Manual

DR.., DRN.., DR2.., EDR.., EDRN.. AC Motors

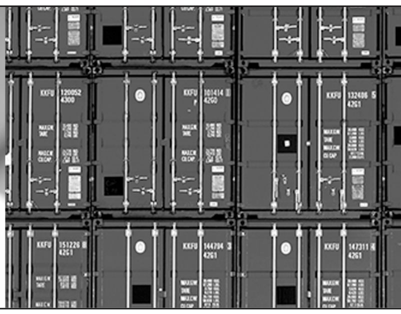
Project Planning for BE.. Brakes

Standard Brake/Safety Brake

Edition 03/2019

25926675/EN



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1 Introduction

1.1 Contents and purpose of this documentation

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

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

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

Make sure you always use the latest edition of this documentation.

The SEW-EURODRIVE homepage (www.sew-eurodrive.com) provides a broad selection of technical documentation downloads in various languages. You can also order the printed documentation from SEW-EURODRIVE.

If you are unclear about any of the information in this documentation, or if you require further information, contact SEW-EURODRIVE.

1.2 Additional documentation

You can find all the brake information required for project planning in the chapters of this manual.

Refer to the following SEW-EURODRIVE catalogs for the required gear unit and motor data.

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

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

1.3 Product names and trademarks

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

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1.4 Copyright notice

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2 Functional safety

2.1 General

When implementing safety functions in machines, the components have to be evaluated regarding their suitability for implementing a safety function.

When using a safety brake from SEW-EURODRIVE, the following safety-related requirements, e.g. according to EN ISO 13849 – parts 1 and 2, are already considered:

- Application of basic safety principles
- Application of proven safety principles
- Information on the characteristic safety value B_{10d}
- Common Cause Failure (CCF)
- Notice of influences and ambient conditions
- Determination of the category (Cat.)
- Retraceability by the unique motor assignment
- Production monitoring with 100% final inspection
- Compliance with normative requirements regarding documentation

For safety brakes, SEW-EURODRIVE has already solved this safety-related requirement as an advantage for the machine designer. The machine designer can rely on the manufacturer confirmation (e.g. through product documentation or TÜV certificate) in his safety-related overall evaluation and considerably reduce own efforts for evaluation and documentation of a brake.

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

2.2 FS mark

Motors from SEW-EURODRIVE are optionally available with functionally safe motor options. These are designed for implementation of safety functions.

The documentation designates the respective functional safety design explicitly as safety encoder plus "type designation" or safety brake plus "type designation".

SEW-EURODRIVE labels a functionally safe motor option at 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 allows to uniquely identify an available functionally safe motor option via the motor nameplate.

FS logo	Available functionally safe motor option		
	Decentralized inverters	Safety brake	Safety encoder
FS 01	X		
FS 02		X	
FS 04			X

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FS logo	Available functionally safe motor option		
	Decentralized inverters	Safety brake	Safety encoder
FS 07	X		X
FS 11		X	X

If the FS logo, e.g. with the code "FS-11", is present on the motor nameplate, the combination of safety encoder and safety brake is available at the motor. If an FS logo is available, adhere to the information specified in the corresponding documentation.

2.3 Underlying standards

The safety assessment is based on the following standard and safety class:

Safety brakes	
Safety class/underlying standard	Category (Cat.) according to EN ISO 13849-1

Safety class SIL 3 or PL e can be achieved if a suitable functionally safe motor option is integrated into a safety system. The requirements (e.g. on the system architecture, the required diagnostics, if necessary, and the characteristic safety values) are to be implemented in accordance with the normative specifications and with this documentation.

2.4 TÜV certification

The following certificate is available for the described safety brakes:

- Certificate of the TÜV NORD Systems GmbH & Co. KG

The TÜV certificate is available for download on the SEW-EURODRIVE website (www.sew-eurodrive.de).

2.5 Safety functions of the safety brake

The implementation of a safety function with brakes requires that the brake is 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 BE.. safety brake into a safe overall system, the following safety functions can be implemented:

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

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INFORMATION

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

The implementation of the SBA and SBH safety functions additionally require the safety functions SBC and STO in the overall system. 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 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 functions must at least meet the required performance level (PLr) of the application.

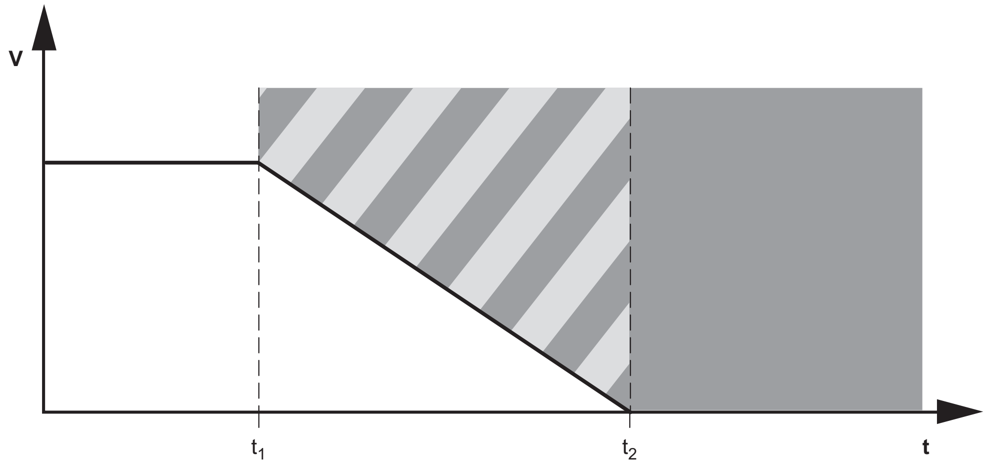
SEW-EURODRIVE recommends to stop the drive using the stop category 1 according to EN 60204-1 prior to activating the SBC and STO safety functions.

2.5.1 SBA – Safe Brake Actuation

The SBA function is defined by SEW-EURODRIVE based on the standard EN 61800-5-2.

When the SBA function is activated, the brake mechanically stops the motor. This is **emergency stop braking in case of danger**, not braking under normal operating conditions.

Stopping the motor shuts off SBA. The SBA function then inevitably segues into SBH (Safe Brake Hold).



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Safety function active, Safe Brake Actuation

Safety function active, Safe Brake Hold

v = Speed
t = Time
t_1 = Time when SBA is triggered.
t_2 = Time in which the motor is stopped and the SBA switches into the SBH function.

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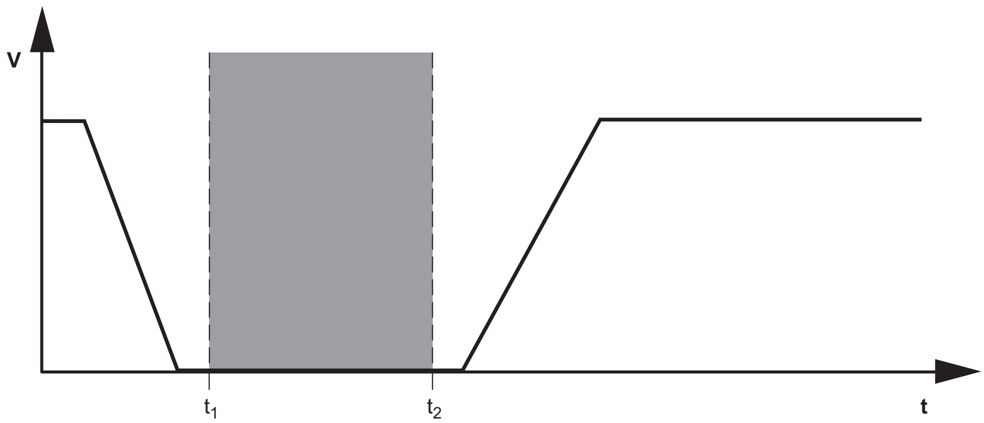
2.5.2 SBH – Safe Brake Hold

The SBH function is defined by SEW-EURODRIVE based on the standard EN 61800-5-2.

When the SBH function is activated, the brake mechanically holds the motor in the current position. The motor is already in standstill when the safety function is activated.



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Safety function is active

v = Speed
t = Time
t_1 = Time when SBH is triggered.
t_2 = Time when SBH is deactivated.

2.6 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 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 diagnostics.
- The failure due to a common cause (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.

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2.7 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.

2.8 Brake diagnostics

In applications with brakes, the braking torque represents an important criterion for the functionality of the brake. In the event of a reduction in or loss of braking torque, proper functionality of the application is no longer ensured. As a result, the safety of the machine and/or even the safety of persons may be decreased. To prevent this from happening, the brake can optionally be checked using brake diagnostics. Brake diagnostics provides the user with information about the status and performance capability of the brake. This allows you to detect potential faults in time and initiate maintenance/repair.

Brake diagnostics may be required by standards, particularly in safety-related applications in accordance with EN ISO 13849 in which a safety function is implemented using a brake. The diagnostic coverage level (DC_{avg}) required by standards must be fulfilled depending on the required Performance Level (PL). The diagnostic coverage is a key figure of the implemented brake diagnostics.

Brake diagnostics must detect the following possible failures separately for each brake:

- Brake is not applied.
- Insufficient braking torque.

To prevent faulty diagnostic results, SEW-EURODRIVE recommends additionally diagnosing the potential failure "Brake does not release".

Brake diagnostics is not part of the brake and must be implemented within the system. SEW-EURODRIVE offers the brake diagnostics solution, e.g. as software for the controller of the performance classes advanced/power. Brake diagnostics fulfills the regulatory requirements and allows for solutions up to performance level e (PL e).

INFORMATION

The diagnostic unit /DUE option for function and wear monitoring of the BE.. brakes also detects the switching status of the brakes and their wear status, but not the available braking torque. The diagnostic unit is not certified from a safety standpoint.

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2.9 Acceptance

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

The effectiveness of each risk minimization must be checked. It must also be checked if the required safety integrity (SIL and/or PL) 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).

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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-proof 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-proof 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-proof 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 and downloaded on the IECEx homepage (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 Applications

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

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

Available brakes

<table>
<tr><th>Application</th><th>ATEX</th><th>IECEx</th><th>HazLoc-NA®</th></tr>
<tr><td>Working brake</td><td colspan="2">• BE.. brake for explosion-proof motors</td><td>BE.. brake</td></tr>
<tr><td>Holding brake with emergency stop function</td><td colspan="2">• BE.. brake for explosion-proof motors
• BE.. safety brake for explosion-proof motors</td><td>BE.. brake for explosion-proof motors</td></tr>
</table>

Designs

<table>
<tr><th>Motor type</th><th>ATEX</th><th>IECEx</th><th>HazLoc-NA®</th></tr>
<tr><td>EDR..BE..</td><td>3D, 3GD</td><td>Not certified</td><td rowspan="2">CID2, CIID2, CICIID2</td></tr>
<tr><td>EDRN..BE..</td><td>3G, 3D, 3GD</td><td>3G-c, 3D-c, 3GD-c</td></tr>
</table>

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

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4 Product description and differentiation

4.1 Possible applications

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

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

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

Working brake

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

Holding brake

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

The type of use must be taken into consideration 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 characteristics in horizontal and vertical applications
- Safety brake in its function as a holding brake with emergency stop characteristics
- Working brake or holding brake with emergency stop characteristics in applications in areas with a risk of explosion
- Safety brake in its function as a holding brake with emergency stop characteristics in applications in areas with a risk of explosion

4.2 General description

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

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

The brake is applied in case of a power failure. It is therefore suited for basic safety requirements in travel and hoist applications (e.g. according to EN 115).

Due to the high overload capacity in case of 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.

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

4.2.1 Mounted to the B-side of the motor

With manual brake release as an option

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 switch-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 (BST..)

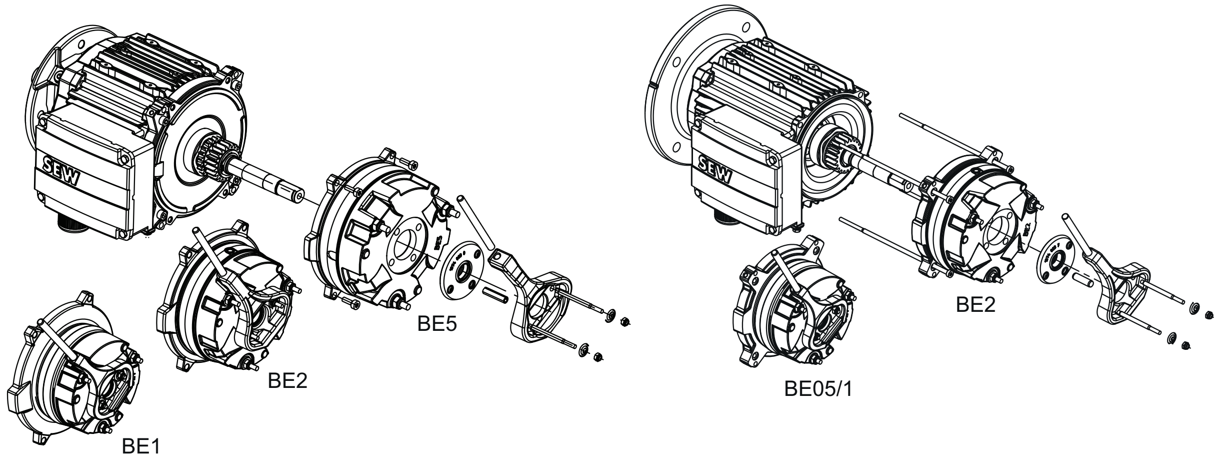
Brakes up to BE2 can also be delivered for operation at an external DC voltage source without additional brake control, if requested by the customer.

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

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



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Adjustability

BE.. brakes 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 – 122

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

Optional with air gap monitoring

For predictive planning of the service intervals, BE1 – 122 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 24 V DC 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.

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4.2.5 Characteristics of the BE.. safety brake

With regard to the general design and the basic functional principle, BE.. safety brakes are identical to BE.. brakes.

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

- SBA – Safe Brake Actuation
- SBH – Safe Brake Hold

A suitable integration into a safe brake system (SBS) allows for all performance levels (up to PL e).

The BE.. safety brakes are developed, tested and evaluated for use in safety-related applications according to EN ISO 13849. As such, motor options and drive combinations are available to a limited degree, where applicable.

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

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

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

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

The EDR.. and EDRN.. explosion-proof brakemotors are available in the following designs:

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

They fulfill the following standards:

Design	EDR..	EDRN
ATEX	EN60079-0:2012/A11:2013 EN60079-15:2010 EN60079-31:2014	EN60079-0:2012/A11:2013 EN60079-7:2015 EN60079-31:2014
IECEx	No brakemotor available	IEC60079-0:2011 IEC60079-7:2015 IEC60079-31:2013
HazLoc-NA®	**EDR.. < 0.75kW** NEC500 C22.1-15 Appendix J	**EDRN ≥ 0.75 kW** NEC500 C22.1-15 Appendix J

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

<table>
<tr><th>Design</th><th>EDR..</th><th>EDRN</th></tr>
<tr><td>ATEX</td><td colspan="2">Ex ec IIB T3 Gc
Ex ec IIC T3 Gc
Ex tc IIIB T120°C Dc
Ex tc IIIC T120°C Dc
Ex tc IIIB T140°C Dc
Ex tc IIIC T140°C Dc</td></tr>
<tr><td>IECEx</td><td>No brakemotor available</td><td>Ex ec IIB T3 Gc
Ex ec IIC T3 Gc
Ex tc IIIB T120°C Dc
Ex tc IIIC T120°C Dc
Ex tc IIIB T140°C Dc
Ex tc IIIC T140°C Dc</td></tr>
<tr><td>HazLoc-NA®</td><td>Cl I, DIV2 GP A, B, C & D T3
Cl I, DIV2 GP A, B, C & D T3B
Cl I, DIV2 GP A, B, C & D T3C
Cl II, DIV2 GP F & G T4A</td><td>Cl I, DIV2 GP A, B, C & D T3
Cl I, DIV2 GP A, B, C & D T3B
Cl I, DIV2 GP A, B, C & D T3C
Cl II, DIV2 GP F & G T4A
Cl II, DIV2 GP F & G T3C</td></tr>
</table>

4.2.7 Differences between the BE.. brake and the BE.. brake for EDR.. and EDRN.. explosion-proof motors

Depending on the design, the EDR.. and EDRN.. explosion-proof 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
- Braking torque has been reduced
- 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.

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

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

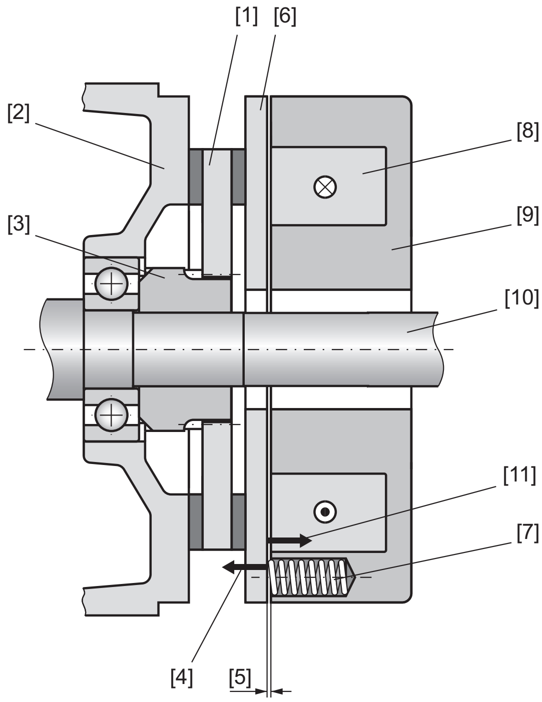
For additional technical data, refer to chapter "Technical data" (→ 🗎 76).

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 lining carrier 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. The brake lining carrier moves clear and the rotor can turn.



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[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). It depends on the current operating temperature and the current friction speed/motor speed.

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Abbreviation according to DIN VDE 0580	Designation	Description
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 a standstill with the brake closed.

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

This 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 consideration 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 planning and selection of the brake. For more extensive applicative requirements of the brake, such as carrying out a brake diagnosis, the characteristic values M_1 and M_4 must be examined and evaluated separately.

INFORMATION

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

If you require more specific information, contact SEW-EURODRIVE.

4.3.3 Brake diagnostics and friction surface activation

In applications with brakes, the braking torque represents an important criterion for the functionality of the brake. In the event of a reduction in or loss of braking torque, the functionality of the application is no longer ensured. As a result, the safety of the machine and/or even the safety of persons may be decreased. To prevent this from happening, the brake can optionally be checked using brake diagnostics. Brake diagnostics provides the user with information about the status and performance capability of the brake. The early detection of potential faults or functional limitations is the advantage of the diagnosis. This makes it possible to arrange maintenance or repair in good time.

Brake diagnostics may be required by standards, particularly in safety-related applications in accordance with EN ISO 13849 in which a safety function is implemented using a brake. The diagnostic coverage level (DC_{avg}) required by standards must be fulfilled depending on the required performance level (PL). The diagnostic coverage level is a key figure of the implemented brake diagnostics.

The braking torque that is present, which cannot be detected by conventional diagnostic systems such as a microswitch /DUB or diagnostic unit /DUE, is an essential criterion for checking a brake.

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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.

INFORMATION

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

Brake diagnostics as a functionality of control from SEW-EURODRIVE

At SEW-EURODRIVE, brake diagnostics is available as a software function for controllers of the advanced/power performance classes. This makes it possible to implement safety functions with brakes in horizontal and vertical applications up to the maximum requirement PL e. The functionality can be individually adapted to the applicative requirements during startup.

A considerable advantage of this diagnosis is the automatic load detection that has been implemented. In this way, the brake is reliably checked with the required test torque, even in changing applicative load situations. The provision of an additional test load for carrying out the diagnosis is not required.

Notes on realizing brake diagnostics

Brake diagnostics can also be implemented by the customer. The customer is responsible for evaluating the diagnostic coverage (DC_{avg}) and correct diagnosis of the brake for such solutions.

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

- Software-based brake diagnostics usually cannot determine the braking torque that is present at the brake. In addition to the braking torque, the torque determined by the diagnostics also includes applicative torques, such as friction. Measuring tolerances of the measuring equipment that is used and the temperature-dependent torque characteristics of the motor can also lead to considerable measurement deviations.
- Because of the possible measurement deviations and the different meaning of the nominal braking torque M_B and the static braking torque M_4, brake slippage can and may occur, even significantly outside the tolerance range of the nominal braking torque M_B.

For the above mentioned reasons, the determination of the test torque to be selected must always be based on the planning requirements. These are requirements such as maximum static load torque of the application and safety factors, where applicable.

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INFORMATION

Performing brake diagnostics with a damaged brake or brake control unit can lead to undesirable movement of the unit. During the implementation and performance of these kinds of diagnostics, always ensure that the safety of persons and the system is guaranteed during this process.

In order to perform a static brake diagnosis, attention must be paid to the following in addition to the above-mentioned notes:

- In systems with more than one brake, e.g. a group drive or motor brake in combination with another brake in the system, each brake must be tested separately in accordance with the standards. Any mechanical stress during the separate diagnosis must be taken into consideration in the design of the machine or must be avoided using suitable automation.
- The brake diagnosis must be carried out with the machine in a test position that avoids injuries to persons and damage to the system in the event of possible movement, e.g. in the event of brake slippage.

If you have any queries with regard to the selection, parameterization, and use of diagnosis mechanisms, please contact SEW-EURODRIVE.

Activating the friction surfaces

When a brake is used as a holding brake, the brake is not usually subjected to dynamic loading. This can cause a gradual reduction in the static friction torque M_4. As compensation, the friction surfaces can be reactivated by a targeted dynamic load. The activation procedure regenerates the top layer of the friction lining in order to compensate for the drop in the static friction torque M_4 caused by a lack of dynamic strain.

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

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

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

INFORMATION

Working brakes on line-operated motors (non-controlled operation) do not need activation, since they are sufficiently loaded by the operational braking procedures.

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4.4 Motor combinations

4.4.1 Motor combinations with BE.. brake

Depending on the demands placed on the brake, different brake mounting sizes with different braking torque steps are available for mounting to the respective motor.

The following tables show the possible combinations of motor and brake as well as the braking torque steps for each brake to achieve the desired nominal braking torque:

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

Design not available as safety brake.

Design available as safety brake.

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4.4.2 Braking torque graduations

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

The following table shows the available braking torque graduations depending on the brake size:

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

1) Not available for BE.. safety brakes.

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

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

Key

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

INFORMATION

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

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

→ Consult SEW-EURODRIVE in these cases.

4.5 Comparing the characteristics and restrictions

4.5.1 General

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

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

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

- BE.. brake in horizontal and vertical applications
- BE.. brake as a safety brake
- BE.. brake for explosion-proof motors
- BE.. brake as safety brake for explosion-proof motors

Brakes	**BE.. brake**	**BE.. safety brake**	**BE.. brake for explosion-proof motors**	**BE.. safety brake for explosion-proof motors**
Available sizes	BE02 – BE122	BE03 – BE32	BE03 – BE122	BE03 – BE32
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
Safety architecture, category (EN ISO 13849-1)	B	1	B	1

Brake options	**BE.. brake**	**BE.. safety brake**	**BE.. brake for explosion-proof motors**	**BE.. safety brake for explosion-proof motors**
Manual brake release	/HR or /HF	/HR	/HR or /HF	/HR
Condition monitoring Brake	BE1 – 122: **/DUE**[1)] BE2 – 122: **/DUB**[2)]	BE1 – 32: **/DUE**[1)] BE2 – 32: **/DUB**[2)]	Not available	Not available

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

2) /DUB for DR.. motors

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

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Brake control	BE.. brake	BE.. safety brake	BE.. brake for explosion-proof motors	BE.. safety brake for explosion-proof motors
Direct DC voltage supply	Available for BE02-BE2, upon request for BE5-BE11	Not available	Available for BE03 – BE2	Not available

4.5.2 Combination options and restrictions, motors and motor options

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

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

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

Output designs[1]	BE.. brake	BE.. safety brake	BE.. brake for explosion-proof motors	BE.. safety brake for explosion-proof motors
F.A/F.B universal foot-mounted version	Available	Available to a limited degree	Available	Available to a limited degree
/FI IEC foot-mounted motor with specification of the shaft height	Available	Available to a limited degree	Available	Available to a limited degree
/FG 7series integral motor	Available	Available to a limited degree	Available	Available to a limited degree
/2W Second shaft end on the brakemotor	Available	Available to a limited degree	Available to a limited degree	Available to a limited degree
/FF IEC flange-mounted motor with bore	Available	Available	Available	Available

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

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

Thermal monitoring	BE.. brake	BE.. safety brake	BE.. brake for explosion-proof motors	BE.. safety brake for explosion-proof motors
/TF Temperature sensor (PTC thermistor or PTC resistor)	Available	Included as standard	Included as standard	Included as standard
/TH Thermostat (bimetallic switch)	Available	Available	Available to a limited degree	Not available
/PT1 One PT100 sensor	Available	Available	Available	Available
/PT3 Three PT100 sensors	Available	Available	Available	Available
/PK One PT1000 sensor	Available	Available	Available	Available

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

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

Bearing	BE.. brake	BE.. safety brake	BE.. brake for explosion-proof motors	BE.. safety brake for explosion-proof motors
/NS Relubrication device	Available	Not available	Available	Not available
/ERF Reinforced bearings on A-side with rolling bearing	Available	Not available	Available	Not available
/NIB Insulated bearing B-side	Available	Available	Available	Available
Preparation for accommodating SPM measuring nipples	Available	Not available	Not available	Not available

Winding of the motor	BE.. brake	BE.. safety brake	BE.. brake for explosion-proof motors	BE.. safety brake for explosion-proof motors
Thermal class B	Available	Available	Not available	Not available
Thermal class F	Available	Available	Available	Available
Thermal class H	Available	Available	Not available	Not available

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

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

Painting and corrosion protection	BE.. brake	BE.. safety brake	BE.. brake for explosion-proof motors	BE.. safety brake for explosion-proof motors
Painting	Standard: RAL 7031 Optional: - Special colors - Surface protection (OS) - unpainted	Standard: RAL 7031 Optional: - Special colors - Surface protection (OS)	Standard: RAL 7031 Optional: - Special colors - Surface protection (OS) - unpainted	Standard: RAL 7031 Optional: - Special colors - Surface protection (OS)
Corrosion protection (KS)	Available	Available	Available	Available
/DH Condensation drain hole	Available	Available	Not available	Not available

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

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

4.5.3 Combination options and restrictions, gear unit

Gear units	BE.. brake	BE.. safety brake	BE.. brake for explosion-proof motors	BE.. safety brake for explosion-proof motors
Helical gear units	Available	Available: RX, RXF, R27-R167, R27F-R87F, RF27-RF167, RZ27-RZ87	Available: RX, RXF, R, R..F, RF, RZ, RM	Available: RX, RXF, R27-R167, R27F-R87F, RF27-RF167, RZ27-RZ87
Parallel-shaft helical gear units	Available	Available: F, FA..B, FH..B, FV..B, FF, FAF, FHF, FVF, FA, FH, FV, FAZ, FHZ, FVZ	Available: F, FA..B, FV..B, FF, FAF, FVF, FA, FV, FAZ, FVZ Available to a limited degree: FH..B, FHF, FH, FT, FHZ	Available: F, FA..B, FV..B, FF, FAF, FVF, FA, FV, FAZ, FVZ Available to a limited degree: FH..B, FHF, FH, FHZ
Helical-bevel gear units	Available	Available: K, KA..B, KH..B, KV..B, KF, KAF, KHF, KVF, KA, KH, KV, KAZ, KHZ, KVZ	Available: K, KA..B, KV..B, KF, KAF, KVF, KA, KV, KAZ, KVZ Available to a limited degree: KH, KH..B, KHF, KHZ, KT, K.9	Available: K, KA..B, KV..B, KF, KAF, KVF, KA, KV, KAZ, KVZ Available to a limited degree: KH, KH..B, KHF, KHZ
Helical-worm gear unit	Available	Available to a limited degree: S, SF, SAF, SHF, SA, SH, SAZ, SHZ	Available: S, SF, SAF, SA, SAZ Available to a limited degree: SH, SHF, SHZ, ST	Available to a limited degree: S, SF, SAF, SHF, SA, SH, SAZ, SHZ

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Gear units	BE.. brake	BE.. safety brake	BE.. brake for explosion-proof motors	BE.. safety brake for explosion-proof motors
SPRIROPLAN® gear unit	Available	Available: W37/47, WF37/47, WAF37/47, WA37/47, WA37/47B, WH37/47B, WHF37/47, WH37/47	Available: W..20, W..30, W37/47, WF37/47, WAF37/47, WA37/47, WA37/47B Available to a limited degree: WH37/47, WH37/47B, WHF37/47	Available: W37/47, WF37/47, WAF37/47, WA37/47, WA37/47B Available to a limited degree: WH37/47, WH37/47B, WHF37/47
Electrified monorail drive HS.., HW.., HK..	Available	Not available	Not available	Not available

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

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

Variable-speed gear unit	BE.. brake	BE.. safety brake	BE.. brake for explosion-proof motors	BE.. safety brake for explosion-proof motors
VU/VZ VARIGEAR	Available	Not available	Available	Not available
VARIMOT®	Available	Not available	Available	Not available

Other designs	BE.. brake	BE.. safety brake	BE.. brake for explosion-proof motors	BE.. safety brake for explosion-proof motors
Compound gear unit	Available	Not available	Available	Not available

Other designs	BE.. brake	BE.. safety brake	BE.. brake for explosion-proof motors	BE.. safety brake for explosion-proof motors
IG mounting	Available	Not available	Available to a limited degree	Not available

4.5.4 Combination options and restrictions, frequency inverter

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

INFORMATION

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

5 Project planning for BE.. brakes

5.1 Introduction

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

- Project planning for BE.. brakes as a working brake or BE.. as a working brake for ATEX, IECEx and HazLoc-NA® (→ 🗎 48),
- Project planning for BE.. brakes and BE.. safety brakes as a holding brake (→ 🗎 58),
- Project planning for BE.. brakes and BE.. safety brakes as a holding brake for ATEX, IECEx and HazLoc-NA® (→ 🗎 67).

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

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

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

5.2 General information

5.2.1 Key to the project planning procedures

	Unit	Description	Source
a_{Bmax}	$m \times s^{-2}$	Maximum deceleration when braking	
d_0	mm	Diameter of the output shaft transmission element	Application
ED	%	Relative cyclic duration factor	Motor project planning
f_{Mmax}	–	Transmission element factor, braking torque, determination in relation to the used load range for braking work	Chapter "Application of load ranges" (→ 🗎 41)
f_{Mmin}	–	Braking torque reduction factor, determination in relation to the used load range for braking work	Chapter "Application of load ranges" (→ 🗎 41)
f_{eso}	–	Factor for determining M_{a_eso} depending on the gear unit	Chapter "Definition of Ma_eso and FRa_eso" (→ 🗎 39)
$F_{R,brake}$	N	Resulting gear unit utilization via created radial load	
F_{Ra}	N	The permitted overhung load on the output end for M_{amax} applies to the point of force application located in the middle of the shaft end or end of the hollow shaft	Product documentation

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	Unit	Description	Source
F_{Ra_esof}	N	Maximum permitted emergency stop overhung load for output shaft in combination with the BE.. brake/safety brake; applies to point of force application located in the middle of the shaft end or end of the hollow shaft	Product documentation
f_V	–	Wear factor; determination in relation to the used load range for braking work	Chapter "Application of load ranges" (→ 🗎 41)
f_Z	–	Transmission element factor for overhung load	Product documentation
i	–	Gear unit ratio	Product documentation
i_V	–	Gear ratio of optional customer's additional transmission	Application
J_{Int}	kgm²	Motor mass moment of inertia (incl. mount-on components), based on the motor shaft	Product documentation
J_X	kgm²	Mass moment of inertia of application and gear unit based on the motor shaft	Application or product documentation
K_J	–	Factor for external mass moment of inertia	Product documentation
K_M	–	Factor for load torque	Product documentation
K_P	–	Factor for static power and relative cyclic duration factor	Product documentation
L_B	h	Brake service life	
M_{amax}	Nm	Maximum permitted output torque	Product documentation
M_{a_eso}	Nm	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 • Horizontally and vertically upwards: Application and gear unit efficiency are considered as "aggravating". • Vertically downwards: Application and gear unit efficiency are considered as "helpful".	
$M_{L,a}$	Nm	Static load torque value at the output shaft, efficiency not considered	Application
M_n	Nm	Nominal motor torque	Product documentation

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	Unit	Description	Source
N_{B1}	–	Number of cycles until brake maintenance in working brake operation	
N_{B2}	–	Number of permitted emergency stop braking operations until brake maintenance. Observe the information in chapter 5	
n_{Brake}	min^{-1}	Real brake application speed, relevant for check	
n_D	min^{-1}	Change of motor speed until brake application	
n_m	min^{-1}	Relevant speed of the application based on the motor shaft	Application
n_{Max}	min^{-1}	Maximum permitted speed for brake application depending on application	Chapter "Limit speed nmax" (→ 🗎 80)
n_{emrg_stop}	min^{-1}	Real emergency stop speed relevant for check	
η_G	–	Gear unit efficiency	Product documentation
η_G'	–	Retrodriving gear unit efficiency (SPIROPLAN® gear units and helical-worm gear units)	
η_L	–	Efficiency of the application	Application
P_N	kW	Nominal power	Product documentation
P_{stat}	kW	Static power	Motor project planning
s_{Bmax}	m	Maximum stopping distance	
t_2	s	Brake application time. Depending on the brake connection type, use $t_{2,I}$ or $t_{2,II}$	Chapter "Pulse frequencies" (→ 🗎 79)
$t_{2,I}$	s	Brake application time for cut-off in the AC circuit (AC shutdown)	Chapter "Pulse frequencies" (→ 🗎 79)
$t_{2,II}$	s	Brake application time for cut-off in the DC and AC circuit (AC/DC shutdown)	Chapter "Pulse frequencies" (→ 🗎 79)
t_{Bmax}	s	Maximum braking time	
t_{Bmin}	s	Minimum braking time	
t_{signal}	s	Plant signal transmit time	Application
t_{cycle}	s	Cycle time	Application
v_{Brake}	$m \times s^{-1}$	Real speed during brake application in normal operation	
v_{emerg_stop}	$m \times s^{-1}$	Real speed during brake application	
W_1	J	Maximum occurring braking work in case of emergency stop	
W_{tot}	J	Total braking work of all braking operations in the driving cycle	

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	Unit	Description	Source
W_{Insp}	J	Permitted work until brake inspection	Chapter "Braking work until mainten-ance" (→ 🗎 43)
W_{max}	J	Maximum value of W_n braking work from all cycles n = 1, 2, 3, …	
W_n	J	Occurring braking work in normal braking operations (in cycles n = 1, 2, 3, … , n)	
$W_{per,n}$	J	Maximum permitted braking work for emergency stop depending on the brake application speed	Chapter "Permitted emer-gency stop braking work Wper, n" (→ 🗎 81)
$W_{per,Z}$	J	Permitted braking work depending on the number of braking operations per hour	Chapter "Characteristic safety values" (→ 🗎 103)
X_B	–	Repeatability of braking distance in line operation	
Z	h^{-1}	Required cycle switching frequency	Application
Z_0	h^{-1}	No-load starting frequency of the mo-tor	Product documentation
Z_M	h^{-1}	Permitted starting 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	

5.2.2 Definition of M_{a_eso} and F_{Ra_eso}

The M_{a_eso} and F_{Ra_eso} values correspond to the gear unit's permitted M_P buffer torques and F_{RP} buffer forces.

The M_P buffer torque is defined as follows:

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

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

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

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

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

Gear unit design	$f_{EmergOff}$
R.., F.., K.., S..	1.7
W10	1.3
W20/30	1.5
W..7	1.4

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5.2.3 Load ranges for horizontal and vertical applications

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

Range	Reduced R	Standard S	Overload range A	Overload range B	Overload range C	Overload range D	Overload range H
Permitted for	all applications	all applications	horizontal applications	horizontal applications	horizontal applications	horizontal applications	vertical applications
max. permitted braking torque stage	All stages[1)]	All stages[1)]	Max. 75% M_{Bmax}	Max. 75% M_{Bmax}	Max. 75% M_{Bmax}	Max. 75% M_{Bmax}	All stages[1)]
Wear factor f_V	Normal	Normal	Normal	Slightly increased	Significantly increased	Massively increased	Massively increased
Tolerance for M_B Min. (f_{Mmin}) Max. (f_{Mmax})	Normal	Normal	Normal	Slightly expanded	Significantly expanded	Extremely expanded	Significantly expanded

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

5.2.4 Assignment of load ranges for BE.. brakes

Not all load ranges are available for every brake size in the BE series. The table lists the current assignments.

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

1) Only for BE30/32

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5.2.5 Application of load ranges

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

INFORMATION

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

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5.2.6 Optional separation of DC and AC circuits

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

- Cut-off in the AC circuit with normal application time
- Cut-off in AC circuit and DC circuit with shortened application time

The correct switch-off type must be ensured by a respective wiring. Certain brake controls by SEW-EURODRIVE realize the same AC and DC cut-off via integrated switching relays (e.g. BMP1.5), or via mounted relays (e.g. BSR or BUR).

The switch-off type is specified on the included wiring diagrams by a pictogram.

⚠ WARNING

Delayed brake application or unintentional ongoing brake release due to incorrect switch-off.

Severe or fatal injuries, e.g. due to falling hoist or extended coasting.

- During project planning, consider the required cut-off type and the effects on the expected stopping distance in particular.
- Only use the faster cut-off in the DC and AC circuit for hoists and hoist-like applications.
- When you are not sure if the application is a hoist-like application, contact SEW-EURODRIVE.
- Make sure that the configured cut-off type (AC or AC-DC) is implemented correctly during startup, regardless of the type of application.

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5.2.7 Braking work until maintenance

When using a brake or safety brake in conjunction with a safety encoder, the braking work is reduced according to the following table until maintenance is performed on the brake.

	Braking work BE.. brake until inspection (W_{insp}) 10^6 J		Braking work BE.. safety brake until inspection (W_{insp}) 10^6 J	
FS code	**–**	**FS04, FS07**	**FS02**	**FS11**
Brake				
BE02	15	–	–	–
BE03	200	200	200	200
BE05	120	120	120	120
BE1	120	120	120	120
BE2	180	180	180	180
BE5	390	270	270	270
BE11	640	285	285	285
BE20	1000	445	445	445
BE30	1500	670	670	670
BE32	1500	670	670	670
BE60	2500	1100	–	–
BE62	2500	1100	–	–
BE120	390	200	–	–
BE122	300	200	–	–

5.2.8 Establishing the maintenance intervals

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

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

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

These special wear factors include:

- No-load wear

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

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

- Double disk brakes

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

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

All listed factors can additionally reduce the calculated service life. The option /DUE also allows for wear monitoring. See chapter "Maintenance-friendly and suitable for condition monitoring" (→ 🗎 16).

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 and high thawing stress.

5.2.9 Project planning measures

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

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

Tests	Formula	Possible measures
Is the braking torque sufficient?	1.1	• Select a greater braking torque. • Select a larger brake size (adhere to feasibility). • Select a larger motor, in case a larger brake could not be mounted prior. • Select a larger gear ratio. • Reduce the load in the application.
Is the permitted switching frequency sufficient?	1.7	• 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?	1.9	• Reduce brake application speed. – Select brake control with AC/DC shutdown. – Select a smaller gear ratio. – Reduce the application speed. – Use a motor with a greater number of poles.[1)] • Select a greater braking torque. • Select a larger brake size (adhere to feasibility).
Is the brake service life sufficient?	1.12	• 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 project planning criteria and procedures, refer to the SEW-EURODRIVE project planning guidelines.	---	• Select a new gearmotor.
Is the braking load of the gear unit (torque) permitted?	1.15	• 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?	1.17	• Select a lower braking torque. • Select a larger gear unit. • Select a different gear unit ratio. • Select a different gear unit design.
Does the stopping distance correspond to the applicative requirement?	1.21	• Select a greater braking torque.

Tests	Formula	Possible measures
Does the deceleration correspond to the applicative requirement?	1.23	• Select a lower braking torque. • Select an additional flywheel mass.

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

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

Tests	Formula	Possible measures
Is the braking torque sufficient?	2.1a and 2.1b	• Select a greater braking torque. • Select a larger brake size (adhere to feasibility). • Select a larger motor, in case a larger brake could not be mounted prior. • Select a larger gear ratio. • Reduce the load in the application.
Is the emergency stop speed permitted?	2.4	• Select brake control with AC/DC shutdown. • Select a smaller gear ratio. • Reduce the application speed.
Is the vertical/horizontal emergency stop braking work sufficient?	2.6	• Reduce the emergency stop speed. • Change the braking torque. • Select a larger brake size (adhere to feasibility).
Is the amount of emergency stop braking operations sufficient?	2.7	• 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 project planning criteria and procedures, refer to the SEW-EURODRIVE project planning guidelines.	–	• Select a new gearmotor.
Is the emergency stop load for the gear unit (torque) permitted?	2.10	• Select a lower braking torque. • Select a larger gear unit. • Select a different gear unit ratio.
Is the emergency stop load for the gear unit (overhung load) permitted?	2.12	• 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?	–	• Select a greater braking torque. • Reduce the emergency stop speed.
Is the deceleration permitted?	–	• Change the braking torque.

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

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

Tests	For-mula	Possible measures
Is the braking torque sufficient?	3.1a and 3.1b	• Select a greater braking torque. • Select a larger brake size (adhere to feasibility). • Select a larger motor, in case a larger brake could not be mounted prior. • Select a larger gear ratio. • Reduce the load in the application.
Is the emergency stop speed permitted?	3.4	• Select brake control with AC/DC shutdown. • Select a smaller gear ratio. • Reduce the application speed.
Is the vertical/horizontal emergency stop braking work sufficient?	3.6	• Reduce the emergency stop speed. • Change the braking torque. • Select a larger brake size (adhere to feasibility).
Is the amount of emergency stop braking operations sufficient?	3.7	• 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 project planning criteria and procedures, refer to the SEW-EURODRIVE project planning guidelines.	–	• Select a new gearmotor.
Is the emergency stop load for the gear unit (torque) permitted?	3.10	• Select a lower braking torque. • Select a larger gear unit. • Select a different gear unit ratio.
Is the emergency stop load for the gear unit (overhung load) permitted?	3.12	• 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?	–	• Select a greater braking torque. • Reduce the emergency stop speed.
Is the deceleration permitted?	–	• Change the braking torque.

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

5.3.1 General information

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

The following project planning procedures are mutually described in chapter "Project planning procedure, BE.. as a working brake" (→ 🗎 49):

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

You must generally use these processes in line-operated applications.

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

The sizes used in the formula, including their definition basis, are listed in a table in chapter "Key to the project planning procedures" (→ 🗎 35).

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

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

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

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

- Vertical rotary table

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

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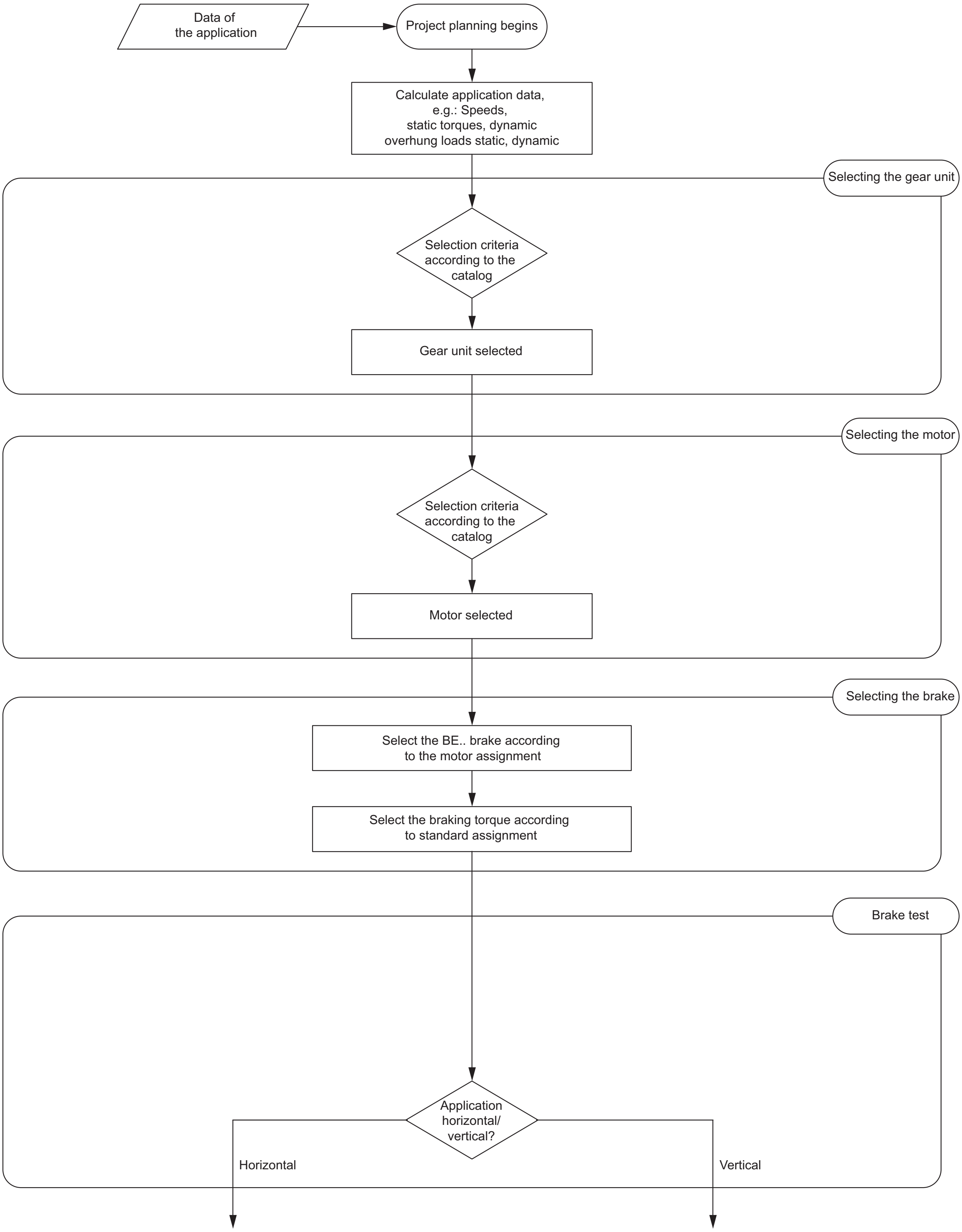
5.3.2 Project planning procedure, BE.. as a working brake



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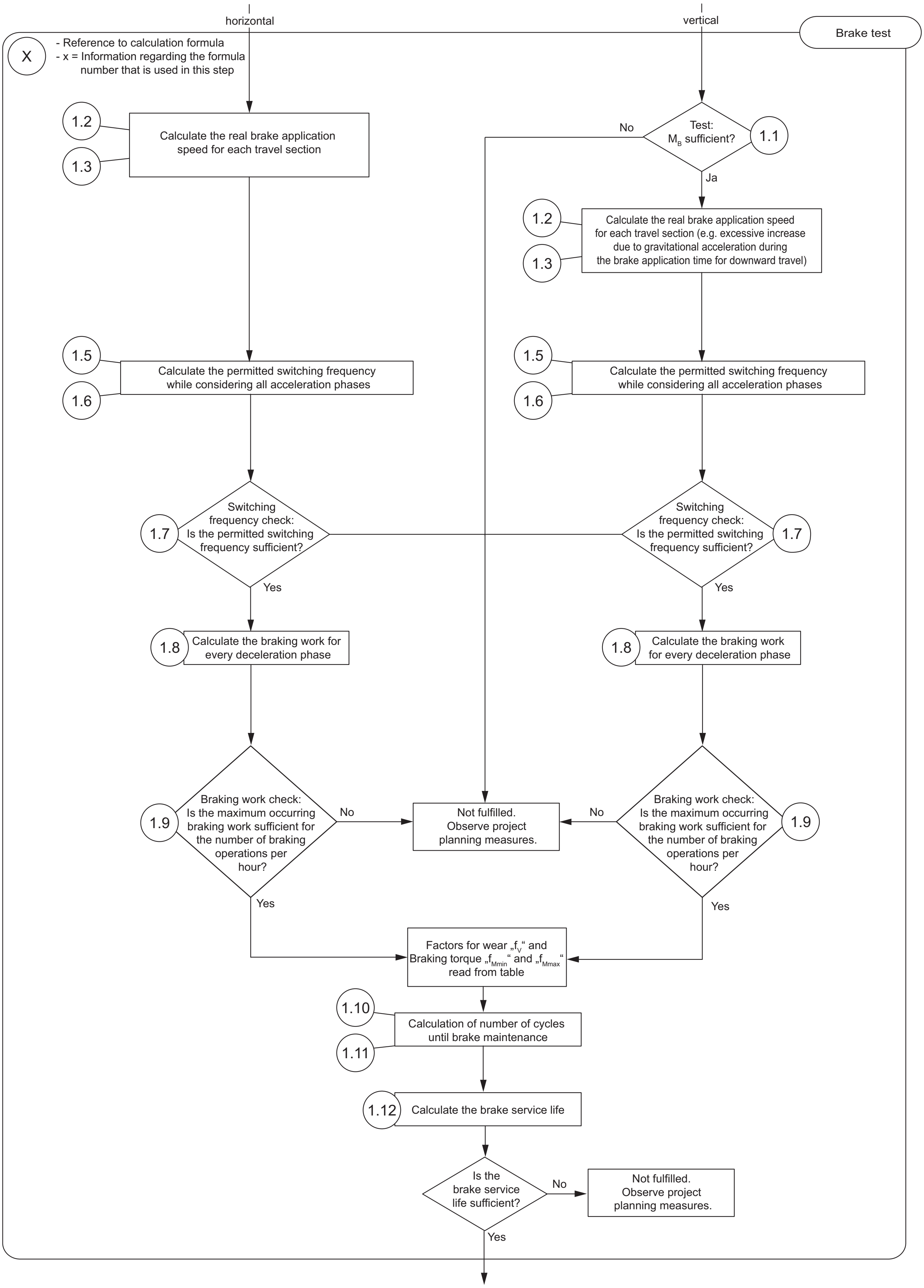

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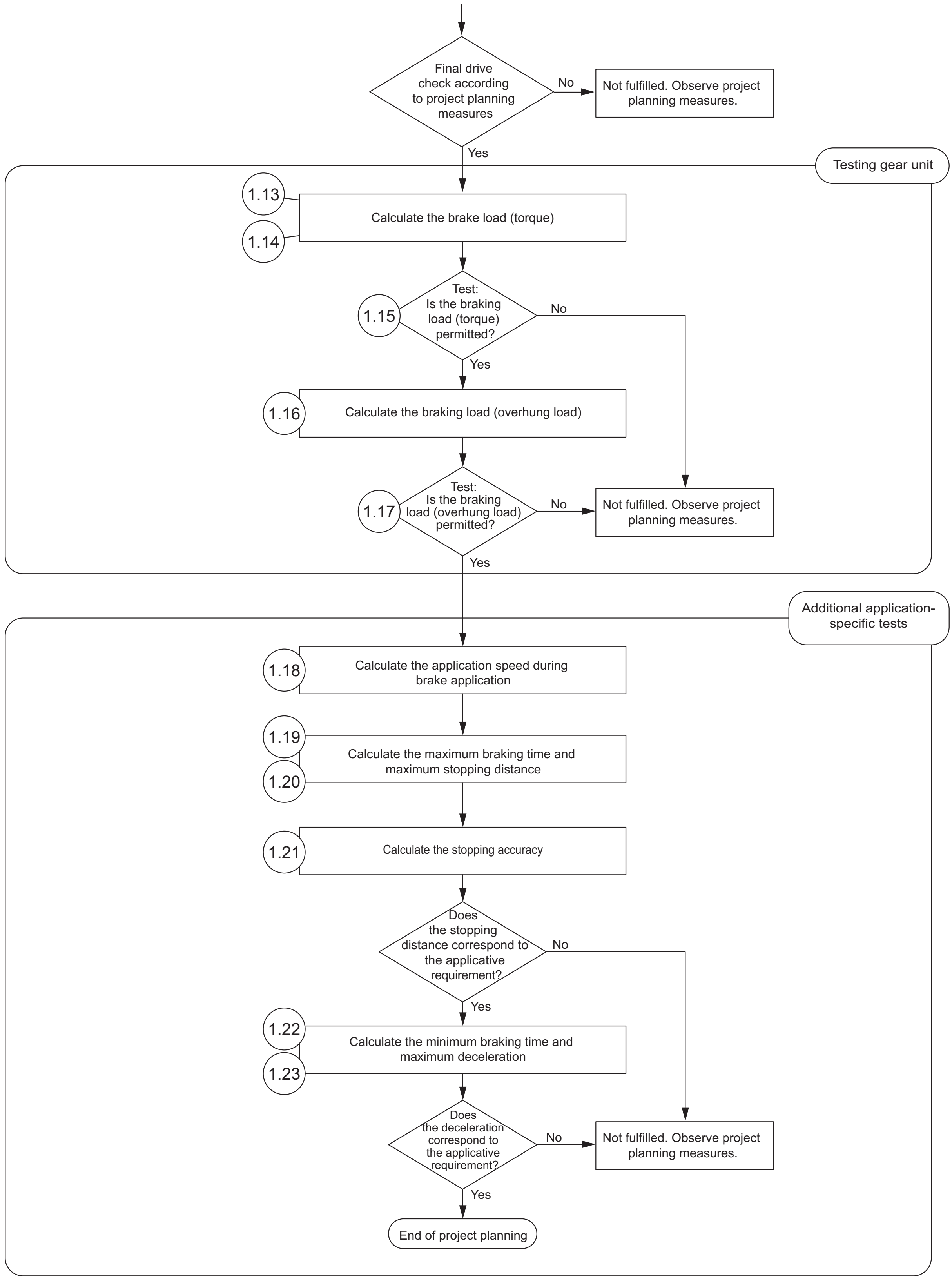

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5.3.3 Calculation formulas, BE.. brake as a working brake

No.	Horizontally and vertically upwards	Vertically downwards
	Static load torque at the motor shaft $$M_L = \frac{M_{L,a}}{i \times \eta_L \times \eta_G}$$ $[M_L]$ = Nm — Static load torque at the motor shaft. Application and gear unit efficiency are considered as "aggravating". $[M_{L,a}]$ = Nm — Static load torque value at the output shaft, efficiency not considered η_L — Efficiency of the application η_G — Efficiency of the gear unit i — Gear unit ratio	**Static load torque at the motor shaft** $$M_L = M_{L,a} \times \frac{\eta_L \times \eta_G}{i}$$ $[M_L]$ = Nm — Static load torque at the motor shaft. Application and gear unit efficiency are considered as "helpful".
1.1	–	**Checking the braking torque** $$M_B \geq 2.0 \times M_L$$ $[M_B]$ = Nm — Nominal braking torque
1.2	**Speed difference during brake application** $$n_D = \frac{9.55 \times M_L \times t_2}{J_{Int} + J_x \times \eta_L \times \eta_G}$$ $[n_D] = min^{-1}$ — Change of motor speed until brake application $[t_2]$ = s — Brake application time; depending on connection type, $t_{2,I}$ or $t_{2,II}$ must be used $[J_{Int}] = kgm^2$ — Motor mass moment of inertia (incl. mount-on components), based on the motor shaft $[J_x] = kgm^2$ — Mass moment of inertia of application + gear unit based on the motor shaft	
1.3	**Calculating the real brake application speed** $$n_{Brake} = n_m - n_D$$ $[n_{Brake}] = min^{-1}$ — For testing the relevant, real brake application speed $[n_m] = min^{-1}$ — Relevant speed of the application based on the motor shaft	**Calculating the real brake application speed** $$n_{Brake} = n_m + n_D$$
1.5	**Calculating the permitted starting frequency of the motor for an acceleration phase** $$Z_M = Z_0 \times K_J \times K_M \times K_P$$ $[Z_M] = h^{-1}$ — For the permitted motor starting frequency, refer to chapter "Permitted starting frequency of the motor" (→ 🗎 56) $[Z_0] = h^{-1}$ — No-load starting frequency of the motor K_J — Factor for external mass moment of inertia K_M — Factor for load torque K_P — Factor for static power and relative cyclic duration factor	

No.	Horizontally and vertically upwards	Vertically downwards
1.6	**Calculating the permitted cycle switching frequency of the motor while considering all acceleration phases** $Z_{M,Cycle,per} = \frac{1}{(\frac{1}{Z_{M,1}} + \frac{1}{Z_{M,2}} + ... + \frac{1}{Z_{M,n}})}$ $[Z_{M,Cycle,per}] = h^{-1}$ Permitted cycle switching frequency $[Z_{M,n}] = h^{-1}$ Permitted switching frequencies of the individual acceleration phases	
1.7	**Checking the motor's cycle switching frequency** $Z \leq Z_{M,cycle,per}$ $[Z] = h^{-1}$ Required cycle switching frequency	
1.8	**Calculation of occurring braking work** $W_n = \frac{M_B}{M_B + M_L} \times \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Brake}^2}{182.5}$ $[W_n] = J$ Occurring braking work in normal braking operations (in cycles n = 1, 2, 3, … , n)	**Calculation of occurring braking work** $W_n = \frac{M_B}{M_B - M_L} \times \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Brake}^2}{182.5}$
1.9	**Checking the maximum occurring braking work against permitted braking work** $W_{max} \leq W_{per,Z}$ $[W_{per,Z}] = J$ Permitted braking work depending on the number of braking operations per hour $[W_{max}] = J$ Maximum value of W_n braking work from all braking operations	
1.10	**Calculation of number of braking operations until brake maintenance** $W_{ges} = W_1 + W_2 + ... + W_n$ $[W_{tot}] = J$ Total braking work of all braking operations in the driving cycle	
1.11	**Calculation of number of cycles until brake maintenance** $N_{B1} = \frac{W_{Insp}}{W_{ges}}$ N_{B1} Number of cycles until brake inspection in working brake operation; observe the project planning note. $[W_{Insp}] = J$ Permitted work until brake inspection	
1.12	**Calculating the brake service life** $L_B = \frac{N_B \times t_{Cycle}}{3600}$ $[L_W] = h$ Brake service life $[t_{Cycle}] = s$ Cycle time	

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No.	Horizontally and vertically upwards		Vertically downwards
1.13	**Calculation of effective torque when braking (gear unit output side)** $$M_{Brake,Output} = \frac{i}{\eta_G}\left[(M_B + M_L)\times\frac{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}}{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}+1}\right] - M_{L,a} \times \eta_L$$		**Calculation of effective torque when braking (gear unit output side)** $$M_{Brake,Output} = \frac{i}{\eta_G}\left[(M_B - M_L)\times\frac{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}}{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}+1}\right] + M_{L,a} \times \eta_L$$
	$[M_{brake,output}]$ = Nm	Resulting gear unit load from the braking torque, based on gear unit output shaft	
	η_G	Gear unit efficiency; for SPIROPLAN® or helical-worm gear units, the retrodriving efficiency η_G‘ must be used (see formula 1.14)	
1.14	**Retrodriving efficiency for SPIROPLAN® or helical-worm gear unit** $$\eta_G{}' = 2 - \frac{1}{\eta_G}$$		
	η_G‘	Gear unit efficiency of SPIROPLAN® or helical-worm gear unit (retrodriving)	
	η_G	Gear unit efficiency of SPIROPLAN® or helical-worm gear unit	
1.15	**Checking the braking load (torque)** $$M_{Brake,output} \leq M_{amax}$$		
	$[M_{amax}]$ = Nm	Maximum permitted output torque	
1.16	**Calculation of the effective gear unit overhung load during braking** $$F_{R,brake} = \frac{M_{brake,output} \times 2000}{d_0} \times f_Z$$		
	$[F_{R,\ brake}]$ = N	Resulting gear unit utilization via created radial load	
	$[d_0]$ = mm	Diameter of the output shaft transmission element	
	f_Z	Transmission element factor for overhung load	
	→ observe additional overhung load by application if necessary		
1.17	**Checking the brake load (overhung load)** $$F_{R,brake} \leq F_{Ramax}$$		
	$[F_{Ramax}]$ = N	Maximum permitted overhung load for output shaft; applies to points of force application located in the middle of the shaft end or end of the hollow shaft	
1.18	**Calculating the braking speed of the application** $$v_{Brake} = \frac{n_{Brake}}{i \times i_v} \times d_0 \times \frac{\pi}{60000}$$		
	$[v_{Brake}]$ = $m \times s^{-1}$	Real speed during brake application	
	i_v	Gear ratio of optional customer's additional transmission	

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<table>
<tr><th>No.</th><th>Horizontally and vertically upwards</th><th>Vertically downwards</th></tr>
<tr><td>1.19</td><td>Calculation of maximum braking time
$$t_{B\max} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Brake}}{9.55 \times (f_{Mmin} \times M_B + M_L)}$$
$[t_{Bmax}]$ = s — Maximum braking time
f_{Mmin} — Braking torque reduction factor, determination in relation to the used load range for braking work</td><td>Calculation of maximum braking time
$$t_{B\max} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Brake}}{9.55 \times (f_{M\min} \times M_B - M_L)}$$</td></tr>
<tr><td>1.20</td><td colspan="2">Calculation of maximum stopping distance
$$S_{Bmax} = v_{Brake} \times (t_{Signal} + t_2 + \frac{1}{2} \times t_{Bmax})$$
$[S_{Bmax}]$ = m — Maximum stopping distance
$[t_{signal}]$ = s — Plant signal transmit time</td></tr>
<tr><td>1.21</td><td colspan="2">Calculating the repeatability of the maximum stopping distance
$$X_B = \pm 0.12 \times s_{Bmax}$$
$[X_B]$ = m — Stopping accuracy</td></tr>
<tr><td>1.22</td><td>Calculation of minimum braking time
$$t_{B\min} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Brake}}{9.55 \times (f_{M\max} \times M_B + M_L)}$$
$[t_{Bmin}]$ = s — Minimum braking time
f_{Mmax} — Transmission element factor, braking torque, determination in relation to the used load range for braking work</td><td>Calculation of minimum braking time
$$t_{B\min} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Brake}}{9.55 \times (f_{M\max} \times M_B - M_L)}$$</td></tr>
<tr><td>1.23</td><td colspan="2">Calculation of maximum deceleration when braking
$$a_{Bmax} = \frac{v_{Brake}}{t_{Bmin}}$$
$[a_{Bmax}]$ = $m \times s^{-2}$ — Maximum deceleration when braking</td></tr>
</table>

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5.3.4 Permitted starting frequency of the motor

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

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

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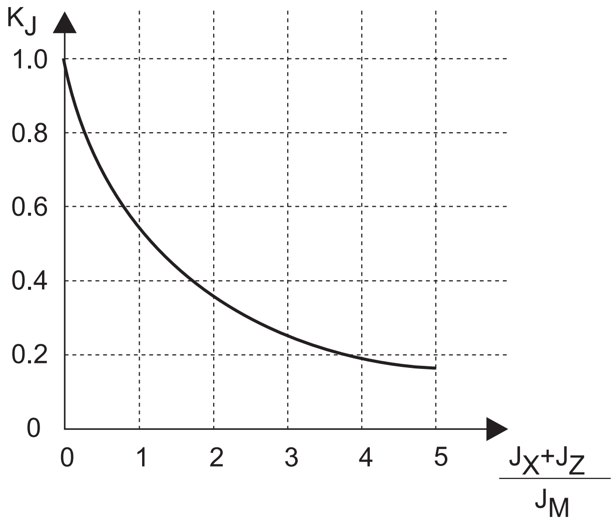
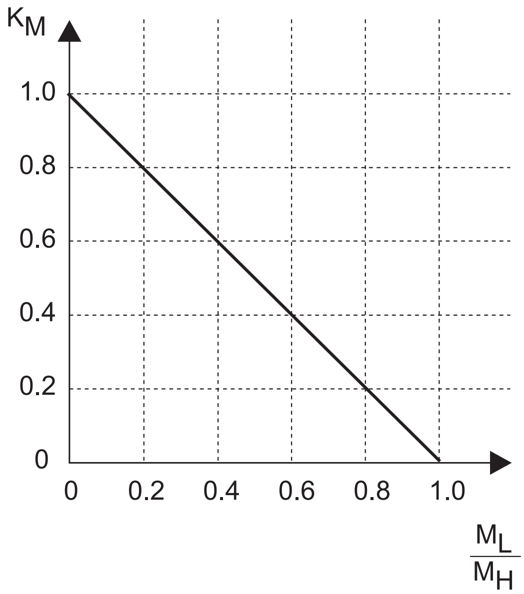
When using the additional flywheel mass/Z option, you must multiply the no-load starting frequency Z_0 by the factor **0.8**.

You can determine the factors $_J$, 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



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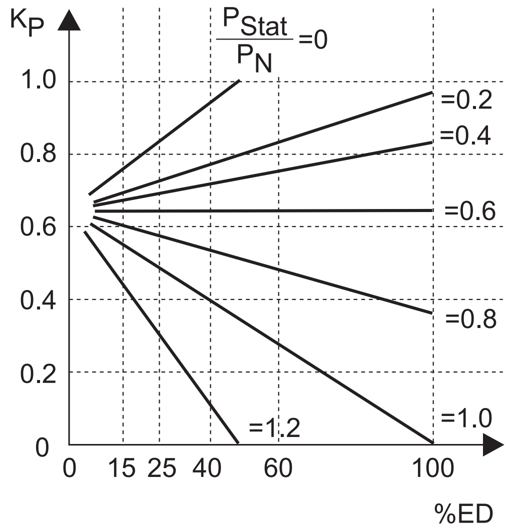
Factor K_P depending on the static power and the relative cyclic duration factor CDF



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

Example

Brakemotor: DRN80M4 with BE1 brake as line-powered drive

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

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

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

The cycle duration is 8.45 s.

The switch-on time amounts to 5.07 s.

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5.4 Holding brake/safety brake

5.4.1 General information

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

The following project planning procedures are mutually described in chapter "Project planning procedure, BE.. brake and BE.. safety brake as a holding brake" (→ 🗎 60):

- BE.. brake functioning as a holding brake with emergency stop characteristics.
- BE.. safety brake functioning as a holding brake with emergency stop characteristics.

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

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

The sizes used in the formula, including their definition basis, are listed in a table in chapter "Key to the project planning procedures" (→ 🗎 35).

Tests against product characteristics, whose testing may turn out negative, are required in some parts of the project planning procedure. Information on additional steps are described in chapter "Project planning measures" (→ 🗎 45).

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

- For vertical applications with a counterweight, it may be necessary to calculate the upward travel after the downward travel has completed and vice versa, depending on the load situation.
- All applications with non-horizontal direction of movement, thus inclining, must be calculated as vertical applications. This also includes further applications with off-center load distribution, such as vertical rotary tables.
- Horizontal applications that are stressed by outside forces (e.g. wind load, pressing force, etc.) must also be planned like hoists.
- For special applications, such as a winder, calender, vertical rotary tables with eccentric load distribution, etc., you cannot readily use the project planning process, since you mostly need to follow additional framework conditions. You must discuss these with the applicant for the respective case and, if necessary, include them in an amended or separate calculation.
- The total number of N_{B2} emergency stop braking operations may not exceed 1000 emergency stop braking operations, irrespective of the calculation results (formula no. 2.7). In case of a calculation result less than 1000, the calculated value must be adhered as the maximum total number of emergency stop braking operations.
- If more than 1000 emergency stop braking operations are required in the application, consult SEW-EURODRIVE.
- Observe the following pause times between 2 emergency stop braking operations:
  – At least 6 minutes for the load ranges R and S

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- At least 12 minutes for the load ranges A – H

- Project planning for stand-alone motors is performed analogously to the procedure for gearmotors, with the difference being that limit values and tests specific to the gear unit are not considered and carried out. Consult SEW-EURODRIVE for the limit values of IEC motor shafts.

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

- Winder

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

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

- Vertical rotary table

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

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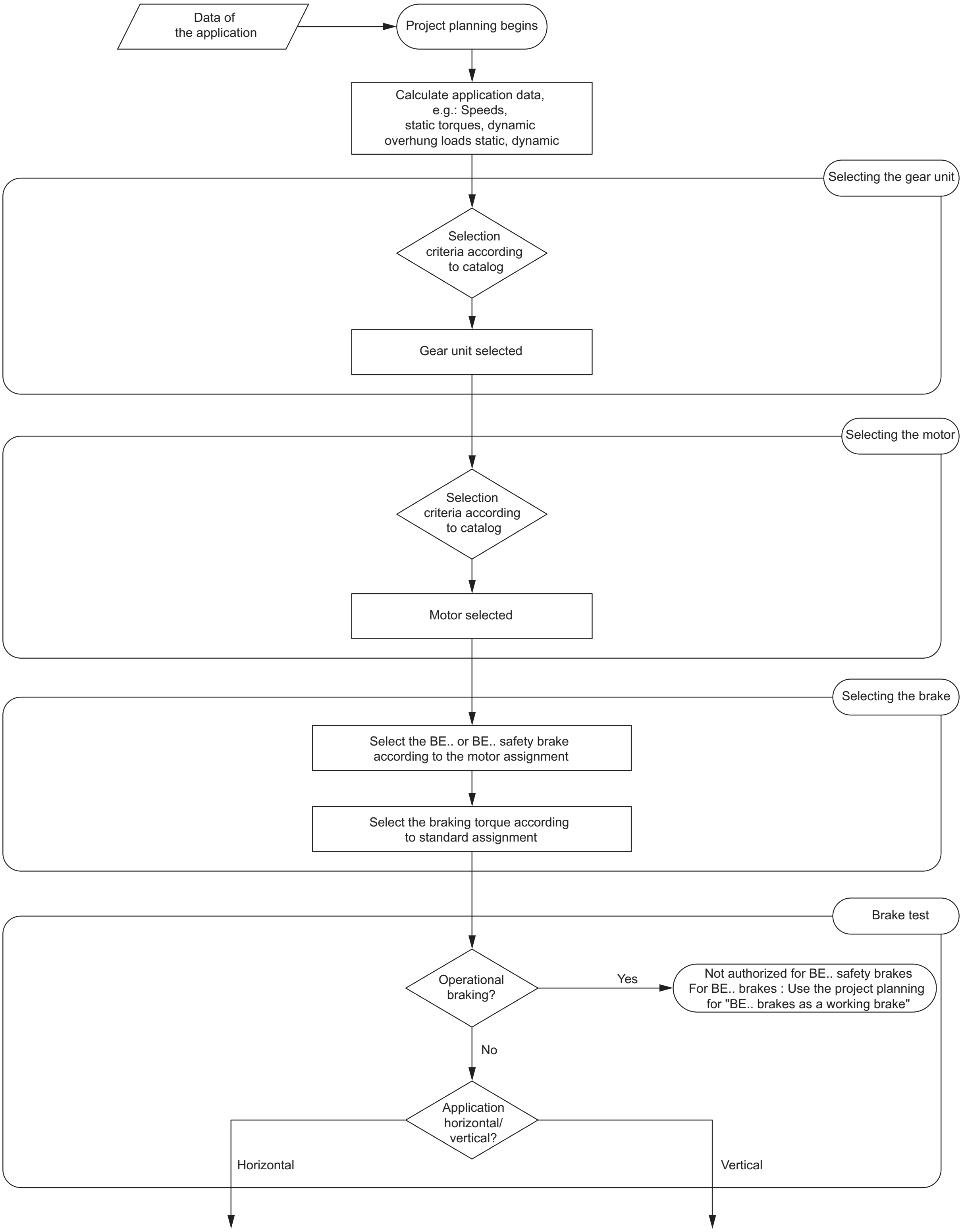
5.4.2 Project planning procedure, BE.. brake and BE.. safety brake as a holding brake



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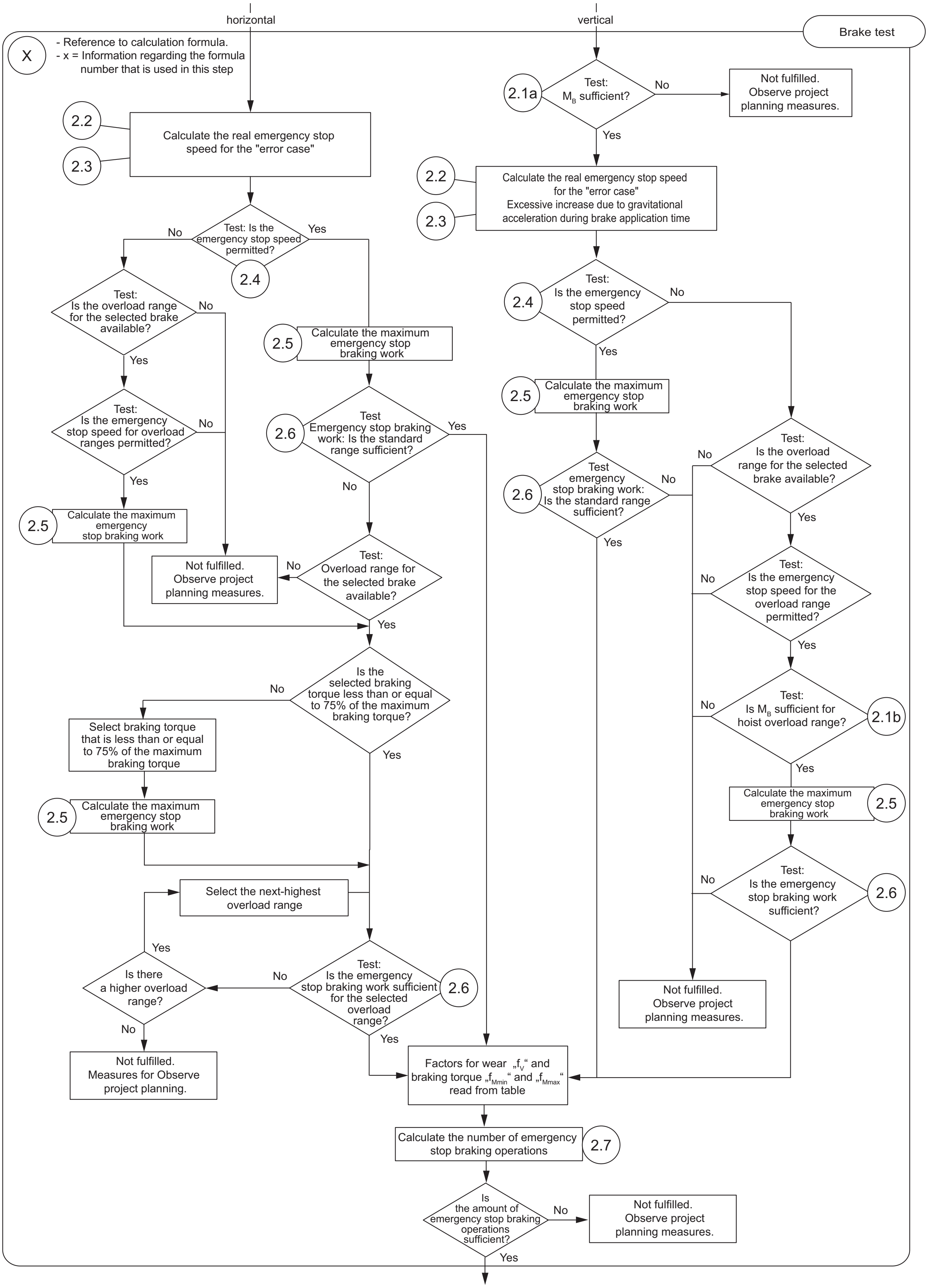

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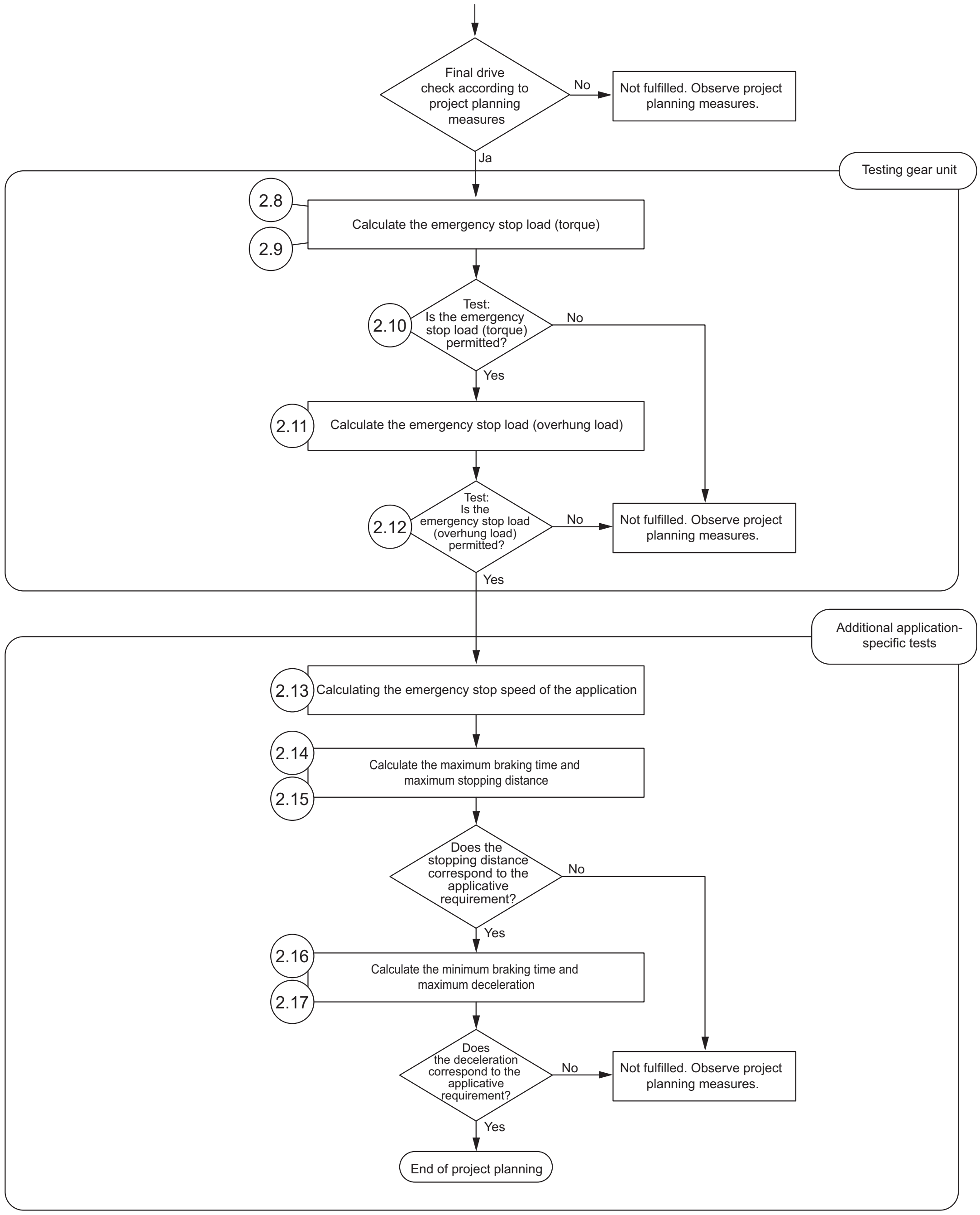

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5.4.3 Calculation formulas, BE.. brake and BE.. safety brake as a holding brake

No.	Horizontally and vertically upwards	Vertically downwards
	Static load torque at the motor shaft	**Static load torque at the motor shaft**
	$M_L = \frac{M_{L,a}}{i \times \eta_L \times \eta_G}$	$M_L = M_{L,a} \times \frac{\eta_L \times \eta_G}{i}$

<table>
<tr><th>No.</th><th>Horizontally and vertically upwards</th><th>Vertically downwards</th></tr>
<tr><td></td><td>$[M_L]$ = Nm — Static load torque at the motor shaft. Application and gear unit efficiency are considered as "aggravating".
$[M_{L,a}]$ = Nm — Static load torque value at the output shaft, efficiency not considered
η_L — Efficiency of the application
η_G — Efficiency of the gear unit
i — Gear unit ratio</td><td>$[M_L]$ = Nm — Static load torque at the motor shaft. Application and gear unit efficiency are considered as "helpful".</td></tr>
<tr><td>2.1a</td><td>–</td><td>**Checking the braking torque**
$M_B \geq 2.5 \times M_L$
$[M_B]$ = Nm — Nominal braking torque</td></tr>
<tr><td>2.1b</td><td>–</td><td>**Checking the braking torque**
$M_B \geq 3 \times M_L$</td></tr>
<tr><td>2.2</td><td colspan="2">**Speed difference during brake application**
$$n_D = \frac{9.55 \times M_L \times t_2}{J_{Int} + J_x \times \eta_L \times \eta_G}$$
$[n_D]$ = min^{-1} — Change of motor speed until brake application
$[t_2]$ = s — Brake application time, use $t_{2,I}$ or $t_{2,II}$ according to the connection type
$[J_{Int}]$ = kgm^2 — Motor mass moment of inertia (incl. mount-on components), based on the motor shaft
$[J_x]$ = kgm^2 — Mass moment of inertia of application + gear unit based on the motor shaft</td></tr>
<tr><td>2.3</td><td>**Calculation, emergency stop speed**
$n_{em.stop} = n_m - n_D$
$[n_{emergency\ stop}]$ = min^{-1} — Real emergency stop speed relevant for check
$[n_m]$ = min^{-1} — Relevant application speed</td><td>**Calculation, emergency stop speed**
$n_{em.stop} = n_m + n_D$</td></tr>
<tr><td>2.4</td><td colspan="2">**Checking the maximum emergency stop speed**
$n_{em.stop} \leq n_{Max}$
$[n_{Max}]$ = min^{-1} — Maximum permitted speed for brake application depending on application</td></tr>
<tr><td>2.5</td><td>**Calculation of maximum occurring braking work**
$$W_1 = \frac{M_B}{M_B + M_L} \times \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Emergency\ stop}^2}{182.5}$$
$[W_1]$ = J — Maximum occurring braking work in case of emergency stop</td><td>**Calculation of maximum occurring braking work**
$$W_1 = \frac{M_B}{M_B - M_L} \times \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Emergency\ stop}^2}{182.5}$$</td></tr>
</table>

No.	Horizontally and vertically upwards	Vertically downwards
2.6	**Verifying if the braking work is within the maximum permitted braking work** $W_1 \leq W_{per,n}$ $[W_{per,n}]$ = J — Maximum permitted braking work for emergency stop depending on the brake application speed	
2.7	**Calculating the number of permitted emergency stop braking operations until brake maintenance** $N_{B2} = \frac{W_{Insp}}{W_1 \times f_v}$ N_{B2} — Number of permitted emergency stop braking operations until brake maintenance. Observe the project planning notes. $[W_{Insp}]$ = J — Permitted braking work until brake inspection f_v — Wear factor; determination in relation to the used load range for braking work	
2.8	**Calculation of effective torque when braking (gear unit output side)** $M_{Brake,Output} = \frac{i}{\eta_G}\left[(M_B + M_L) \times \frac{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}}{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}} + 1} - M_{L,a} \times \eta_L\right]$ $[M_{brake,output}]$ = Nm — Resulting gear unit load from the braking torque, based on gear unit output shaft η_G — Gear unit efficiency; for SPIROPLAN® or helical-worm gear units, the retrodriving efficiency η_G‘ must be used (see formula 2.9)	**Calculation of effective torque when braking (gear unit output side)** $M_{Brake,Output} = \frac{i}{\eta_G}\left[(M_B - M_L) \times \frac{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}}{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}} + 1} + M_{L,a} \times \eta_L\right]$
2.9	**Retrodriving efficiency for SPIROPLAN® or helical-worm gear unit** $\eta_G' = 2 - \frac{1}{\eta_G}$ η_G‘ — Gear unit efficiency of SPIROPLAN® or helical-worm gear unit (retrodriving) η_G — Gear unit efficiency of SPIROPLAN® or helical-worm gear unit	
2.10	**Checking the emergency stop load (torque)** $M_{Brake,Output} \leq M_{aEmerg.off}$ $[M_{aEmergOff}]$ = Nm — Maximum permitted emergency stop torque in combination with BE.. brake or BE.. safety brake.	

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No.	Horizontally and vertically upwards	Vertically downwards
2.11	**Calculation of the effective gear unit overhung load during braking** $$F_{R,brake} = \frac{M_{brake,output} \times 2000}{d_0} \times f_Z$$ $[F_{R,\ brake}]$ = N Resulting gear unit utilization via created radial load $[d_0]$ = mm Diameter of the output shaft transmission element f_Z Transmission element factor for overhung load → observe additional overhung load by application if necessary	
2.12	**Checking the emergency stop load (overhung load)** $$F_{R,Brake} \leq F_{RaEmerg.off}$$ $[F_{RaEmergOff}]$ = N Maximum permitted emergency stop overhung load for output shaft in combination with the BE.. brake or BE.. safety brake; applies to point of force application located in the middle of the shaft end or end of the hollow shaft	
2.13	**Calculating the emergency stop speed of the application** $$v_{em.stop} = \frac{n_{em.stop}}{i \times i_v} \times d_0 \times \frac{\pi}{60000}$$ $[v_{emergency\ stop}]$ = $m \times s^{-1}$ Real speed during brake application i_v Gear ratio of optional customer's additional transmission	
2.14	**Calculation of maximum braking time** $$t_{B\max} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{em.stop}}{9.55 \times (f_{Mmin} \times M_B + M_L)}$$ $[t_{Bmax}]$ = s Maximum braking time f_{Mmin} Braking torque reduction factor, determination in relation to the used load range for braking work	**Calculation of maximum braking time** $$t_{B\max} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{em.stop}}{9.55 \times (f_{M\min} \times M_B - M_L)}$$
2.15	**Calculation of maximum stopping distance** $$S_{B\max} = v_{em.stop} \times \left(t_{signal} + t_2 + \frac{1}{2} \times t_{B\max} \right)$$ $[S_{Bmax}]$ = m Maximum stopping distance $[t_{signal}]$ = s Plant signal transmit time	
2.16	**Calculation of minimum braking time** $$t_{B\min} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Emergency\ stop}}{9.55 \times (f_{M\max} \times M_B + M_L)}$$ $[t_{Bmin}]$ = s Minimum braking time f_{Mmax} Transmission element factor, braking torque, determination in relation to the used load range for braking work	**Calculation of minimum braking time** $$t_{B\min} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Emergency\ stop}}{9.55 \times (f_{M\max} \times M_B - M_L)}$$

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No.	Horizontally and vertically upwards		Vertically downwards
2.17	**Calculation of maximum deceleration when braking**		
		$$a_{B\max} = \frac{v_{em.stop}}{t_{B\min}}$$	
	$[a_{Bmax}]$ = m × s^{-2}	Maximum deceleration when braking	

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

5.5.1 General information

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

The following project planning procedure is described in chapter "Project planning procedure BE.. brake and BE.. safety brake as a holding brake for ATEX, IECEx, and HazLoc-NA®" (→ 🗎 69):

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

In general this process must be used in controlled applications (drive is operated on a frequency inverter) inside explosion-proof areas.

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

The sizes used in the formula, including their definition basis, are listed in a table in chapter "Key to the project planning procedures" (→ 🗎 35).

Tests against product characteristics, whose testing may turn out negative, are required in some parts of the project planning procedure. Information on additional steps are described in chapter "Project planning measures" (→ 🗎 45).

In addition to the project planning procedures, the following notes must be adhered:

- For vertical applications with a counterweight, it may be necessary to calculate the upward travel after the downward travel has completed and vice versa, depending on the load situation.
- All applications with non-horizontal direction of movement, thus inclining, must be calculated as vertical applications. This also includes further applications with off-center load distribution, such as vertical rotary tables.
- Horizontal applications that are stressed by outside forces (e.g. wind load, pressing force, etc.) must also be planned like hoists.
- For special applications, such as a winder, calender, vertical rotary tables with eccentric load distribution, etc., you cannot readily use the project planning process, since you mostly need to follow additional framework conditions. You must discuss these with the applicant for the respective case and, if necessary, include them in an amended or separate calculation.
- The total number of emergency stop braking operations N_{B2} may not exceed 1000 emergency stop braking operations, irrespective of the calculation results (formula no. 3.7). In case of a calculation result less than 1000, the calculated value must be adhered as the maximum total number of emergency stop braking operations.
- If the customer requires more than 1000 emergency stop braking operations, consult SEW-EURODRIVE.

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- A minimum pause of 6 minutes must be adhered in between two emergency stop braking operations.
- Project planning for stand-alone motors is performed analogously to the procedure for gearmotors, with the difference being that limit values and tests specific to the gear unit are not considered and carried out. Consult SEW-EURODRIVE for the limit values of IEC motor shafts.

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

- Winder

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

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

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

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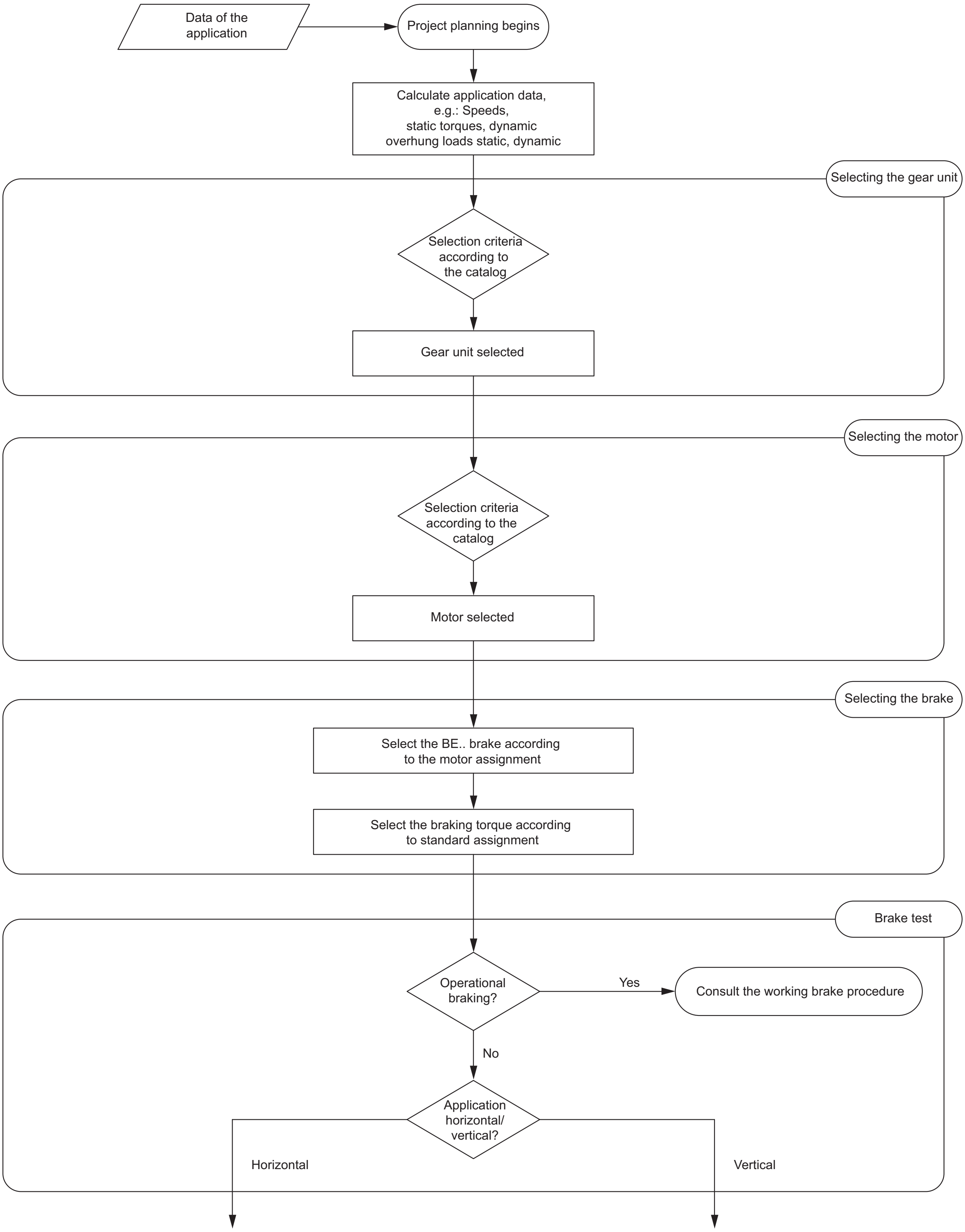
5.5.2 Project planning procedure BE.. brake and BE.. safety brake as a holding brake for ATEX, IECEx, and HazLoc-NA®



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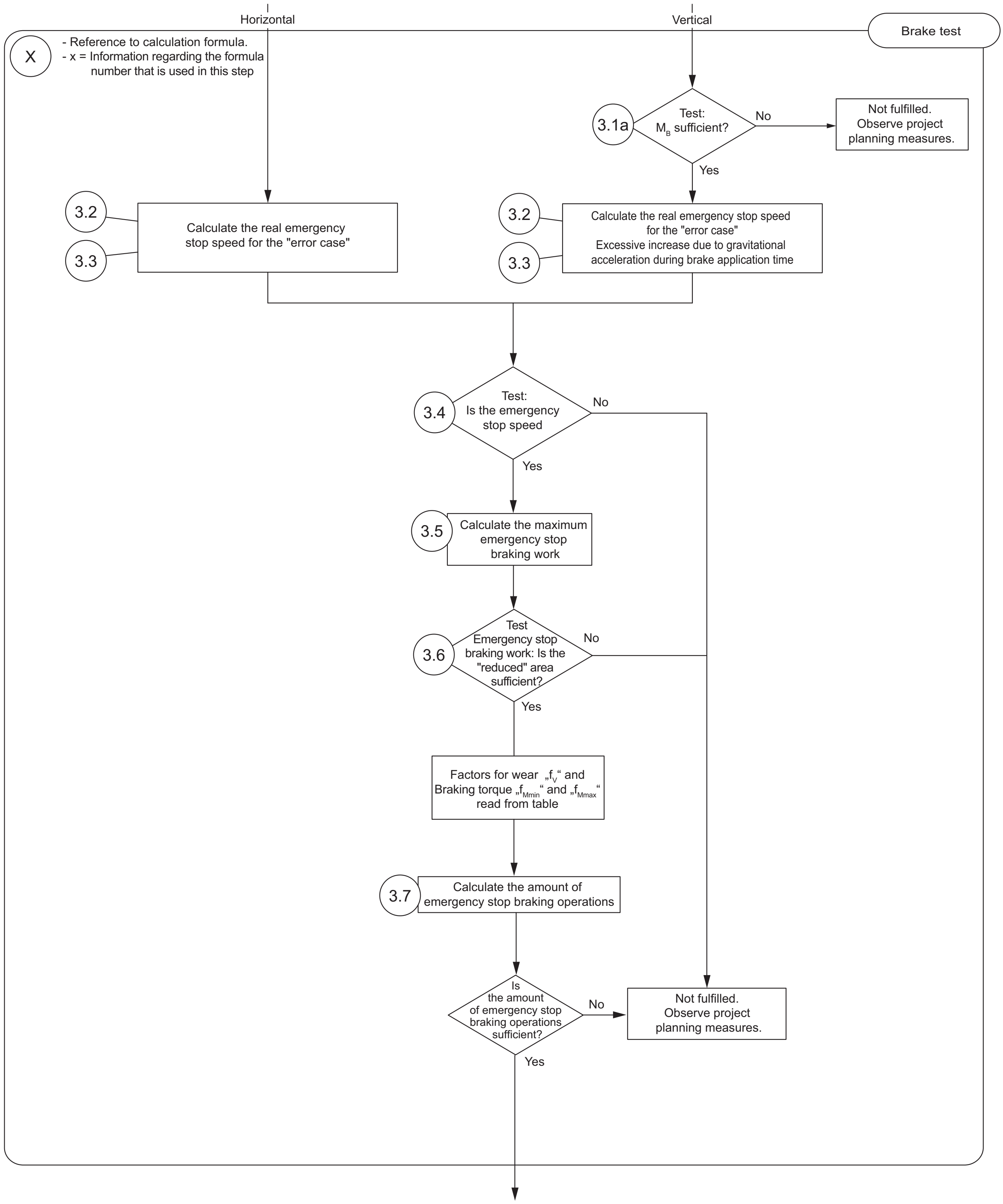

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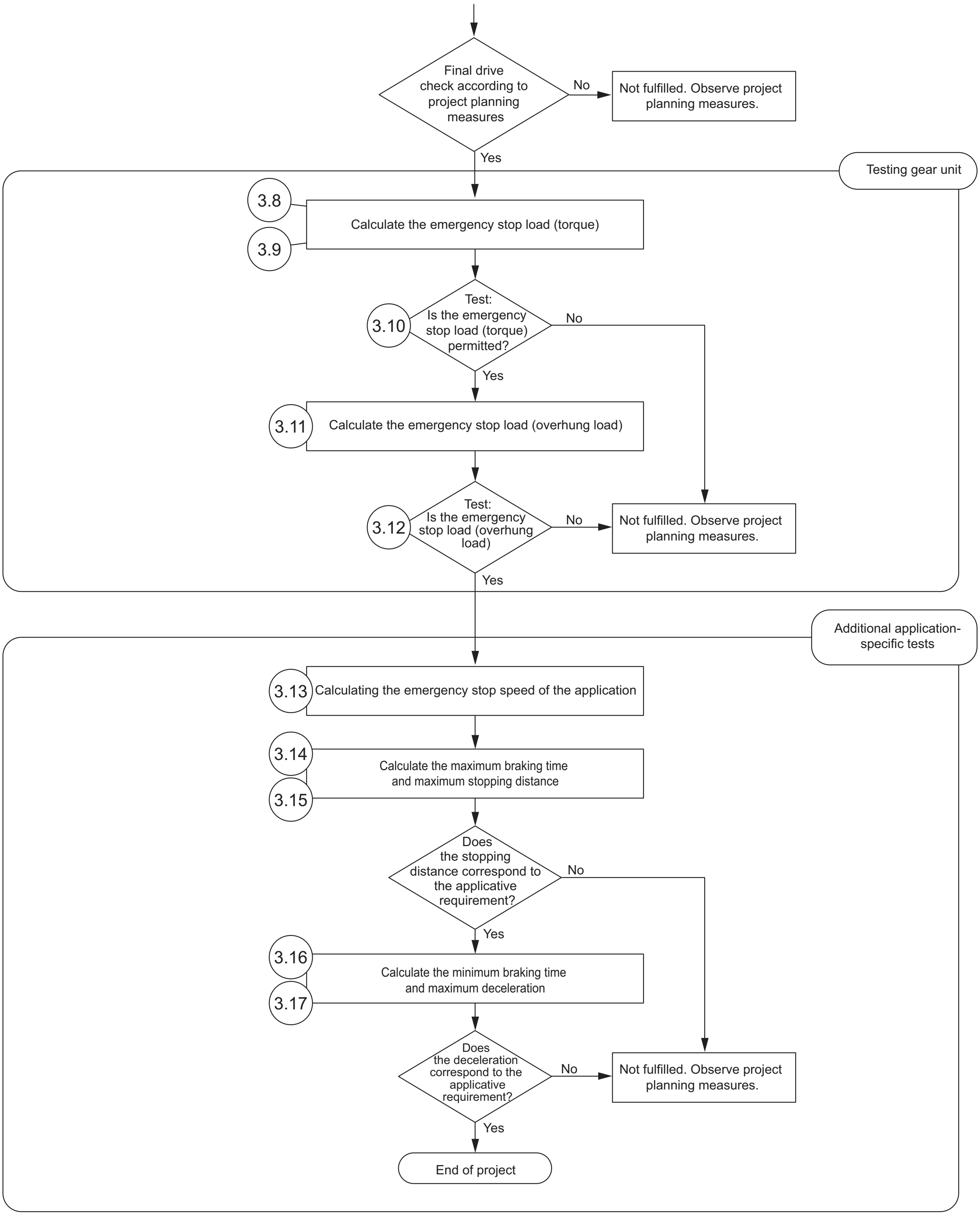

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5.5.3 Calculation formulas BE.. brake and BE.. safety brake as a holding brake for ATEX, IECEx, and HazLoc-NA®

No.	Horizontally and vertically upwards	Vertically downwards
	Static load torque at the motor shaft $$M_L = \frac{M_{L,a}}{i \times \eta_L \times \eta_G}$$ $[M_L]$ = Nm — Static load torque at the motor shaft. Application and gear unit efficiency are considered as "aggravating". $[M_{L,a}]$ = Nm — Static load torque value at the output shaft, efficiency not considered η_L — Efficiency of the application η_G — Efficiency of the gear unit i — Gear unit ratio	**Static load torque at the motor shaft** $$M_L = M_{L,a} \times \frac{\eta_L \times \eta_G}{i}$$ $[M_L]$ = Nm — Static load torque at the motor shaft. Application and gear unit efficiency are considered as "helpful".
3.1a	–	**Checking the braking torque** $$M_B \geq 2.5 \times M_L$$ $[M_B]$ = Nm — Nominal braking torque
3.2	**Speed difference during brake application** $$n_D = \frac{9.55 \times M_L \times t_2}{J_{Int} + J_x \times \eta_L \times \eta_G}$$ $[n_D]$ = min^{-1} — Change of motor speed until brake application $[t_2]$ = s — Brake application time; depending on connection type, $t_{2,I}$ or $t_{2,II}$ must be used $[J_{Int}]$ = kgm^2 — Motor mass moment of inertia (incl. mount-on components), based on the motor shaft $[J_x]$ = kgm^2 — Mass moment of inertia of application + gear unit based on the motor shaft	
3.3	**Calculation, emergency stop speed** $$n_{em.stop} = n_m - n_D$$ $[n_{emergency\ stop}]$ = min^{-1} — Real emergency stop speed relevant for check $[n_m]$ = min^{-1} — Relevant application speed	**Calculation, emergency stop speed** $$n_{em.stop} = n_m + n_D$$
3.4	**Checking the maximum emergency stop speed** $$n_{em.stop} \leq n_{Max}$$ $[n_{Max}]$ = min^{-1} — Maximum permitted speed for brake application depending on application	

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<table>
<tr><th>No.</th><th colspan="2">Horizontally and vertically upwards</th><th colspan="2">Vertically downwards</th></tr>
<tr><td rowspan="2">3.5</td><td colspan="2">Calculation of maximum occurring braking work
$$W_1 = \frac{M_B}{M_B + M_L} \times \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Emergency\ stop}^2}{182.5}$$</td><td colspan="2" rowspan="2">Calculation of maximum occurring braking work
$$W_1 = \frac{M_B}{M_B - M_L} \times \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Emergency\ stop}^2}{182.5}$$</td></tr>
<tr><td>$[W_1]$ = J</td><td>Maximum occurring braking work in case of emergency stop</td></tr>
<tr><td rowspan="2">3.6</td><td colspan="4">Verifying if the braking work is within the maximum permitted braking work
$$W_1 \leq W_{per,n}$$</td></tr>
<tr><td>$[W_{per,n}]$ = J</td><td colspan="3">Maximum permitted braking work for emergency stop depending on the brake application speed</td></tr>
<tr><td rowspan="4">3.7</td><td colspan="4">Calculating the number of permitted emergency stop braking operations until brake inspection
$$N_{B2} = \frac{W_{Insp}}{W_1 \times f_v}$$</td></tr>
<tr><td>N_{B2}</td><td colspan="3">Number of permitted emergency stop braking operations until brake inspection. Observe the project planning notes.</td></tr>
<tr><td>$[W_{Insp}]$ = J</td><td colspan="3">Permitted braking work until brake inspection</td></tr>
<tr><td>f_v</td><td colspan="3">Wear factor; determination in relation to the used load range for braking work</td></tr>
<tr><td rowspan="3">3.8</td><td colspan="2">Calculation of effective torque when braking (gear unit output side)
$$M_{Brake,Output} = \frac{i}{\eta_G}\left[(M_B + M_L) \times \frac{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}}{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}} + 1}\right] - M_{L,a} \times \eta_L$$</td><td colspan="2">Calculation of effective torque when braking (gear unit output side)
$$M_{Brake,Output} = \frac{i}{\eta_G}\left[(M_B - M_L) \times \frac{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}}}{\frac{J_x \times \eta_L \times \eta_G}{J_{Int}} + 1}\right] + M_{L,a} \times \eta_L$$</td></tr>
<tr><td>$[M_{brake,output}]$ = Nm</td><td>Resulting gear unit load from the braking torque, based on gear unit output shaft</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>η_G</td><td>Gear unit efficiency; for SPIROPLAN® or helical-worm gear units, the retrodriving efficiency η_G‘ must be used (see formula 3.9)</td></tr>
<tr><td rowspan="3">3.9</td><td colspan="4">Retrodriving efficiency for SPIROPLAN® or helical-worm gear unit
$$\eta_G' = 2 - \frac{1}{\eta_G}$$</td></tr>
<tr><td>η_G‘</td><td colspan="3">Gear unit efficiency of SPIROPLAN® or helical-worm gear unit (retrodriving)</td></tr>
<tr><td>η_G</td><td colspan="3">Gear unit efficiency of SPIROPLAN® or helical-worm gear unit</td></tr>
<tr><td rowspan="2">3.10</td><td colspan="4">Checking the emergency stop load (torque)
$$M_{Brake,Output} \leq M_{aEmerg.off}$$</td></tr>
<tr><td>$[M_{aEmergOff}]$ = Nm</td><td colspan="3">Maximum permitted emergency stop torque in combination with BE.. brake or BE.. safety brake.</td></tr>
</table>

No.	Horizontally and vertically upwards	Vertically downwards
3.11	**Calculation of the effective gear unit overhung load during braking** $$F_{R,brake} = \frac{M_{brake,output} \times 2000}{d_0} \times f_Z$$ $[F_{R,\ brake}]$ = N Resulting gear unit utilization via created radial load $[d_0]$ = mm Diameter of the output shaft transmission element f_Z Transmission element factor for overhung load → observe additional overhung load by application if necessary	
3.12	**Checking the emergency stop load (overhung load)** $$F_{R,Brake} \leq F_{RaEmerg.off}$$ $[F_{RaEmergOff}]$ = N Maximum permitted emergency stop overhung load for output shaft in combination with the BE.. brake or BE.. safety brake; applies to point of force application located in the middle of the shaft end or end of the hollow shaft	
3.13	**Calculating the emergency stop speed of the application** $$v_{em.stop} = \frac{n_{em.stop}}{i \times i_v} \times d_0 \times \frac{\pi}{60000}$$ $[v_{emergency\ stop}]$ = m × s^{-1} Real speed during brake application i_v Gear ratio of optional customer's additional transmission	
3.14	**Calculation of maximum braking time** $$t_{B\max} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{em.stop}}{9.55 \times (f_{Mmin} \times M_B + M_L)}$$ $[t_{Bmax}]$ = s Maximum braking time f_{Mmin} Braking torque reduction factor, determination in relation to the used load range for braking work	**Calculation of maximum braking time** $$t_{B\max} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{em.stop}}{9.55 \times (f_{M\min} \times M_B - M_L)}$$
3.15	**Calculation of maximum stopping distance** $$S_{B\max} = v_{em.stop} \times \left(t_{signal} + t_2 + \frac{1}{2} \times t_{B\max}\right)$$ $[S_{Bmax}]$ = m Maximum stopping distance $[t_{signal}]$ = s Plant signal transmit time	
3.16	**Calculation of minimum braking time** $$t_{B\min} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Emergency\ stop}}{9.55 \times (f_{M\max} \times M_B + M_L)}$$ $[t_{Bmin}]$ = s Minimum braking time f_{Mmax} Transmission element factor, braking torque, determination in relation to the used load range for braking work	**Calculation of minimum braking time** $$t_{B\min} = \frac{(J_{Int} + J_x \times \eta_L \times \eta_G) \times n_{Emergency\ stop}}{9.55 \times (f_{M\max} \times M_B - M_L)}$$

No.	Horizontally and vertically upwards	Vertically downwards
3.17	**Calculation of maximum deceleration when braking** $$a_{B\max} = \frac{v_{em.stop}}{t_{B\min}}$$ $[a_{Bmax}]$ = $m \times s^{-2}$ Maximum deceleration when braking	

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6 Technical data

6.1 Operating currents

6.1.1 General information on determining operating currents

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

The acceleration current I_B (= inrush current) flows for a short time when releasing the brake (approx. 160 ms for BE02 – 62, 400 ms for BE60 – 122 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 rms values. Only use current measurement units that are designed to measure rms values.

INFORMATION

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

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

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

Legend

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

The following values are specified:

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

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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../DR2../DRN..	EDR../EDRN..
Rated power	Table values for currents and power without adjustment	Drives for ambient temperatures up to a max of +60 °C	Explosion-proof 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-proof drives according to ATEX, IECEx or HazLoc-NA® (inverter operation)
2nd reduced power	Table values for currents and power × 0.63	Drives for ambient temperatures up to a max of +100 °C	–

BE02, BE03, BE05, BE1, BE2 brakes

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

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

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

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

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

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Brake BE120, BE122

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

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

6.2 Pulse frequencies

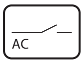
The pulse frequencies of the brake generally depend on many factors, e.g. on the operating temperature of the brakes, the wear condition and the tolerances of the component parts used. A particular factor determining the pulse times is the braking torque set.

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

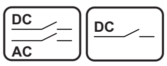
- Response time $t_{1,I}$ for standard excitation

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

  When operating with the BGE., 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 separation only in the DC circuit (DC)

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

Brake	t_1 in 10^{-3} s		t_2 in 10^{-3} s	
	$t_{1,I}$	$t_{1,II}$	$t_{2,I}$	$t_{2,II}$
BE02	30	25	100	10
BE03	60	23	73	15
BE05	34	15	42	10
BE1	55	10	76	12

Brake	t_1 in 10^{-3} s		t_2 in 10^{-3} s	
	$t_{1,I}$	$t_{1,II}$	$t_{2,I}$	$t_{2,II}$
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

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

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

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

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

INFORMATION

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

6.3 Limit speed n_{max}

The following speed limits apply to all brake designs:

Brake		Limit speeds n_{max} in min^{-1}						
		Reduced R	Standard S	Overload range A	Overload range B	Overload range C	Overload range D	Overload range H
BE02	Standard		3600					
BE03 - BE5	Standard		3600					
	FS		3600					
	Ex	3000						
	Ex-FS	3000						
BE11 – BE20	Standard		3600	3600	3600	3600	3600	
	FS		3600	3600	3600	3600	3600	
	Ex	3000						
	Ex-FS	3000						

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Brake		Limit speeds n_{max} in min^{-1}						
		Reduced R	Standard S	Overload range A	Overload range B	Overload range C	Overload range D	Overload range H
BE30/32	Standard		1800	3600	3600	3600	3600	3000
	FS		1800	3600	3600	3600	3600	
	Ex	1800						
	Ex-FS	1800						
BE60 – BE122	Standard		1800				1800	
	Ex	1800						

6.4 Permitted emergency stop braking work $W_{per,n}$

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

⚠ WARNING

Risk of explosion during explosion-proof operation when using the limit values of the S, A, B, C, D or H load range.

Risk of explosion

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

Brake types	Load ranges	Section
BE02	S	6.4.1
BE03 – BE5	R, S	6.4.1
BE11	R, S, A, B, C, D	6.4.2
BE20	R, S, A, B, C, D	6.4.3
BE30/32	R, S, A, B, C, D, H	6.4.4
BE60/62	R, S, D	6.4.5
BE120/122	R, S, D	6.4.6

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

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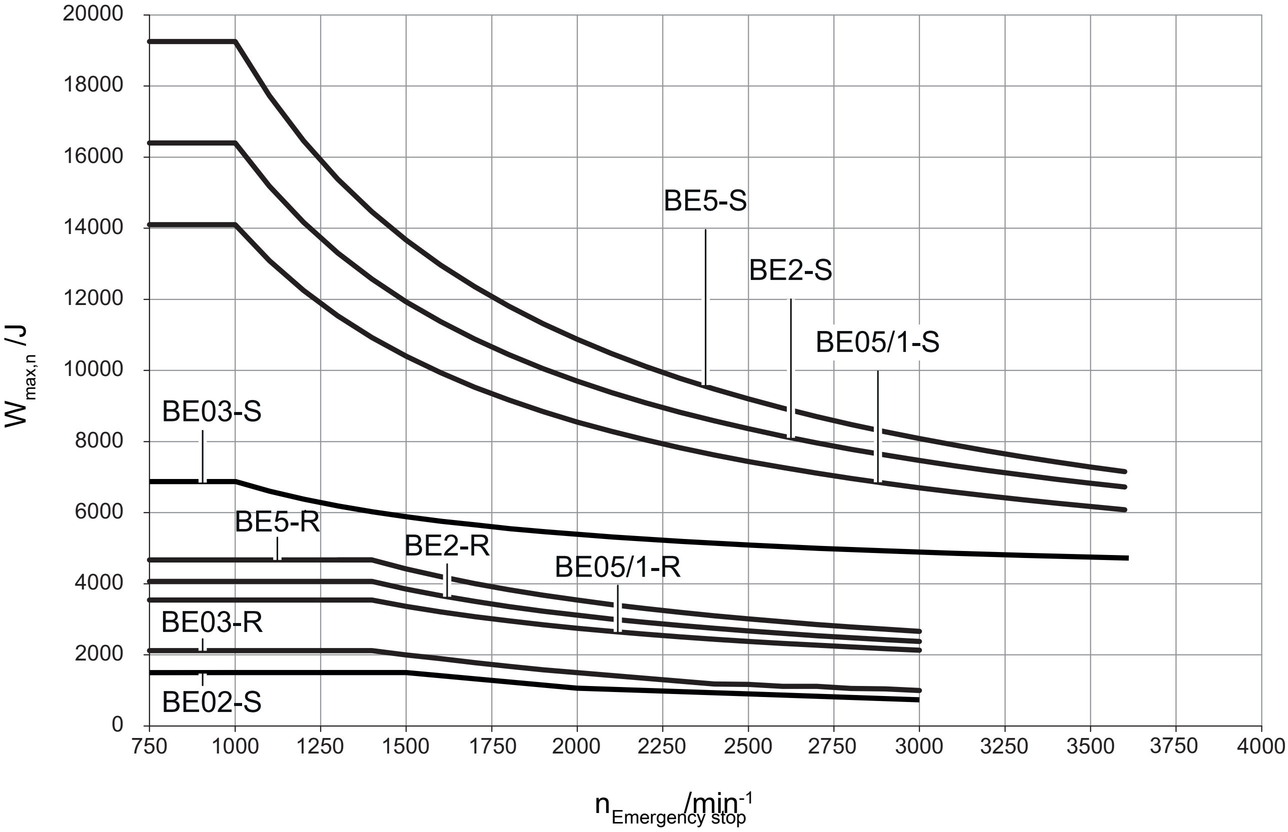
6.4.1 BE02 – 5 (load ranges R and S)



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

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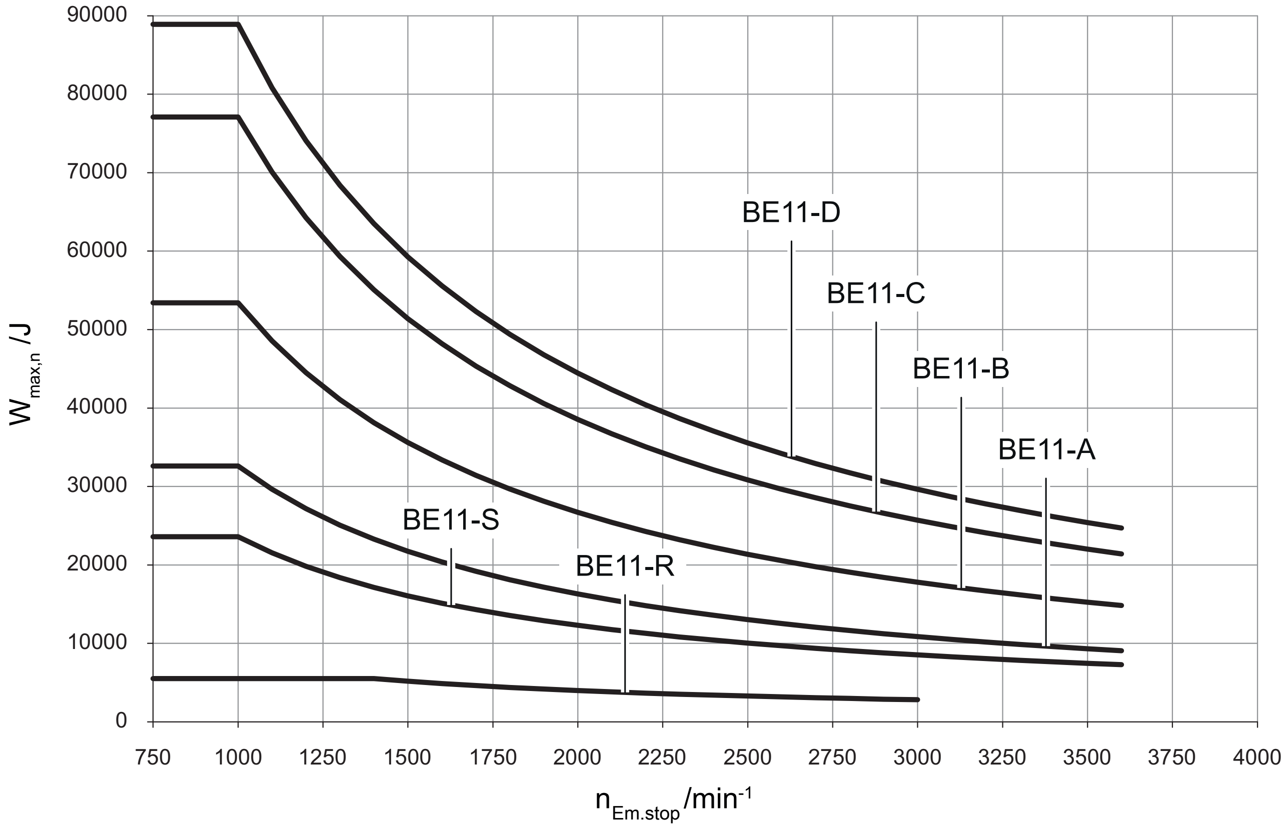
$n_{emergency\ stop}$	**BE02**	**BE03**	**BE05/1**	**BE2**	**BE5**	**BE03**	**BE05/1**	**BE2**	**BE5**
	Load range S	**Load range R**				**Load range S**			
min^{-1}	**$W_{max,n}$ /J**								
2300	980	1304	2510	2810	3060	5196	7830	8830	9780
2400	940	1250	2450	2740	2970	5142	7630	8580	9480
2500	900	1200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

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



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

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

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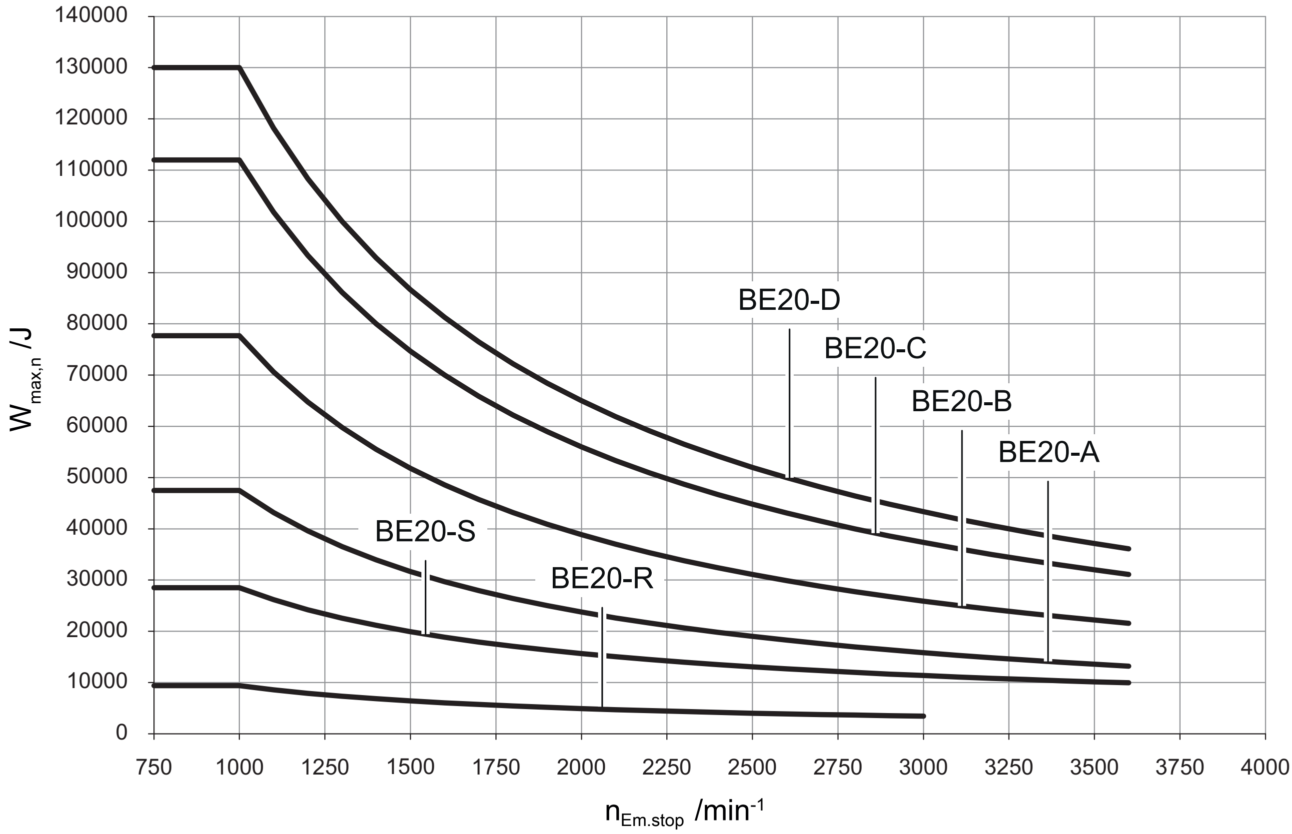
6.4.3 BE20 (load ranges R, S, A, B, C, D)



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

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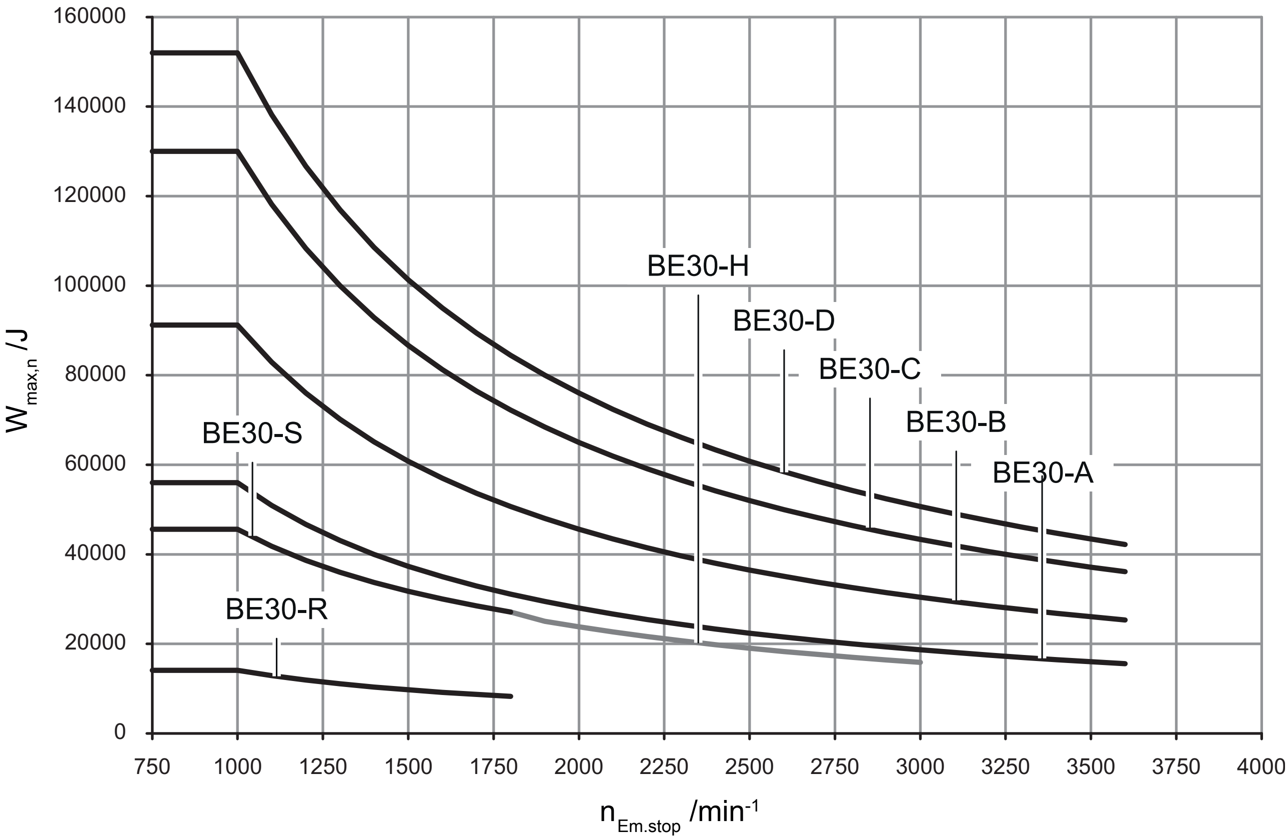
$n_{emergency\ stop}$	BE20					
min^{-1}	**Load range R**	**Load range S**	**Load range A**	**Load range B**	**Load range C**	**Load range D**
	$W_{max,n}$ /J					
2300	4410	14000	20700	33800	48700	56500
2400	4260	13500	19800	32400	46700	54200
2500	4120	13100	19000	31100	44800	52000
2600	3980	12700	18300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

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

INFORMATION

Observe that during capacity utilization of the load range H in the speed range from 1800 – 3000 min^{-1} for hoists and hoist-like applications, a greater nominal braking torque may be necessary to fulfill project planning requirements (see formula 2.1b in chapter "Holding brake/safety brake" (→ 58)).



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

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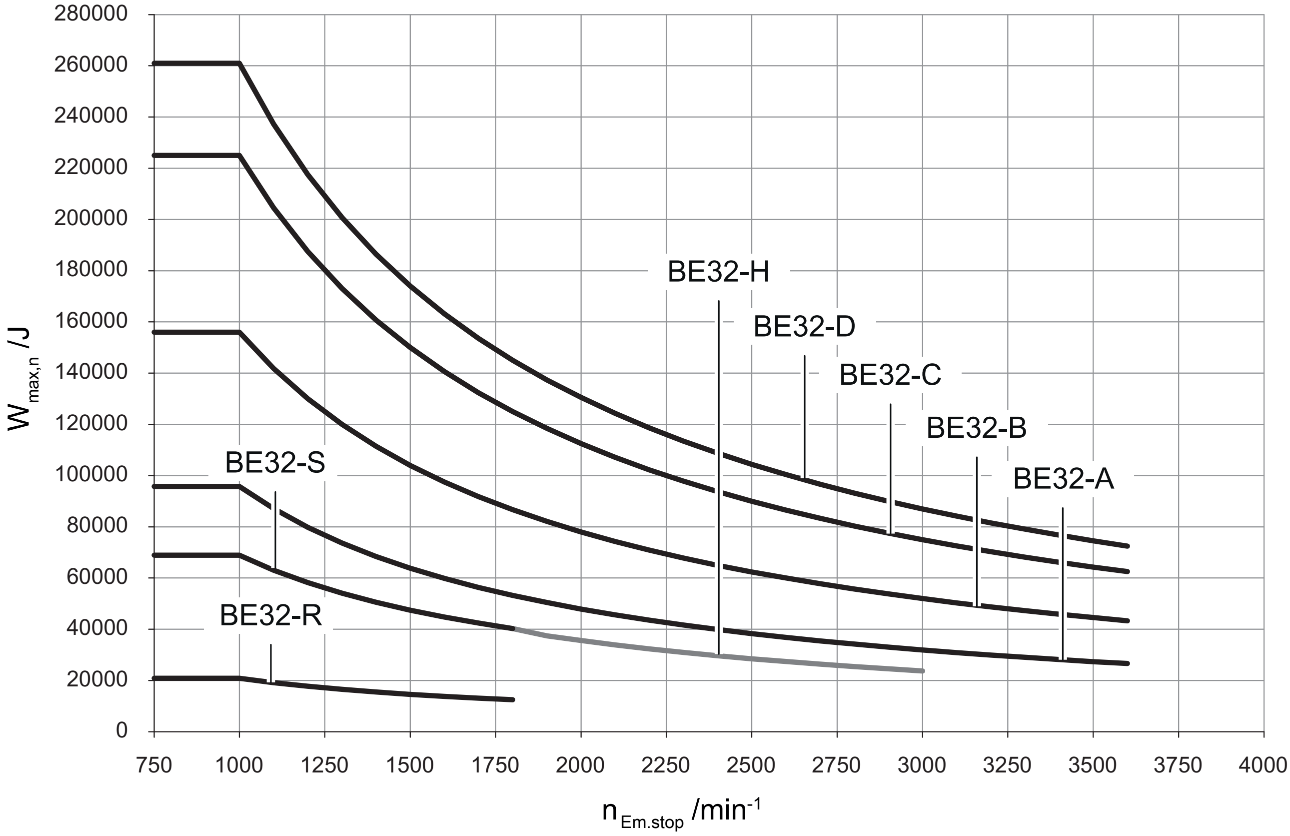
$n_{emergency\ stop}$	BE30						
min^{-1}	Load range R	Load range S	Load range A	Load range B	Load range C	Load range D	Load range H
	$W_{max,n}$ /J						
1800	7920	27100	31100	50700	72200	84400	27100
1900	–	–	29500	48000	68400	80000	25700
2000	–	–	28000	45600	65000	76000	24400
2100	–	–	26700	43400	61900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

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

INFORMATION

Observe that during capacity utilization of the load range H in the speed range from 1800 – 3000 min^{-1} for hoists and hoist-like applications, a greater nominal braking torque may be necessary to fulfill project planning requirements (see formula 2.1b in chapter "Holding brake/safety brake" (→ 🗎 58)).



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

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

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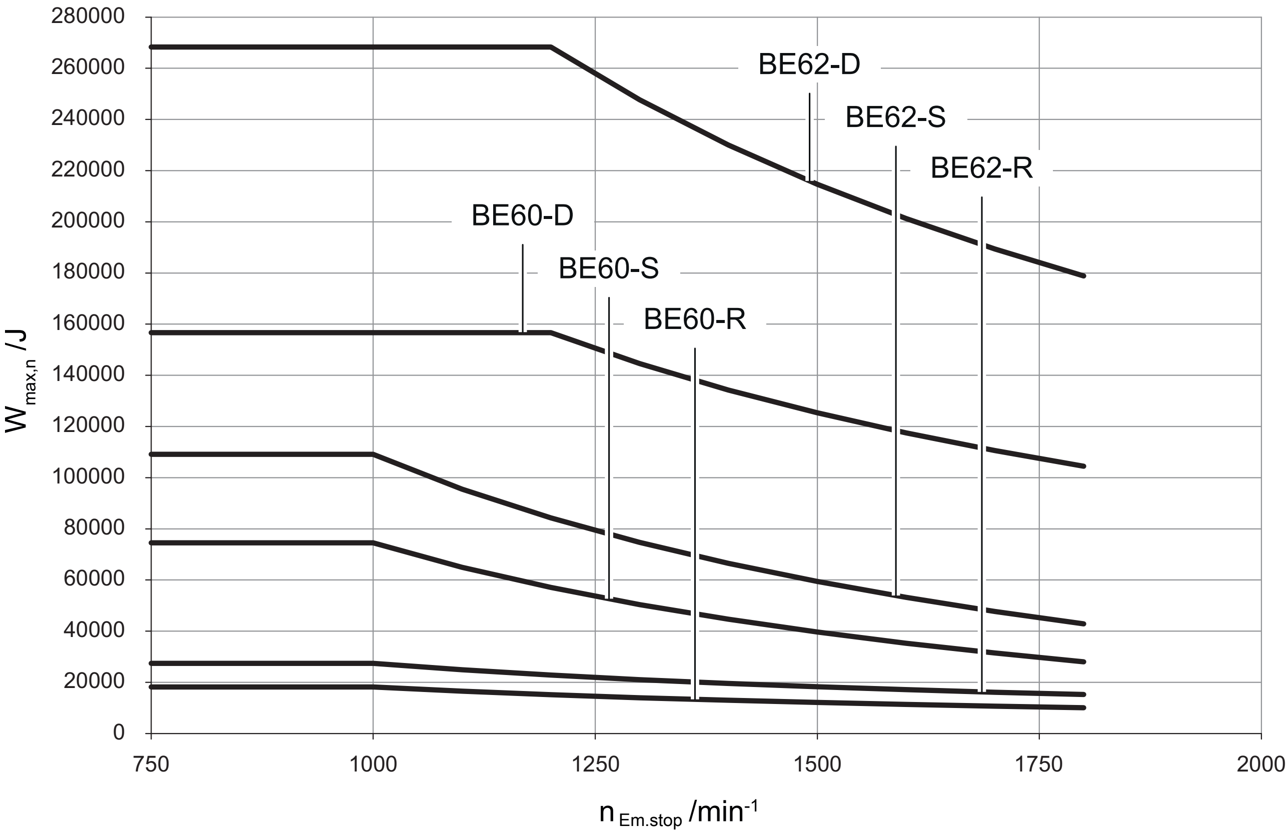
6.4.6 BE60/62 (load ranges R, S, D)



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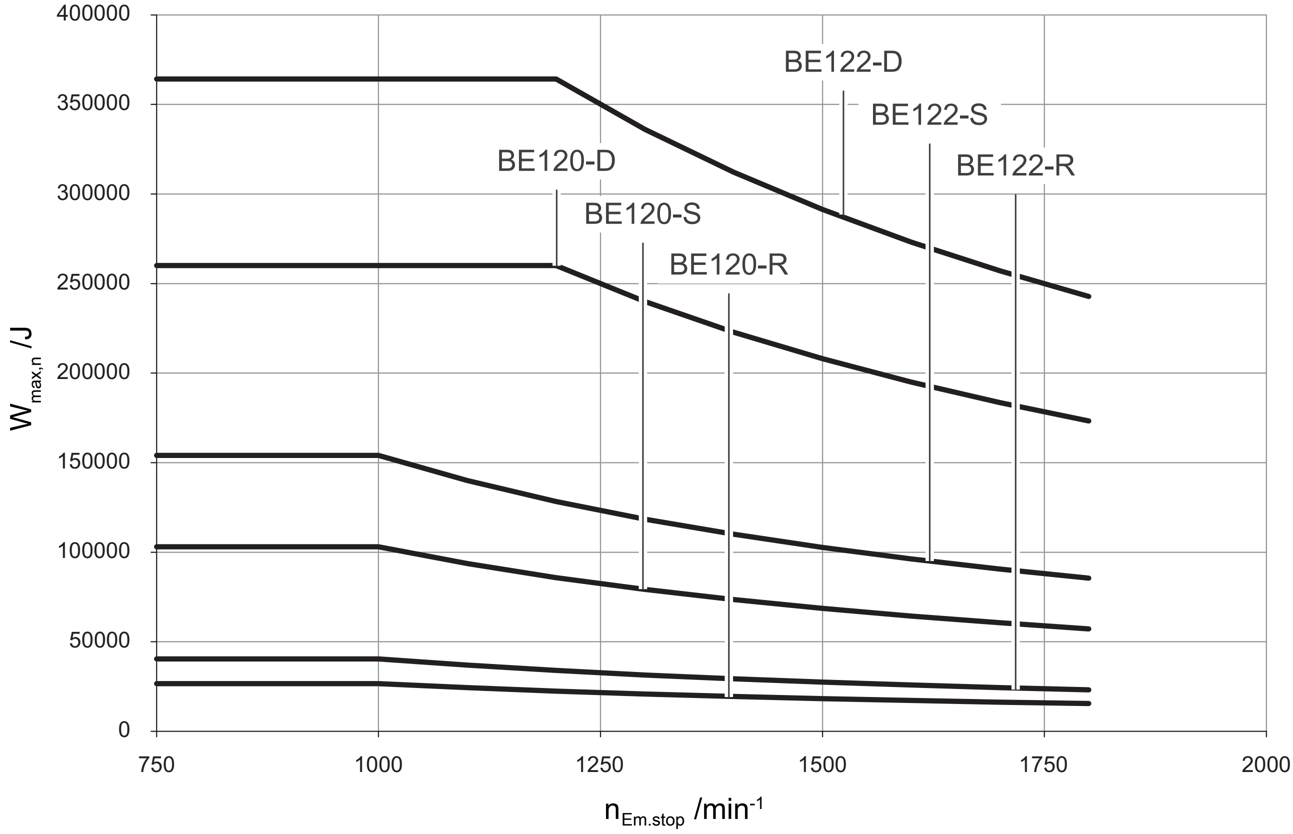
$n_{emergency\ stop}$	BE60			BE62		
min^{-1}	Load range R	Load range S	Load range D	Load range R	Load range S	Load range D
	$W_{max,n}$ /J					
750	17800	74500	157000	26700	109000	268000
900	17800	74500	157000	26700	109000	268000
1000	17800	74500	157000	26700	109000	268000
1100	16200	65000	157000	24300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

6.4.7 BE120/122 (load ranges R, S, D)



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

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

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

⚠ WARNING

Risk of explosion during explosion-proof operation when using the limit values of load range S.

Risk of explosion.

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

Load range	Reference speed min^{-1}	Application	Section
S	1000	Braking operation from operating speed with 6 motor poles, 50 Hz operation	6.5.1
S	1200	Braking operation from operating speed with 6 motor poles, 60 Hz operation	6.5.2
S	1500	Braking operation from operating speed with 4 motor poles, 50 Hz operation	6.5.3
S	1800	Braking operation from operating speed with 4 motor poles, 60 Hz operation	6.5.4
S	3000	Braking operation from operating speed with 2 motor poles, 50 Hz operation	6.5.5
S	3600	Braking operation from operating speed with 2 motor poles, 60 Hz operation	6.5.6
R	1500	Braking operation from operating speed with 4 motor poles, 50 Hz operation	6.5.7
R	1800	Braking operation from operating speed with 4 motor poles, 60 Hz operation	6.5.8

INFORMATION

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

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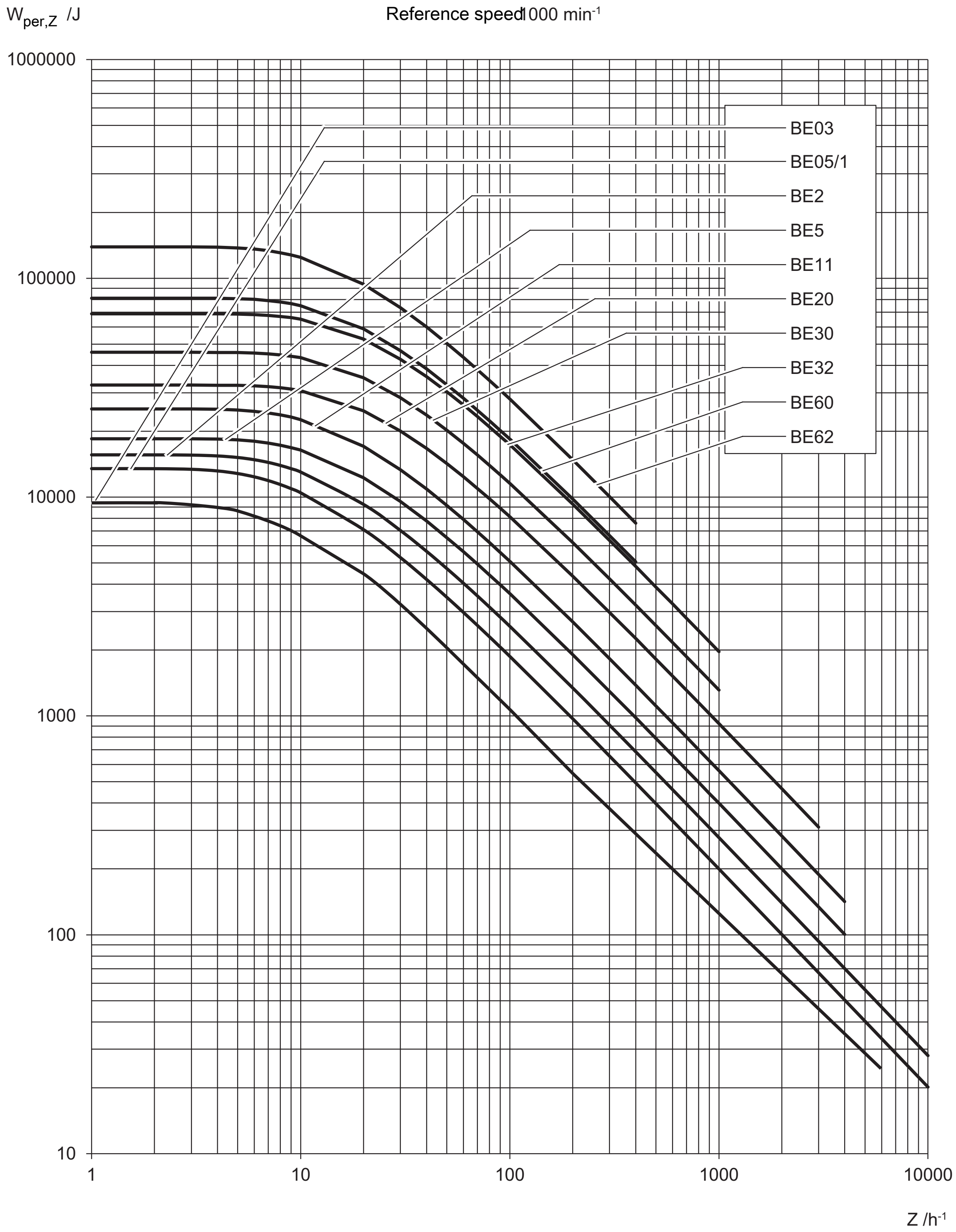
6.5.1 Braking operation from operating speed, load range S, 6 motor poles, 50 Hz



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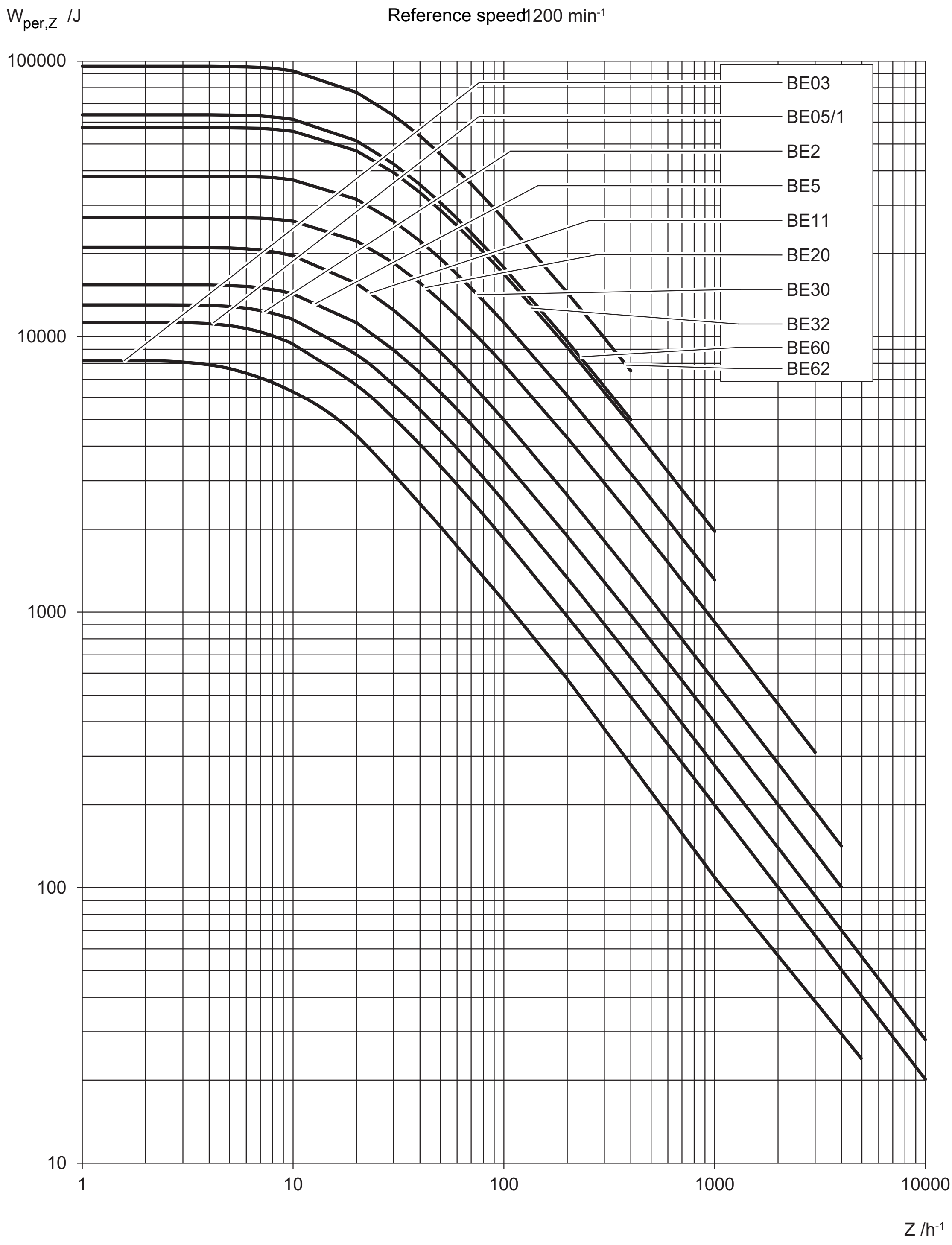
6.5.2 Braking operation from operating speed, load range S, 6 motor poles, 60 Hz



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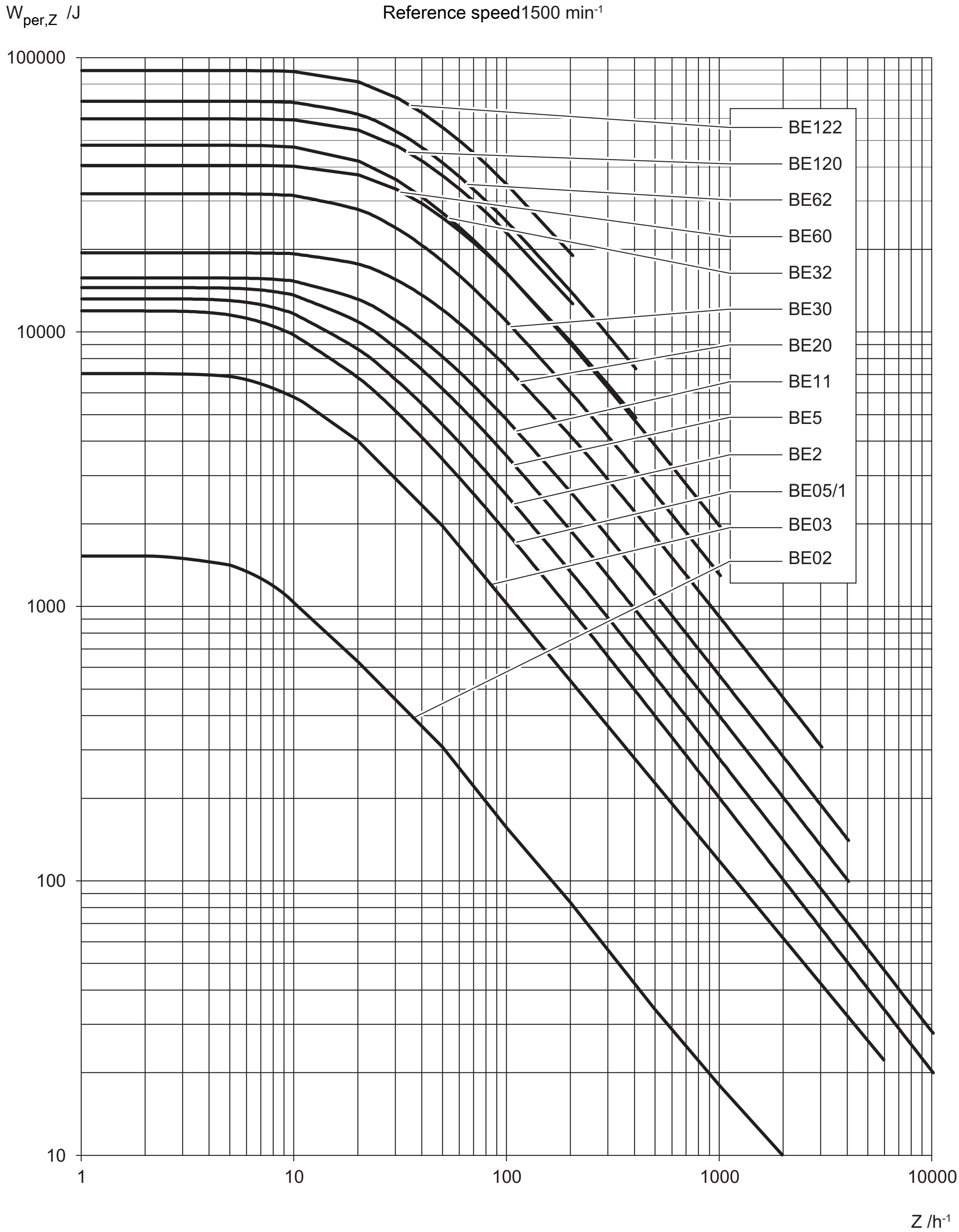
6.5.3 Braking operation from operating speed, load range S, 4 motor poles, 50 Hz



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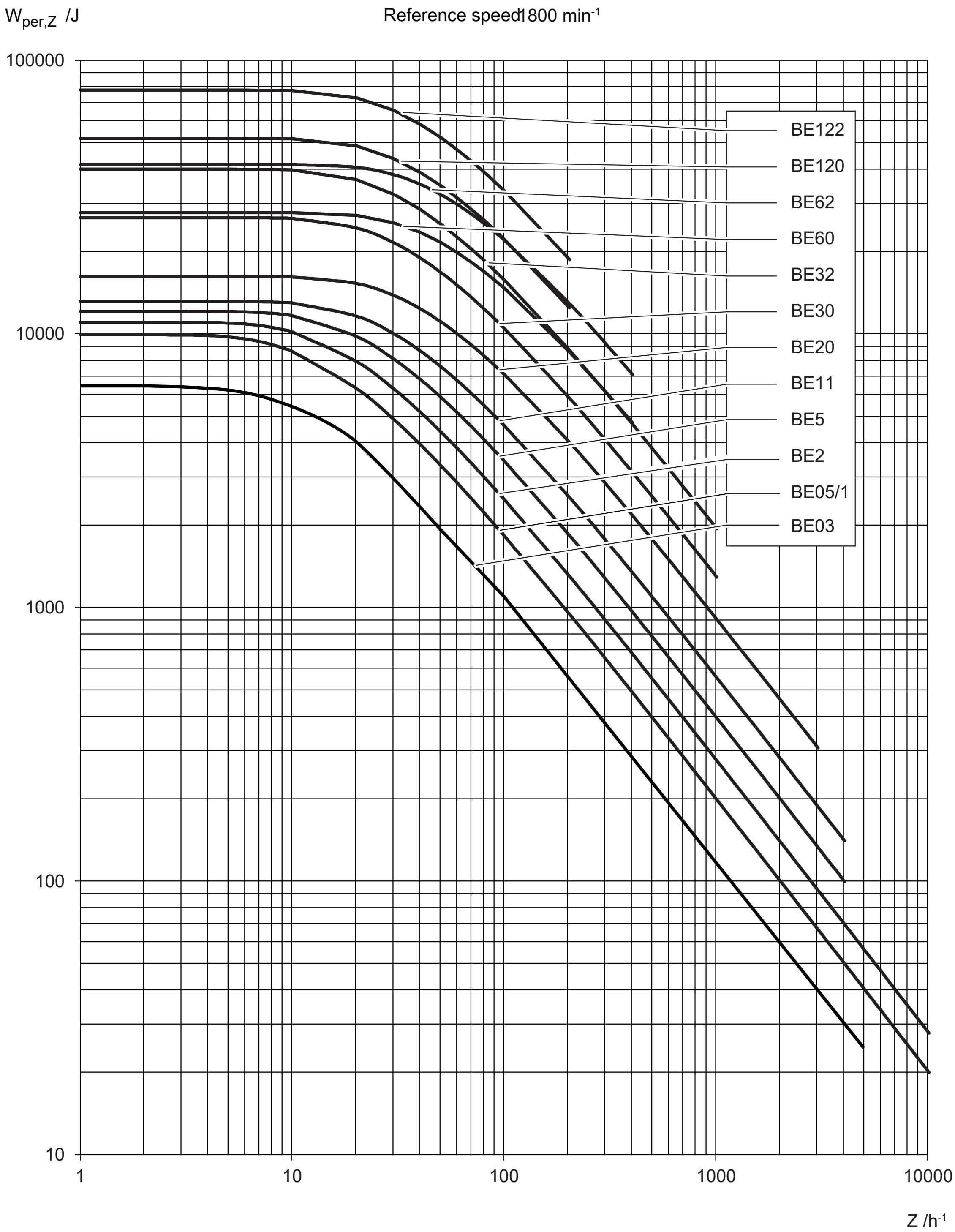
6.5.4 Braking operation from operating speed, load range S, 4 motor poles, 60 Hz



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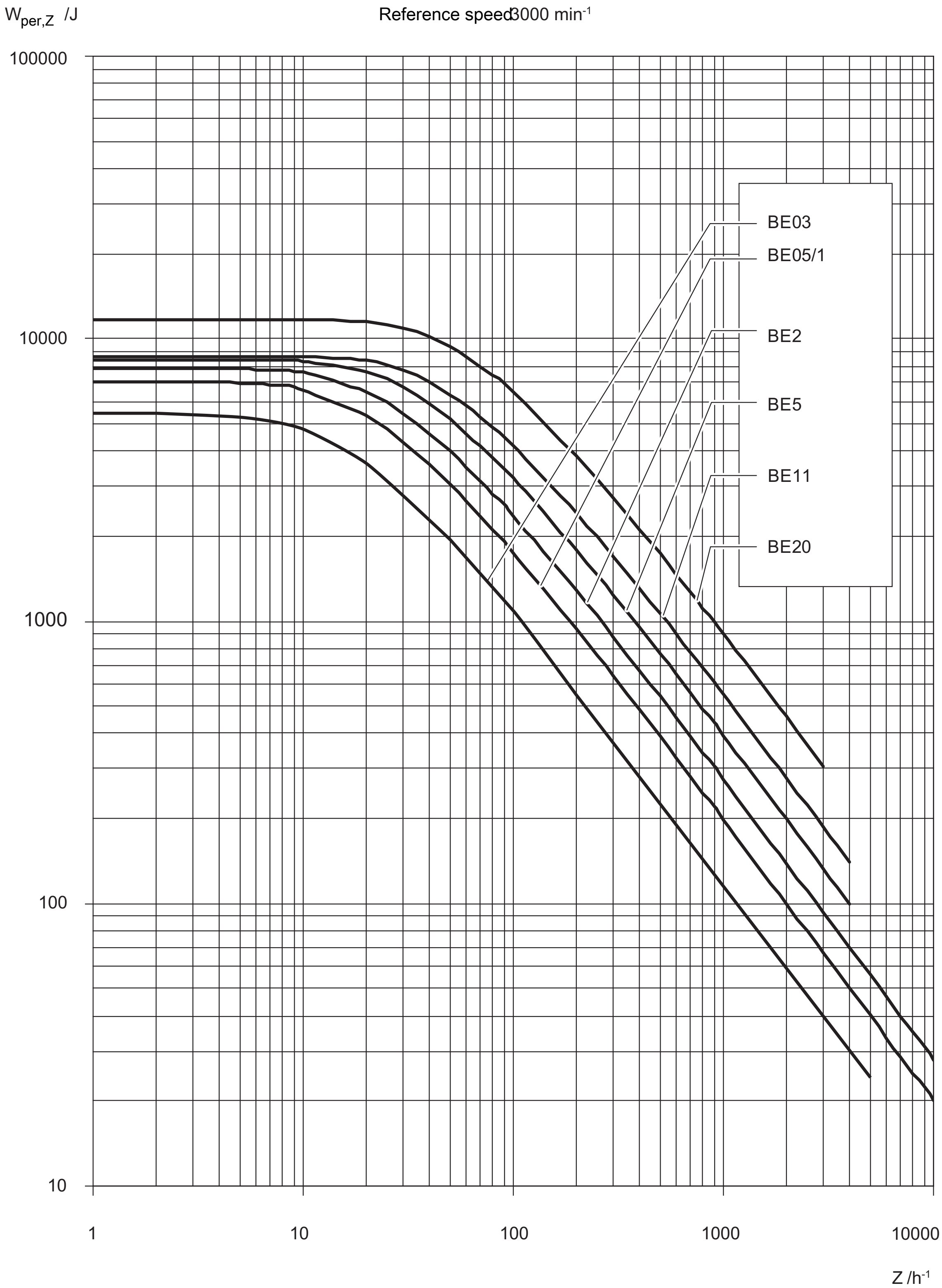
6.5.5 Braking operation from operating speed, load range S, 2 motor poles, 50 Hz

INFORMATION

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



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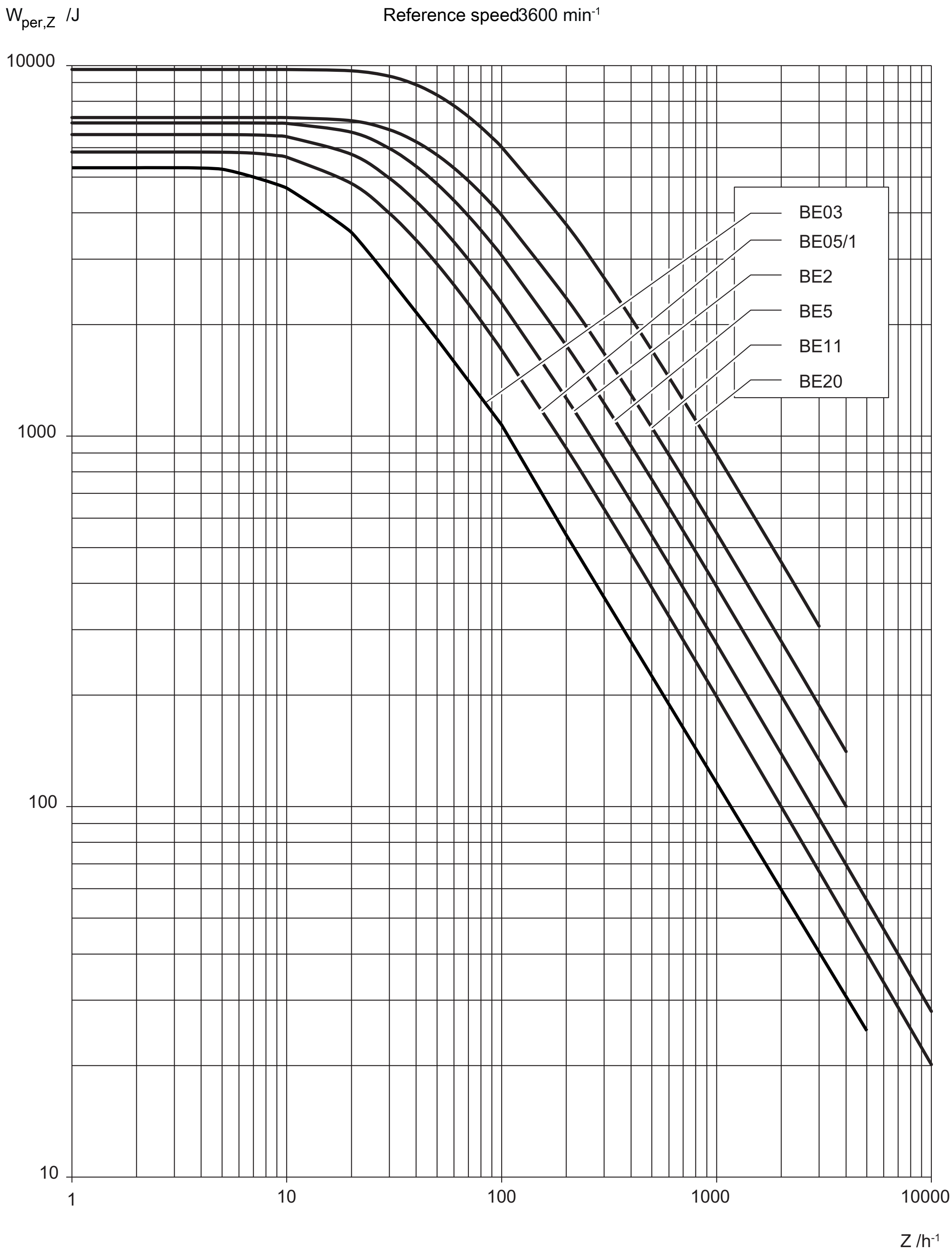
6.5.6 Braking operation from operating speed, load range S, 2 motor poles, 60 Hz

INFORMATION

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



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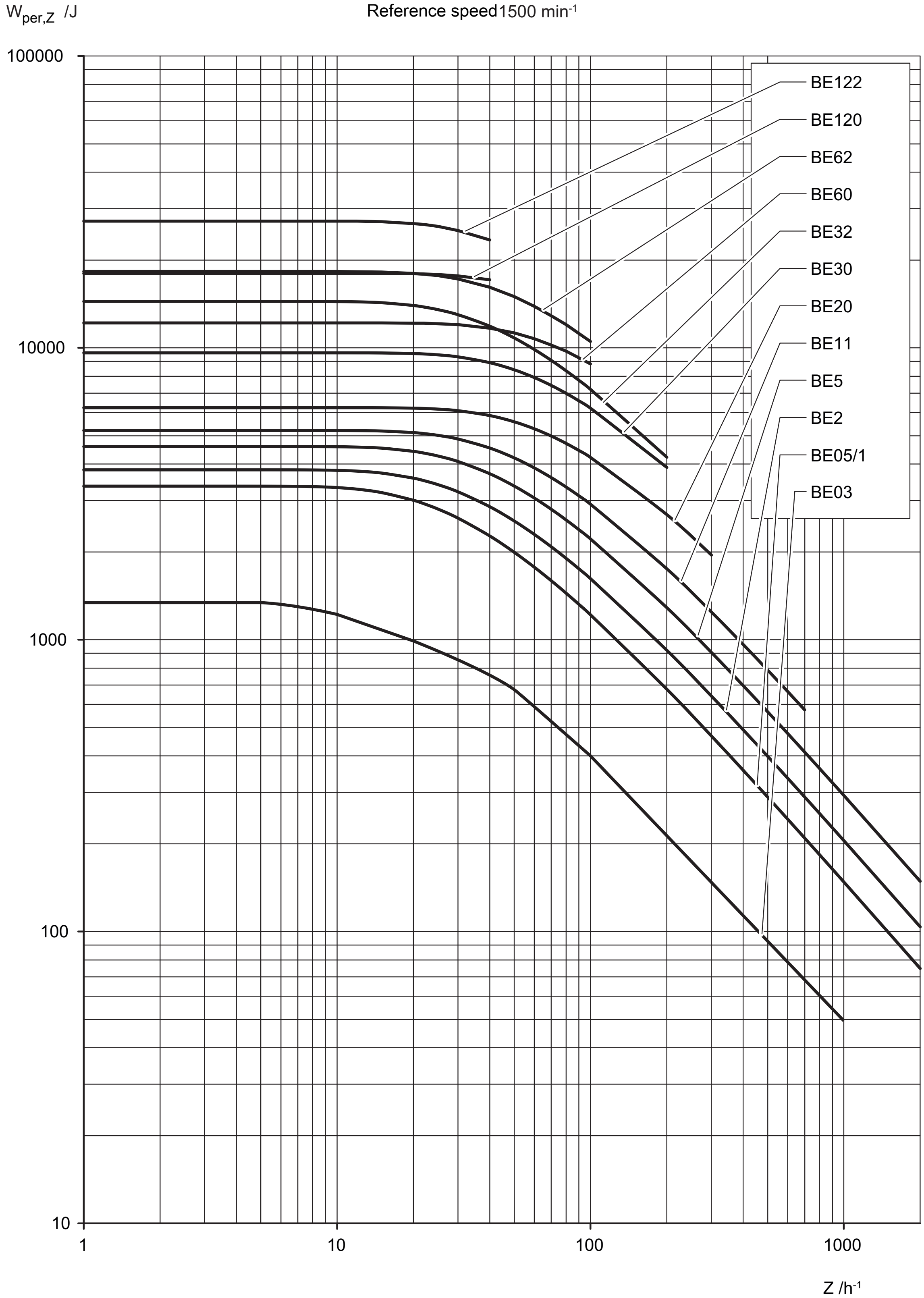
6.5.7 Braking operation from operating speed, load range R, 4 motor poles, 50 Hz



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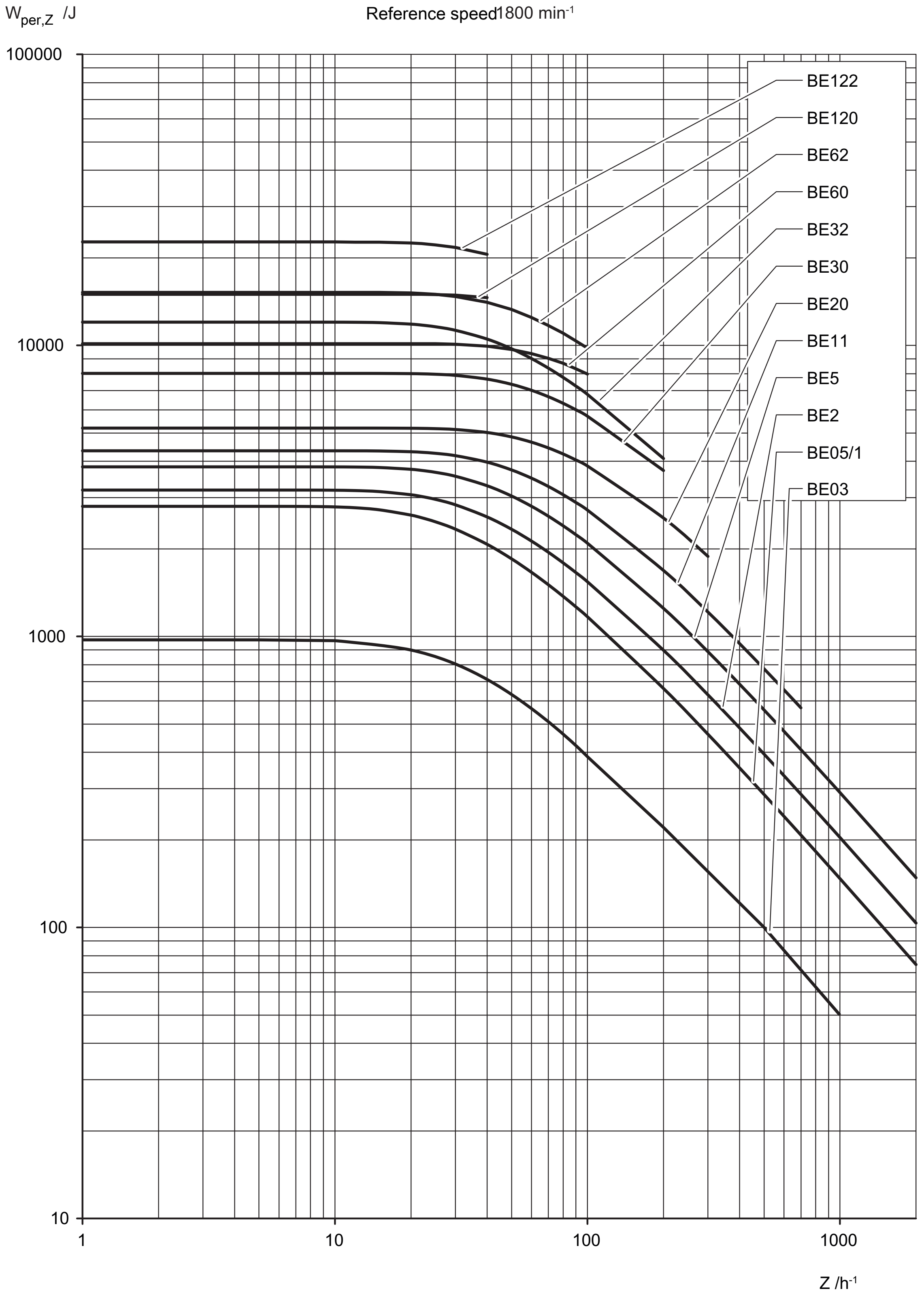
6.5.8 Braking operation from operating speed, load range R, 4 motor poles, 60 Hz



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6.6 Characteristic safety values

INFORMATION

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

6.6.1 Characteristic safety values for BE.. brakes

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

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

SEW-EURODRIVE offers BE.. bakes also as safety brakes up to size BE32. For more information, consult the addendum to the operating instructions "Safety Encoders and Safety Brakes – AC Motors DR.., DRN.., DR2.., EDR.., EDRN.. – Functional Safety".

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6.6.2 Characteristic safety values for BE.. safety brake

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

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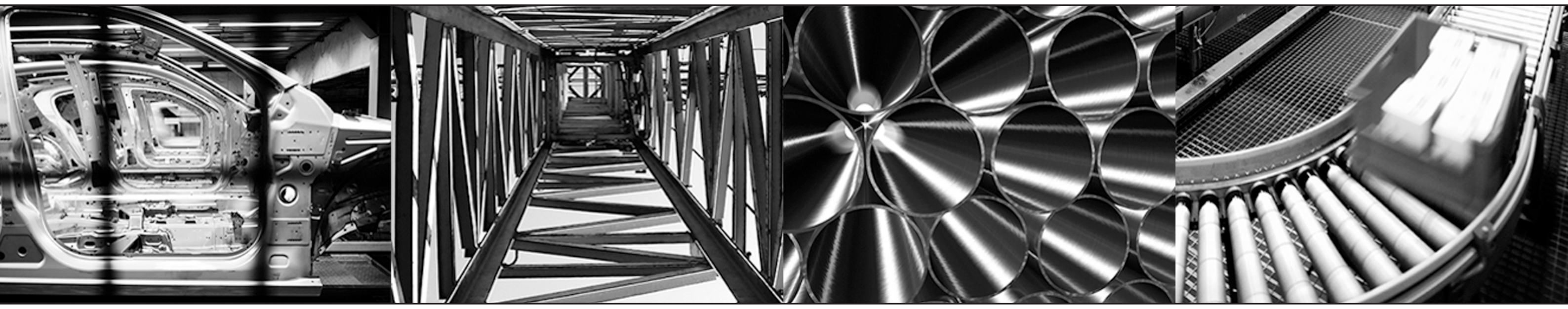

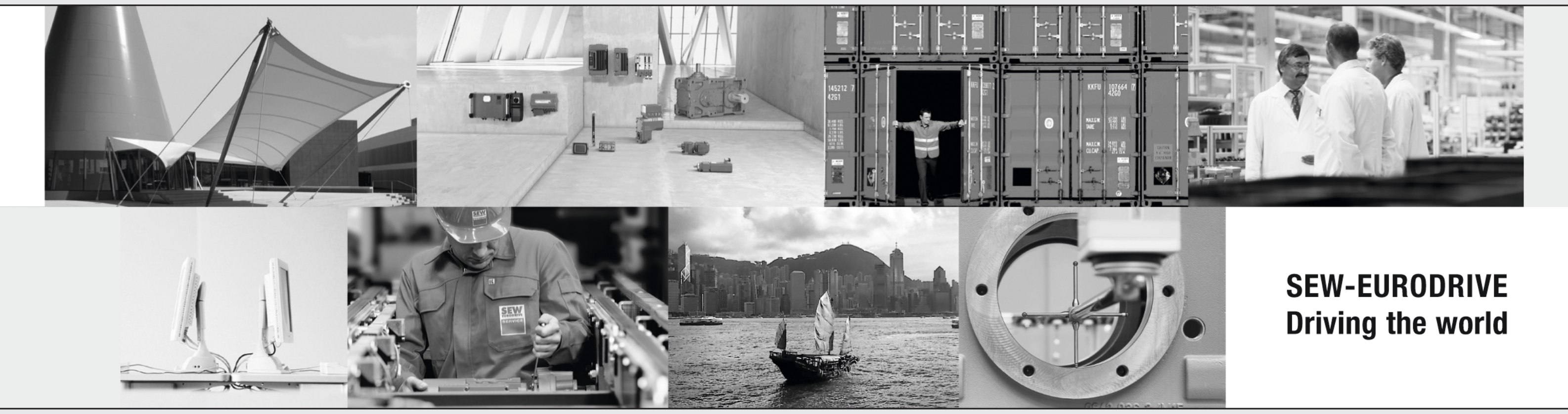

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