4 BZFM Brake
for Offshore and Marine Application, flood- and seawater-proof
Stromag

Founded in 1932, Stromag has grown to become a globally recognized leader in the development and manufacture of innovative power transmission components for industrial drivetrain applications. Stromag engineers utilize the latest design technologies and materials to provide creative, energy-efficient solutions that meet their customer’s most challenging requirements.

Stromag’s extensive product range includes flexible couplings, disc brakes, limit switches, an array of hydraulically, pneumatically, and electrically actuated brakes, and a complete line of electric, hydraulic and pneumatic clutches.

Stromag engineered solutions improve drivetrain performance in a variety of key markets including energy, off-highway, metals, marine, transportation, printing, textiles, and material handling on applications such as wind turbines, conveyor systems, rolling mills, agriculture and construction machinery, municipal vehicles, forklifts, cranes, presses, deck winches, diesel engines, gensets and stage machinery.

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Altra Industrial Motion

Altra is a leading global designer and manufacturer of quality power transmission and motion control products utilized on a wide variety of industrial drivetrain applications. Altra clutches and brakes, couplings, gearing and PT component product lines are marketed under the industries most well known manufacturing brands. Each brand is committed to the guiding principles of operational excellence, continuous improvement and customer satisfaction. Highly-engineered Altra solutions are sold in over 70 countries and utilized in a variety of major industrial markets, including food processing, material handling, packaging machinery, mining, energy, automotive, primary metals, turf and garden and many others.

Altra’s leading brands include Ameridrives, Bauer Gear Motor, Bibby Turboflex, Boston Gear, Delroyd Worm Gear, Formsprag Clutch, Guardian Couplings, Huco, Industrial Clutch, Inertia Dynamics, Kilian, Lamiflex Couplings, Marland Clutch, Matrix, Nuttall Gear, Stieber, Stromag, Svendborg Brakes, TB Wood’s, Twiflex, Warner Electric, Warner Linear and Wichita Clutch.

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Applications

- Holding and working brake variations for off shore and industrial applications where high protection against harsh environment is essential
- Usable for windlasses, anchor winches, shipboard cranes, cargo winches, trawler winches

Main features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
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<tbody>
<tr>
<td>Coil body with coil</td>
<td>Thermal class 155, nitrocarburated and postoxidated</td>
</tr>
<tr>
<td>Armature disc</td>
<td>Special protection: nitrocarburated and postoxidated</td>
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<tr>
<td>Brake disc</td>
<td>Special protection: nitrocarburated and postoxidated</td>
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<tr>
<td>Friction lining</td>
<td>Low wear rate with low torque fade over a high range of temperature. High thermal capacity.</td>
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<tr>
<td>Flange</td>
<td>To IEC standard</td>
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<tr>
<td>Cover</td>
<td>Manufactured of gray cast, from size 400 of seawater protected aluminium</td>
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<tr>
<td>Pinion</td>
<td>Nitrocarburated and postoxidated</td>
</tr>
<tr>
<td>Fixing screws</td>
<td>All stainless steel</td>
</tr>
<tr>
<td>Flying leads</td>
<td>1.5 metre long, radial or axial</td>
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<tr>
<td>Seals</td>
<td>For high protection</td>
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Optional extras

- Micro switch for monitoring switching states or wear detection
- Terminal box
- Standstill heater
- Preparation for speedometer installation

Switching modules

- Half wave or full wave
- Quick switching units
- Built in terminal box
- Attached for mounting into the motor terminal box
**Advantages**

- Comprehensive torque range 63 – 11,000 Nm
- Operative without cover
- Type approvals: GL, LRS, ABS, DNV, BV, RR (on request)
- Simple assembly to motor, no dismantling of brake required
- Less wear
- Compatibility of consumable spares
- Simple maintenance, one time wear re-adjustment by reversing of the brake disc
- Proven reliable design
- Sealed inspection holes for air gap or lining wear
- Extremely low inertia
- High heat dissipation
- Free from axial loads when braking and running
- Suitable for vertical mounting, please consult Stromag Dessau GmbH
- Many optional extras available
- Facilities to design to customer’s special requirements
- Protection available up to IP 67
- "Asbestos free" linings as standard

**Voltages available**

- Usual voltage: 24 V DC, 110 V DC, 190 V DC and 207 V DC, other voltages (e.g. 103 V DC) on request.
- Coils available to suit: AC – supplies with integral Half and Full wave rectification.
- We suggest the following alternative - Customer to take standard voltage with rectifier which Stromag Dessau can provide.
**Brake operation**

The brake 4 BZFM is a spring-loaded electromagnetic double-face brake which brakes without current and is released electromagnetically.

The brake is screwed to a motor or any other machine part by means of cyl. screws via the flange (04). The coil body (01) contains a coil (33) which is potted with a synthetic resin compound in accordance with thermal class 155, (max. limit of temperature 155°C).

If the coil (33) is not excited, the springs (34) press the armature disc (32) against the friction disc with friction lining (02), which is firmly clamped between the torsion-protected armature disc (32) and the brake disc (03) and thus prevented from rotating. The braking effect is transmitted from the geared friction disc with friction lining (02) via the pinion (05) and a fitting key to the shaft. If the coil is connected to a direct voltage as specified on the nameplate, the magnetic force will draw the armature disc (32) to the coil body (01) overcoming the spring pressure. The friction disc with friction lining (02) is released, the braking effect is cancelled and the brake is released.
**Micro switch**
Optional availability, inboard proving switch, one common contact, one normally open contact and one normally closed contact.
This can be interlocked with motor contactor for parking brake duty, i.e. brake release before starting motor.

**Brake termination**
Three standard versions:
- Flying leads usually 1.5 meter long, axial with a cable bushing and radial through cable gland in flange.
- IP 66 terminal box, for easy connection and removal, at execution with terminal box the brake complies with protection IP 66!
- Versions for AC supply with built-in full wave or half wave rectification inside the terminal box.

**Emergency release by means of emergency release screws**
For mechanical release in case of emergency or for the adjustment of the system emergency release screws are available.

**Flange to IEC**
Manufactured to suit your motor on B-side to our brake with IEC connection dimensions.

**Standstill heater**
Inboard standstill heaters can be provided.

**Speedometer installation**
If a speedometer connection is required for the brake, the brake cover is provided with connecting bores in accordance with "Euro dimension". The type of protection only maintains when the speedometer is rigidly connected to the cover by means of a flange gland which is sealed by round ring.

**Special surface finishes**
All components are surface finished with a special surface protection against abrasive environment; e.g. against saline atmosphere on deck, etc..
### Table 1: Technical data

<table>
<thead>
<tr>
<th>Size (4) BZFM</th>
<th>(M_{es}) Nm</th>
<th>(M_{r}) Nm</th>
<th>(n_1) rpm</th>
<th>(n_{zn}) rpm</th>
<th>(U^*) V DC</th>
<th>(P_e) W</th>
<th>airgap min/max</th>
<th>(W) kJ</th>
<th>(P_{es}) kW</th>
<th>(J) kgm²</th>
<th>(m) kg</th>
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</table>

* other voltages on request
### Electromagnetic Spring-Applied Brake

4 BZFM

**Switchable nominal torque at 1 m/s frictional speed to DIN VDE 0580 (applies to dry operation with an oil- and grease-free friction lining after running-in)**

**Transmissible static nominal torque without slip, to DIN VDE 0580 (applies to dry operation with an oil- and grease-free friction lining after running-in)**

**Maximum idling speed**

**Admissible switching speed**

**Excitation output at 20°C**

**Nominal braking capacity (S4-40 % I.O.)**

**Switch work per switching operation for z = 1 – 5 h\(^{-1}\)**

**Mass moment of inertia of rotating parts**

**Weight**

**Mode of operation**

**S1, S2, S4-40 % I.O.**

**Thermal class**

**155 (F) in accordance with DIN VDE 0580**

**AC-control**

**Via rectifier**

#### Table 2: List of dimensions (all dimensions in mm)

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<tr>
<th>Size 4 BZFM</th>
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</table>

Keyways to DIN 6885/1

Standard flange to DIN 42948
Optional Accessories

4 BZFM – Electromagnetic Spring-Applied Brake

- 6x60° = 360°
- 8x5.7 mm deep
- 6 M6, 8 mm deep
- Cap with a hole for a rotary shaft seal
- Standstill heating
- Terminal box with terminal block, rectifier or quick switching unit
- Cable duct into flange
- 15 m axial cable connection
- Cable gland with 15 m cable duct into flange
- Micro switch
**Example of designation**

<table>
<thead>
<tr>
<th>Component</th>
<th>Code</th>
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<tbody>
<tr>
<td>Brake type</td>
<td>4 BZFM</td>
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<tr>
<td>Brake size</td>
<td>10</td>
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<td>Nominal voltage</td>
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<td>Bore diameter, prebored</td>
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<tr>
<td>With quick switching unit</td>
<td>SB</td>
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</table>

**Calculations**

Figure 1:

The diagram shows the time response of an Electromagnetic Spring-Applied Brake as defined by VDE regulations 0580.
**M₁ = Switchable torque [Nm]**
The switchable (dynamic) torque is the torque which can be transmitted by a brake under slip condition depending on the friction coefficient and at working temperature. \(M₁ = 0.9M_{SN}\)

**M₃ = Synchronization torque [Nm]**
The synchronization torque is the torque which arises for a short time after finishing the switching process.

**M₀ = Transmissible torque [Nm]**
The transmissible (static) torque is the max. torque that can be applied to a brake without the risk of slipping.

**M₅ = Switchable nominal torque [Nm]**
The switchable nominal torque is the dynamic torque as stated in the catalogue at a frictional speed of 1 m/sec.

**M₇ = Load torque [Nm]**
+ \(M₇\) for acceleration, − \(M₇\) for deceleration. The load torque should always be considered with relative safety factors.

**M₅ = No-load torque (drag torque) [Nm]**
The no-load torque is the torque which the brake transmits at working temperature when free running.

**M₆ = Decelerating torque [Nm]**
The decelerating torque results from the addition (subtraction for lifting gear during lowering) of the switchable torque and load torque.

**Operation times**
The operation times shown in the diagram are based on the example of a brake actuated by loss of electrical current. The basic characteristic is also applicable to brakes with alternate methods of operation.

The time delay \(t_{11}\) is the time from the instant of de-energization (actuation) to the commencement of the torque build-up (of no importance for d.c. switching). The torque build-up time \(t_{12}\) is the time from the commencement of torque build-up to the attainment of 90% of the switchable nominal torque \(M_{SN}\). The switching time \(t₁\) is the sum of the time delay and torque build-up time:

\[
t₁ = t_{11} + t_{12}
\]

The time delay \(t_{21}\) is the time from energization (actuation) to the commencement of the torque will decrease. The fall time \(t_{22}\) is the time from the commencement of the torque decrease to 10% of the switchable nominal brake torque \(M_{SN}\). The switching time \(t₂\) is the sum of the time delay and the fall time:

\[
t₂ = t_{21} + t_{22}
\]

To decrease the switching times of Electromagnetic Spring-Applied brakes, special switching is required.

Please ask for particular information. The switching times stated in the dimensional tables apply to d.c. switching, working temperature and nominal voltage without special switching techniques.
Nomenclature

\( A \_r \)  \( \text{cm}^2 \)  Friction surface
\( m \)  \( \text{kg} \)  Mass
\( Q \)  Joule(J)  Heat quantity
\( Q_\text{h} \)  Watt(W)  Heat per hour
\( c \)  \( \frac{\text{kJ}}{\text{kgK}} \)  Specific heat

Steel \( c = 0.46 \frac{\text{kJ}}{\text{kgK}} \)
Cast iron \( c = 0.54 \frac{\text{kJ}}{\text{kgK}} \)

\( n \)  rpm  Speed
\( t_\text{A} \)  s  Braking time
\( t_\text{S} \)  s  Slipping time

Mass moment of inertia \( J \) [kgm²]

The mass moment of inertia \( J \) stated in the formula is the total mass moment of inertia of all the masses to be retarded referred to the brake.

Reduction of moments of inertia

The reduction of moments of inertia is calculated from the formula

\[ J_1 = J_2 \times \left( \frac{n_2}{n_1} \right)^2 \text{[kgm}^2\text{]} \]

Moments of inertia of linear masses

The equivalent moment of inertia \( J\_\text{Ers} \) for a linear mass \( m \) and a velocity \( v \) referred to the brake speed \( n \) is calculated from the formula

\[ J\_\text{Ers} = 91 \times m \times \left( \frac{v}{n} \right)^2 \text{[kgm}^2\text{]} \]

\([v = \text{m/s}] \quad [n = \text{min}^{-1}] \quad [m = \text{kg}]\)

Torque considerations for the brake

The mean torque of the driving or driven machine may be calculated from

\[ M = 9550 \times \frac{P}{n} \text{[Nm]} \]

\([P = \text{kW}] \quad [n = \text{rpm}]\)

If the system includes gearing, all torques must be referred to the brake shaft. Depending on the type and functioning of the driving or driven machine resp. shock and peak loads are an important factor for the determination of brake sizes. If precise deceleration times are required a sufficient decelerating torque must already been taken into account when selecting the brake size on the torque rating. Considering the load torque direction, the following switchable nominal torque \( M\_\text{SN} \) of a brake is attained (+\( M\_L \) for lifting devices when lowering).

\[ M\_\text{SN} = M\_A \pm M\_L \]
4 BZFM – Electromagnetic Spring-Applied Brake

When expressing the decelerating torque $M_A$ by means of the pulse principle, we obtain after corresponding conversion.

<table>
<thead>
<tr>
<th>Acceleration by load</th>
<th>Brake support by load</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_A = J \cdot \frac{d\omega}{dt}$ [Nm]</td>
<td>$M_A = J \cdot \frac{d\omega}{dt}$ [Nm]</td>
</tr>
<tr>
<td>$M_{SN} = \frac{J \cdot n}{9,55 \cdot t_a + M_L}$ [Nm]</td>
<td>$M_{SN} = \frac{J \cdot n}{9,55 \cdot t_a - M_L}$ [Nm]</td>
</tr>
<tr>
<td>$t_a = \frac{J \cdot n}{9,55 \cdot (M_{SN} - M_L)}$ [s]</td>
<td>$t_a = \frac{J \cdot n}{9,55 \cdot (M_{SN} + M_L)}$ [s]</td>
</tr>
</tbody>
</table>

It is assumed that the dynamic torque is achieved instantaneously. Note that the dynamic torque decreases with the speed.

**Considerations of dissipated energy**

For all operations at speed with slip, dissipated energy is generated in the brake which is transformed into heat. The admissible amount of dissipated energy resp. power capacity must not be exceeded in order to avoid any inadmissible heating. Often the selection of the brake size upon the torque requirement only is not sufficient. Therefore it must always be checked whether the heat capacity of the brake is sufficient.

Generally the dissipated energy in a brake, slipping at time $dt$ with its dynamic torque $M_s$ at an angular speed $\omega_s$ is:

$$dQ = M_s \cdot \omega_s \cdot dt$$

With $\omega_s$ and conversion by means of the pulse principle the following dissipated energy amount is determined for a single deceleration process with existing load torque:

<table>
<thead>
<tr>
<th>Acceleration by load</th>
<th>Brake support by load</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Q = \frac{M_{SN}}{(M_{SN} - M_J)} \cdot \frac{J \cdot n^2}{182.000}$ [kJ]</td>
<td>$Q = \frac{M_{SN}}{(M_{SN} + M_J)} \cdot \frac{J \cdot n^2}{182.000}$ [kJ]</td>
</tr>
</tbody>
</table>

If a brake slips with constant slipping speed under operation, the dissipated energy is calculated from the formula

$$Q = 0,105 \cdot 10^{-3} \cdot M_s \cdot n_s \cdot t_s$$

[kJ]

**Working brake**

The brake has to brake a shaft with switching frequency "X" from speed "Y" to speed zero and has to hold it.

**Holding brake with emergency stop function**

The brake actuates with shaft speed zero and has to hold; in case of emergency, however, it must be able to brake from shaft speed "Y" to zero.
**4 BZFM – Electromagnetic Spring-Applied Brake**

Permissible heat capacity at 1500 rpm

\[ W \text{ [kJ]} \times \text{Switching operations} \times \frac{1}{z} \text{ operations per hour} \]

Figure 2: Heat capacity of series 4 BZFM \( n = 1500 \text{ rpm} \). By known operations and number of operations per hour the brake size can be obtained.

Example: \( W = 100 \text{ kJ/operation} \) and \( z = 10 \text{ operations/hour} \) choose the size 4 BZFM 40

** permissible switching operations per switching at other speed ratings on request**
### Questionnaire to allow the determination of Spring-Applied Brakes

#### DRIVING MACHINE

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency controlled motor</td>
<td></td>
</tr>
<tr>
<td>Pole changing motor</td>
<td></td>
</tr>
<tr>
<td>Constant speed motor</td>
<td></td>
</tr>
<tr>
<td>Other motor types</td>
<td></td>
</tr>
<tr>
<td>Nominal and maximum power</td>
<td>kW</td>
</tr>
<tr>
<td>Nominal and maximum speed</td>
<td>rpm</td>
</tr>
<tr>
<td>Maximum torque (i.e. breakdown torque)</td>
<td>Nm</td>
</tr>
</tbody>
</table>

#### DRIVEN MACHINE

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slewing system</td>
<td></td>
</tr>
<tr>
<td>Hoisting system</td>
<td></td>
</tr>
<tr>
<td>Trolley or gantry system</td>
<td></td>
</tr>
<tr>
<td>Winch system</td>
<td></td>
</tr>
<tr>
<td>People transporting system</td>
<td></td>
</tr>
<tr>
<td>Other application</td>
<td></td>
</tr>
</tbody>
</table>

#### BRAKE TYPE

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working and emergency brake</td>
<td></td>
</tr>
<tr>
<td>Holding brake with emergency characteristic</td>
<td></td>
</tr>
</tbody>
</table>

#### CALCULATION DATA

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal braking speed</td>
<td>rpm</td>
</tr>
<tr>
<td>Emergency braking speed</td>
<td>rpm</td>
</tr>
<tr>
<td>Load torque at nominal braking speed</td>
<td>Nm</td>
</tr>
<tr>
<td>Load torque at emergency braking speed</td>
<td>Nm</td>
</tr>
<tr>
<td>Maximum possible load torque</td>
<td>Nm</td>
</tr>
<tr>
<td>Number of braking operations per hour at nominal / required speed (incl. load data)</td>
<td></td>
</tr>
<tr>
<td>Number of braking operations per required time unit at emergency speed (incl. maximum load data)</td>
<td></td>
</tr>
<tr>
<td>Moment of inertia of the parts moved by the motor or braked by the brake (motor, gearbox, winch etc.)</td>
<td>kgm²</td>
</tr>
<tr>
<td>Demanded switching cycles of the brake</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>°C</td>
</tr>
<tr>
<td>Protection class or short description of environmental conditions</td>
<td>Marine, port, in house</td>
</tr>
<tr>
<td>Options: Microswitch, rectifier, switching unit, terminal box, heater or other</td>
<td></td>
</tr>
</tbody>
</table>
## The Brands of Altra Industrial Motion

### Couplings
- **Ameridrives**
  - website: www.ameridrives.com
- **Bibby Turboflex**
  - website: www.bibbyturboflex.com
- **Guardian Couplings**
  - website: www.guardiancouplings.com
- **Huco**
  - website: www.huco.com
- **Lamiflex Couplings**
  - website: www.lamiflexcouplings.com
- **Stromag**
  - website: www.stromag.com
- **TB Wood’s**
  - website: www.tbwoods.com

### Geared Cam Limit Switches
- **Stromag**
  - website: www.stromag.com

### Electric Clutches & Brakes
- **Inertia Dynamics**
  - website: www.idicb.com
- **Matrix**
  - website: www.matrix-international.com
- **Stromag**
  - website: www.stromag.com
- **Warner Electric**
  - website: www.warnerelectric.com

### Linear Products
- **Warner Linear**
  - website: www.warnerlinear.com

### Engineered Bearing Assemblies
- **Kilian**
  - website: www.kilianbearings.com

### Heavy Duty Clutches & Brakes
- **Industrial Clutch**
  - website: www.industrialclutch.com
- **Twiflex**
  - website: www.twiflex.com
- **Stromag**
  - website: www.stromag.com
- **Wichita Clutch**
  - website: www.wichitACLUTCH.com

### Belted Drives
- **TB Wood’s**
  - website: www.tbwoods.com

### Gearing
- **Bauer Gear Motor**
  - website: www.bauergears.com
- **Boston Gear**
  - website: www.bostongear.com
- **Delroyd Worm Gear**
  - website: www.delroyd.com
- **Nuttall Gear**
  - website: www.nuttallgear.com

### Overrunning Clutches
- **Formsprag Clutch**
  - website: www.formsprag.com
- **Marland Clutch**
  - website: www.marland.com
- **Stiebel**
  - website: www.stiebelclutch.com

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