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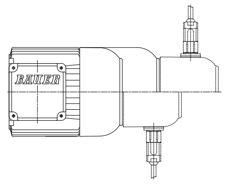

**Functional description**

The compression springs act on the anchor disc, which is free to move in the axial direction and presses the brake disc, which is keyed to the rotor shaft, against the friction plate or the motor bearing plate. This produces the braking torque.

When a DC voltage is applied to the coil in the electromagnet housing, it generates a magnetic force that opposes the spring force and causes the anchor disc to be pulled toward the electromagnet enclosure.
This releases the brake disc and disengages the brake.

Brakes are classified into two types according to how they are used: holding brakes and working brakes.

Holding brake ES.. / ZS..
brake that in normal operation does not convert kinetic energy into frictional energy but is only used to hold a mechanism in a particular position, but which can also be used for motion braking in an emergency.

Service brake ESX.. / ZSX..
A brake that converts kinetic energy into frictional energy in normal operation, which means that it brakes mechanical motion.
When a working brake is used as a holding brake, the braking torque tolerance of up to -30 % (in new condition) must be taken into account.

**Product description of type ES(X) spring-actuated brakes**

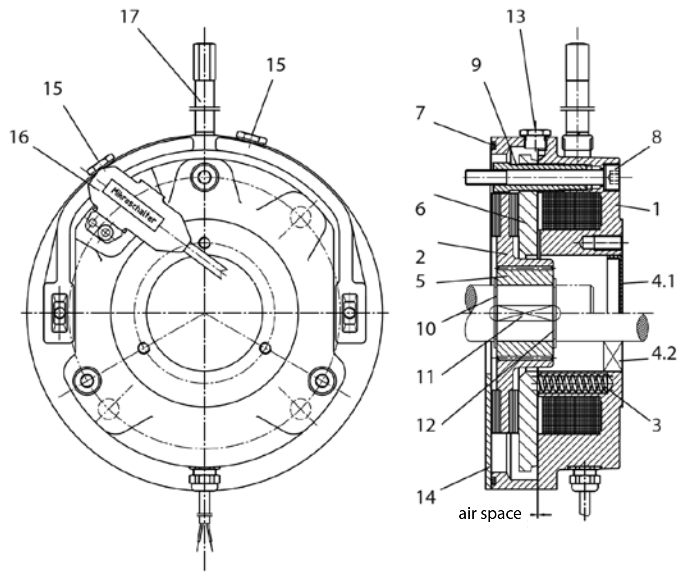


Figure 1: Construction of ES(X) brake

**Brake mounting**

ES and ESX: Brake mounting is under the fan cover
EH and EHX: Brake mounting is on the fan cover

**Product description of type ZS(X) spring-actuated brakes**

**Options**

- Manual release, non-locking or locking
- Microswitch for monitoring operation or wear

**Construction**

| | |
|---|---|
| 1 | Electromagnet housing |
| 2 | Brake disc |
| 3 | Compression spring |
| 4.1 | Cover plate with closed brake |
| 4.2 | Shaft seal with through shaft |
| 5 | Drive bush |
| 6 | Anchor disc |
| 7 | O-ring |
| 8 | Fitting screw with copper washer |
| 9 | Hollow screw |
| 10 | Retaining ring |
| 11 | Key |
| 12 | Retaining ring |
| 13 | Screw plug for checking air gap |
| 14 | Friction plate (only with motor size Dxx08 or Dxx09) |
| 15 | Screw plug for checking microswitch setting |
| 16 | Microswitch (optional) |
| 17 | Manual release (optional) |

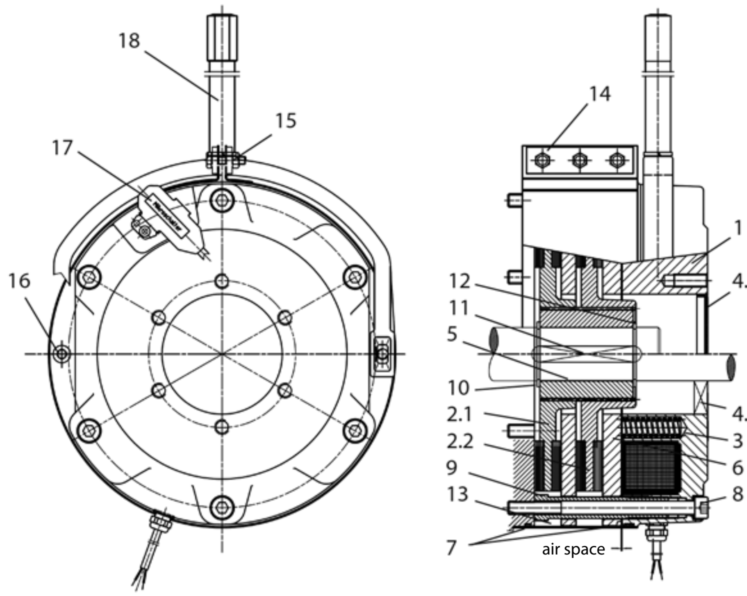


Figure 2: ZS(X) brake construction

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**Options**

- Manual release, non-locking or locking
- Microswitch for monitoring operation or wear

**Construction**

| | |
|---|---|
| 1 | Electromagnet housing |
| 2 | Brake disc 2.1 and 2.2 |
| 3 | Compression spring |
| 4.1 | Cover plate |
| 4.2 | Shaft seal with through shaft |
| 5 | Drive bush |
| 6 | Anchor disc |
| 7 | O-ring |
| 8 | Fitting screw with copper washer |
| 9 | Hollow screw |
| 10 | Retaining ring |
| 11 | Key |
| 12 | Retaining ring |
| 13 | Cover |
| 14 | Fitting screws |
| 15 | Bracket |
| 16 | Assembly screw/assembly aid |
| 17 | Microswitch (optional) |
| 18 | Manual release (optional) |

**Brake selection and sizing**

If the working brake is undersized, it will have increased wear and a shorter lifetime. If it is oversized, the resulting mechanical forces may overload the drive.

If specific application data is not available, in the case of horizontally driven equipment we recommend selecting a braking torque with a safety factor (K) of 1 to 1.5 times the rated torque of the motor.
For braking to standstill, the selected braking torque should be at least 80 % of the rated torque of the drive.

Rated torque:

$$M_{Berf} = \frac{P \times 9550}{n_2} \times K$$

| | | |
|---|---|---|
| $M_{Berf}$ | Braking torque | [Nm] |
| P | Motor power | [kW] |
| n | Rated speed at rotor shaft | [rpm] |

For lifting operation, a braking torque equal to twice the rated motor torque should always be chosen for safety reasons.

If the moment of inertia, speed and allowable deceleration time of the machine are known, the braking torque can be calculated as described below.

**External moments of inertia**

If the masses to be decelerated by the brake do not run at the same speed as the rotor shaft, the moment of inertia ($J_{ext}$) must be reduced to the value at the rotor shaft

$$J_{ext'} = \frac{J_{ext1} \times n_1^2 + J_{ext2} \times n_2^2 + \ldots + J_{extn} \times n_n^2}{i^2}$$

or the external moment of inertia reduced by the gear ratio of the gear unit to the value at the rotor shaft.

15

$$J_{ext'} = \frac{J_{ext}}{i^2}$$

$J_{ext}$ Total external moment of inertia [kgm²]
$J_{ext'}$ Total external moment of inertia referenced to the rotor shaft [kgm²]
$J_{ext1,2,...}$ Individual external moments of inertia [kgm²]
i Gear reduction ratio
n Rotor shaft speed
$n_{1,2}$... Speeds of the individual moments of inertia [rpm]

Load torque under static load

$$M_L = F \times r$$

$M_L$ Load torque [Nm]
F Force [N]
r radius [m]

**Braking torque with dynamic load**

A purely dynamic load is present when flywheels, rolls, etc. must be decelerated and the static load torque is negligible.

$$M_a = \frac{J_{ges} \times n_a}{9{,}55 \times (t_a - t_A)} = \frac{(J_{ext'} + J_{rot} + J_{Br}) \times n_a}{9{,}55 \times (t_a - t_A)}$$

$J_{br}$ Moment of inertia of the brake [kgm²]
$J_{rot}$ Moment of inertia of the rotor shaft and rotor [kgm²]
$M_a$ Deceleration torque [Nm]
$n_a$ Initial speed at start of deceleration [rpm]
$t_a$ Total deceleration time (from switch-off until drive is stationary) [s]
$t_A$ The response time of the brake for braking corresponds to $t_{AC}$ or $t_{DC}$ in the specification tables [s]

**Dynamic and static loads**

In most application situations, both static and dynamic loads are present.

$M_{Berf} = (M_a \pm M_L) \times K$ where $M_{Berf} \leq M_{Br}$ must hold true.

$M_L$ braking (positive) or driving (negative) load torque [Nm]

**Heat generated by each brake cycle**

Friction converts the kinetic energy of the moving masses into heat.
This amounts to

$$W = \frac{J_{ges} \times n^2}{182{,}5} = \frac{(J_{ext'} + J_{rot} + J_{Br}) \times n_a^2}{182{,}5}$$ where $W \leq W_{max}$ must hold true.

W Braking energy for each brake cycle [J]
$M_{max}$ Maximum permissible frictional energy per brake cycle (see brake tables)

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**Thermally allowable braking energy of working brakes**

With a uniform sequence of brake cycles, which means a certain average number of brake cycles per hour, the temperature rises until an equilibrium between heat input and heat dissipation is reached. The temperature rise must be sized to avoid overheating the coil and the friction layer, taking the ambient temperature into account.

**Braking to standstill:**

$$W_Z = W \times Z \leq W_{th}$$

| | |
|---|---|
| $W_{th}$ | Maximum allowable braking energy per hour |
| $W_Z$ | Braking energy with Z brake cycles |
| Z | Number of brake cycles per hour |

**Lifting operation**

In lowering operation, the drive motor acts as a generator and its braking effect results in a steady downward motion (constant speed). If we ignore transmission losses, under full load the drive must brake the load with the rated motor torque. If a mechanical brake with a braking torque equal to the braking torque of the motor is applied after the drive is switched off, the downward motion will continue at the same speed. This means that additional braking torque is necessary to stop the motion of the load. For example, if the brake is dimensioned for 200 % braking torque, approximately 100 % is used for "static" deceleration and the rest is used for "dynamic" deceleration.
If part of the braking torque is required for braking the load during lowering (downward motion), the brake engagement time is greater, and the thermal load is therefore greater.

In this case

$$W_H = \frac{M_{Br}}{M_{Br} - M_L} \times W_Z$$

| | |
|---|---|
| $W_H$ | Friction energy per hour in lifting operation |
| $M_{Br}$ | Braking torque of the brake |

**Brake lifetime**
The energy absorbed during braking causes the brake disc to wear, which increases the air gap. If the air gap increases beyond a certain maximum gap size, the magnetic field is so weak that the pulling force of the electromagnet is no longer sufficient to release the brake. A proper air gap must be restored by adjusting the air gap or by replacing the brake disc, depending on the type of brake construction.

The maximum number of brake cycles until service is necessary can be calculated as follows:

$$Z_L = \frac{W_L}{W}$$

| | |
|---|---|
| $Z_L$ | Number of brake cycles until the air gap limit is reached |
| $W_L$ | Maximum allowable braking energy until maintenance; i.e. replacing the brake disc or adjusting the air gap. Adjustment of the air gap is possible only with type ZXSxx brakes. |

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**Deceleration time**
The pure braking time from the start of mechanical braking to standstill depends on the braking deceleration.
Especially with lifting operation, but also in other types of operation, it is necessary to check whether the load torque reinforces the braking effect or counters the braking effect.

The deceleration time is therefore calculated as follows:

$$t_a = \frac{J_{ges} \times n_a}{9{,}55 \times (M_{Br} \pm M_L)}$$

**Electrical connection**

**General**

There are two basic options for providing the supply voltage for the DC electromagnet:

1. Externally from an existing DC control voltage mains or a rectifier in the cabinet.
2. From a rectifier built into the motor or brake terminal box. In this case, the rectifier can be powered either directly from the motor terminal board or from the mains.

Note that in the following cases the rectifier is not allowed to be connected to the terminal board of the motor:

- Pole-changing motors and motors with wide operating voltage range
- Operation from a frequency converter
- Other configurations in which the motor voltage is not constant, such as operation with soft-start devices, start-up transformers, etc.

**Release**

When the rated voltage is applied to the electromagnet coil, the current through the coils increases exponentially and with it the generated magnetic field. The current must rise to a certain value ($I_{release}$) before it overcomes the spring force and starts to release the brake.

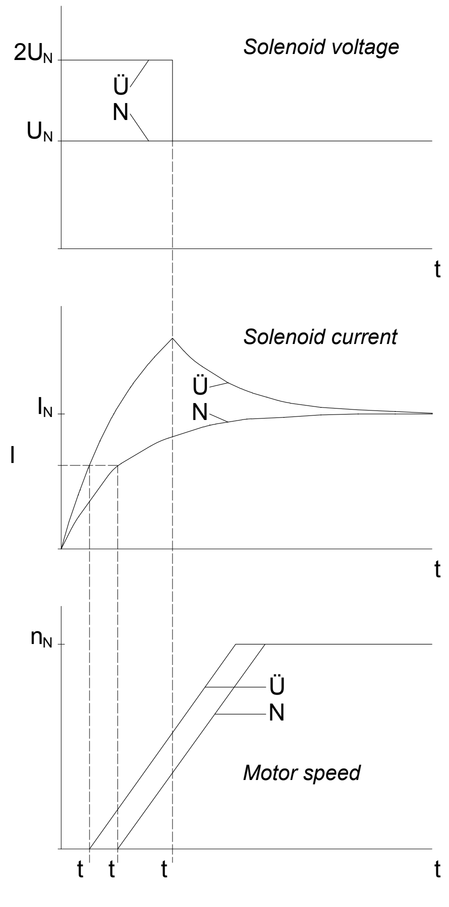


Figure 3: Idealised curves of coil voltage, coil current and motor speed with normal excitation (N) and overexcitation (Ü). $t_{Ü}$: overexcitation time; $t_{AN}$, $t_{AÜ}$: Response time with normal excitation and overexcitation.

Two different situations can arise during the response time tA, assuming that the voltage is applied to the motor and the brake simultaneously:

- The motor is locked if $M_A < M_L + M_{Br}$
  The motor draws its locked-rotor current, which increases the thermal load on the motor.
  This situation is illustrated in Figure 3.
- The brake slips if $M_A > M_L + M_{Br}$
  In this case, the brake is also thermally stressed during start-up and wears faster.

$M_A$: locked rotor torque of the motor; $M_L$: load torque; $M_{Br}$: braking torque

As can be seen, there is an additional load on the motor and brake in both cases. The effect of the response time increases with increasing brake size. Consequently, it is advisable to reduce the response time, especially with medium-sized and large brakes and with a high cycle rate. This can be achieved relatively easily by means of electrical overexcitation. With this approach, the coil is briefly operated at twice its rated voltage after switch-on.

This causes the current to rise faster than with normal excitation, and it reduces the response time by approximately 50 %. This overexcitation function is built into the type MSG special rectifier.

The release current increases with increasing air gap, and with it the response time. When the release current exceeds the rated coil current, the brake will not be released with normal excitation and the brake has reached its wear limit.

**Braking**
The brake does not start generating braking torque immediately after the coil voltage is switched off. First the magnetic energy must decline to the point that the spring force can overcome the magnetic force. This occurs at the holding current $I_{hold}$, which is lower than the release current.
The response time depends on how the voltage is switched off.

Switching off the AC supply voltage to a type SG standard rectifier

a) Rectifier powered from the motor terminal board (Figure 4, curve 1)
Response time $t_{A1}$: very long

Cause: Due to the residual magnetism of the motor, after the motor voltage is switched off a slowly decaying voltage is induced, and it continues to supply power to the rectifier and thereby to the brake. In addition, the magnetic energy of the brake coil is dissipated relatively slowly in the freewheel circuit of the rectifier.

b) Rectifier powered separately (Figure 4, curve 2)
Response time $t_{A2}$: long

Cause: After the rectifier voltage is switched off, the magnetic energy of the brake coil is dissipated relatively slowly in the freewheel circuit of the rectifier.

If the supply voltage is interrupted on the AC side, no significant switch-off voltage occurs on the electromagnet coil.

**Interrupting the DC circuit of the electromagnet coil (Figure 4, curve 3)**

a) By a mechanical switch
- with separate power supply from a DC control voltage mains or
- at the DC switch contacts (A2 and A3) of the type SG standard rectifier
Response time $t_{A3}$: very short

Cause: The magnetic energy of the brake coil is dissipated very quickly by arcing across the switch contacts.

b) Electronic

Using a type ESG or MSG special rectifier
Response time $t_{A3}$: short

Cause: The magnetic energy of the brake coil is dissipated quickly by a varistor integrated in the rectifier.

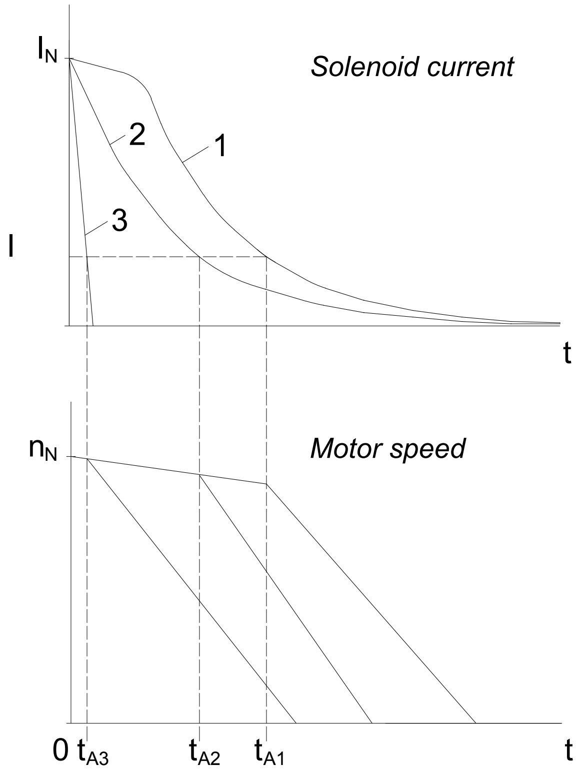


Figure 4: Idealised coil current and motor speed curves after switching off power on the AC side (1 and 2) or DC side (3)

If the circuit is interrupted on the DC side, a high voltage $u_q$ is induce by the electromagnet coil. The magnitude of this voltage depends on the inductance L of the coil and the switch-off speed di/dt according to the formula

$$u_q = L \cdot \frac{di}{dt}$$

Due to the winding design, the inductance L increases with increasing rated coil voltage. Consequently, the voltage spikes induced at switch-off can reach hazardous levels with relatively high coil voltages. For this reason, a varistor is included in the circuit for all brakes with voltages greater than 24 V.
This varistor is solely intended to protect the electromagnet coil; it is not intended to protect adjacent electronic components or devices against electromagnetic interference. On request, brakes with rated voltages of 24 V or less can also be fitted with a varistor.
If the circuit is interrupted on the DC side by a mechanical switch, the resulting arcing over the switch contacts causes strong erosion of the contacts. For this reason, only special DC contactors or adapted AC contactors with contacts rated for use class AC3 as specified in EN 60947-4-1 may be used.

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**Specifications of holding brakes with emergency stop capability**

The maximum allowable friction energy values stated here do not apply to brake motors for use in areas with potentially explosive atmospheres.
Refer to separate data in appropriate documents for explosion-proof drives.

| Type | $M_{Br}$ [Nm] | $W_{max}$ [$10^3$ J] | $W_{th}$ [$10^3$ J] | $W_L$ [$10^6$ J] | $t_A$ [ms] | $t_{AC}$ [ms] | $t_{DC}$ [ms] | $P_{el}$ [W] | J [10-3 kgm²] |
|---|---|---|---|---|---|---|---|---|---|
| E003B9 | 3 | 1,5 | - | - | 35 | 150 | 15 | 20 | 0,01 |
| E003B7 | 2,2 | 1,8 | - | - | 28 | 210 | 20 | | |
| E003B4 | 1,5 | 2,1 | - | - | 21 | 275 | 30 | | |
| E004B9 | 5 | 2,5 | - | - | 37 | 125 | 15 | 30 | 0,017 |
| E004B8 | 4 | 3 | - | - | 30 | 160 | 18 | | |
| E004B6 | 2,8 | 3,6 | - | - | 23 | 230 | 26 | | |
| E004B4 | 2 | 4,1 | - | - | 18 | 290 | 37 | | |
| E004B2 | 1,4 | 4,8 | - | - | 15 | 340 | 47 | | |
| ES010AX | 15* | 3 | - | - | 110 | - | 30 | 35 | 0,045 |
| ES010A9 | 10 | 3 | - | - | 60 | 100 | 15 | | |
| ES010A8 | 8 | 3 | - | - | 55 | 150 | 20 | | |
| ES010A5 | 5 | 3 | - | - | 45 | 220 | 20 | | |
| ES010A4 | 4 | 3 | - | - | 30 | 250 | 20 | | |
| ES010A2 | 2,5 | 3 | - | - | 25 | 350 | 25 | | |
| ES027AX | 32* | 2,5 | - | - | 80 | - | 30 | 50 | 0,172 |
| ES/EH027A9 | 27 | 2,5 | - | - | 120 | 100 | 15 | | |
| ES/EH027A7 | 20 | 2,5 | - | - | 100 | 130 | 20 | | |
| ES/EH027A6 | 16 | 2,5 | - | - | 80 | 170 | 25 | | |
| ES/EH040A9 | 40 | 3,5 | - | - | 100 | 100 | 20 | 65 | 0,45 |
| ES/EH040A8 | 34 | 3,5 | - | - | 80 | 200 | 25 | | |
| ES/EH040A7 | 27 | 3,5 | - | - | 70 | 250 | 30 | | |
| ES070AX | 90* | 3,5 | - | - | 120 | - | 40 | 85 | 0,86 |
| ES070A9 | 70 | 3,5 | - | - | 120 | 150 | 18 | | |
| ES070A8 | 63 | 3,5 | - | - | 120 | 200 | 20 | | |
| ES070A7 | 50 | 3,5 | - | - | 90 | 220 | 25 | | |
| ES/EH125A9 | 125 | 4,5 | - | - | 170 | 220 | 25 | 105 | 1,22 |
| ES/EH125A8 | 105 | 4,5 | - | - | 150 | 320 | 28 | | |
| ES/EH125A7 | 85 | 4,5 | - | - | 135 | 350 | 30 | | |
| ES/EH125A6 | 70 | 4,5 | - | - | 120 | 440 | 35 | | |
| ES125A5 | 57 | 4,5 | - | - | 100 | 600 | 40 | | |
| ES125A3 | 42 | 4,5 | - | - | 90 | 700 | 45 | | |
| ES/EH200A9 | 200 | 8 | - | - | 400 | 150 | 22 | 105 | 2,85 |
| ES/EH200A8 | 150 | 8 | - | - | 280 | 250 | 35 | | |
| ES/EH200A7 | 140 | 8 | - | - | 200 | 320 | 35 | | |
| ES250AX | 350* | 9 | - | - | 180 | - | 70 | 135 | 6,65 |
| ES250A9 | 250 | 9 | - | - | 300 | 500 | 45 | | |
| ES250A8 | 200 | 9 | - | - | 200 | 960 | 60 | | |
| ES250A6 | 150 | 9 | - | - | 160 | 1100 | 60 | | |
| ES250A5 | 125 | 9 | - | - | 150 | 1500 | 90 | | |
| ES250A4 | 105 | 9 | - | - | 130 | 1800 | 110 | | |
| ZS300A9 | 300 | 8 | - | - | 280 | 220 | 35 | 75 | 5,7 |
| ZS300A8 | 250 | 8 | - | - | 210 | 380 | 45 | | |
| EH400A9 | 400 | 10 | - | - | 300 | 600 | 60 | 180 | 19,5 |
| EH400A7 | 300 | 10 | - | - | 200 | 850 | 75 | | |
| EH400A5 | 200 | 10 | - | - | 150 | 1400 | 85 | | |
| ZS500A9 | 500 | 9 | - | - | 320 | 320 | 50 | 100 | 13,3 |
| ZS500A8 | 400 | 9 | - | - | 260 | 600 | 60 | | |
| ZS800A9 | 800 | 20 | - | - | 400 | 550 | 65 | 140 | 38,5 |
| ZS800A7 | 600 | 20 | - | - | 320 | 920 | 80 | | |
| ZS800A5 | 400 | 20 | - | - | 250 | 1450 | 100 | | |



* Requires overexcitation; permissible only with MSG rectifier

Braking torque tolerance: -10 / +30 %

$W_{th}$ and WL are not specified because little or no braking energy is dissipated by holding brakes when they are used as intended.

For versions with braking torque marked with *, which may only be used with an MSG rectifier, the values of $t_A$ and $t_{DC}$ apply to operation with an MSG rectifier; i.e. $t_A$ for overexcitation or $t_{DC}$ for electronic circuit interruption on the DC side.

Due to the effects of operating temperature and manufacturing tolerances, actual response times may differ from the guideline values listed here.

**Specifications of working brakes**

The maximum braking energy values stated here do not apply to brake motors for use in areas with potentially explosive atmospheres.
Refer to separate data in appropriate documents for explosion-proof drives.

| Type | $M_{Br}$ [Nm] | $W_{max}$ [$10^3$ J] | $W_{th}$ [$10^3$ J] | $W_L$ [$10^6$ J] | | $t_A$ [ms] | $t_{AC}$ [ms] | $t_{DC}$ [ms] | $P_{el}$ [W] | J [$10^{-3}$ kgm$^2$] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | without HL | with HL | | | | | |
| E003B9 | 3 | 1,5 | 36 | 55 | 55 | 35 | 150 | 15 | 20 | 0,01 |
| E003B7 | 2,2 | 1,8 | 36 | 90 | 90 | 28 | 210 | 20 | | |
| E003B4 | 1,5 | 2,1 | 36 | 140 | 140 | 21 | 275 | 30 | | |
| E004B9 | 5 | 2,5 | 60 | 50 | 50 | 37 | 125 | 15 | 30 | 0,017 |
| E004B8 | 4 | 3 | 60 | 100 | 100 | 30 | 160 | 18 | | |
| E004B6 | 2,8 | 3,6 | 60 | 180 | 180 | 23 | 230 | 26 | | |
| E004B4 | 2 | 4,1 | 60 | 235 | 235 | 18 | 290 | 37 | | |
| E004B2 | 1,4 | 4,8 | 60 | 310 | 310 | 15 | 340 | 47 | | |
| ESX010AX | 15* | 3 | 250 | 120 | 120 | 110 | - | 30 | 35 | 0,045 |
| ESX010A9 | 10 | 3 | 250 | 120 | 120 | 60 | 100 | 15 | | |
| ESX010A8 | 8 | 3 | 250 | 150 | 150 | 55 | 150 | 20 | | |
| ESX010A5 | 5 | 3 | 250 | 240 | 240 | 45 | 220 | 20 | | |
| ESX010A4 | 4 | 3 | 250 | 300 | 240 | 30 | 250 | 20 | | |
| ESX010A2 | 2,5 | 3 | 250 | 390 | 240 | 25 | 350 | 25 | | |
| ESX027AX | 27* | 10 | 350 | 150 | 150 | 80 | - | 30 | 50 | 0,172 |
| ESX/EHX027A9 | 22 | 10 | 350 | 150 | 150 | 120 | 100 | 15 | | |
| ESX/EHX027A7 | 16 | 10 | 350 | 300 | 300 | 100 | 130 | 20 | | |
| ESX/EHX027A6 | 13 | 10 | 350 | 350 | 350 | 80 | 170 | 25 | | |
| ESX/EHX040A9 | 32 | 20 | 450 | 420 | 420 | 100 | 100 | 20 | 65 | 0,45 |
| ESX/EHX040A8 | 27 | 20 | 450 | 560 | 490 | 80 | 200 | 25 | | |
| ESX/EHX040A7 | 22 | 20 | 450 | 700 | 490 | 70 | 250 | 30 | | |
| ESX070AX | 72* | 28 | 550 | 700 | 700 | 120 | - | 40 | 85 | 0,86 |
| ESX070A9 | 58 | 28 | 550 | 500 | 500 | 120 | 150 | 18 | | |
| ESX070A8 | 50 | 28 | 550 | 800 | 700 | 120 | 200 | 20 | | |
| ESX070A7 | 40 | 28 | 550 | 1200 | 700 | 90 | 220 | 25 | | |
| ESX/EHX125AX | 100* | 40 | 700 | 1900 | 1900 | 100 | - | 70 | 105 | 1,22 |
| ESX/EHX125A9 | 85 | 40 | 700 | 1700 | 1700 | 150 | 320 | 28 | | |
| ESX/EHX125A8 | 70 | 40 | 700 | 1900 | 1700 | 135 | 350 | 30 | | |
| ESX/EHX125A7 | 58 | 40 | 700 | 2700 | 1700 | 120 | 440 | 35 | | |
| ESX125A5 | 45 | 40 | 700 | 3300 | 1700 | 100 | 600 | 40 | | |
| ESX125A3 | 34 | 40 | 700 | 3300 | 1700 | 90 | 700 | 45 | | |
| ESX/EHX200AX | 160* | 60 | 850 | 2000 | 2000 | 105 | - | 70 | 105 | 2,85 |
| ESX/EHX200A9 | 120 | 60 | 850 | 1700 | 1700 | 280 | 250 | 35 | | |
| ESX/EHX200A8 | 110 | 60 | 850 | 2600 | 2600 | 200 | 320 | 35 | | |
| ESX250AX | 280* | 84 | 1000 | 2300 | 2300 | 180 | - | 70 | 135 | 6,65 |
| ESX250A9 | 200 | 84 | 1000 | 2800 | 2800 | 300 | 500 | 45 | | |
| ESX250A8 | 160 | 84 | 1000 | 6800 | 5700 | 200 | 960 | 60 | | |
| ESX250A6 | 120 | 84 | 1000 | 8500 | 5700 | 160 | 1100 | 60 | | |
| ESX250A5 | 100 | 84 | 1000 | 11000 | 5700 | 150 | 1500 | 90 | | |
| ESX250A4 | 85 | 84 | 1000 | 11000 | 5700 | 130 | 1800 | 110 | | |
| ZSX300A9 | 250 | 60 | 850 | 1300 | 1300 | 280 | 220 | 35 | 75 | 5,7 |
| ZSX300A8 | 200 | 60 | 850 | 2000 | 2000 | 210 | 380 | 45 | | |
| EHX400A9 | 320 | 120 | 1100 | 3000 | 3000 | 300 | 600 | 60 | 180 | 19,5 |
| EHX400A7 | 240 | 120 | 1100 | 4800 | 4800 | 200 | 850 | 75 | | |
| EHX400A5 | 160 | 120 | 1100 | 6000 | 4800 | 150 | 1400 | 85 | | |
| ZSX500A9 | 400 | 84 | 1000 | 2800 | 2800 | 320 | 320 | 50 | 100 | 13,3 |
| ZSX500A8 | 320 | 84 | 1000 | 4000 | 4000 | 260 | 600 | 60 | | |
| ZSX800A9 | 640 | 120 | 1150 | 1550 | 1550 | 400 | 550 | 65 | 140 | 38,5 |
| ZSX800A7 | 480 | 120 | 1150 | 1550 | 1550 | 320 | 920 | 80 | | |
| ZSX800A5 | 320 | 120 | 1150 | 1550 | 1550 | 250 | 1450 | 100 | | |

15

* Requires overexcitation; permissible only with MSG rectifier

Braking torque tolerance:
E003 / E004: -10 / +30 %
ESXxx / ZSXxx: -20 / +30 % after run-in; up to -30 % in new condition.

For versions with braking torque marked with *, which may only be used with an MSG rectifier, the values of $t_A$ and $t_{DC}$ apply for operation with an MSG rectifier; i.e. $t_A$ for overexcitation or $t_{DC}$ for electronic circuit interruption on the DC side.

The values for $W_L$ are guidelines; actual values may vary significantly depending on the application situation. Periodic inspection of the air gap or brake disc thickness is recommended.

Actual response times may differ from the times listed here due to the effects of operating temperature, brake disc wear and manufacturing tolerances.

**Key to symbols**

| | |
|---|---|
| $M_{Br}$ | Rated braking torque |
| $W_{max}$ | Maximum allowable friction energy for an emergency stop with a holding brake |
| $W_{max}$ | Maximum allowable friction energy for each brake cycle with working brakes |
| $W_{th}$ | Maximum allowable braking energy per hour |
| $W_L$ | Maximum allowable braking energy until maintenance; i.e. brake disc replacement or air gap adjustment. Air gap adjustment is possible only with type ZSXxx brakes. |
| $H_L$ | Manual release |
| $t_A$ | Response time for release with normal excitation. Overexcitation with a type MSG special rectifier reduces the response time by approximately 50 %. |
| $t_{AC}$ | Response time for brakes with AC-side switch-off, i.e. by switching off the supply voltage to a separately powered standard rectifier. If the supply voltage for the rectifier is taken from the motor terminals, considerably longer response times should be expected (depending on the motor size and winding design). |
| $t_{DC}$ | Response time for braking with DC-side circuit interruption by a mechanical switch. In the case of electronic circuit interruption on the DC side by a type ESG or MSG special rectifier, the response times will be approximately two to three times as long. |
| $P_{el}$ | Electromagnet coil power consumption at 20° C. Depending on the rated voltage of the coil, the actual power may differ from the guideline value stated here. |
| J | Moment of inertia of the drive bush and brake disc(s) |

**Connection**

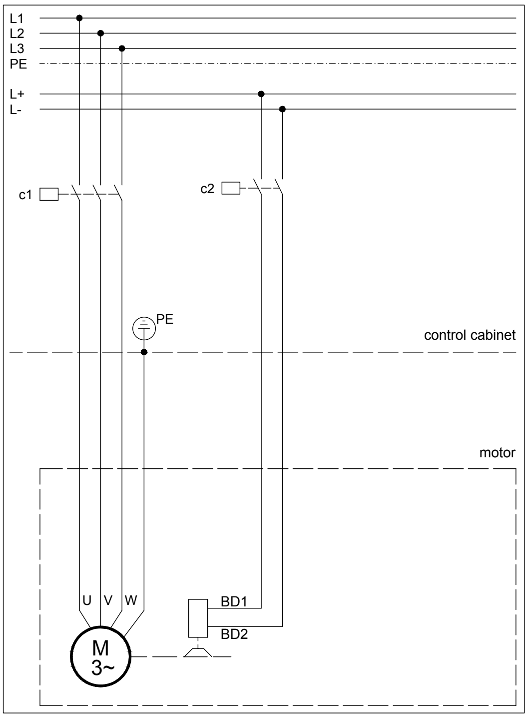
The electrical connections to the brake are made in the motor terminal box using terminals or the rectifier. Standard voltages:

380–420 V 50/60 Hz (brake coil voltage 180 V DC)
220–230 V 50/60 Hz (brake coil voltage 105 V DC)
24 V DC (brake coil voltage 24 V DC)

Other voltages are available at additional cost.

**DC connection via terminals (K)**

The brake must be connected via separate terminals in the motor or brake terminal box directly to the DC voltage. The standard voltages are 180 V DC, 105 V DC and 24 V DC. Brakes with other operating voltages are available at additional cost.

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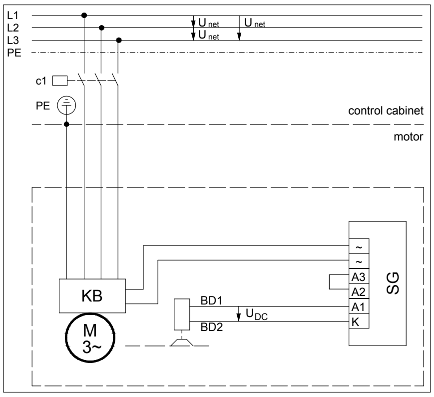
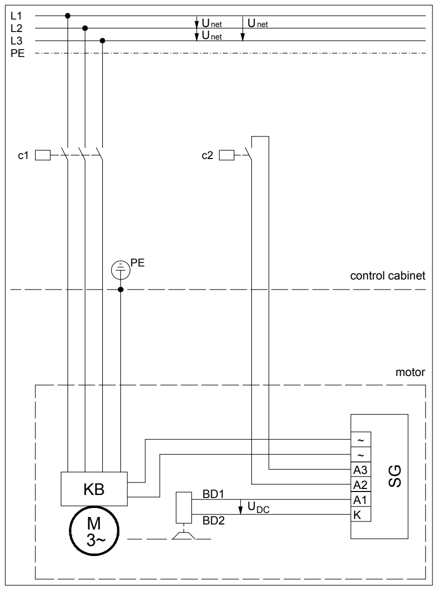
**Standard rectifier (S)**

| | |
|---|---|
| Working principle | Half-wave rectifier with switch contacts for DC-side circuit interruption |
| Input voltage $U_1$ | max. 575 VAC +5 % |
| Output voltage | 0.45 x $U_1$ VDC |
| Max. output current | 2.5 A DC |
| Ambient temperature | -40 to +40° C |
| Connection | Caged Clamp terminals with clamp lever |
| Clampable conductor cross-section | max. 1.5 $mm^2$ without wire end sleeve<br>max. 1.5 $mm^2$ with wire end sleeve |
| Approvals | c-CSA-us<br>c-UL-us (only in combination with B2000 geared motors and brakes in the ES(X) or ZS(X) product series |

The brake must be connected to the AC supply via the standard rectifier in the motor terminal box or brake terminal box. The standard voltages are 380 ... 420 V 50/60 Hz or 220 ... 230 V 50/60 Hz. Other voltages up to 575 V are available at extra cost. In a configuration with standard rectifier, the brake circuit can be interrupted by an extra contact on the d.c. side in order to reduce the response time. This significantly reduces the braking time and overtravel distance.



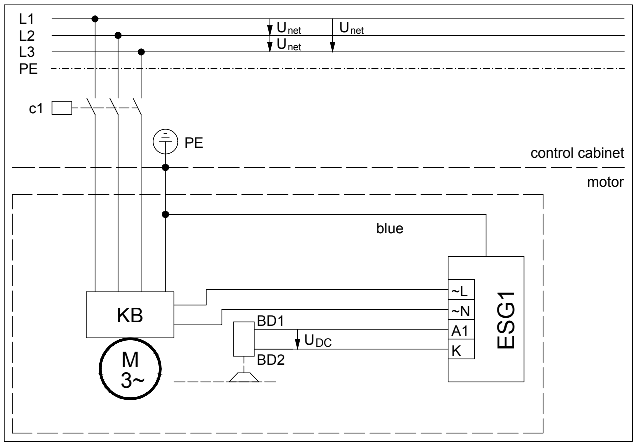

Voltage connection for the rectifier from the motor terminal block or cage clamp (see Rectifier Connection on Motor Terminal Block or Cage Clamp)

15

**Rectifier for electronic rapid shutdown (E)**

| | |
|---|---|
| Working principle | Half-wave rectifier with electronic DC-side circuit interruption |
| Input voltage $U_1$ | 220–460 V AC ±5 %, 50/60 Hz |
| Output voltage | 0.45 x $U_1$ V DC |
| Max. output current | 1 A DC |
| Ambient temperature | -20° C to +40° C |
| Clampable conductor cross-section | max. 1.5 mm² |

This rectifier permits electronic DC-side interruption of the brake circuit. No additional cable to the rectifier is necessary. The rectifier is supplied complete with a protective resistor which prevents a mains short- circuit via the shutdown arc of the high-speed motor contactor. Brake response times are significantly shorter than those achievable by AC-side interruption of the brake circuit. They are, however, longer than those achievable with DC-side interruption by a mechanical switch. The brake must be connected to the alternating current via the rapid shutdown rectifier in the motor terminal box or the brake terminal box. The standard voltages are 380 ... 420 V 50/60 Hz or 220 ... 230 V 50/60 Hz. Other voltages up to 460 V are available at extra cost.



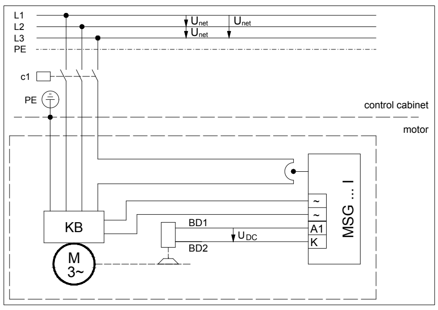

Voltage connection for the rectifier from the motor terminal block or cage clamp (see Rectifier Connection on Motor Terminal Block or Cage Clamp)

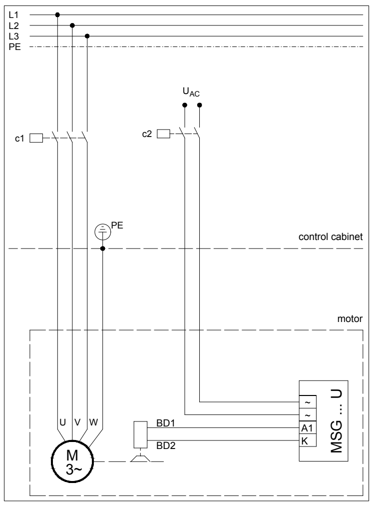
**Standard rectifier (M)**

| | |
|---|---|
| Working principle | MSG 1.5.480I<br>Half-wave rectifier with time-limited overexcitation and electronic DC-side circuit interruption<br>Fast shutdown due to no motor current in one phase |
| Input voltage $U_1$ | 220–480 V AC +6 / -10 %, 50/60 Hz |
| Output voltage | 0.9 x $U_1$ V DC during overexcitation<br>0.45 x $U_1$ V DC over overexcitation period |
| Overexcitation time | 0.3 s |
| Max. output current | 1.5 A DC |
| Ambient temperature | -20° C to +40° C |
| Clampable conductor cross-section | max. 1.5 mm$^2$ |

| | |
|---|---|
| Working principle | MSG 1.5.500U<br>Half-wave rectifier with time-limed overexcitation and electronic DC-side circuit interruption<br>Fast shutdown due to the absence of input voltage |
| Input voltage $U_1$ | 220–500 V AC ±10 %, 50/60 Hz |
| Output voltage | 0.9 x $U_1$ V DC during overexcitation<br>0.45 x $U_1$ V DC over overexcitation period |
| Overexcitation time | 0.3 s |
| Max. output current | 1.5 A DC |
| Ambient temperature | -20° C to +40° C |
| Clampable conductor cross-section | max. 1.5 mm$^2$ |

In cases where there are high motor switching frequencies, the brake can be de-energised more rapidly with this rectifier thereby significantly reducing the thermal stress on the motor. In addition, interrupting the brake‘s DC circuit by electronic means significantly reduces response times. Depending on the circumstances in which they are to be used, either the MSG 1.5.500 U (rapid shutdown brought about by removed supply voltage ) or MSG 1.5.480 I (rapid shutdown brought about by removed motor current in a phase) is used. Power supply 220 to 480 V AC.

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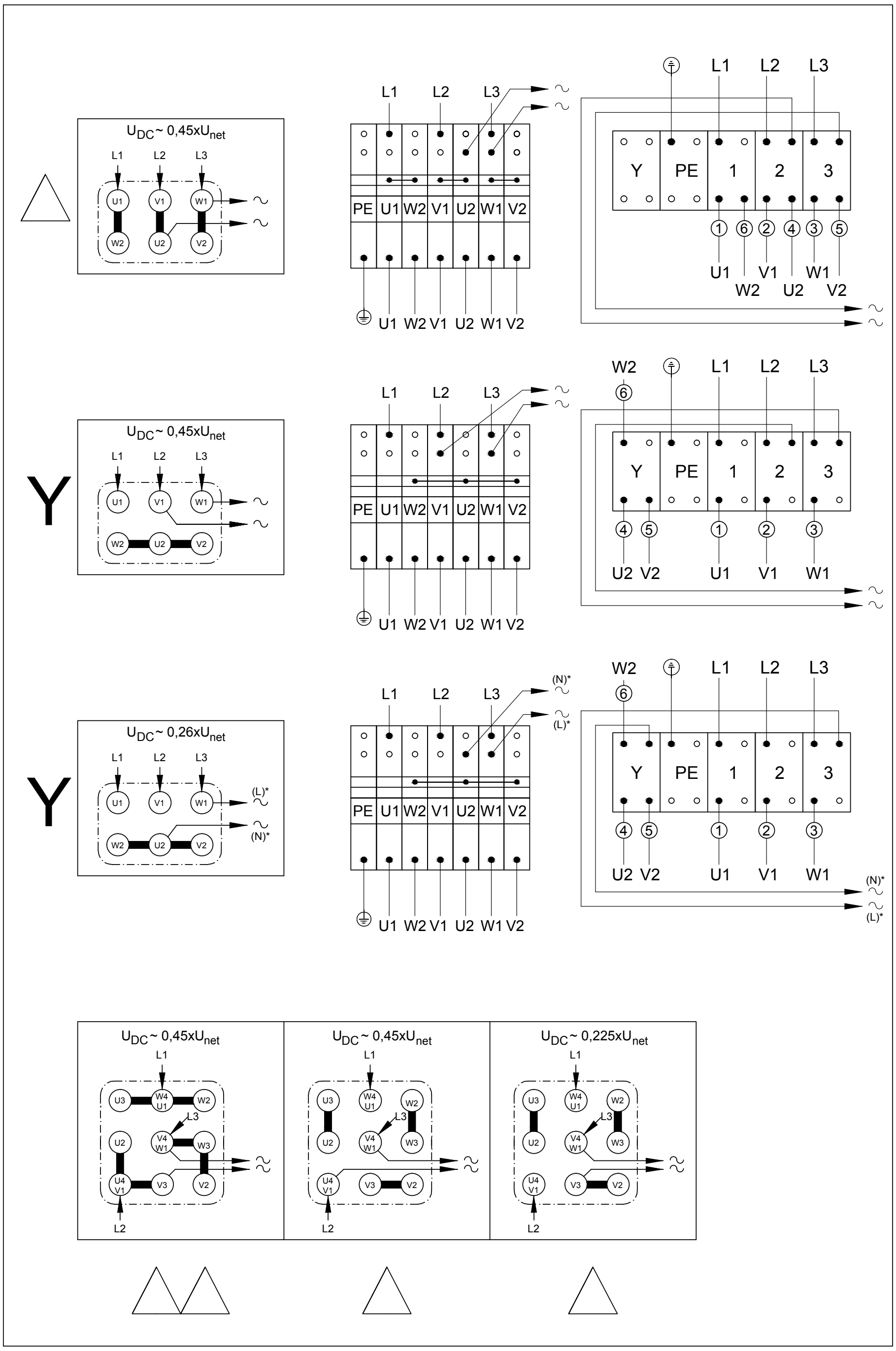
Rectifier Connection on Motor Terminal Block or Cage Clamp



**Brake connection, operation with frequency converter**

The voltage present at the motor terminal block when operating with a frequency converter is frequency-dependent. Brakes require a constant voltage, so they need a seperate electrical connection. This is the reason why the brake is not connected to the motor terminals ex- works.

**Brake connection, pole-changing motors**

The brakes of pole-changing motors need a seperate electrical connection. As is the case with motors for operation with frequency inverters, the brake is not connected to the motor terminals ex-works.

**Manual release (HA, HN)**

All brakes are available with mechanical manual release on request. Non-latching manual release is the standard version (HN). A latching manual release (HA) can be supplied if required for all brake sizes.

**Degree of protection**

All BAUER brakes comply with degree of protection IP65.

**Special corrosion protection**

If high requirements for corrosion resistance apply, the brakes are available with two levels of enhanced corrosion protection:

**CORO1 (C1):** Finished with two-component paint to protect against chemically aggressive gases and vapours.
**CORO2 (C2):** Same finish as CORO1. The screws for the terminal-box cover are non- rusting steel. The mechanical internals of the brake are made of corrosion- proofed material.

**CE mark**

BAUER geared motors with externally mounted spring-loaded brakes bear the CE mark.

The brakes comply with:

- the **Machinery Directive (2006/42/EG)**
  Manufacturer's declaration available on request

- the **Low-Voltage Directive (2006/95/EG)**
  Documented by the CE mark

- the **EMC Directive (2004/108/EG)**
  Documented by the CE mark

See BAUER special print SD33.. for more information.

**Explosion protection**

Brakes for use in hazardous areas are subject to special regulations. Please consult our support specialists in these special cases.

**Back stop (RR, RL)**

Motors of size D..09 (1,1 kW) up to D..18 (30 kW) are available with backstop. The locking rotational direction clockwise (RR) or anticlockwise (RL) is to given in the order. The reference is the connection side of the gearbox. Should the connection side not be clearly defined, gearbox side "V" (front) will be assumed (see chapter 17 Dimensions drawing "Motor with back stop").

Note that the back-stop functionality on a motor operating with a frequency converter is guaranteed only at rotor speeds above 670/min.

It is advisable to consult BAUER for applications in corrosive atmospheres, especially for motor-down installed positions.

**Second motor shaft extension (ZW, ZV)**

The motors are also available on request with a second motor shaft extension in design ZW (shaft with key) or ZV (shaft with square end).

Half the central motor's rated power is available at each of the two shafts. Permissible radial loads available on request. Guards are not included in the scope of supply (for dimensional drawing see chapter 17).

Motors with brakes are available on request with a second shaft stub extended through the brake.

**Protective fan cowl (D)**

A protective hood over the fan cowl is recommended for outdoor installations where the motor is pointing upward and subject to severe or prolonged exposure to water (dimensional drawing, see chapter 17).

This protective hood is mandatory for upright explosion-proof motors.

A special fan cowl for the textiles industry is available on request at extra cost. This design prevents airborne fibres and fluff clogging the fan cowl.

**Motor-independent fan (FV)**

For special applications, standard motors and brake motors of size D08 and larger are available with externally mounted motor-independent fans. The standard line voltage of the motor-independent fan matches the voltage of the geared motor (dimensional drawing for motor-independent fan, see chapter 17).

The independent fans are supplied as standard with Bayonet-fitting for standard motors sizes D..16 and D..18 and brake motors sizes D..11 to D..18. Standard enclosure IP66.

**Technical Data:**
Multivolt Conception Running capacitor for single phase duty enclosed as standard.

| Mode | Frame size | Blower diameter | Range of voltage | | max. permissible current | max. power input |
|---|---|---|---|---|---|---|
| | | (mm) | 50 Hz | 60 Hz | (A) | W |
| 1 ~ ⊥ (Δ) | 63 | 118 | 230-277 | 230-277 | 0,12 | 32 |
| | 71 | 132 | 230-277 | 230-277 | 0,12 | 33 |
| | 80 | 150 | 230-277 | 230-277 | 0,14 | 37 |
| | 90 | 169 | 230-277 | 230-277 | 0,29 | 65 |
| | 100 | 187 | 230-277 | 230-277 | 0,30 | 75 |
| | 112 | 210 | 230-277 | 230-277 | 0,37 | 94 |
| | 132 | 250 | 230-277 | 230-277 | 0,60 | 149 |
| | 160-200 | 300 | 230-277 | --- | 0,96 | 236 |
| | | | | | | |
| 3 ~ Y | 63 | 118 | 380-500 | 380-575 | 0,06 | 28 |
| | 71 | 132 | 380-500 | 380-575 | 0,06 | 29 |
| | 80 | 156 | 380-500 | 380-575 | 0,06 | 34 |
| | 90 | 169 | 380-500 | 380-575 | 0,19 | 75 |
| | 100 | 187 | 380-500 | 380-575 | 0,17 | 94 |
| | 112 | 210 | 380-500 | 380-575 | 0,17 | 99 |
| | 132 | 250 | 380-500 | 380-575 | 0,25 | 148 |
| | 160-200 | 300 | 380-500 | 380-575 | 0,54 | 360 |
| | | | | | | |
| 3 ~ Δ | 63 | 118 | 220-290 | 220-332 | 0,10 | 28 |
| | 71 | 132 | 220-290 | 220-332 | 0,10 | 28 |
| | 80 | 156 | 220-290 | 220-332 | 0,10 | 34 |
| | 90 | 169 | 220-290 | 220-332 | 0,33 | 78 |
| | 100 | 187 | 220-290 | 220-332 | 0,31 | 87 |
| | 112 | 210 | 220-290 | 220-332 | 0,31 | 103 |
| | 132 | 250 | 220-290 | 220-332 | 0,45 | 146 |
| | 160-200 | 300 | 220-290 | 220-332 | 0,91 | 360 |

**Shaft encoder (G)**

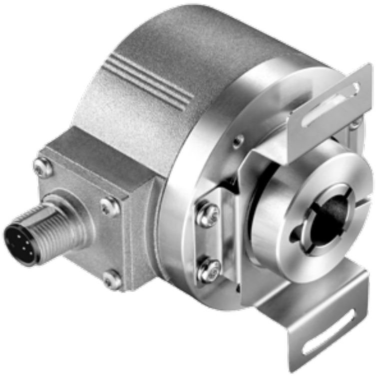
Bauer gear motors can be fitted with either an incremental encoder or an absolute encoder for special applications. Both the standard incremental encoder and the absolute encoder are optimised and suitable for use with all modern inverters.

Bauer standard encoders as from motor frame size D05 (0,18 kW) are protected against mechanical damage by means of a protective cover (Additional Dimension Sheet see chapter 17).

Special features: standard incremental encoder:
- Robust mount
- Degree of protection IP66
- EMC-tested
- Protected against polarity reversal
- Supply voltage 8-30 V DC
- A-, B- and N-lines and inverted signals or output signals as preferred
- HTL output circuit (TTL on request)
- 1024 pulses per revolution

Special features: standard absolute encoder
- Enclosure: IP66
- Steps per revolution: 8192 (13 Bit)
- Number of turns: 4096 (12 Bit) shaft turns
- Execution of electronic: SSI (Synchronous-Serial Interface)
- Output code: Gray-Code
- Supply voltage: 11-27 V DC
- Loss efficiency (no load): ≤ 3 Watt
- Output driver: RS-422 (2-wire)

### Functional description



Incremental encoders are used to determine motor shaft positions. An incremental encoder detects rotary motion and coverts it into an electrical output signal. An encoder disc with a specific number of periods per rotation senses angular motion. The optoelectronic scanning unit generates signals and issues pulses after the signals have been processed in trigger stages. The resolution is defined by the number of opaque and clear segments on the encoder disc. For example, an encoder with 1024 lines will generate a sequence of 1024 pulses for one full rotation.

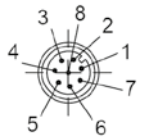
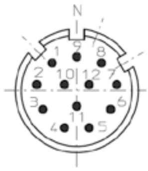
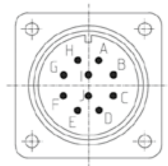
The combination of an incremental encoder and a frequency converter allows optimised solutions to be developed, such as
- speed controllers with a wide adjustment range
- accurate speed control
- constant-speed control
- position control

| | |
|---|---|
| Supply voltage: | 8–30 V DC with HTL<br>5 V DC with differential TTL |
| Output signals: | HTL A, B and N tracks; optional TTL |
| Pulses per revolution: | 1024<br>Optional 1…65536 |
| Enclosure rating: | IP65 (optional IP67) |
| Temperature range: | -40° C to +100° C |

### Electrical specifications

| Output voltage | RS 422 (TTL compatible) | RS 422 (TTL compatible) | Differential | Differential (7272) |
|---|---|---|---|---|
| Supply voltage | 5–30 V DC | 5 V ±5% | 8–30 V DC | 5–30 V DC |
| No-load current consumption<br>With inversion: | max. 70 mA | max. 70 mA | max. 70 mA | max. 70 mA |
| Allowable load per channel:<br>Pulse rate: | max. ±20 mA<br>max. 300 kHz | max. ±20 mA<br>max. 300 kHz | max. ±20 mA<br>max. 160 kHz | max. ±20 mA<br>max. 160 kHz |
| High signal level: | min. 2.5 V | min. 2.5 V | min. UB – 3 V | min. UB – 3 V |
| Low signal level: | max. 0.5 V | max. 0.5 V | max. 1 V | max. 1 V |

**Plug end view with male pin insert**

| Connector type | 8-pin<br>M12 plug | 12-pin<br>M23 plug | MIL connector<br>10-pin |
|---|---|---|---|
| Layout |  |  |  |
| Order code: | 8.5000.XXX3.XXXX<br>8.5000.XXX4.XXXX | 8.5000.XXX7.XXXX<br>8.5000.XXX8.XXXX | 8.5000XXXY.XXXX |
| Mating connector: | 05.CMB-8181-0 | 8.0000.5012.0000 | 8.0000.5062.0000 |

**Signal assignments**

| Signal: | 0 V<br>GND | $+U_B$ | 0 V<br>Sens | +Ub<br>Sens | A | A | B | B | Z | Z | Shield |
|---|---|---|---|---|---|---|---|---|---|---|---|
| M23 Multifast, 12-pin connector; pin assignments:<br>M12 Eurofast, 8-pin connector; pin assignments: | 10<br>1 | 12<br>2 | 11 | 2 | 5<br>3 | 6<br>4 | 8<br>5 | 1<br>6 | 3<br>7 | 4<br>8 | 1)<br>1) |
| Military version; 10-pin connector; pin assignments: | F | D | | E | A | G | B | H | C | I | J[1]) |
| Cable; lead colour: | WH | BN | GY PK | RD BU | GN | YE | GY | PK | BU | RD | Shield |

[1] Shield connected to plug housing.

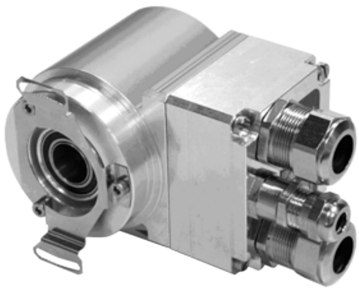
Insulate unused outputs before putting into service.

15

**Functional description**

Absolute encoders detect both angular and rotational motions and convert them into electrical signals. In contrast to incremental encoders, with absolute encoders the current position is directly available. If an absolute encoder is moved mechanically while it is switched off, after the power is switched on again the current position can be read out immediately and directly. Absolute encoders are available in single-turn and multi-turn versions.

**Profibus DP interface**



### Specifications

| | |
|---|---|
| Supply voltage | 11–27 VDC |
| No-load current consumption | < 350 mA |
| Total resolution [1] | ≤ 33 bits |
| Number of steps per revolution, standard/extended [1] | ≤ 8,192 / ≤ 32,768 |
| Number of turns, standard/extended [1] | ≤ 4,096 / ≤ 256,000 |
| Profibus DP V0 | IEC 61158, IEC 61784 |
| PNO encoder profile | Class 1/Class 2 |
| parameters [1] | Counting direction switchover, scaling function, etc. |
| Output code [1] | Binary, Gray, truncated Gray |
| Address | 3–99, set using a rotary switch |
| Baud rate | 9.6 kbit/s to 12 Mbit/s |
| TR-specific functions [1] | Gear and speed outputs |
| Data width on bus for actual position | ≤ 25 bits |
| Permissible mechanical speed | ≤ 12,000 rpm |
| Shaft load | Own mass |
| Bearing life | ≥ 3.9 x $10^{10}$ revolutions at |
| - speed | ≤ 6,000 rpm |
| - operating temperature | ≤ 60 °C |
| Shaft diameter [mm] | 10H7 |
| Permissible angular acceleration | ≤ $10^4$ rad/s$^2$ |
| Moment of inertia | 2.5 x $10^{-6}$ kg m$^2$ (typical) |
| Start-up torque at 20° C | 2 Ncm (typical) |
| Weight | 0.3–0.5 kg |

1 Configurable parameter

### Ambient conditions

| | |
|---|---|
| Vibration (EN 60068-2-6:1996) | ≤ 100 m/s$^2$, sinusoidal 50–2,000 Hz |
| Shock (EN 60068-2-27:1995) | ≤ 1000 m/s$^2$, half-cycle sinusoidal 11 ms |
| EMC | |
| - Interference emission compliant with EN 61000-6-3:2007 | |
| - Interference immunity compliant with EN 61000-6-2:2006 | |
| Operating temperature | 0° C to +60° C; optionally -20° C to +70° C |
| Storage temperature | -30° C to +80° C, dry |
| Relative humidity (EN 60068-3-4:2002) | 98 %, non condensing |
| Enclosure rating (EN 60529:1991)[2] | IP65 |

2 With mating connector fitted and/or cable glands fitted and tightened

15

**SSI interface**

**Specifications**

| | |
|---|---|
| Supply voltage | 11–27 VDC |
| No-load current consumption | < 350 mA |
| Total resolution [1] | ≤ 25 bits |
| Number of steps per revolution [1] | ≤ 8,192 |
| Number of rotations, standard [1] | ≤ 4,096 |
| Number of rotations, extended [1] | ≤ 256,000 |
| SSI | Synchronous Serial Interface |
| Clock input | Optocoupler |
| Data output | RS-422, 2-wire |
| Clock frequency | 80 kHz – 1 MHz |
| Monostable time $t_M$ | 16 µs ≤ $t_M$ ≤ 25 µs (20 µs typical) |
| Output code [1] | Binary, Gray, BCD |
| Output format [1] | Standard, Tannenbaum, SSI + CRC, 26-bit cycle, variable number of data bits |
| Negative values [1] | Sign and magnitude, twos complement |
| SSI or parallel special bits [1] | Limit switch, overspeed, direction indication, motion indication, error indication, parity |
| F/R [1] | Counting direction |
| Preset [1] | Electronic alignment |
| Logic levels | "0" < +2 VDC; "1" = supply voltage |
| Permissible mechanical speed | ≤ 12,000 rpm |
| Shaft load | Own mass |
| Bearing life | ≥ 3.9 x $10^{10}$ revolutions at |
| - speed | ≤ 6,000 rpm |
| - operating temperature | ≤ 60 °C |
| Shaft diameter [mm] | 10H7 |
| Permissible angular acceleration | ≤ $10^4$ rad/s² |
| Moment of inertia | 2.5 x $10^{-6}$ kg m² (typical) |
| Start-up torque at 20 °C | 2 Ncm (typical) |
| Weight | 0.3–0.5 kg |
| Optional | |
| - incremental signals, RS422 levels | K1+, K1-, K2+, K2- with 1024 or 2048 pulses |

1) Configurable parameter

**Ambient conditions**

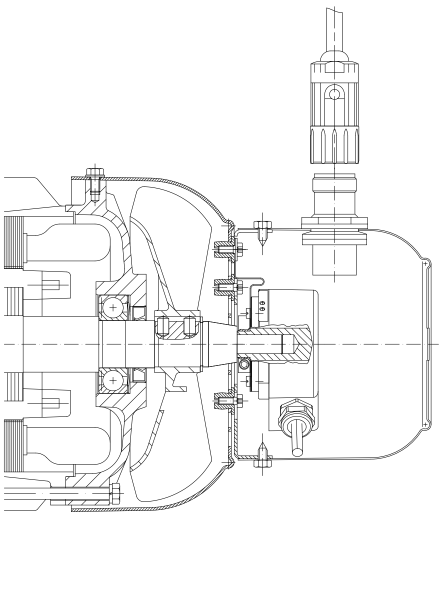
| | |
|---|---|
| Vibration (EN 60068-2-6:1996) | ≤ 100 m/s², sinusoidal 50–2,000 Hz |
| Shock (EN 60068-2-27:1995) | ≤ 1000 m/s², half-cycle sinusoidal 11 ms |
| EMC | |
| - Interference emission compliant with EN 61000-6-3:2007 | |
| - Interference immunity compliant with EN 61000-6-2:2006 | |
| Operating temperature | 0° C to +60° C; optionally -20° C to +70° C |
| Storage temperature | -30° C to +80° C, dry |
| Relative humidity (EN 60068-3-4:2002) | 98 %, non condensing |
| Enclosure rating (EN 60529:1991)[2] | IP65 |

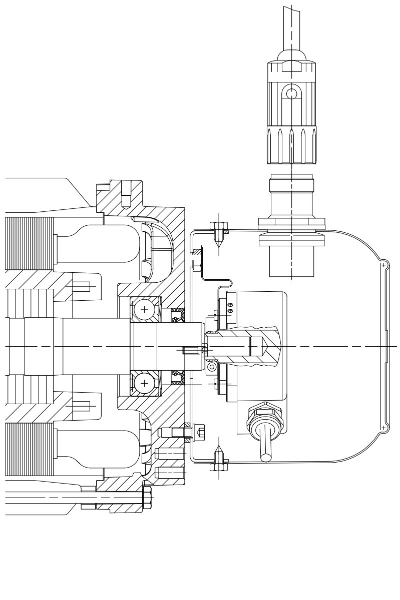
2) With mating connector fitted and/or cable glands fitted and tightened

In addition to the angular position within a rotation, multiturn encoders detect multiple rotations. An internal reduction gear mechanism connected to the motor shaft is used to detect the number of turns. Consequently, the value measured by a multiturn encoder consists of the current angular position and the number of turns. As with incremental encoders, the reading is calculated and output via various interface modules, depending on the interface.

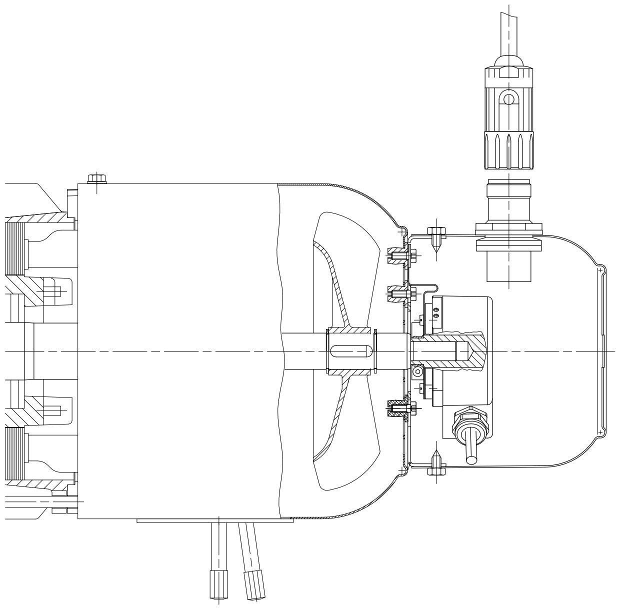
On request, a large range of motor frames can be fitted with sensor bearings. The output signal from the sensor allows the direction of rotation to be determined, among other things. The number of possible pulse counts depends on the frame size. Please enquire for more information.

**Motor and encoder**





**Motor, brake and encoder**



**Motor and forced ventilation**