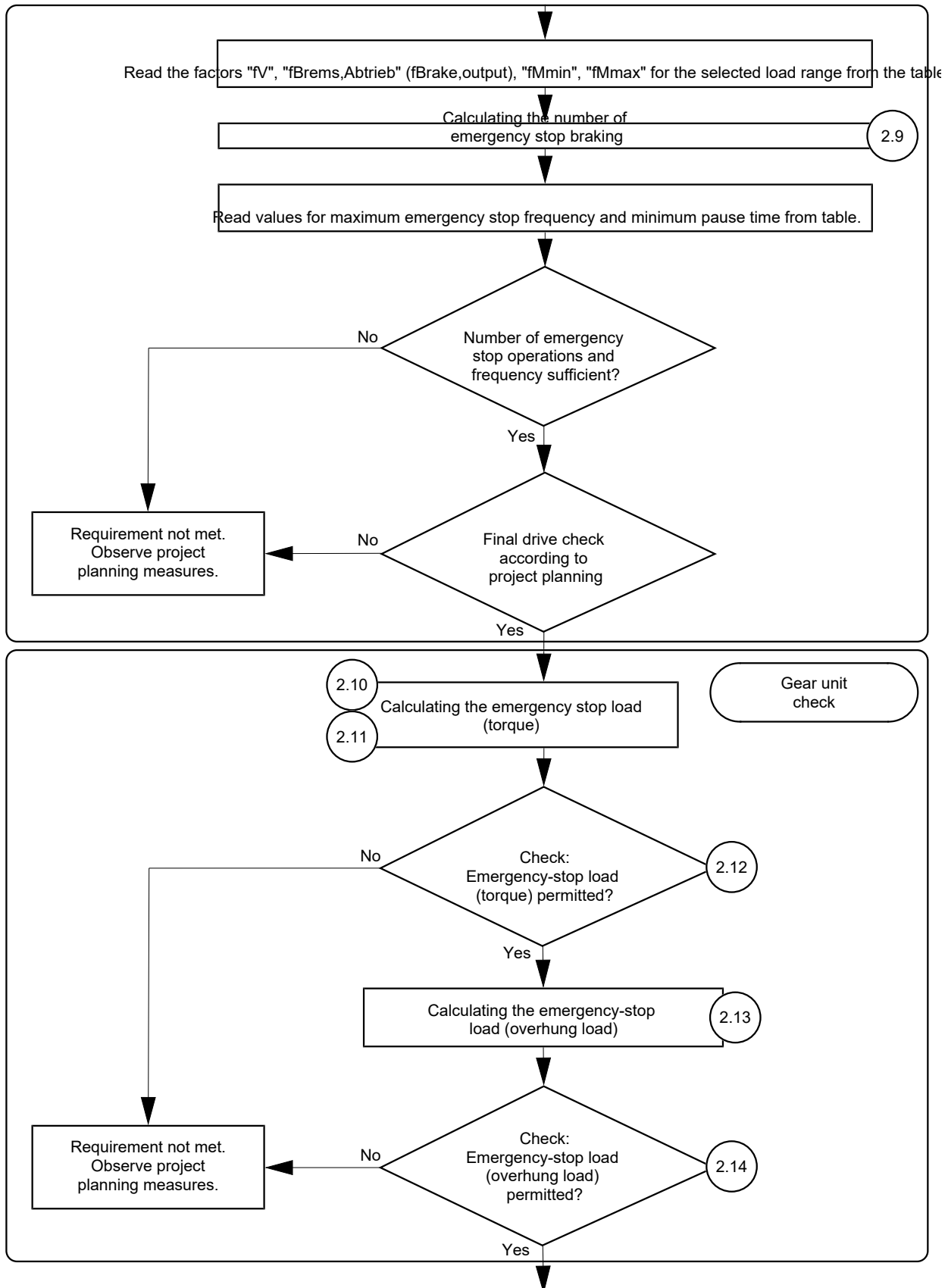


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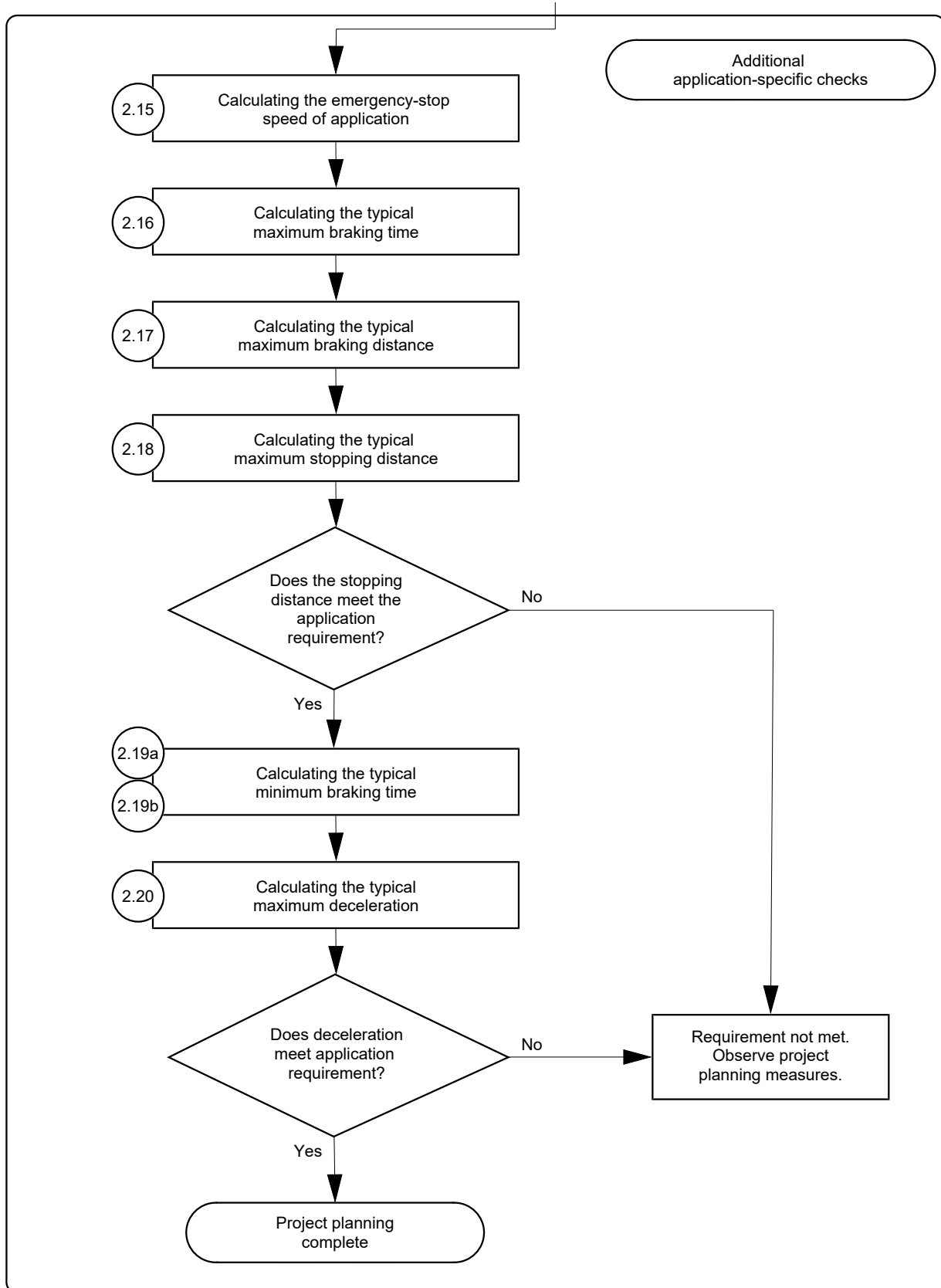


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6.4.3 Calculation formulas BE..., BE.H brake, or BE.. safety brake as a holding brake

Formula 2.0: Static load torque at the motor shaft

Horizontal and vertical upward		Vertical downward	
$M_L = \frac{M_{L,a}}{i \times \eta_L \times \eta_G}$		$M_L = M_{L,a} \times \frac{\eta_L \times \eta_G}{i}$	
[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		
[η _L] = 1	Efficiency of the application		
[η _G] = 1	Efficiency of the gear unit		
[i] = 1	Gear unit ratio		

Formula 2.1: Checking the braking torque (braking and holding function)

Horizontal and vertical upward		Vertical downward	
–		$M_B \geq f_A \times M_L$	
		[M _B] = Nm	Nominal braking torque
		[f _A] = 1	Application factor

Formula 2.2: Check of the no-load starting frequency

Horizontal and vertical upward		Vertical downward	
$Z \leq Z_{B0}$			
$[Z] = h^{-1}$	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

Horizontal and vertical upward		Vertical downward	
$n_{m,1}, n_{m,2}, \dots \leq n_{max,0}$			
$[n_{max,0}] = \text{min}^{-1}$	Maximum permitted operating speed of the brakemotor		

Formula 2.4: Speed difference during brake application

Horizontal and vertical upward	Vertical downward
$n_D = \frac{9.55 \times M_L \times t_2}{J_M \times \eta_L \times \eta_G + (J_G + J_L) \times \eta_L}$	
$[n_D] = \text{min}^{-1}$	Change in motor speed until brake application
$[t_2] = \text{s}$	Brake application time. Depending on the connection type, use $t_{2,I}$ (AC) or $t_{2,II}$ (AC/DC and DC).
$[J_M] = \text{kgm}^2$	Motor mass moment of inertia with mount-on components, based on the motor shaft
$[J_G] = \text{kgm}^2$	Mass moment of inertia of the gear unit, based on the motor shaft
$[J_L] = \text{kgm}^2$	Mass moment of inertia of the application, based on the motor shaft

Formula 2.5: Calculating the emergency stop speed

Horizontal and vertical upward	Vertical downward
$n_{\text{Nothalt}} = n_m - n_D$	$n_{\text{Nothalt}} = n_m + n_D$
$[n_{\text{Nothalt}}] = \text{min}^{-1}$	Real emergency stop speed
$[n_m] = \text{min}^{-1}$	Relevant motor speed of the application

Formula 2.6: Check of the maximum emergency stop speed

Horizontal and vertical upward	Vertical downward
$n_{\text{Nothalt}} \leq n_{\text{max},1}$	
$[n_{\text{max},1}] = \text{min}^{-1}$	Maximum permitted emergency stop speed depending on the use case

Formula 2.7: Calculating the maximum occurring braking work

Horizontal and vertical upward	Vertical downward
$W_1 = \frac{M_B}{M_B + M_L} \times \frac{(J_M + J_G \times \eta_G + J_L \times \eta_L \times \eta_G) \times n_{\text{Nothalt}}^2}{182.5}$	$W_1 = \frac{M_B}{M_B - M_L} \times \frac{(J_M + J_G \times \eta_G + J_L \times \eta_L \times \eta_G) \times n_{\text{Nothalt}}^2}{182.5}$
$[W_1] = \text{J}$	Maximum occurring braking work during emergency stop

Formula 2.8: Checking the braking work in relation to the maximum permitted braking work

Horizontal and vertical upward	Vertical downward
$W_1 \leq W_{\text{zul},n}$	
$[W_{\text{perm},n}] = \text{J}$	Maximum permitted braking work for emergency stop depending on the emergency stop speed

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

Horizontal and vertical upward	Vertical downward
$N_{B2} \leq \frac{W_{Insp}}{W_1 \times f_v}$ $N_{B2} \leq N_{B2max}$	
$[N_{B2}] = 1$	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 brake maintenance
$[f_v] = 1$	Wear factor. Determined based on the applied load range for braking work.

Formula 2.10: Calculating the effective torque when braking (gear-unit output side)

Horizontal and vertical upward	Vertical downward
$M_{Brems, Abtrieb} = \frac{i}{\eta_G} \left[(M_B \times f_{Brems, Abtrieb} + M_L) \times \frac{\frac{J_L \times \eta_L \times \eta_G}{J_M + J_G \times \eta_G}}{\frac{J_L \times \eta_L \times \eta_G}{J_M + J_G \times \eta_G} + 1} \right] - M_{L,a} \times \eta_L$	$M_{Brems, Abtrieb} = \frac{i}{\eta_G} \left[(M_B \times f_{Brems, Abtrieb} - M_L) \times \frac{\frac{J_L \times \eta_L \times \eta_G}{J_M + J_G \times \eta_G}}{\frac{J_L \times \eta_L \times \eta_G}{J_M + J_G \times \eta_G} + 1} \right] + M_{L,a} \times \eta_L$
$[M_{brake, output}] = Nm$	Resulting gear unit load from the braking torque, based on gear unit output shaft
$[\eta_G] = 1$	Gear unit efficiency For gear units with efficiency $\eta_G < 90\%$, back-driving efficiency η_G' must be used.
$[f_{brake, output}] = 1$	Output design factor for the selected brake or gear unit combination

Formula 2.11: Back-driving efficiency for gear units with efficiency $\eta_G < 90\%$

Horizontal and vertical upward	Vertical downward
$\eta_G' = 2 - \frac{1}{\eta_G}$	
$[\eta_G'] = 1$	Gear unit efficiency (back-driving)
$[\eta_G] = 1$	Gear unit efficiency

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

Horizontal and vertical upward	Vertical downward
$M_{Brems, Abtrieb} \leq M_{aNotaus}$	
$[M_{aNotaus}] = Nm$	Maximum permitted emergency stop torque

Formula 2.13: Calculating the effective gear unit radial force during braking

Horizontal and vertical upward	Vertical downward
$F_{R,Brems} = \frac{M_{Brems, Abtrieb} \times 2000}{d_0} \times f_z$	
$[F_{R, brake}] = N$	Resulting gear unit load due to the radial load generated
$[d_0] = mm$	Diameter of the output shaft transmission element
$[f_z] = 1$	Transmission element factor for the overhung load. Observe additional overhung load by application, if necessary.

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

Horizontal and vertical upward	Vertical downward
$F_{R,Brems} \leq F_{RaNotaus}$	
$[F_{RaNotaus}] = N$	Maximum permitted emergency-stop overhung load for the output shaft. Applies when the point of force application is at the center of the shaft end, or at the face end in the case of hollow shafts.

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

Horizontal and vertical upward	Vertical downward
$v_{Nothalt} = \frac{n_{Nothalt}}{n_m} \times v_L$	
$[v_{Nothalt}] = m \times s^{-1}$	Actual speed of the load in the application at brake engagement
$[v_L] = m \times s^{-1}$	Relevant speed of the load in the application at the point in time when the emergency stop is requested

Formula 2.16: Calculating the typical maximum braking time

Horizontal and vertical upward	Vertical downward
$t_{Bmax} = \frac{(J_M + J_G \times \eta_G + J_L \times \eta_L \times \eta_G) \times n_{Nothalt}}{9.55 \times (M_B \times f_{Mmin} + M_L)}$	$t_{Bmax} = \frac{(J_M + J_G \times \eta_G + J_L \times \eta_L \times \eta_G) \times n_{Nothalt}}{9.55 \times (M_B \times f_{Mmin} - M_L)}$
$[t_{Bmax}] = s$	Maximum typical braking time
$[f_{Mmin}] = 1$	Braking torque reduction factor

Formula 2.17: Calculating the typical maximum braking distance

Horizontal and vertical upward	Vertical downward
$s_{Bmax} = v_{Nothalt} \times \left(\frac{1}{2} \times t_{Bmax} \right)$	
$[s_{Bmax}] = m$	Maximum typical braking distance

Formula 2.18: Calculating the typical maximum stopping distance

Horizontal and vertical upward	Vertical downward
$s_{Amax} = v_L \times t_{Signal} + \left(\frac{v_{Nothalt} + v_L}{2} \right) \times t_2 + s_{Bmax}$	
$[S_{Amax}] = m$	Maximum typical stopping distance
$[t_{Signal}] = s$	System signal propagation time

Formula 2.19a: Calculating the typical minimum braking time (for gear units with $n_G \geq 90\%$)

Horizontal and vertical upward	Vertical downward
$t_{Bmin} = \frac{(J_M + J_G \times \eta_G + J_L \times \eta_L \times \eta_G) \times n_{Nothalt}}{9.55 \times (M_B \times f_{Mmax} + M_L)}$	$t_{Bmin} = \frac{(J_M + J_G \times \eta_G + J_L \times \eta_L \times \eta_G) \times n_{Nothalt}}{9.55 \times (M_B \times f_{Mmax} - M_L)}$
$[t_{Bmin}] = s$	Typical minimum braking time
$[f_{Mmax}] = 1$	Transmission element factor braking torque

Formula 2.19b: Calculating the typical minimum braking time (for gear units with $n_G < 90\%$)

Horizontal and vertical upward	Vertical downward
$t_{Bmin} = \frac{(J_M + J_G \times \eta_G' + J_L \times \eta_L \times \eta_G') \times n_{Nothalt}}{9.55 \times (M_B \times f_{Mmax} + M_L \times \frac{\eta_G}{\eta_G'})}$	$t_{Bmin} = \frac{(J_M + J_G \times \eta_G' + J_L \times \eta_L \times \eta_G') \times n_{Nothalt}}{9.55 \times (M_B \times f_{Mmax} - M_L \times \frac{\eta_G'}{\eta_G})}$
$[t_{Bmin}] = s$	Typical minimum braking time
$[f_{Mmax}] = 1$	Transmission element factor braking torque

Formula 2.20: Calculating the typical maximum deceleration when braking

Horizontal and vertical upward	Vertical downward
$a_{Bmax} = \frac{v_{Nothalt}}{t_{Bmin}}$	
$[a_{Bmax}] = m \times s^{-2}$	Typical maximum deceleration when braking

7 Thermal project planning

7.1 Introduction of thermal project planning

Plan BE.. and BE.H 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. For applications with variable-speed operation (frequency inverter operation), the brake could be operated in a speed range in which the specified temperature limit of the brake is not observed. For this reason, thermal configuration of the brake must be carried out, see "Thermal project planning BE.. brakes" (→ 93).

If you have any questions, contact the SEW-EURODRIVE contact person.

7.2 General information

7.2.1 Key to the thermal 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

7.2.2 Operating modes according to IEC 60034

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

According to IEC standard 60034-1 "Rotating electrical machines - Part 1: Rating and operating behavior", the electrical operating modes are defined using 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 steady-state thermal condition.

S2 short-time duty

Operation at a constant load for a time which is less than the time required for reaching a steady-state thermal 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

Duty that is 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 non-periodic changes in load and speed within the permitted operating range. In this duty cycle, overloads occur that significantly exceed the reference load.

7.2.3 Line operation

When operated on the supply system, the motor is operated at a constant speed depending on the line frequency and number of poles. The permitted operating time of the motor is defined by the information on the nameplate. Since the speed of the motor and thus the cooling are constant during operation, no separate thermal project planning of the brake is required for ventilated drives. The prerequisite for this is that the brake is de-energized when the motor is switched off.

7.2.4 Frequency inverter operation

Frequency inverters enable variable-speed operation. As a result, a fan-cooled motor (IC411)¹⁾ can be operated in speed ranges in which the specified temperature limits of the brake can no longer be adhered to during continuous duty. For this reason, thermal configuration of the brake must be carried out, see "Thermal project planning BE.. brakes" (→ 93).

When using a forced cooling fan (IC416)¹⁾, the cooling capacity is constant regardless of the motor speed. As a result, thermal project planning of the brake is not required for line operation.

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

For the brake or temperature development of the brake, on the other hand, the control mode of the motor is of secondary importance and can therefore be neglected.

1) IEC 60034-6 Rotating electrical machines - Part 6: Classification of the cooling processes (IC code)

7.2.5 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.

Fan-cooled (IC411)

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.

Forced cooling fan (IC416)

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

Designation ¹⁾	Description	Sizes
without	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

1) In type designation

Non-ventilated (IC410)

As an option, asynchronous motors from SEW-EURODRIVE are available in designs that do not have a fan wheel for self-cooling. Heat is dissipated from the motor and brake to the ambient air exclusively by free convection. Due to the greatly reduced cooling capacity, the power output of the motor is significantly reduced compared to other types of cooling or limited to short-time duty or intermittent duty.

7.2.6 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	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	without
	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	without
DRL.. DR2L..	IEC, UR, CSA	1200, 1700, 2100, 3000	FI operation	without
EDRS.. EDRE.. EDRN..	ATEX	4	Line nameplate	Supplemental table sticker
	IECEEx	4	Line nameplate	Supplemental table sticker
	HazLoc-NA®	4	Line nameplate	CT setting range
DR2C..A	e.g. IEC or combined approvals	2000, 3000	FI operation, MOVIMOT® advanced	without
DR2C..U	e.g. IEC or combined approvals	1500, 1800, 3000	FI operation	without

DRS..., DRE..., DR2S..., DRN..., DRU..

Normally, these are 4-pole drives with self-ventilation 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, drives with other numbers of poles are also operated on the frequency inverter (e.g. 2-pole or 6-pole drives).

The motors are designed in various nominal power ratings for the duty types S1 "continuous duty", S2 "short-time duty", S3 "intermittent duty" or S9 exclusively "frequency inverter operation". As a rule, only the rated data for line operation is specified on the nameplate of the drive, whereby the operating mode specification also refers explicitly to this rated point.

Even if the nameplate does not contain any information on inverter operation, the drives can also be run on the frequency inverter (thermal and dynamic limit characteristic curves for inverter operation) in accordance with the SEW-EURODRIVE project planning specifications.

MOVIMOT® (DRN..)

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

There are 2 different setting ranges based on a fixed combination of motor power and inverter power. Since the inverter is integrated in the motor connection box, the possible input voltage of the frequency inverter and the nominal frequency of the supply voltage are specified on the nameplate, not the rated motor voltage of 230/400 V 50 Hz.

For MOVIMOT® motors, a setting range and a CT value are shown on the motor nameplate. The CT value refers to the lower speed point.

The MOVIMOT® unit takes over the brake control as standard. This means that no external supply voltage is required for the brake. The nominal voltage of the brake is selected depending on the MOVIMOT® size because the brake coil simultaneously absorbs the regenerative energy with MOVIMOT®.

DRE...J, DRP...J, DRU...J

DR...J with LSPM technology (line start permanent magnet) are AC motors with squirrel-cage rotor that contain permanent magnets in the rotor.

The LSPM motors are only available in a 4-pole variant and can be operated both on the supply system and on the frequency inverter.

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

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

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

In frequency inverter operation, also note that the LSPM motors specify 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.

The LSPM motors do not exhibit any rotor losses due to their operating principle. The result is a very high efficiency in a very compact design.

The DR...J motors are only available in duty type S1.

The nameplate is based on the standard asynchronous motor, but shows additional LSPM-specific elements. In addition, the LSPM motors are equipped with an additional adhesive label on which various operating points are shown.

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 to replace the DR...J motors.

DRM.., DR2M..

The DRM.. and DR2M.. torque motors are 8-pole or 12-pole AC motors that are designed for operation with rated torque at standstill. They are comparable to springs with endless spring deflection.

The synchronous speeds range from 500 – 750 min⁻¹.

The DRM.. motors are available in duty types S1 and S3 (15%).

DRM.. motors are usually operated on the supply system and rarely operated on the frequency inverter. In line operation, the motors move against the block at nominal speed and thus hold the application at speed 0 to position.

A thermal check of the brake is not necessary for these motors because the brake has already been developed for this purpose.

DRL.., DR2L..

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

In combination with an encoder, a thermal protection, and in "thermal class F" design, they are operated 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 implemented via 2 winding calculations each in star and delta connection. In frequency inverter operation, the rated speed indicates the beginning of field weakening. Below the rated speed, the DRL.., DR2L.. motors can be operated permanently with the limit torques defined in the S1 thermal characteristic curve.

The nameplate of the DRL.., DR2L.. motors does not indicate power, but only the nominal torque and the maximum possible motor torque.

However, the actual maximum torque depends on the inverter power used. At high inverter power ratings, the maximum motor torque exceeds the torque that can be transmitted via the standard pinion shaft end (dynamics package 1). For these applications with servo-like dynamics, the DRL.., DR2L.. motors offer a reinforced pinion shaft end (dynamics package 2).

EDRS.., EDRE.., EDRN..

The 4-pole EDR.., EDRN.. motor series are designed for duty type S1 (continuous duty). They are suitable for line operation as well as for frequency inverter operation and are available in the 50 Hz or 60 Hz variant.

ATEX/IECEx

An explosion-protected gearmotor has 2 nameplates: a nameplate on the gear unit and a nameplate on the motor. When operating on a frequency inverter, an additional adhesive label is attached to the terminal box on which the permitted motor data is shown in a table form.

For brakemotors, the specification of the cyclic duration factor of the brake is specified on the additional adhesive label. The linear course 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 is specified as a 2-stage model. Below the thermal breakpoint frequency, the cyclic duration factor of the brake is reduced. The cyclic duration factor above the thermal breakpoint frequency is 100%. For the permitted values and the linear course, refer to the limit characteristic curves in "Permitted cyclic duration factor and thermal breakpoint speed" (→ 135).

HazLoc-NA®

An explosion-protected gearmotor has 2 nameplates: a nameplate on the gear unit and a nameplate on the motor. When operating on a frequency inverter, the setting range is also shown on the motor nameplate. In contrast, for brakemotors, no additional specification of the cyclic duration factor of the brake is provided for outside the motor setting range.

DR2C..A

DR2C.A 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.A motors are available in sizes 71MK – 132S in speed classes 2000 and 3000 min⁻¹. The IPM motors achieve energy efficiency class IE5 and can only be operated on a frequency inverter.

DR2C..U

DR2C..U motors are synchronous reluctance motors. They consist of adapted stators of the asynchronous motors rotors with reluctance technology without asynchronous cage.

DR2C.U motors are available in sizes 160MUR – 280MU in speed classes 1500/1800 min⁻¹ and 3000 min⁻¹. The reluctance motors achieve energy efficiency class IE5 and can only be operated on a frequency inverter.

7.2.7 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.

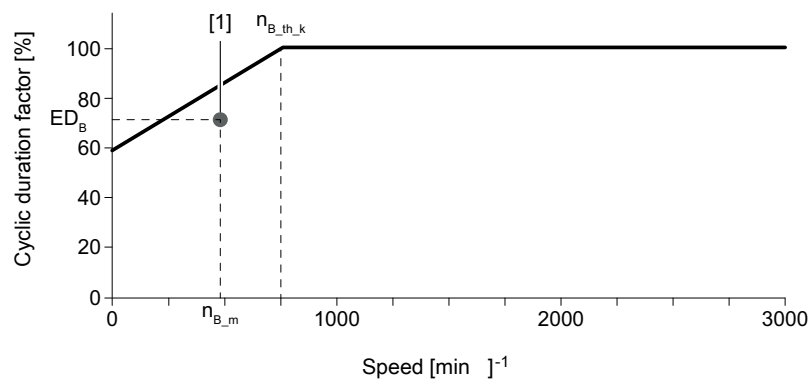
Cyclic duration factor of brake cdf_B

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

In the thermal project planning of the brake, a distinction must be made between the respective cyclic duration factor of the motor and the cyclic duration factor of the brake cdf_B . When determining the cyclic duration factor of the brake, all travel sections of the cycle where the brake is electrically released are included in the calculation. The travel sections with applied brake are not considered.

Limit characteristics for the permitted cyclic duration factor of the brake

The following diagram shows the permitted cyclic duration factor of the brake depending on the speed. The effective operating point of the brake must be below the characteristic curve.



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[1] Effective operating point of the brake

For the limit characteristic curves of the individual brake sizes, refer to "Permitted cyclic duration factor and thermal breakpoint speed" (→ 135).

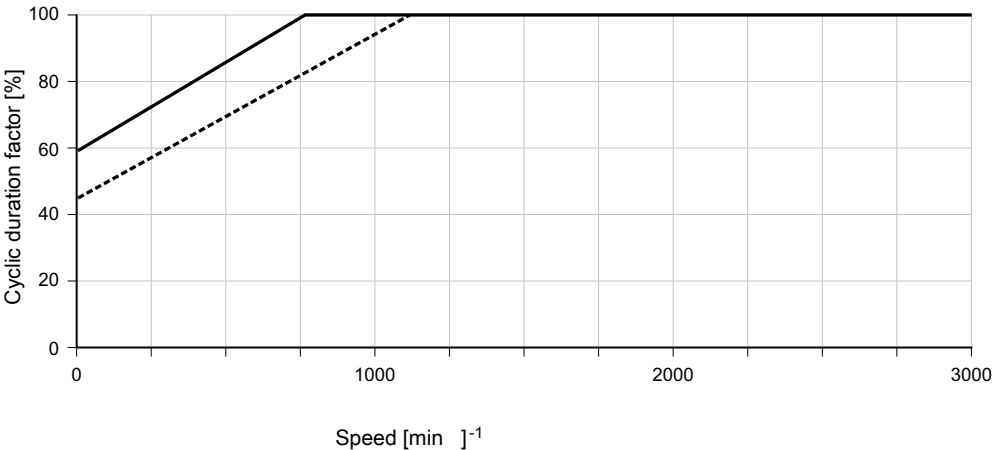
Ambient temperature

The permitted temperature range of the motor is specified on the nameplate. The rated data of the motor and the cyclic duration factor of the brake always refer to this temperature range. If the motor is operated at a lower temperature, it is possible to implement a higher cyclic duration factor even at low motor speeds. In this case, contact SEW-EURODRIVE.

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.



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

7.3 Thermal project planning BE.. brakes

7.3.1 General information

The project planning procedure describes the procedure for thermal project planning of a BE.. brake on drives that are operated on a frequency inverter.

Information on the calculation formulas

At the relevant points in the design process, a formula number refers to the corresponding calculation formula. The formulas in table form can be found in the chapter following the project planning procedure.

At several points in the configuration process, checks are performed against product-specific characteristic values; these checks may yield a negative result. For information on how to proceed, see "Measures for thermal project planning" (→ 93).

Information on the product characteristic values

For the size- and design-dependent values, refer to "Permitted cyclic duration factor and thermal breakpoint speed" (→ 135).

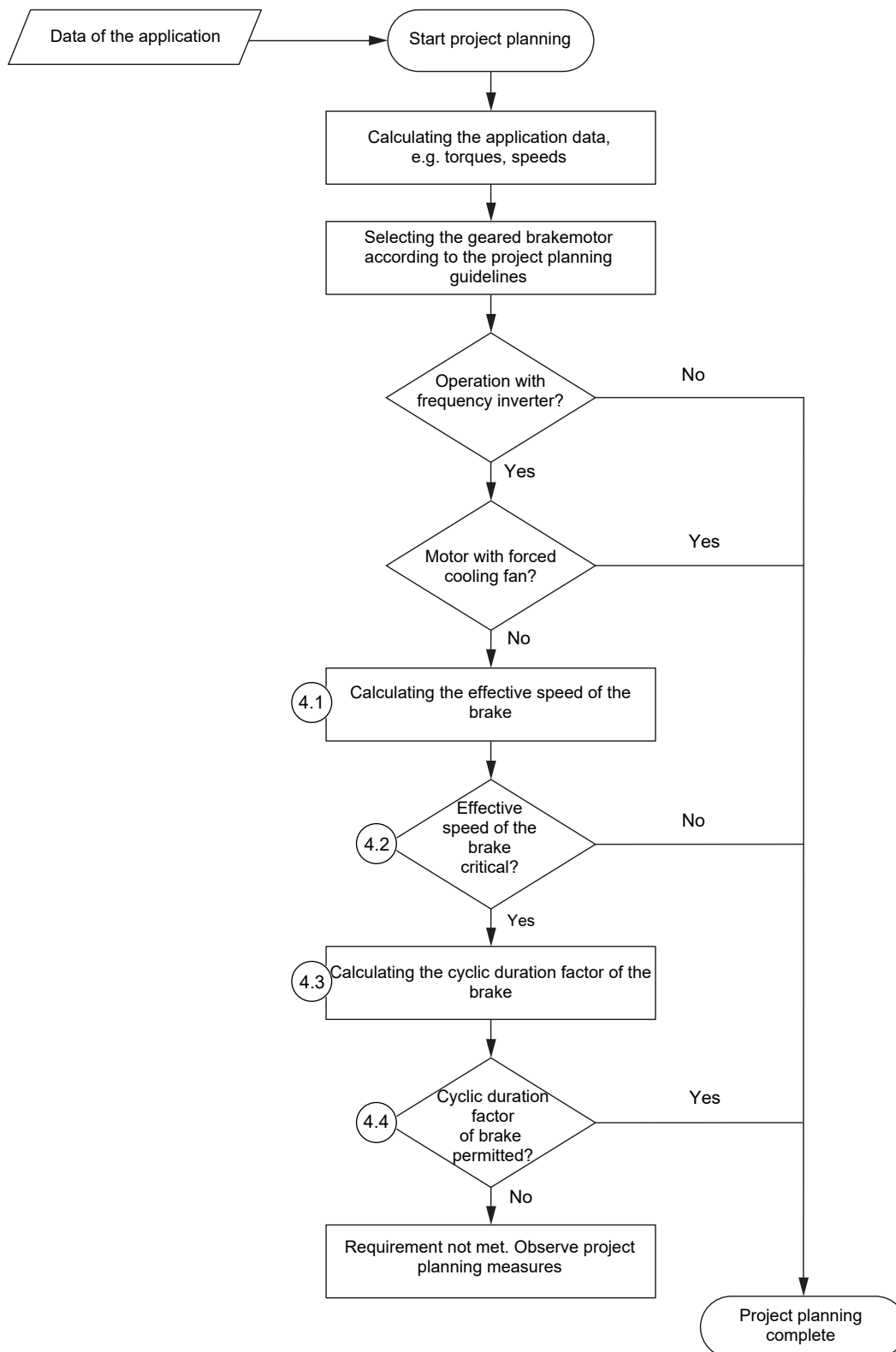
Only values for explosion-protected brakemotors are available in this documentation. If you plan to use brakemotors, contact SEW-EURODRIVE.

7.3.2 Measures for thermal project planning

The following table provides information to find solutions if, during the thermal project planning for a BE.. brake (also for ATEX, IECEx, and HazLoc-NA®), the result of the respective test is negative during the project planning process.

Checks	Formula	Possible measures
Effective speed of the brake critical?	4.2	• Apply the brake for break sections with position control. • Increase the motor speed by increasing the gear unit ratio. • Use forced cooling fan.
Cyclic duration factor of brake permitted?	4.4	• Apply the brake for break sections with position control. • Adjust the travel cycle to achieve shorter break times with released brake. • Use forced cooling fan.

7.3.3 Project planning procedure for thermal project planning



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7.3.4 Calculation formulas for thermal project planning

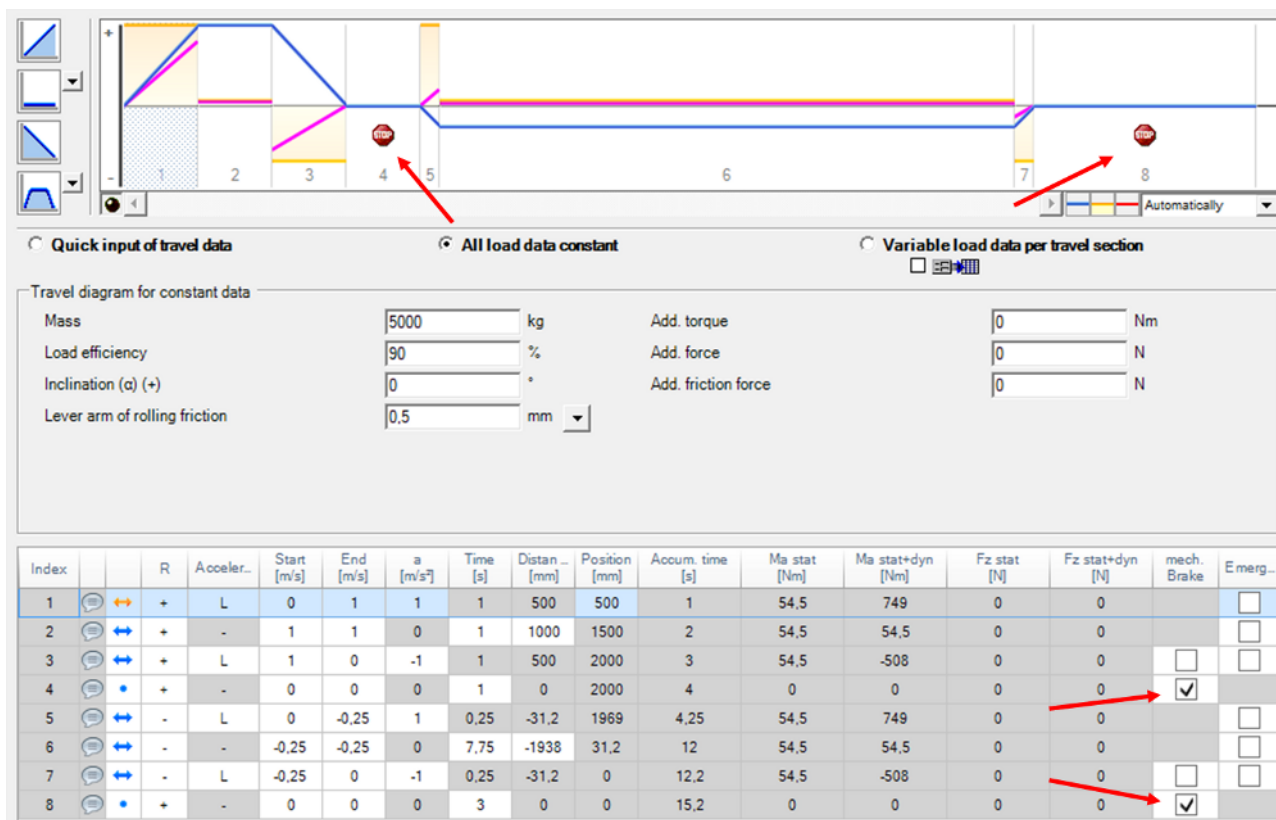
No.	Formula
4.1	Calculating the effective speed of the brake $n_{B_m} = \frac{n_{M_1} \times t_1 + \dots + n_{M_n} \times t_n}{t_1 + \dots + t_n}$ [n_{B_m}] = min⁻¹ Effective speed of the brake [t_n] = s Duration of the individual travel sections with released brake [n_{M_n}] = min⁻¹ Motor speed of the 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" (→ 135) [f_{B_AH}] Application factor for taking into account the installation altitude of the brakemotor above sea level
4.3	Calculating the cyclic duration factor of the brake $cdf_B = \frac{t_1 + \dots + t_n}{t_{tot}} \times 100$ [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" (→ 135)

7.3.5 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



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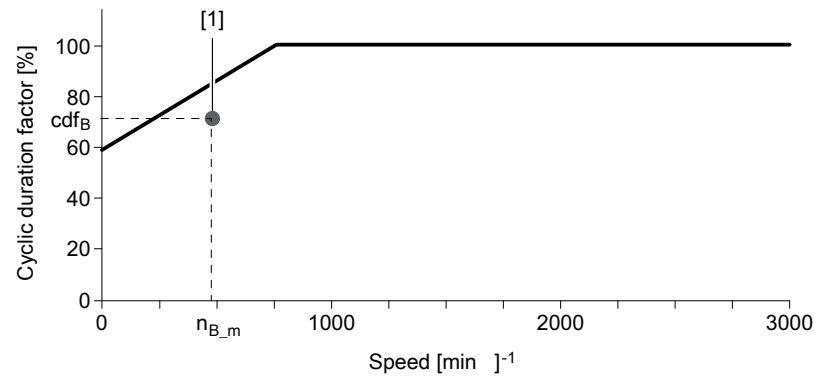
It is apparent from the stop icons in the diagram as well as the check marks in the table for travel sections 4 and 8 that the brake is applied in these break sections.

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 $n_{B_m} = 497.6 \text{ min}^{-1}$, see formula 4.1 (→ 95)
- Cyclic duration factor of the brake $\text{cdf}_B = 74\%$, see formula 4.3 (→ 95)
- Installation altitude < 1000 m above sea level. $\text{NHN} \rightarrow f_{B_{AH}} = 1$ (→ 140)

The following operating point of the brake results:

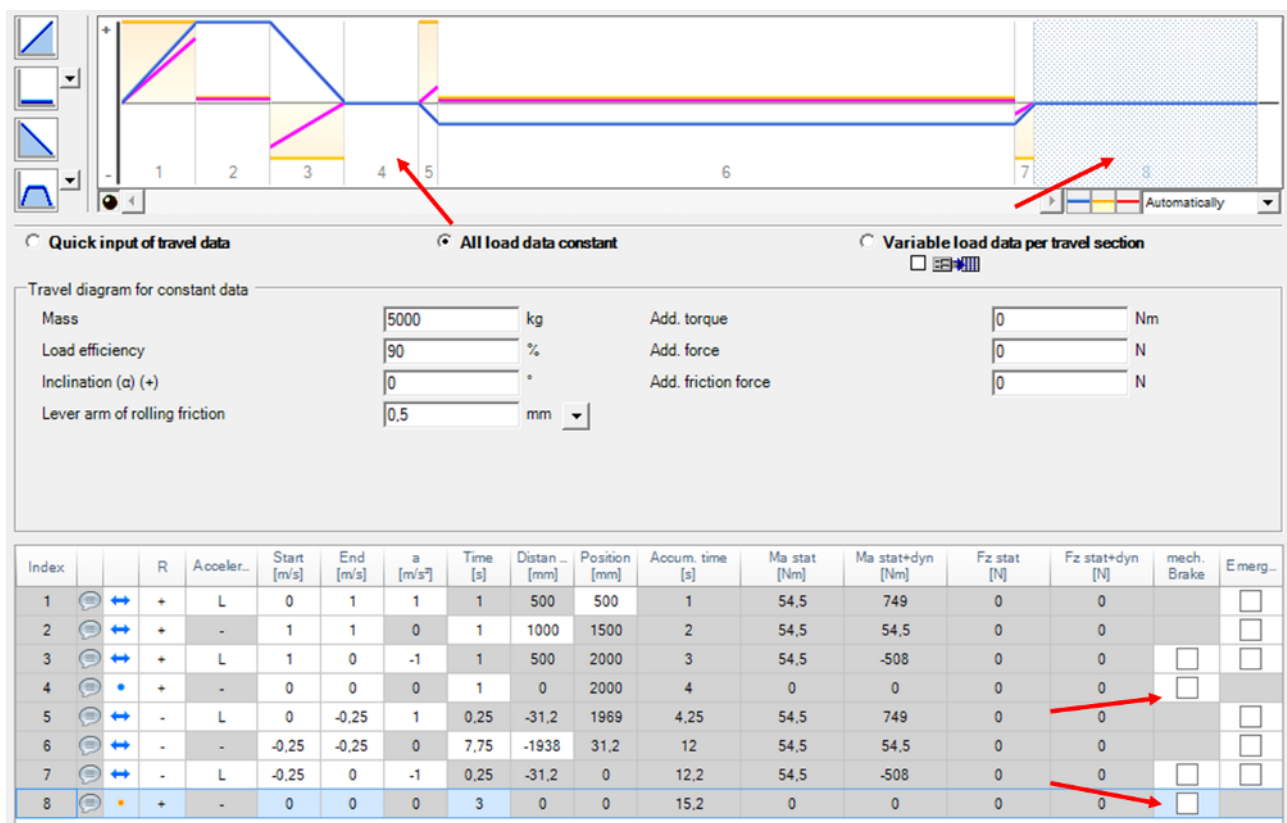


900723498655019

- 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)



35705406603

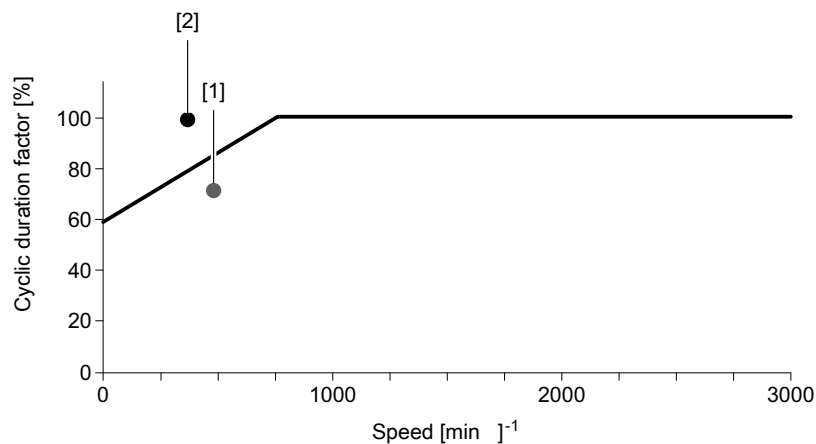
If no check mark is selected in the break sections, the brake remains released in these sections. This can also be seen in the missing stop symbols in the diagram.

Since the brake is energized in these sections, these lead to 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 $n_{B_m} = 359.3 \text{ min}^{-1}$, see formula 4.1 (→ 95)
- Cyclic duration factor of the brake $\text{cdf}_B = 100\%$, see formula 4.3 (→ 95)

The following operating point of the brake results:



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— Permitted cyclic duration factor cdf_{B_per} at 40 °C, 50 °C

[1] Operating point with applied brake (case 1)

[2] Operating point with applied brake

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

8 Brake test

8.1 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.

8.2 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 subfunction, a brake test for the brake may be required by one or more standards, e.g. by EN ISO 13849-1.

The brake test typically is not an independent safety subfunction, but rather supplements a higher-level safety system for the testing of the brakes required by applicable 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 subfunction 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.

8.3 Performing a brake test

A brake test is generally understood to be a test function that checks the functionality 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.

The key aspect of the test is to verify whether the brake is still capable of opening and closing. 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 hold. The defined torque can be generated, for example, as a motor torque or by a testing weight. The test 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 taken into account when dimensioning the brake. In machines in which multiple brakes act on the same axis, a separate dynamic test of each brake typically leads to stresses 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 the separate testing required by the standards.

The dynamic test is generally unsuitable as the sole test method in a machine.

Note: 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 test must be taken into consideration in the design of the machine or must be avoided using suitable automation.

8.4 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 before it occurs. This can be due, e.g. to preventive maintenance, increasing availability, or even protecting investments.

8.5 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.

Various publications such as the German social accident insurance (DGUV, Deutsche Gesetzliche Unfallversicherung) or the Institute for occupational safety (IFA, Institut für Arbeitsschutz) of the DGUV, among others, describe options for implementing a safety-related brake system as well as a brake test.

8.6 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

8.7 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 the ratio of the number of detectable dangerous failures of a brake to the total number of dangerous failures of that brake. The DC value is an 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.

8.8 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 $M_{4,100\text{ °C}}$ 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 $M_{4,100\text{ °C}}$, 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) 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.

8.9 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.

8.9.1 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.

$M_{\text{test}} = 1.3 \times \text{the maximum static load torque of the application}$

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.

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

Example for 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:

SEW-EURODRIVE			
76646 Bruchsal/Germany			
R87 DRN100LM4/BE5/TF/EK8S			
01.8005477174.0001.22			
50 Hz		Inverter duty VPWM	
r/min 1456/23		3ph. IEC60034	
v 220-230Δ/380-400Y		IP 54	
kW 2.2 S1		TEFC	
A 8.4/4.85		Nom. Eff. % 86,7 IE3	
P.F. 0,76		Nom. Eff. % 89,5 IE3	
kW 2.2 S1		P.F. 0.73	
A 7.4/4.3		K.V.A-Code M	
60 Hz		Design NEMA A	
r/min 1762/28		CT 700-1800rpm	
v 254-266Δ/440-460Y		V _{br} 220-277 AC	
Th.Kl. 130(B)		Nm 40	
S.F. 1.0		BST1.2S	
ML03		IM M1	
i 63,68		Nm 920/760	
CLP 220 Miner.Öl/2.3 l		kg 99.000	
AMB °C -20..40		188 572 3DE	
Made in Germany			

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

- Determination using the documentation

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

Table section from the operating instructions of the motor:

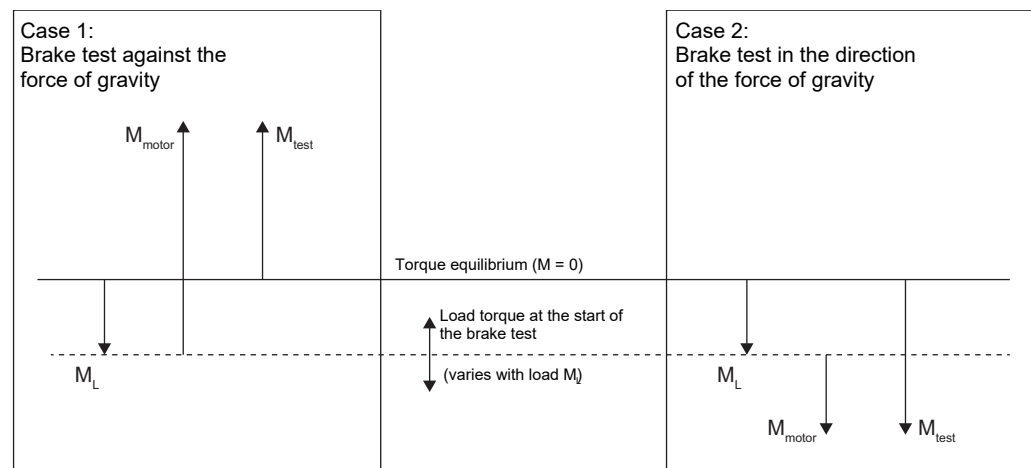
Motor	Brake	Braking torque level M_B [Nm]
DRN100LM4	BE5	55
		40
		28
		20
		14

8.9.3 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.



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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:

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

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

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.

8.10 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.

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.
- Preferably activate the friction surfaces by allowing the brake to apply from a significantly reduced motor speed ($< 750 \text{ min}^{-1}$).
- Activation of the friction surfaces by controlled acceleration of the motor against the closed brake is permissible, provided that the motor speed does not exceed 100 min^{-1} and the activation time does not exceed 5 seconds.

If you have any questions regarding the design of a friction-surface activation process, please consult SEW-EURODRIVE.

8.11 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 basically 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 way, wear-related function restrictions can be detected and rectified by means of maintenance.

Note: 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.

9 Technical data

9.1 Application factor f_A

The following table defines the application factors for testing the holding function and the braking function for hoists and hoist-like applications. The table contains information for use as a working brake or as a holding brake in the load ranges R, S, and H.

No factors are defined for load ranges A to D since its use is not permitted for hoist-like applications.

Brake	Used as	Load range	f_{out}
BE..	Working brake	R and S	2
	Holding brake	R and S	2.5
		H	3
BE.H	Holding brake	S	2.5

9.2 Pulse frequencies

The switching times of the brake generally depends on many factors, e.g. on the operating temperature of the brakes, the wear condition and the tolerances of the components used. The set braking torque is a particularly decisive factor influencing the switching times.

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 for direct supply with DC voltage without brake control
- Response time $t_{1,II}$ for high-speed excitation
For operation with the BGE., BG1Z, BME., BMP., BMK., BMKB., BMH., BSG., or BMV.. brake controls
- 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 switching times are identical for the BE.. brake and the BE.. safety brake.

Brake		t_1 in 10^{-3} s		t_2 in 10^{-3} s	
		$t_{1,I}$	$t_{1,II}$	$t_{2,I}$	$t_{2,II}$
BE..	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
	BE62	–	90	120	25
	BE120	–	120	130	40
	BE122	–	120	130	40
BE.H	BE1H	55	10	76	12
	BE2H	73	17	68	10

$t_{1,I}$ = 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 (AC/DC or DC cut-off)

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

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

9.3.1 Permitted no-load starting frequency of the brake Z_{B0}

Brake		Maximum permitted no-load starting frequency in h^{-1}	
		$Z_{B0,I}$ for normal control	$Z_{B0,II}$ for fast control
BE..	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		
BE.H	BE1H	6000	4000
	BE2H	6000	4000

9.3.2 Minimum pause times before switching on again

Brake control	Minimum pause time before switching on again in ms
BG.., BS..	50
BGE.., BSG..	100
BUR..	100
BG1Z	–

For pause times of the brake controls for control cabinet installation (e.g. BMK..., SBM...) refer to the corresponding brake control product manual.

9.4 Limit speeds $n_{\max,0}$ and $n_{\max,1}$

The following speed limits apply to all brake designs:

Brake			Maximum permitted emergency-stop speed $n_{\max,1}$ in min^{-1}				Maximum permitted operating speed $n_{\max,0}$ in min^{-1}
			Reduced R	Standard S	Overload range A, B, C, D	Overload range H	
BE..	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	–	–	–	2500
		Ex-FS	1800	–	–	–	2500
	BE60 - BE122	Standard	–	1800	2500	–	2500
		Ex	1800	–	–	–	1800
BE.H	BE1H – BE2H	Standard	–	3600	–	–	4500

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

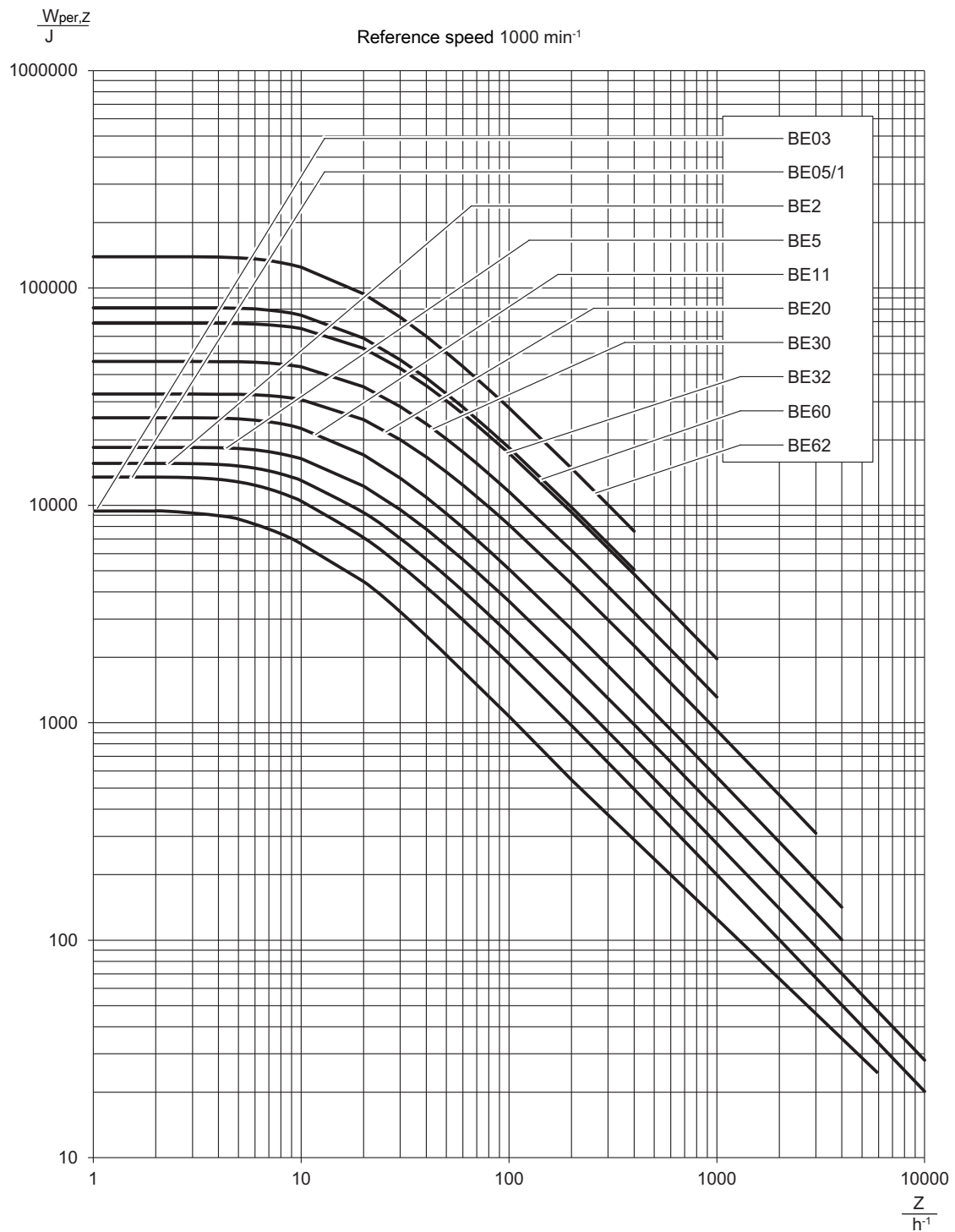
Note that service braking operations for the BE.. safety brake and BE.H brake are not permitted.

The following table contains references to the permitted braking work for service braking operations $W_{zul,Z}$. Depending on the reference speed, the permitted braking work is shown in a diagram for all brake sizes together.

Load range	Reference speed min^{-1}	Application	Area
S	1000	Braking operation from operating speed with 6 motor poles, 50 Hz operation	(→ 112)
S	1200	Braking operation from operating speed with 6 motor poles, 60 Hz operation	(→ 113)
S	1500	Braking operation from operating speed with 4 motor poles, 50 Hz operation	(→ 114)
S	1800	Braking operation from operating speed with 4 motor poles, 60 Hz operation	(→ 115)
S	3000	Braking operation from operating speed with 2 motor poles, 50 Hz operation	(→ 116)
S	3600	Braking operation from operating speed with 2 motor poles, 60 Hz operation	(→ 117)
R	1500	Braking operation from operating speed with 4 motor poles, 50 Hz operation	(→ 118)
R	1800	Braking operation from operating speed with 4 motor poles, 60 Hz operation	(→ 119)

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

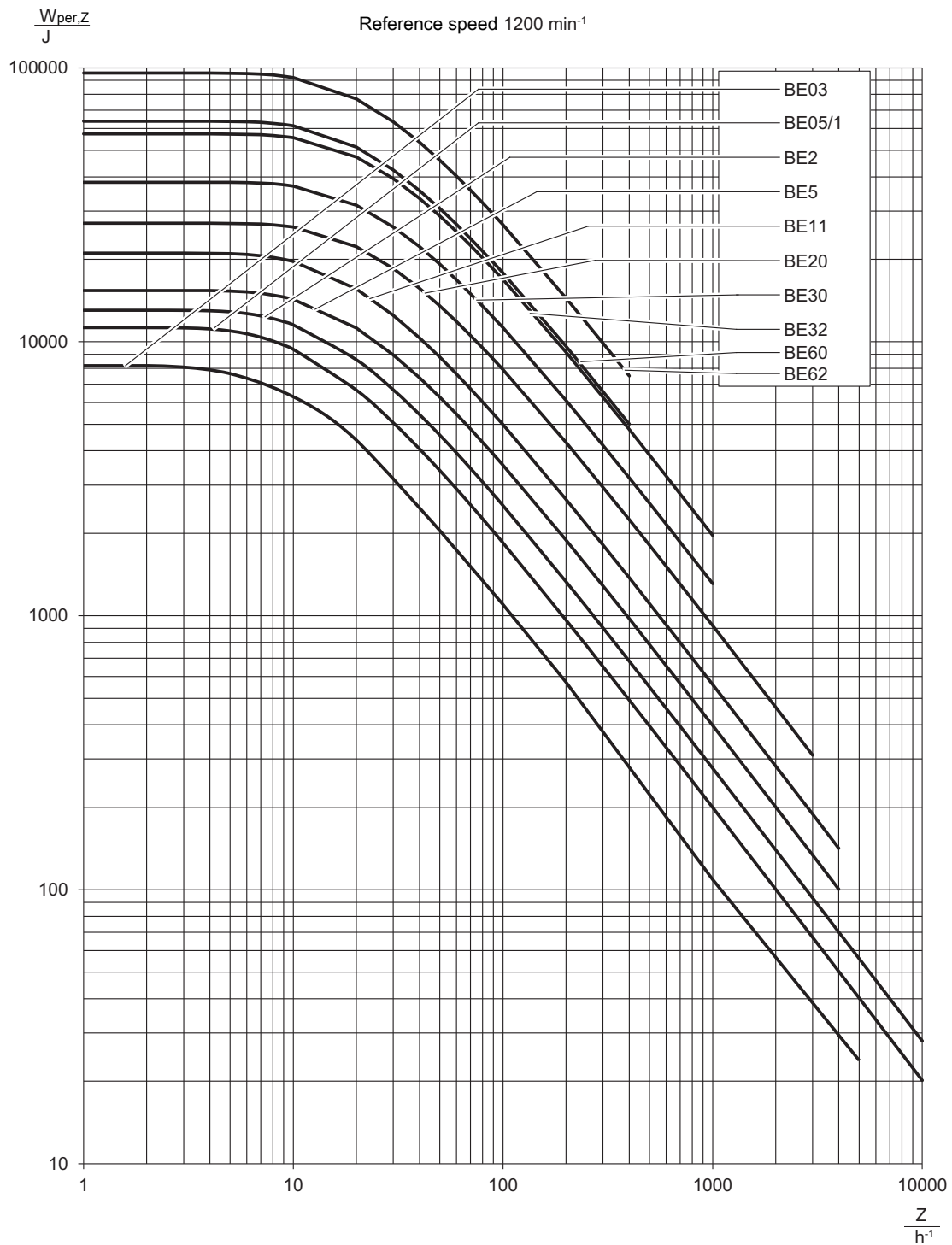
9.5.1 Braking from operating speed – load range S, 6 motor poles, 50 Hz



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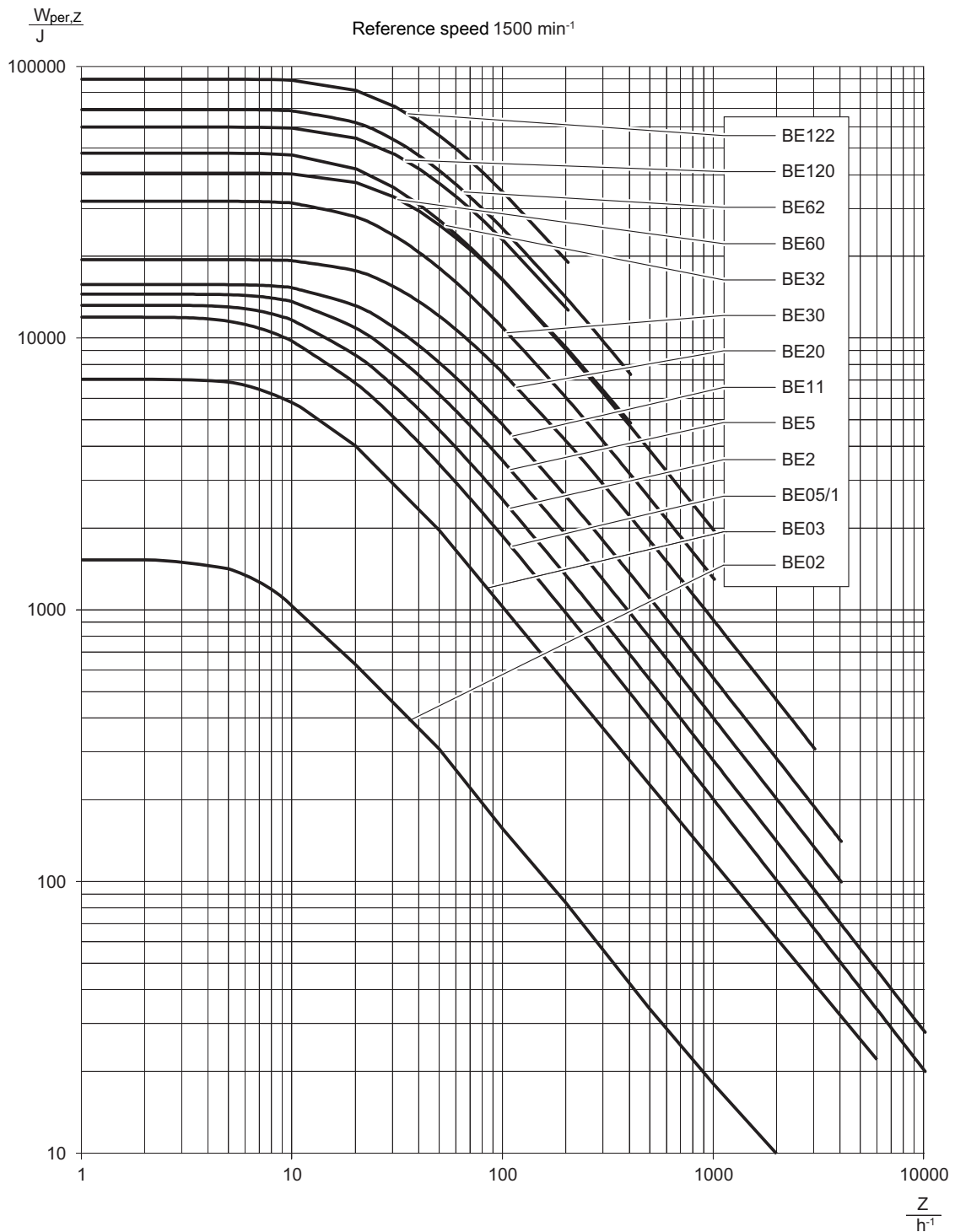
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9.5.2 Braking from operating speed – load range S, 6 motor poles, 60 Hz



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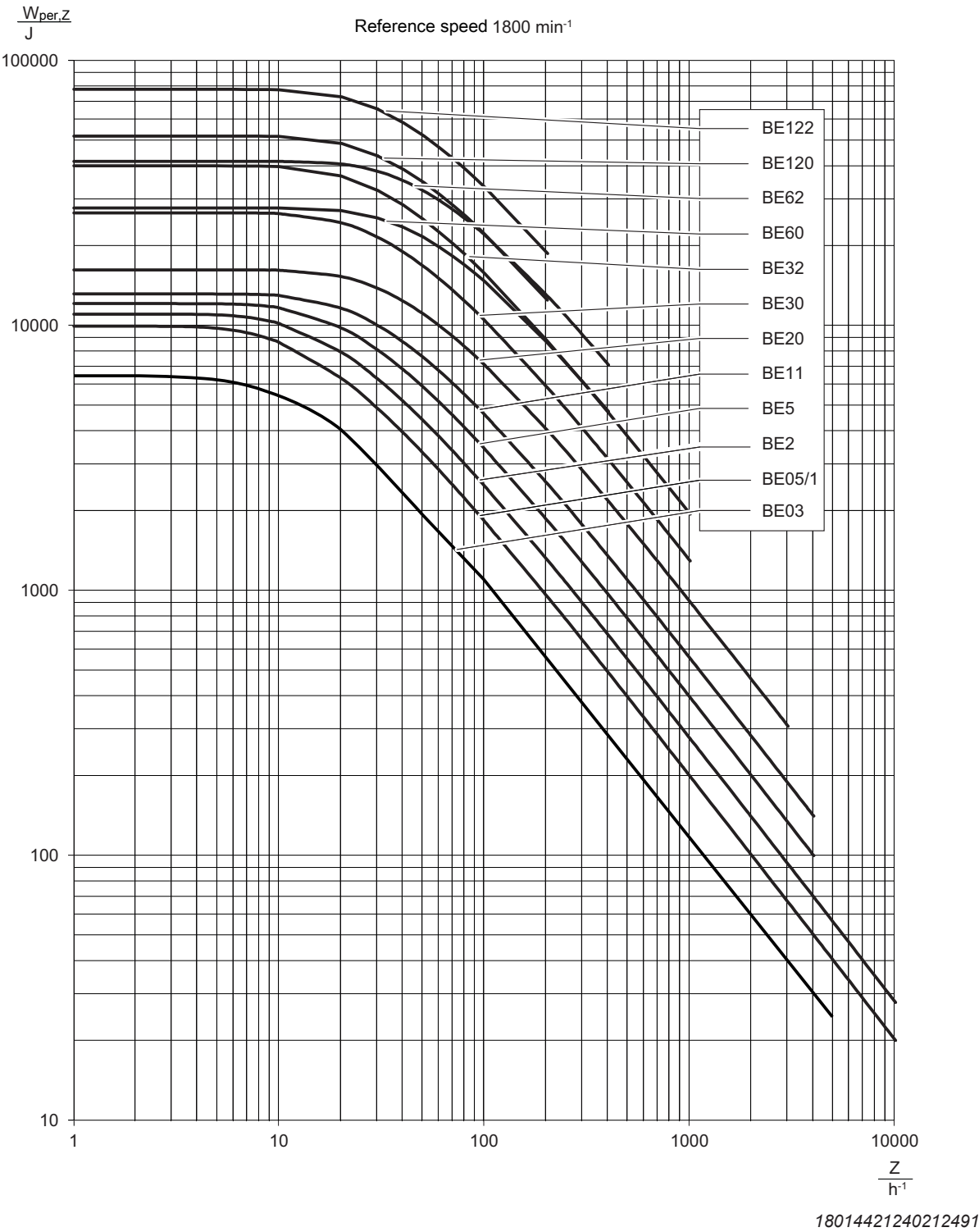
9.5.3 Braking from operating speed – load range S, 4 motor poles, 50 Hz



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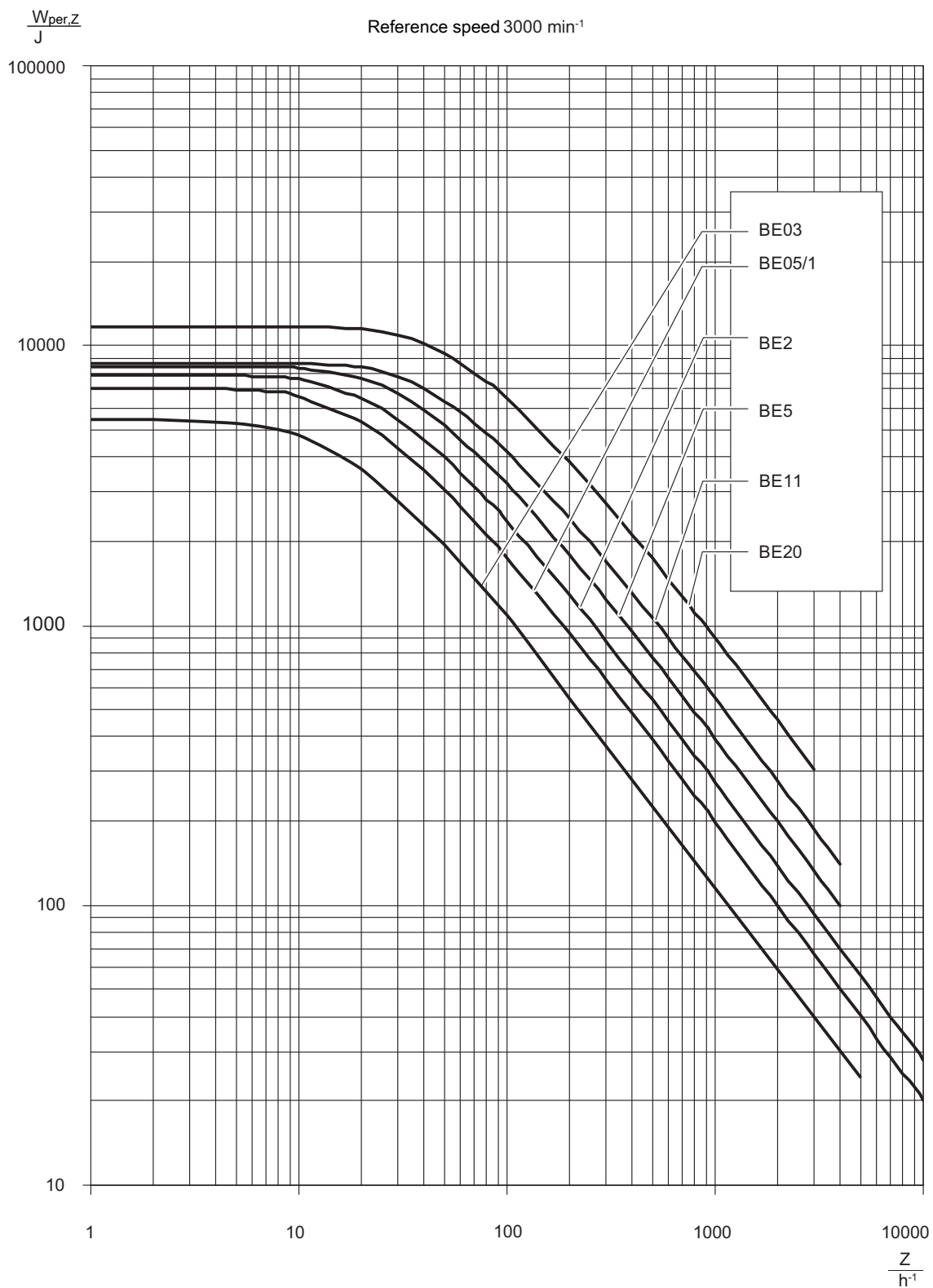
9.5.4 Braking from operating speed – load range S, 4 motor poles, 60 Hz



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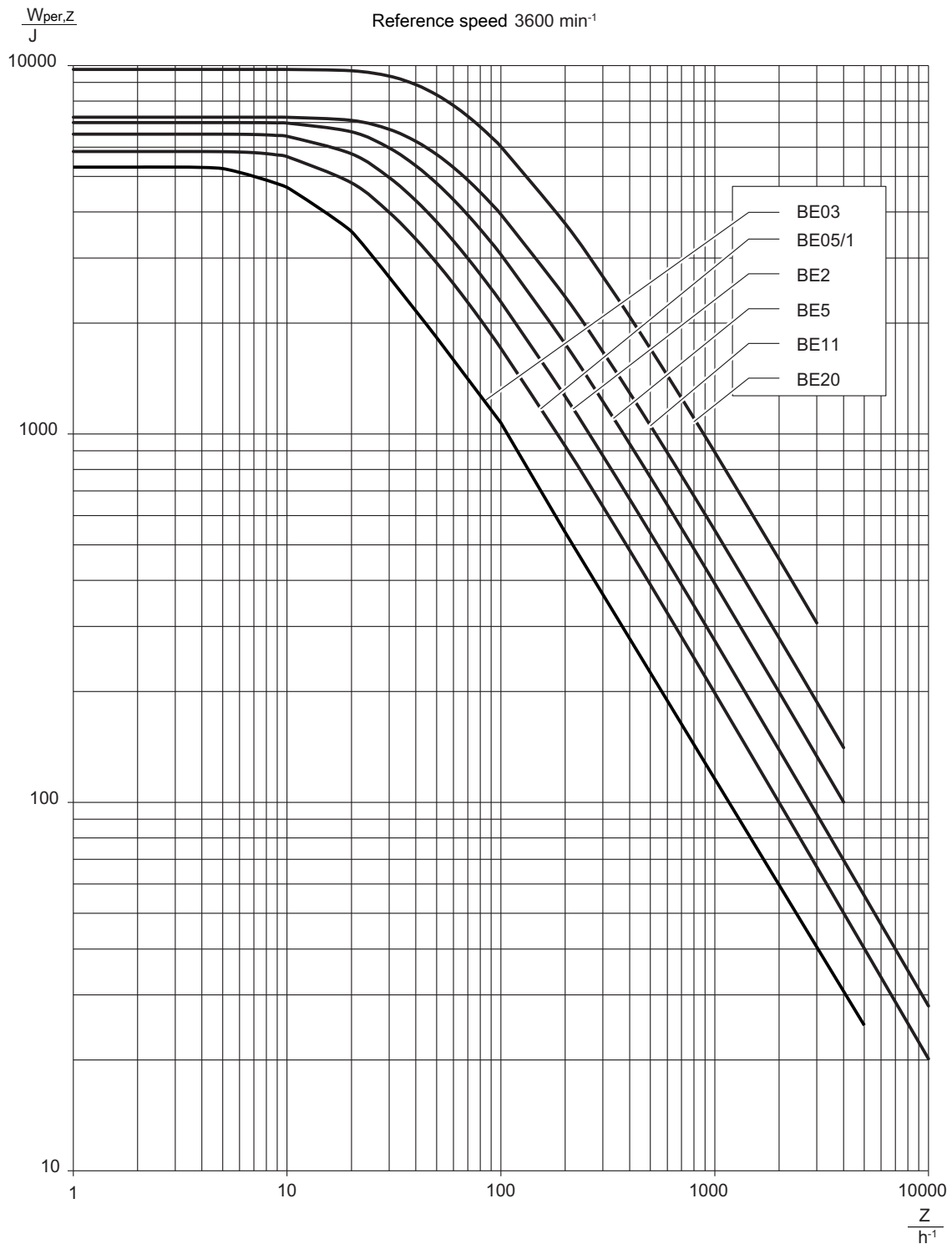
9.5.5 Braking from operating speed – load range S, 2 motor poles, 50 Hz

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

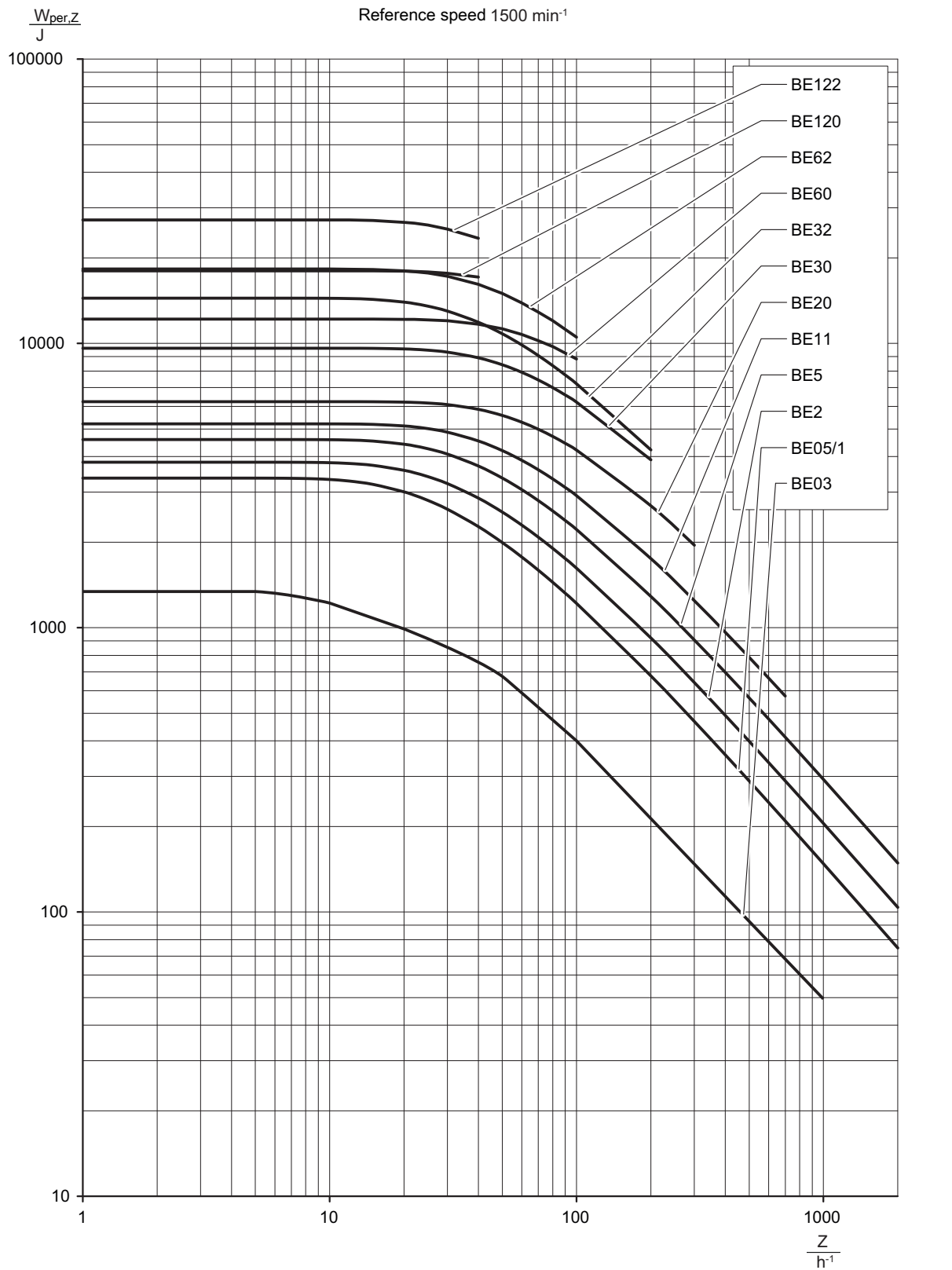


9.5.6 Braking from operating speed – load range S, 2 motor poles, 60 Hz

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

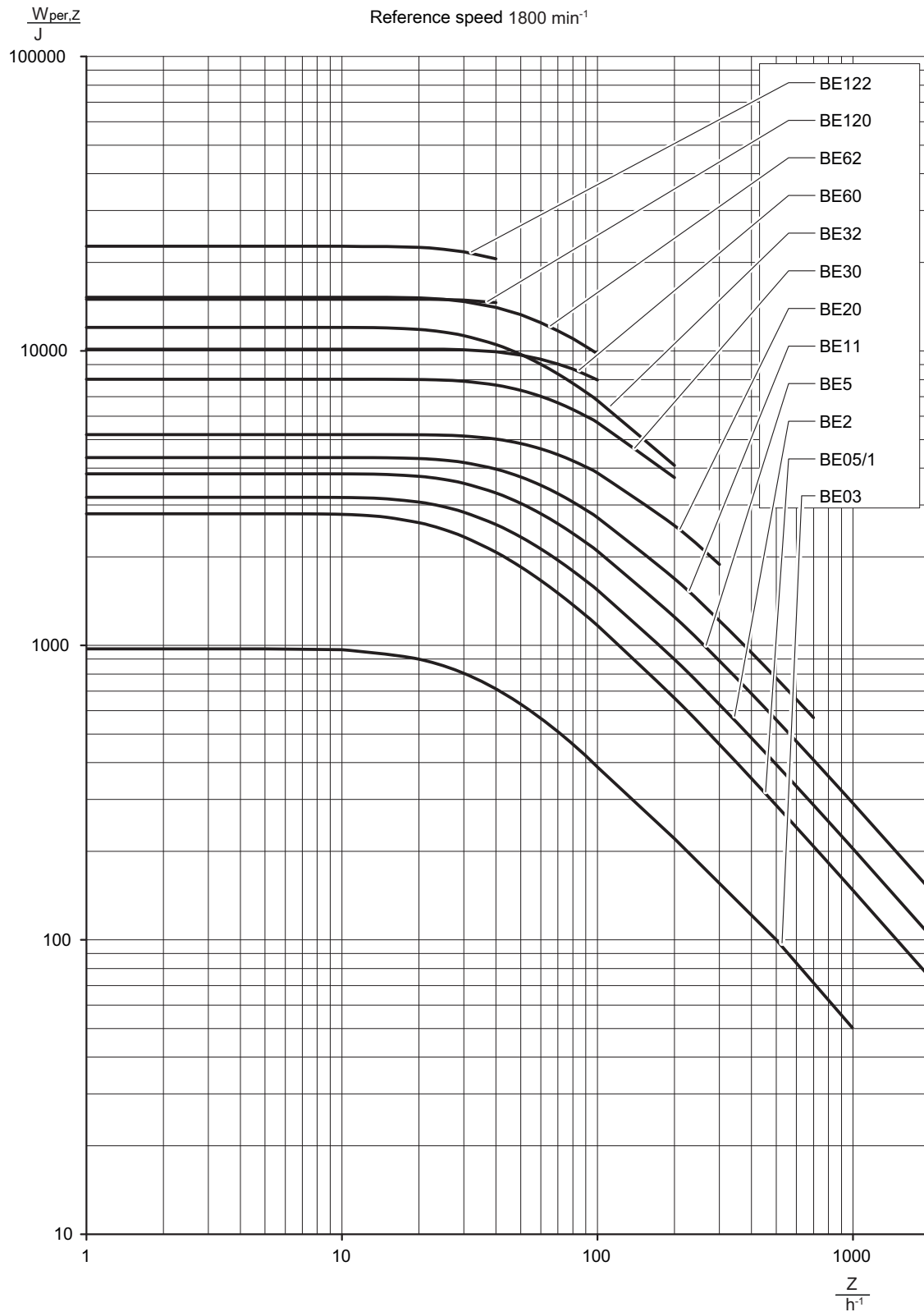


9.5.7 Braking from operating speed – load range R, 4 motor poles, 50 Hz



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9.5.8 Braking from operating speed – load range R, 4 motor poles, 60 Hz



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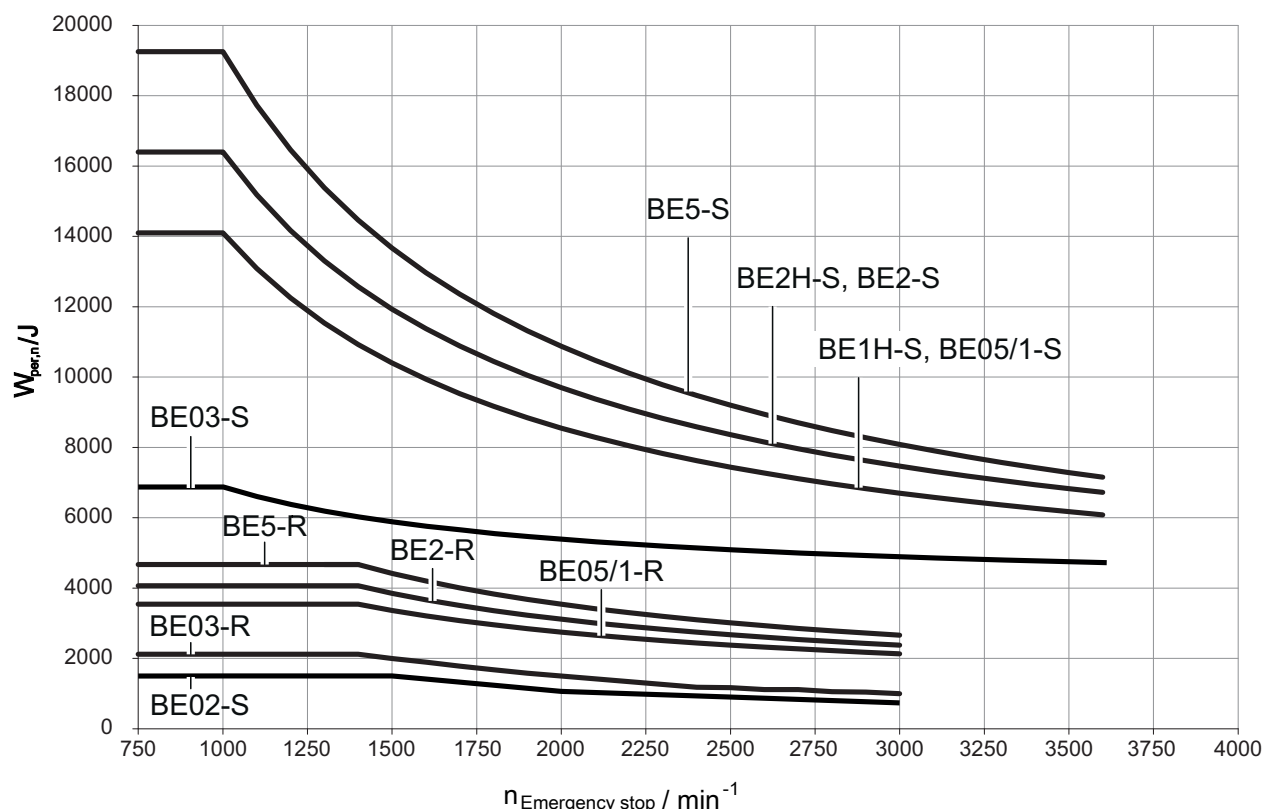
9.6 Permitted emergency-stop braking work $W_{zul, n}$

The following table contains references to the permitted emergency stop braking operations $W_{zul, n}$. Depending on the load range, the permitted braking work is shown in a diagram for all brake sizes together.

Brake		Load range	Area
BE..	BE02	S	(→ 121)
	BE03 – BE5	R, S	(→ 121)
	BE11	R, S, A, B, C, D	(→ 123)
	BE20	R, S, A, B, C, D	(→ 125)
	BE30	R, S, A, B, C, D, H	(→ 127)
	BE32	R, S, A, B, C, D, H	(→ 129)
	BE60, BE62	R, S, D	(→ 131)
	BE120, BE122	R, S, D	(→ 132)
BE.H	BE1H, BE2H	S	(→ 121)

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

9.6.1 BE02 – BE5 (load ranges R and S)

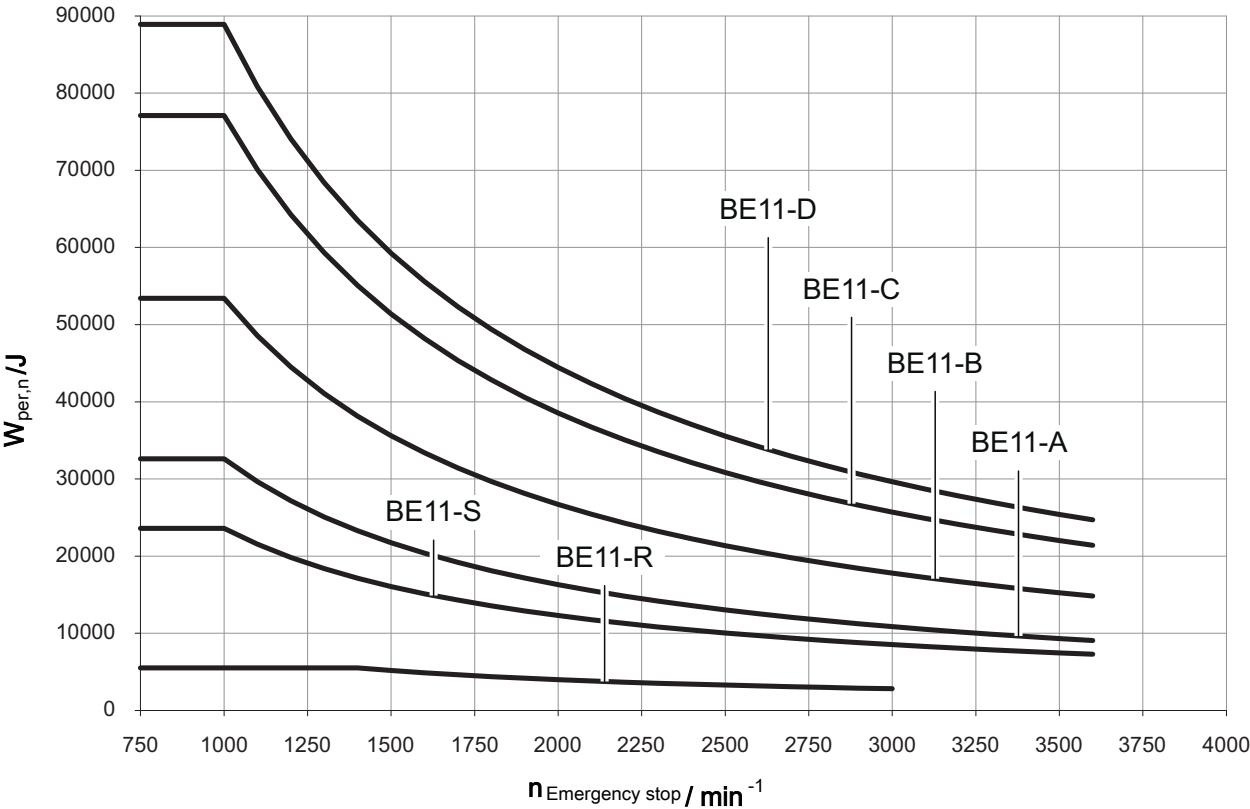


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	BE..					BE.H		BE..				
	BE02	BE03	BE05/1	BE2	BE5	BE1H	BE2H	BE02	BE03	BE05/1	BE2	BE5
	Load range S							Load range R				
n_{Nohalt} in min^{-1}	$W_{per,n}$ in J											
800	1500	6880	14100	16400	19300	14100	16400	—	2140	3450	3910	4480
1000	1500	6880	14100	11700	19300	14100	16400	—	2140	3450	5470	4480
1100	1500	6610	13100	15200	17700	13100	15200	—	2140	3450	5470	4480
1200	1500	6380	12300	14200	16500	12300	14200	—	2140	3450	3910	4480
1300	1500	6190	11500	13300	15400	11500	13300	—	2140	3450	2190	4480
1400	1500	6030	10900	12600	14500	10900	12600	—	2140	3450	3910	4480
1500	1500	5890	10400	11900	13700	10400	11900	—	2000	3290	3720	4240
1600	1410	5760	9940	11400	13000	9940	11400	—	1880	3150	3560	4030
1700	1320	5650	9530	10900	12400	9530	10900	—	1760	3020	3410	3840
1800	1250	5560	9170	10400	11800	9170	10400	—	1670	2910	3280	3680
1900	1180	5470	8840	10100	11300	8840	10100	—	1580	2820	3170	3530
2000	1130	5390	8550	9700	10900	8550	9700	—	1500	2730	3070	3390
2100	1070	5320	8290	9380	10500	8290	9380	—	1430	2650	2970	3270
2200	1020	5250	8050	9090	10100	8050	9090	—	1360	2580	2890	3160

	BE..					BE.H		BE..				
	BE02	BE03	BE05/1	BE2	BE5	BE1H	BE2H	BE02	BE03	BE05/1	BE2	BE5
	Load range S							Load range R				
n_{Nohalt} in min^{-1}	$W_{per,n}$ in J											
2300	980	5200	7830	8830	9780	7830	8830	–	1300	2510	2810	3060
2400	940	5140	7630	8580	9480	7630	8580	–	1250	2450	2740	2970
2500	900	5090	7440	8360	9200	7440	8360	–	1200	2390	2670	2880
2600	870	5050	7270	8150	8940	7270	8150	–	1150	2340	2610	2810
2700	830	5000	7110	7960	8700	7110	7960	–	1110	2290	2560	2730
2800	800	4960	6960	7790	8480	6960	7790	–	1070	2250	2500	2670
2900	780	4930	6830	7620	8280	6830	7620	–	1030	2210	2460	2600
3000	750	4890	6700	7470	8080	6700	7470	–	1000	2170	2410	2550
3100	730	4860	6580	7320	7900	6580	7320	–	–	–	–	–
3200	700	4830	6470	7190	7730	6470	7190	–	–	–	–	–
3300	680	4800	6360	7060	7580	6360	7060	–	–	–	–	–
3400	660	4780	6260	6940	7430	6260	6940	–	–	–	–	–
3500	640	4750	6170	6830	7290	6170	6830	–	–	–	–	–
3600	630	4730	6080	6720	7150	6080	6720	–	–	–	–	–

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



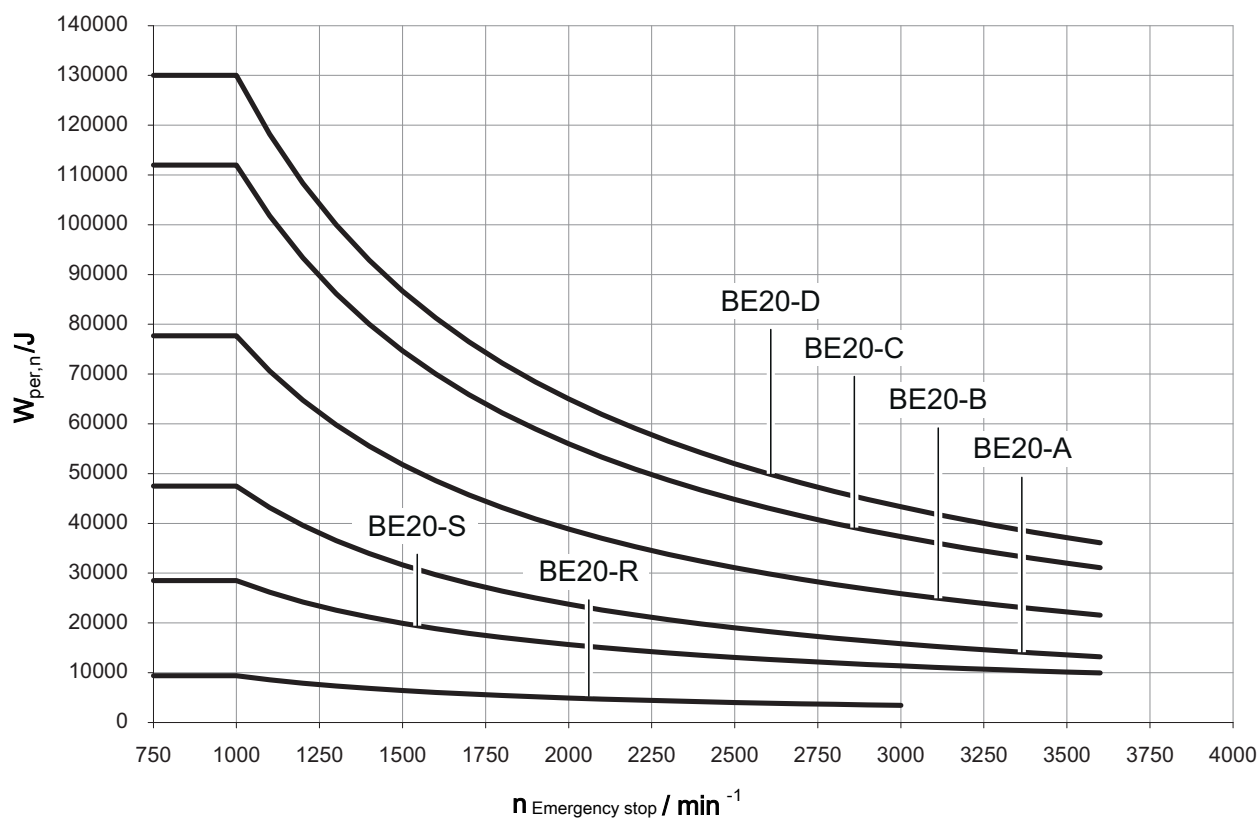
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	BE11					
	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D
$n_{Nothalt}$ in min^{-1}	$W_{zul,n}$ in J					
750	5360	23600	32600	53400	77100	88900
900	5360	23600	32600	53400	77100	88900
1000	5360	23600	32600	53400	77100	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

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	BE11					
	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D
$n_{Nothalt}$ in min^{-1}	$W_{zul,n}$ in 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

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



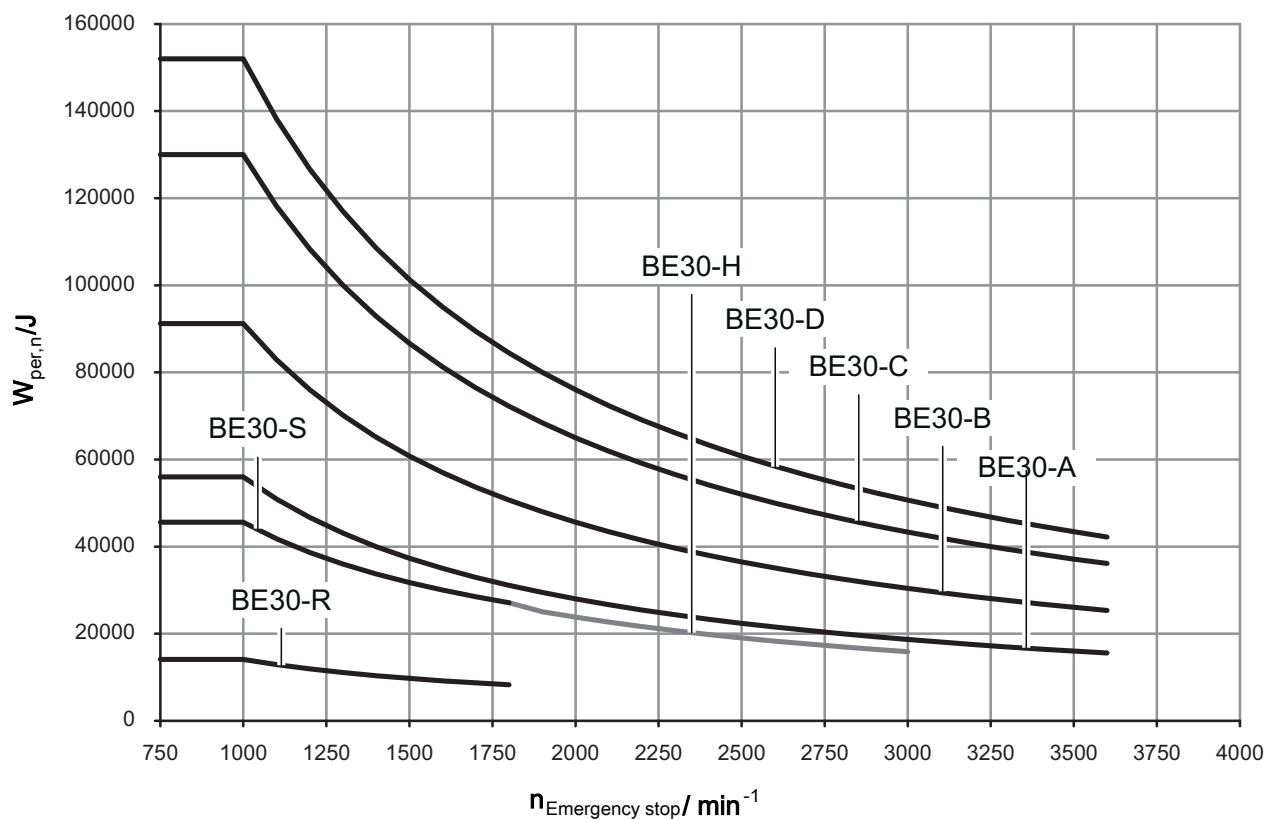
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	BE20					
	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D
n_{Nothalt} in min^{-1}	$W_{zul, n}$ in J					
750	9240	28500	47500	77700	112000	130000
900	9240	28500	47500	77700	112000	130000
1000	9240	28500	47500	77700	112000	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

	BE20					
	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D
$n_{Nothalt}$ in min^{-1}	$W_{zul,n}$ in 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

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

Note: 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 fulfill project planning requirements (see formula 2.1).



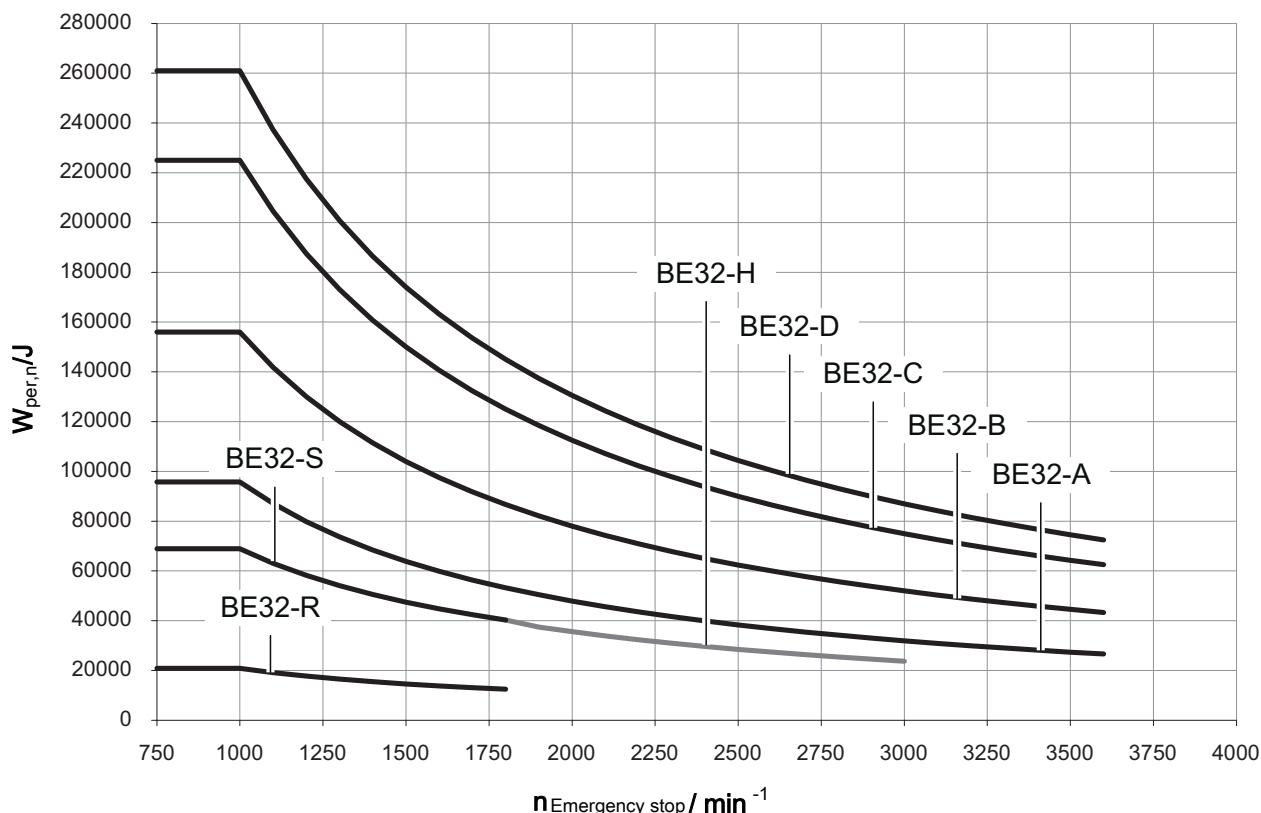
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	BE30						
	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D	Load range H
$n_{Nothalt}$ in min^{-1}	$W_{zul, n}$ in J						
750	14100	45600	56000	91200	130000	152000	–
900	14100	45600	56000	91200	130000	152000	–
1000	14100	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	–
1800	7920	27100	31100	50700	72200	84400	27100
1900	–	–	29500	48000	68400	80000	25700

	BE30						
	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D	Load range H
$n_{Nothalt}$ in min^{-1}	$W_{zul, n}$ in J						
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	–

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

Note: 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 fulfill project planning requirements (see formula 2.1).

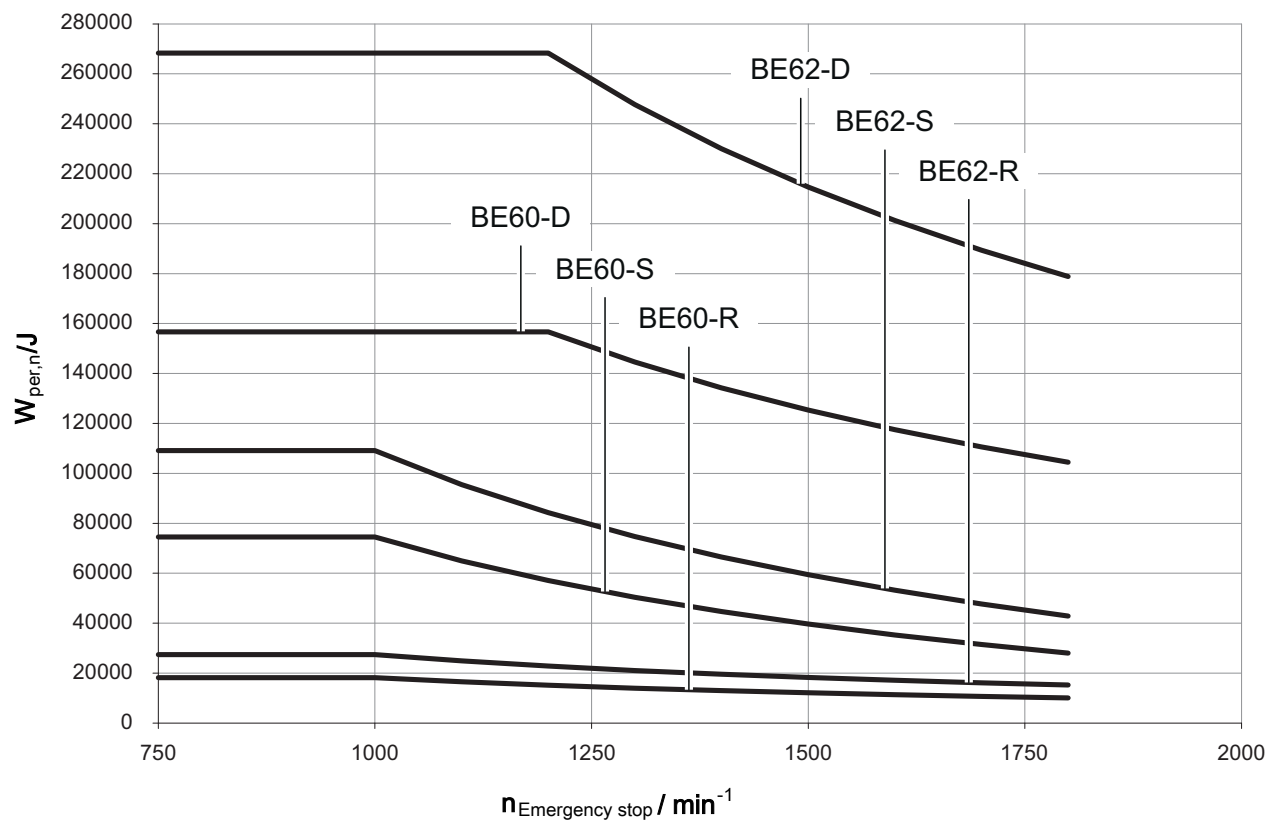


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	BE32						
	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D	Load range H
$n_{Nothalt}$ in min^{-1}	$W_{zul, n}$ in J						
750	21300	69000	95800	156000	225000	261000	–
900	21300	69000	95800	156000	225000	261000	–
1000	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	–
1800	11900	40300	53200	86700	125000	145000	40300
1900	–	–	50400	82100	118000	137000	38200

	BE32						
	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D	Load range H
$n_{Nothalt}$ in min^{-1}	$W_{zul, n}$ in J						
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	—

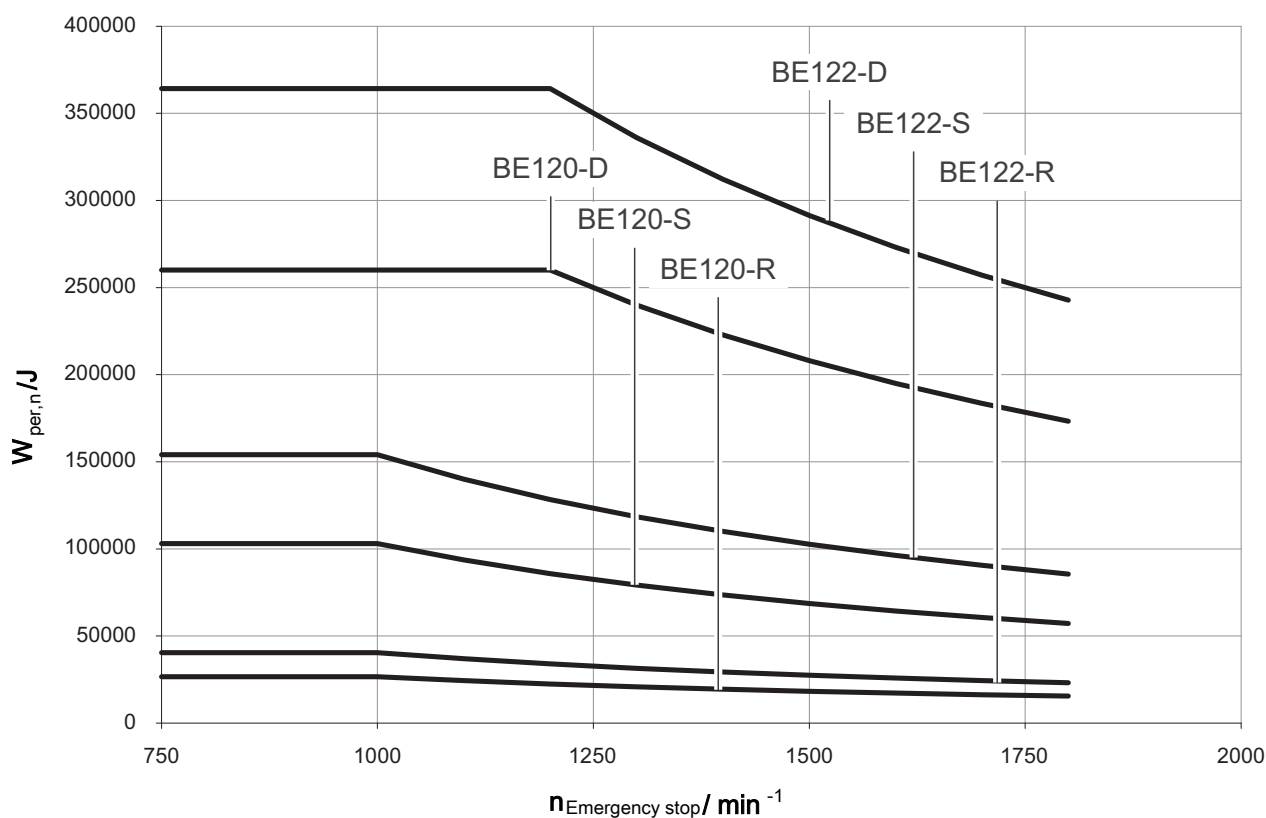
9.6.6 BE60 – BE62 (load ranges R, S, D)



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	BE60			BE62		
	Load range R	Load range S	Load range D	Load range R	Load range S	Load range D
$n_{Nothalt}$ in min^{-1}	$W_{zul, n}$ in 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

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



9007221974811147

	BE120			BE122		
	Load range R	Load range S	Load range D	Load range R	Load range S	Load range D
$n_{Nothalt}$ in min^{-1}	$W_{zul,n}$ in 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

9.7 Permitted braking work until maintenance

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

Brake		Braking work until maintenance W_{insp} in 10^6 J			
		FS code			
		– Standard design	FS04, FS07 Brake in combination with safety encoder	FS02 Safety brake	FS11 Safety brake in combination with safety encoder
BE..	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	–	–
BE.H	BE1H	25	25	–	–
	BE2H	35	35	–	–

9.8 Load range-dependent calculation coefficients f_v , f_{Mmin} , f_{Mmax}

Brake	Load range	f_v	f_{Mmin}	f_{Mmax}
		permitted emergency-stop braking operations until maintenance	for calculating the ... maximum braking time and maximum braking distance	minimum braking time and maximum deceleration
BE.. BE.H	R	1	0.9	1.5
	S	1	0.9	1.5
	A	1	0.9	1.5
	B	10	0.8	1.5
	C	50	0.7	1.5
	D	100	0.6	1.5
	A	100	0.7	1.5

9.9 Output factor $f_{\text{brake,output}}$

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

Output design	BE.., BE.H
HW.., HS,.. HK..	1
F..7, K..7, R..7, S..7, W..0, 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

9.10 Permitted cyclic duration factor and thermal breakpoint speed

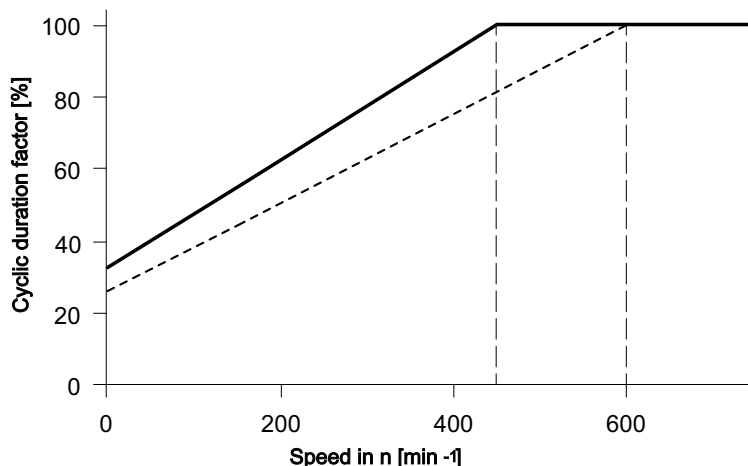
Below is a summary of the current values of the technical data and characteristic values used in the project planning.

The diagrams and tables show the permitted cyclic duration factor of the brake $\text{cdf}_{\text{B,per}}$ depending on the speed and/or frequency and the ambient temperature. The maximum permissible cyclic duration factor above the thermal breakpoint speed $n_{\text{B,th,k}}$ is 100%.

9.10.1 BE03 – BE5 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
450	600

Permitted cyclic duration factor cdf_{B_per} 

35732107915

— Permitted cyclic duration factor cdf_{B_per} at 40 °C, 50 °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

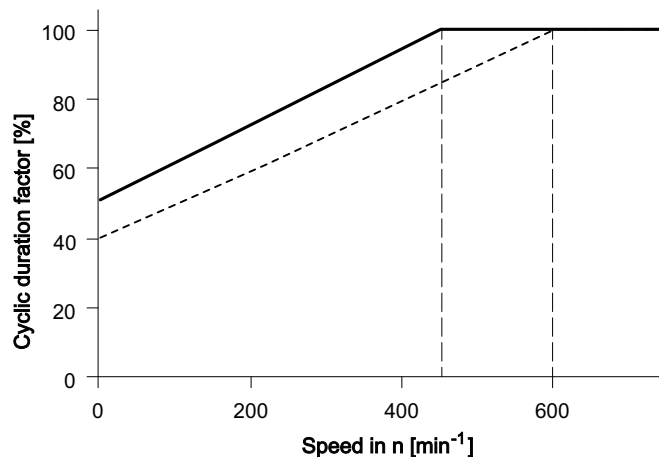
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9.10.2 BE11 – BE32 brake for explosion-protected motors

Thermal breakpoint speed $n_{B_th_k}$

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

Permitted cyclic duration factor cdf_{B_per}



35732418059

— Permitted cyclic duration factor cdf_{B_per} at 40 °C, 50 °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

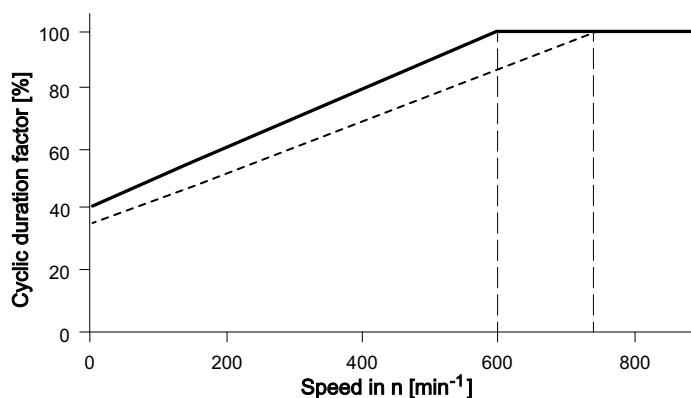
VFC operating data				VFCE operating data			
40 °C, 50 °C		60 °C		40 °C, 50 °C		60 °C	
f in Hz	cdf_{max} in %	f in Hz	cdf_{max} in %	f in Hz	cdf_{max} in %	f in Hz	cdf_{max} in %
< 15	65	< 20	55	< 15	50	< 20	40

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9.10.3 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

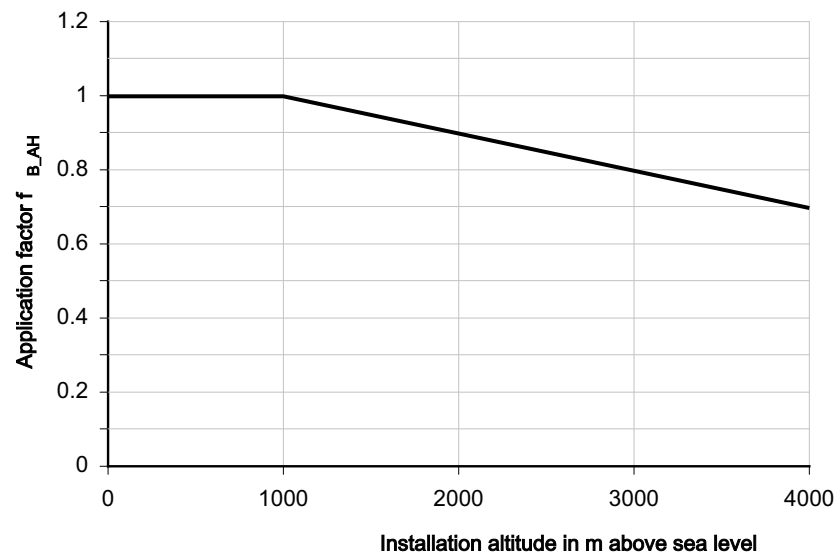
- Permitted cyclic duration factor cdf_{B_per} at 40 °C, 50 °C
 - - - Permitted cyclic duration factor cdf_{B_per} at 60 °C
 - - - Thermal breakpoint speed $n_{B_th_k}$

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	$\text{cdf}_{\max}$ %	f in Hz	$\text{cdf}_{\max}$ in %
< 20	55	< 25	45

9.11 Application factor for installation altitude f_{B_AH}



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9.12 Characteristic safety values

For the characteristic safety values of components from SEW-EURODRIVE, refer to the respective documentation or the SEW-EURODRIVE library for the "SISTEMA" software tool. The documentation and the library are available for download from www.sew-eurodrive.com.

9.12.1 Characteristic safety values for brakes BE.. and BE.H

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	
B10d value	BE02	1.5×10^6
	BE03	20×10^6
	BE05	16×10^6
	BE1 BE1H	12×10^6
	BE2 BE2H	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".

9.12.2 Characteristic safety values for BE.. safety brake

	Characteristic safety values in accordance with EN ISO 13849-1	
Class	Category 1	
System structure	1-channel (Cat. 1)	
Operating mode	High demand	
Safe state	The brake is applied	
Safety subfunctions	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	$0.1 \times MTTF_D$	
$MTTF_D$ 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

9.13 Operating currents

9.13.1 General information on determining operating currents

The tables 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 devices for the current measurement that are suitable for the measurement of effective values.

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
V_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 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 ICR
I_B/I_G	Inrush current ratio ICR for DC 24 V supply with BSG or BMV

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	–

9.13.2 Operating currents of the brakes

BE02, BE03, BE05, BE1, BE1H, BE2, BE2H brakes

	BE02	BE03	BE05, BE1, BE1H	BE2, BE2H
Nominal power brake coil in W	25	25	30	41
Inrush current ratio ICR	4	4	4	4

Nominal voltage (rated voltage range) V _N		BE02		BE03		BE05, BE1, BE1H		BE2, BE2H	
AC V	DC V	I _H AC A	I _G DC A	I _H AC A	I _G DC A	I _H AC A	I _G DC A	I _H AC A	I _G 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

Brakes BE5, BE11, BE20

	BE5	BE11	BE20
Nominal power brake coil in W	50	70	95
Inrush current ratio ESV	5.9	6.6	7.5

Nominal voltage (rated voltage range) V _N		BE5		BE11		BE20	
		I _H		I _H		I _H	
AC V	DC V	AC A	DC A	AC A	DC A	AC A	DC A
60 (57 – 63)	24	1.28	1.57	2.05	2.55	2.55	3.15
120 (111 – 123)	–	0.64	–	1.04	–	1.28	–
184 (174 – 193)	–	0.41	–	0.66	–	0.81	–
208 (194 – 217)	–	0.37	–	0.59	–	0.72	–
230 (218 – 243)	–	0.33	–	0.52	–	0.65	–
254 (244 – 273)	–	0.29	–	0.47	–	0.58	–
290 (274 – 306)	–	0.26	–	0.42	–	0.51	–
330 (307 – 343)	–	0.23	–	0.37	–	0.46	–
360 (344 – 379)	–	0.21	–	0.33	–	0.41	–
400 (380 – 431)	–	0.18	–	0.30	–	0.37	–
460 (432 – 484)	–	0.16	–	0.27	–	0.33	–
500 (485 – 542)	–	0.15	–	0.24	–	0.29	–
575 (543 – 600)	–	0.13	–	0.22	–	0.26	–

Brakes BE30, BE32, BE60, BE62, BE120, BE122

	BE30, BE32	BE60, BE62	BE120, BE122
Nominal power brake coil in W	120	195	220
Inrush current ratio ICR	8.5	9.2	6

Nominal voltage (rated voltage range) V _N	BE30, BE32	BE60, BE62	BE120, BE122
	I _H	I _H	I _H
AC V	AC A	AC A	AC A
60 (57 – 63)	–	–	–
120 (111 – 123)	1.66	–	–
184 (174 – 193)	1.05	–	–
208 (194 – 217)	0.94	1.50	–
230 (218 – 243)	0.84	1.35	1.45
254 (244 – 273)	0.75	1.20	1.30
290 (274 – 306)	0.67	1.12	1.16
330 (307 – 343)	0.59	0.97	–
360 (344 – 379)	0.53	0.86	0.92
400 (380 – 431)	0.47	0.77	0.82
460 (432 – 484)	0.42	0.68	0.73
500 (485 – 542)	0.38	0.60	0.65
575 (543 – 600)	0.34	0.54	0.58

Operating currents with BG1Z

The following tables show the operating currents of the BE.. and BE.H 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:

U_N Nominal voltage (rated voltage range) of the brake in V (AC or DC)

I_H Nominal holding current of the brake in A (AC or DC). Effective value of the current in the supply cable to the SEW-EURODRIVE brake control

I_B Acceleration current in A (AC or DC) when operated with an SEW-EURODRIVE brake control for high-speed excitation

I_B/I_H Inrush current ratio ESV

	BE03	BE05	BE1	BE1H	BE2	BE2H	BE5	BE11	BE20	BE30	BE32	BE60	BE62
Inrush current ratio ESV	3.9	3.4	4.2	4.2	4.5	4.5	2.9	3.6	3.5	3.9	3.9	3.0	3.0

Rated voltage (rated voltage range) U_N	BE03	BE05	BE1	BE1H	BE2	BE2H	BE5	BE11	BE20	BE30	BE32	BE60	BE62
	Nominal holding current I_H												
AC V	AC A												
200 V to 500 V	0.06	0.08	0.08	0.08	0.09	0.09	0.15	0.35	0.40	0.48	0.48	0.52	0.52

9.14 Brake controls

9.14.1 Brake controls with supply from AC voltage supply systems

Brake control	Function	Voltage	Holding current I_{H_max} A	Type	Part number	Color code
BME..	Half-wave rectifier with electronic switching	AC 150 to 500 V	1.5	BME 1.5	08257221	Vermilion
		AC 42 to 150 V	3.0	BME 3	0825723X	Light blue
BMH..	Half-wave rectifier with electronic switching and heating function	AC 150 to 500 V	1.5	BMH 1.5	0825818X	Green
		AC 42 to 150 V	3	BMH 3	08258198	Yellow
BMP..	Half-wave rectifier with electronic switching, integrated voltage relay for cut-off in the DC circuit	AC 150 to 500 V	1.5	BMP 1.5	08256853	Light gray
		AC 42 to 150 V	3.0	BMP 3	08265666	Light green
BMK..	Half-wave rectifier with electronic switching, DC 24 V control input, and cut-off in the DC circuit	AC 150 to 500 V	1.5	BMK 1.5	08264635	Water blue
		AC 42 to 150 V	3.0	BMK 3	08265674	Light pink
BMKB..	Half-wave rectifier with electronic switching, DC 24 V control input, cut-off in the DC circuit, and a diode to display the control voltage	AC 150 to 500 V	1.5	BMKB 1.5	08281602	Water blue

9.14.2 Brake controls with supply from DC voltage supply systems

Brake control	Function	Voltage	Holding current I_{H_max} A	Type	Part number	Color code
BSG..	Control unit for DC 24 V connection with electronic switching	DC 24 V	5.0	BSG	08254591	Pure white
BMV..	Electronic switching, DC 24 V control input and cut-off in the DC circuit	DC 24 V	5.0	BMV	13000063	Pure white

9.14.3 Brake controls with supply through frequency inverter

Brake control	Function	Voltage supply V_Z DC V	Rated output voltage V_N (rated range)	Rated output current I_N DC A	Rated output power P_A W	Part number
BST0.6S-460V-00	Safe brake control with electronic switching, DC 24 V control input and safe DC 24 V control input. Supply via the DC link of the inverter	350 – 750	AC 460 V (DC 171 – 209 V)	0.6	120	08299714
BST0.7S-400V-00			AC 400 V (DC 150 – 184V)	0.7		13000772
BST1.2S-230V-00			AC 230 V (DC 86 – 106V)	1.2		13001337
BST0.6S-460V-0B	Safe brake control with electronic switching, DC 24 V control input and safe DC 24 V control input. Supply via the DC link of the inverter. With additional TF/TH terminal	350 – 750	AC 460 V (DC 171 – 209 V)	0.6	120	18255191
BST0.7S-400V-0B			AC 400 V (DC 150 – 184V)	0.7		18255205
BST1.2S-230V-0B			AC 230 V (DC 86 – 106V)	1.2		18255213

Brake control	Function	Voltage supply V_Z DC V	Rated output voltage V_N (rated range)	Rated output current I_N DC A	Rated output power P_A W	Part number
SBM S-230-120-00 (size 1)	Safe brake control with electronic switching, control input (DC 24 V), safe control input (DC 24 V), and status feedback (DC 24 V). Supply via the DC link of the inverter.	250 – 800	AC 230 V (DC 90 – 98 V)	1.28	120	28277171
SBM S-400-120-00 (size 1)			AC 400 V (DC 158 – 170 V)	0.73		28277198
SBM S-460-120-00 (size 1)			AC 460 V (DC 181 – 194 V)	0.62		28277201

Brake control	Function	Voltage supply V_z	Rated output voltage V_N (rated range)	Rated output current I_N	Rated output power P_A	Part number
		DC V		DC A	W	
SBM S-230-250-00 (size 2)	Safe brake control with electronic switching, control input (DC 24 V), safe control input (DC 24 V), and status feedback (DC 24 V). Supply via the DC link of the inverter.	250 – 800	AC 230 V (DC 90 – 98 V)	2.66	250	28277732
SBM S-400-250-00 (size 2)			AC 400 V (DC 158 – 170 V)	1.52		28277848
SBM S-460-250-00 (size 2)			AC 460 V (DC 181 – 194 V)	1.33		28277864

9.14.4 Integrated MOVILINK® DDI brake control

For descriptions of the integrated MOVILINK® DDI brake control, e.g. BS1Z, BG1Z, refer to the addendum of the operating instructions of the motor with MOVILINK® DDI interface.

10 Contacting SEW-EURODRIVE

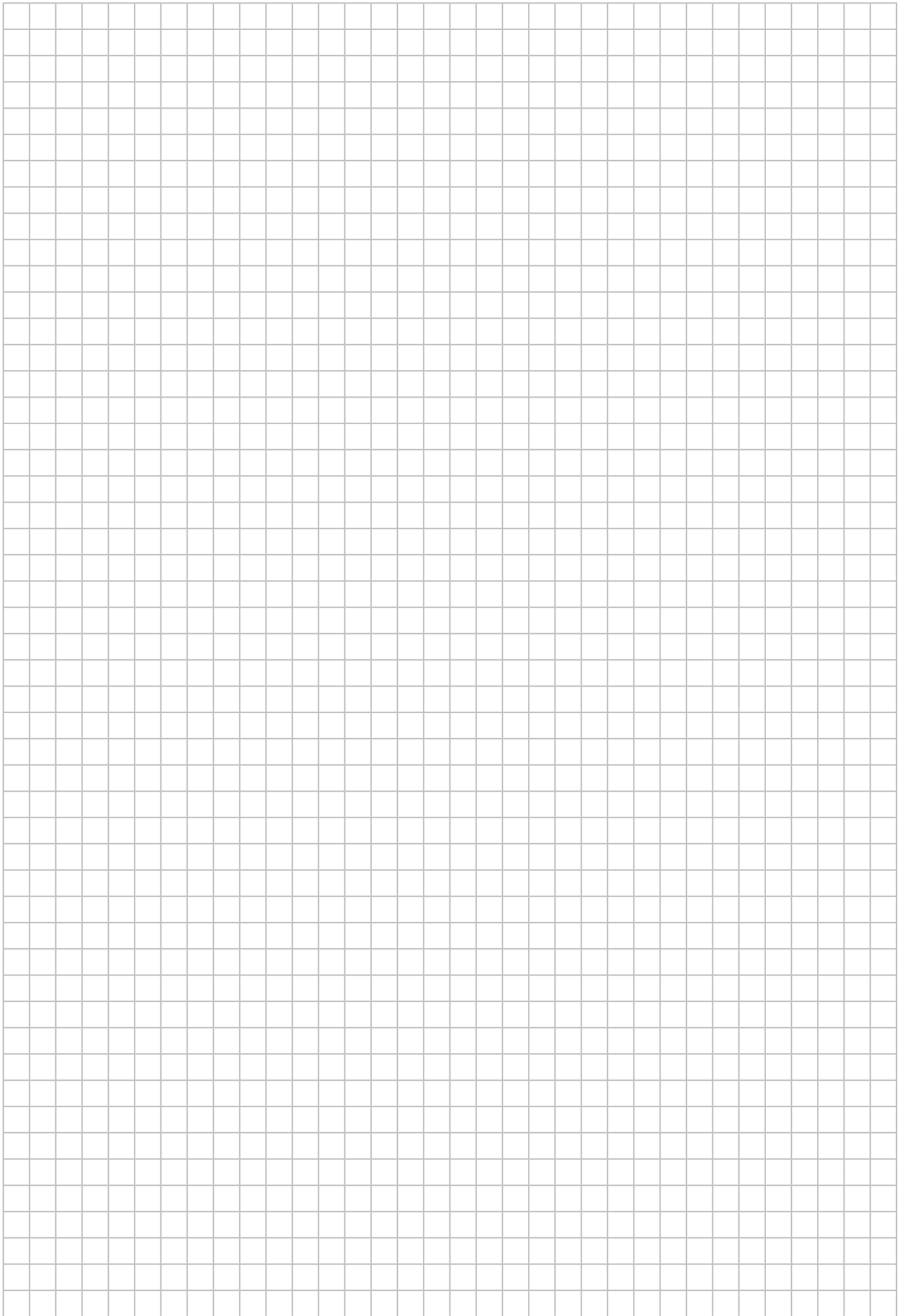
You can find the worldwide contact data and locations on the **SEW-EURODRIVE website** via the following link or the QR code shown below.

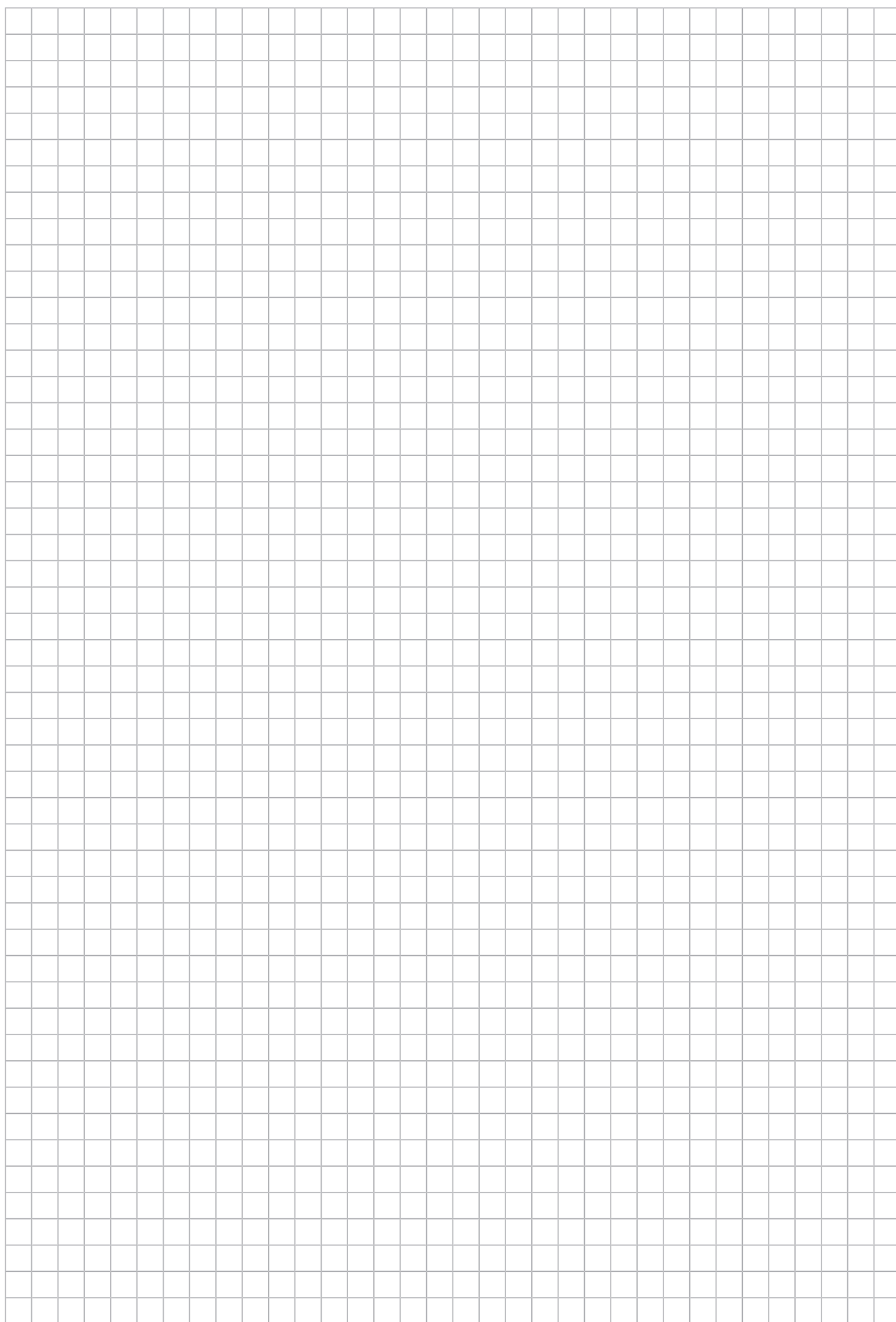
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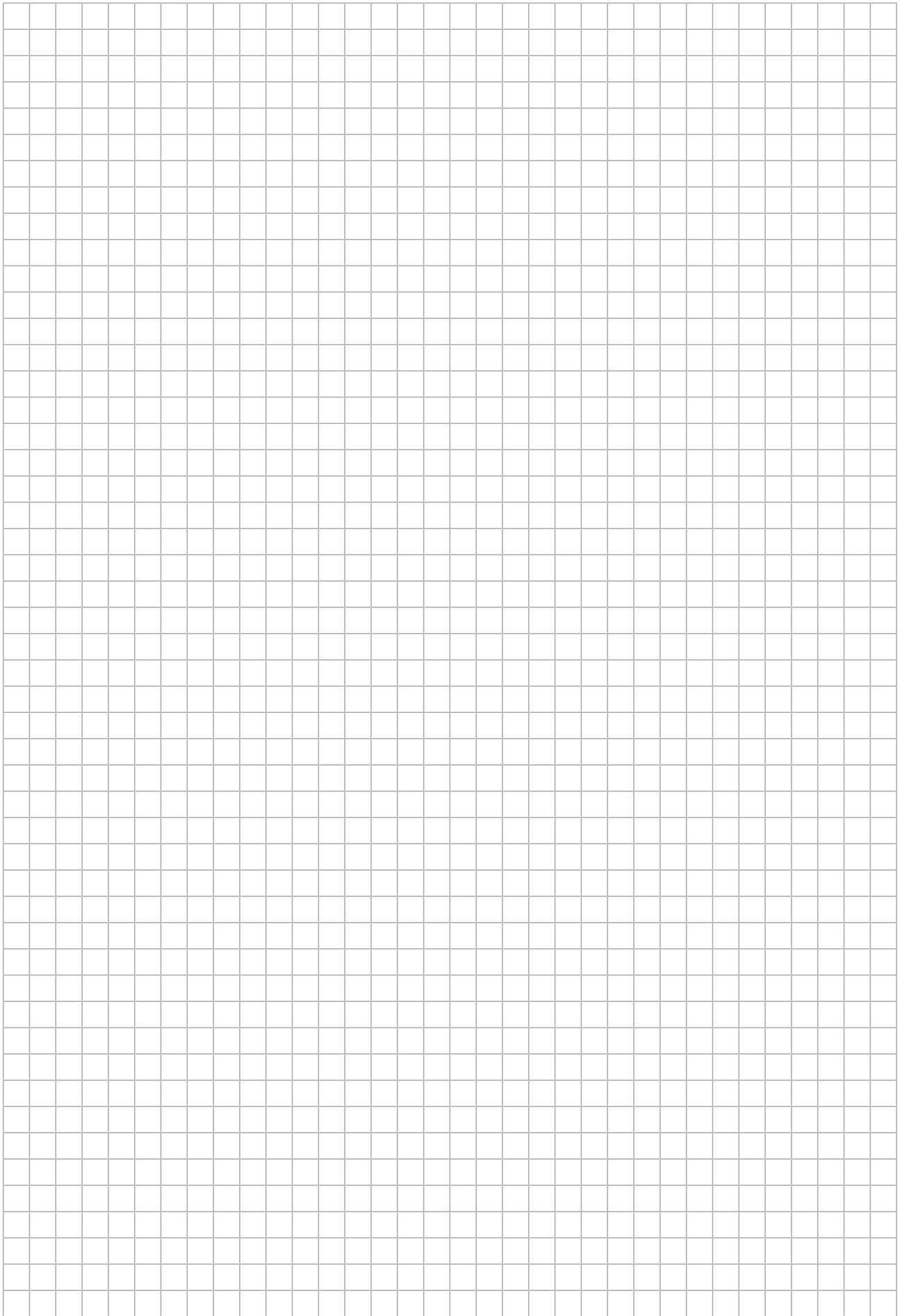


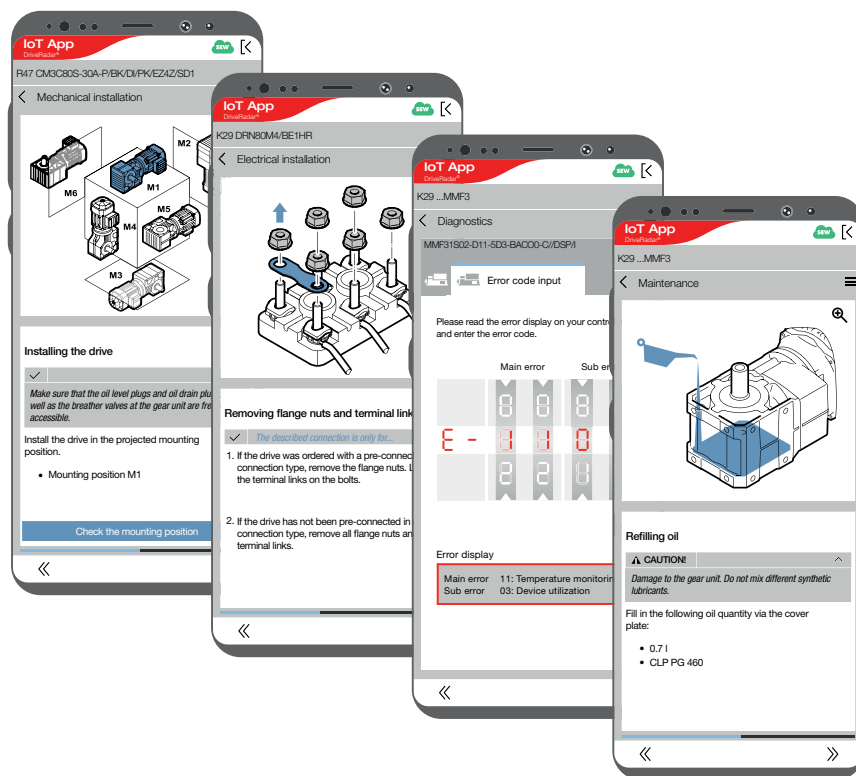
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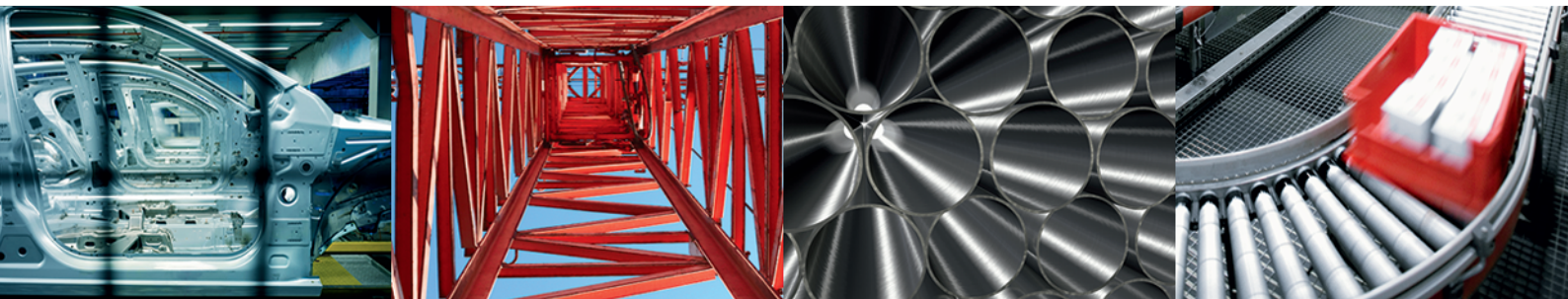


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