9 BY Brake

9.1 Description of the BY brake

On request, SEW-EURODRIVE motors can be supplied with an integrated mechanical brake. The brake is a DC-operated electromagnetic disk brake with a high working capacity that is released electrically and applied using spring force. The brake is applied in case of a power failure. It meets the basic safety requirements.

The brake can also be released mechanically if equipped with manual brake release. The manual brake release function is self-reengaging (..HR). A hand lever is supplied.

The HR manual brake release option is not available in combination with a VR forced cooling fan in standard design.

The brake is controlled by a brake controller that is either installed in the control cabinet or in the terminal box.

A main advantage of brakes from SEW-EURODRIVE is their very short design. The integrated construction of the brakemotor permits particularly compact and sturdy solutions.

Observe the notes in the relevant operating instructions concerning the switching sequence of motor enable and brake control during standard operation.

The BY brake can be used for the following rated speeds depending on the motor size:

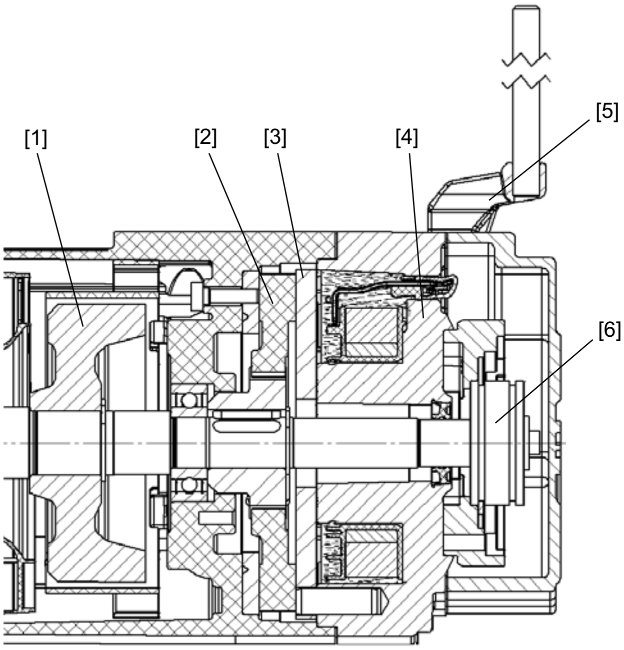
Motor type	Brake type	Speed class
CMPZ71S	BY2	3000, 4500, 6000
CMPZ71M/L		
CMPZ80S	BY4	3000, 4500
CMPZ80M/L		
CMPZ100S	BY8	3000, 4500
CMPZ100M/L		

9.2 Principles of the BY brake

Basic functions

The pressure plate is forced against the brake disk by the brake springs when the electromagnet is deenergized. The brake is applied to the motor. Braking torque determined by number and type of brake springs. When the brake coil is connected to the corresponding DC voltage, the force of the brake springs is overcome by magnetic force, thereby bringing the pressure plate into contact with the magnet. The brake disk moves clear and the rotor can turn.

Basic structure of the working brake:



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[1]	Additional flywheel mass	[4]	Magnets, complete
[2]	Brake disk	[5]	Releasing lever
[3]	Pressure plate	[6]	RH1M encoder

9.3 General information

The BY working brake can only be mounted to the motors CMPZ71 - CMPZ100 (motor variant with additional additional flywheel mass).

The size of the brakemotor and its electrical connection must be selected carefully to ensure the longest possible service life.

The following aspects described in detail must be taken into account:

1. Selecting the braking torque in accordance with the project planning data, see page 160.
2. Dimensioning and routing the cable, see page 165.
3. Selecting the brake contactor, if applicable, see page 165.
4. Important design information, see page 166.

9.4 Selecting the brake according to the project planning data

The mechanical components, brake type and braking torque, are determined when the drive motor is selected. The drive type or application areas and the standards that have to be taken into account are used for the brake selection.

Selection criteria:

- Servomotor - motor size.
- Number of braking operations during service and number of emergency braking operations.
- Working brake or holding brake.
- Amount of braking torque ("soft braking"/"hard braking").
- Hoist application.
- Minimum/maximum deceleration.

Values determined/calculated during brake selection:

Basic specification	Link / supplement / comment
Motor type	Brake type/Brake control system
Braking torque[1)]	Brake springs
Brake application time	Connection type of the brake control system (important for the electrical design for wiring diagrams)
Braking time **Braking distance** **Braking deceleration** **Braking accuracy**	The required data can only be observed if the aforementioned parameters meet the requirements

1) The braking torque is determined from the requirements of the application with regards to the maximum deceleration and the maximum permitted distance or time.

For detailed information on selecting the size of the brakemotor and calculating the braking data, refer to the documentation "Drive Engineering - Practical Implementation Ð Project Planning for Drives".

Selecting the brake

The brake suitable for the relevant application is selected by means of the following main criteria:

- Required braking torque
- Required working capacity

Braking torque

The braking torque is usually selected according to the required deceleration.

The table "Brake assignment" (page 175) shows the possible braking torque stepping.

Braking torque for hoist applications

The selected braking torque must be greater by at least factor 2 than the maximum load torque.

Working capacity

The working capacity of the brake is determined by the permitted braking work W_1 per braking operation and the total permitted braking work W_{insp} until the next inspection of the brake.

For the permitted total braking work W_{insp}, refer to the table on page 175 .

Permitted number of braking operations until maintenance of the brake:

$$NB = \frac{W_{insp}}{W_1}$$

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Braking work per braking operation:

$$W_1 = \frac{J_{ges} \times n^2 \times M_B}{182.4 \times (M_B \pm M_L)}$$

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NB	= Number of braking operations until service
W_{insp}	= Total braking work until service [J]
W_1	= Braking work per braking operation [J]
J_{ges}	= Total mass moment of inertia (related to the motor shaft) in [kg m^2]
n	= Motor speed [1/min]
M_B	= Braking torque [Nm]
M_L	= Load torque [Nm] (note the sign) +: for vertical upward and horizontal movement -: for vertical downward movement

EMERGENCY STOP features

The permitted maximum braking work (refer to the table on page 176) must not be exceeded even in the event of an EMERGENCY STOP.

9.5 Determining the brake voltage

The brake voltage should always be selected on the basis of the available AC supply voltage or motor operating voltage. This means the user is always guaranteed the most cost-effective installation for lower braking currents.

The standard brake voltages are listed in the following table:

Brakes	**BY2, BY4, BY8**
	Brake voltage
Rated voltage[1)]	DC 24 V AC 110 V AC 230 V AC 400 V AC 460 V

1) The 24 V brake voltage requires a high current and is only possible with a limited cable length.

The maximum current during the brake release is 7 times the holding current. The voltage at the brake coil must not drop below 90% of the rated voltage.

9.6 Selection of the brake control

Only SEW brake control systems are used for controlling the brake. All brake control systems are fitted as standard with varistors to protect against overvoltage.

The brakes are available with DC and AC voltage connection.

- AC voltage connection:
  - **BME**, equipped with DIN rail profile
- DC voltage connection:
  - **BSG**

There are two possible ways of electrical disconnection:

- Normal application times: Cut-off in the AC circuit.
- Particularly short application times: Cut-off in the AC and DC circuits.

The brake control systems are mounted in the control cabinet. They are not included in the scope of delivery.

The following options are available:

- AC supply, cut-off in the AC and DC circuits without additional switch contact, particularly short application times: **BMP**.
- AC supply, brake heating function when switched off: **BMH**.
- The **BMK/BMKB/BMV** control system energizes the brake coil if the supply system and a DC 24 V signal (e.g. from the PLC) are present simultaneously. The brake is applied if one condition is not being met. BMK/BMKB/BMV allow for shortest response and application times.

INFORMATION

A disconnection of all poles is required for EMERGENCY STOP and for hoists in general (terminal 1 and 2 of the brake rectifier).

The following table lists SEW brake control systems for installation in the control cabinet. The different housings have different colors (= color code) to make them easier to distinguish.

Brake control	Function	Voltage	Holding current I_{Hmax} (A)	Type	Part number	Color code
BME	One-way rectifier with electronic switching function	AC 150 - 500 V	1.5	BME 1.5	825 722 1	Red
		AC 42 - 150 V	3.0	BME 3	825 723 X	Blue
BMH	One-way rectifier with electronic switching and heating function	AC 150 - 500 V	1.5	BMH 1.5	825 818 X	Green
		AC 42 - 150 V	3	BMH 3	825 819 8	Yellow
BMP	One-way rectifier with electronic switching, integrated voltage relay for cut-off in the DC circuit	AC 150 - 500 V	1.5	BMP 1.5	825 685 3	White
		AC 42 - 150 V	3.0	BMP 3	826 566 6	Light blue
BMK	One-way rectifier with electronic switch mode, DC 24 V control input and separation in the DC circuit	AC 150 - 500 V	1.5	BMK 1.5	826 463 5	Water blue
		AC 42 - 150 V	3.0	BMK 3	826 567 4	Light red
BMKB	One-way rectifier with electronic switch mode, DC 24 V control input, cut-off in the DC circuit and a diode to signal the readiness for operation	AC 150 - 500 V	1.5	BMKB 1.5	828 160 2	Water blue
BSG	Control unit for DC 24 V connection with electronic switch mode	DC 24 V	5.0	BSG	825 459 1	White
BMV	Electronic switch mode, DC 24 V control input and cut-off in the DC circuit	DC 24 V	5.0	BMV	1 300 006 3	White

Short response times

A characteristic feature of the SEW brake is the patented two-coil system. This system consists of accelerator coil and coil section. The special SEW brake control system ensures that the accelerator coil is switched on with a high current inrush when the brake is released, after which the coil section is switched on. The result is a particularly short response time when releasing the brake. The brake disk moves clear very swiftly and the motor starts up with hardly any brake friction.

This principle of the two coil system also reduces self-induction so that the brake is applied more rapidly. The result is a reduced braking distance. The SEW brake can be cut off in the DC and AC circuits to achieve particularly short response times when applying the brake, for example for hoists.

9.7 Dimensioning and routing the cable for terminal box terminal box

a) Selecting the cable

Select the cross section of the brake cable according to the currents in your application. Observe the inrush current of the brake when selecting the cross section. When taking the voltage drop into account due to the inrush current, the value must not drop below 90 % of the rated voltage. The data sheets for the brakes provide information on the possible supply voltages and the result operating currents.

For a quick source of information about dimensioning the cable cross sections and cable lengths, refer to chapter "Assignment table of cables and CMP servomotors", page 205.

Wire cross sections of max. 2.5 mm_2 **can be connected to the terminals of the brake control systems. Intermediate terminals must be used if the cross sections are larger.**

b) Routing information

Brake cables must always be routed separately from other power cables with phased currents unless they are shielded.

Ensure adequate equipotential bonding between the drive and the control cabinet (for an example, see the documentation Drive Engineering - Practical Implementation ãEMC in Drive Engineering").

Power cables with phased currents are in particular

- Output cables from frequency inverters and servo controllers, soft start units and brake units
- Supply cables to braking resistors

9.8 Selecting the brake contactor

- In view of the high current loading and the DC voltage to be switched at inductive load, contactors in utilization category ACß3 (EN 60947-4-1) must always be used for controlling the brake rectifiers.
- Brake control via BSG and BMV requires contactors of utilization category DC 3 (EN 60947-4-1).

Standard design

If not specified otherwise, the CMPZ are delivered with with BME for the AC connection.

Connection via contactor

Brake size	AC connection	DC 24 V connection
BY2	BME	BSG
BY4		
BY8		

Control via inverter

Brake size	AC connection	DC 24 V connection
BY2	BMK	BMV
BY4		
BY8		

9.9 Important design information

a) EMC (Electromagnetic compatibility)

The EMC instructions in the servo controller documentation must also be taken into account for the operation of SEW servomotors with brake.

You must always adhere to the cable routing instructions (see page 150).

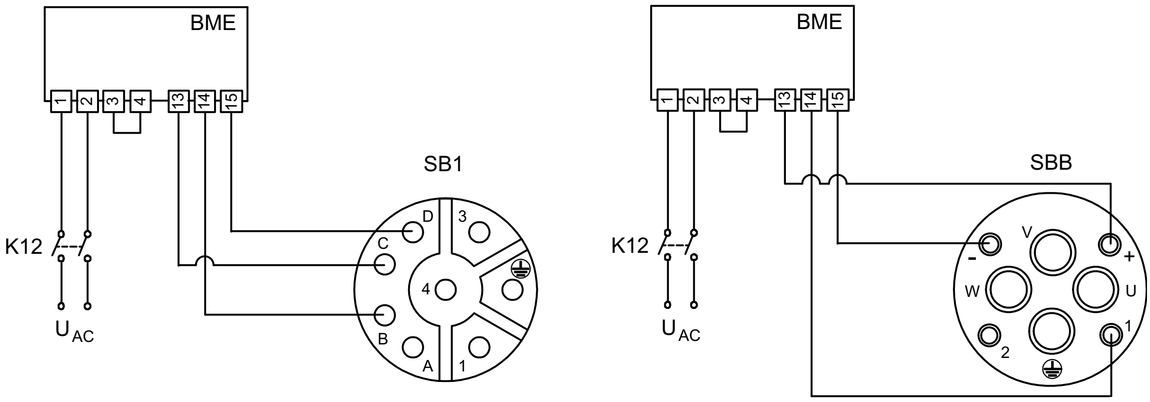
b) Maintenance intervals

The time to maintenance is determined on the basis of the expected brake wear. This value is important for setting up the maintenance schedule for the machine to be used by the customer's service personnel (machine documentation).

9.10 Block diagram of the brake control – plug connector

BME brake rectifier

Cut-off in the AC circuit/normal application of the brake.



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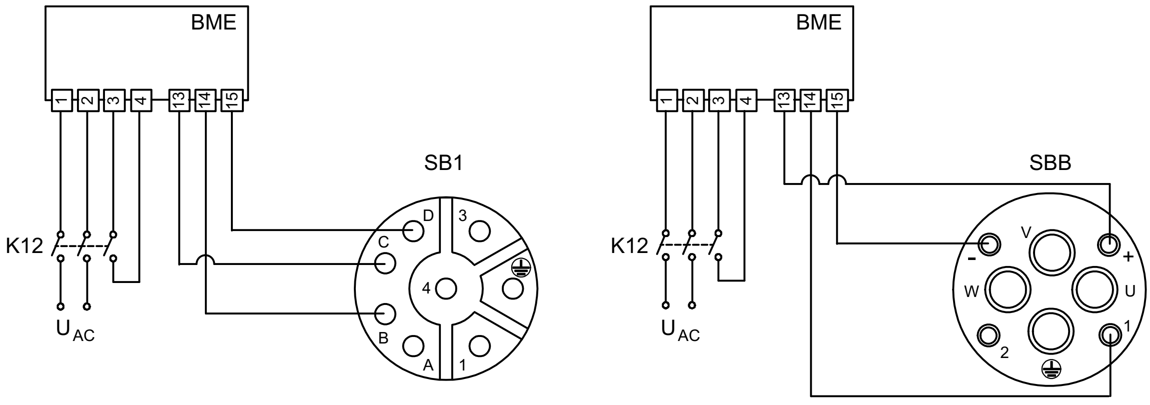
Cut-off in the DC and AC circuits/rapid application of the brake.



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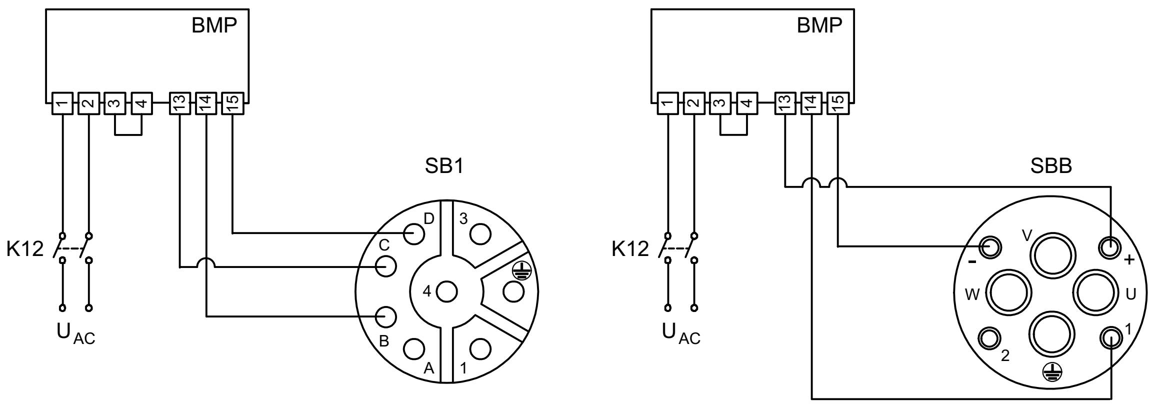
BMP brake rectifier

Cut-off in the DC and AC circuits/rapid application of the brake/integrated voltage relay.



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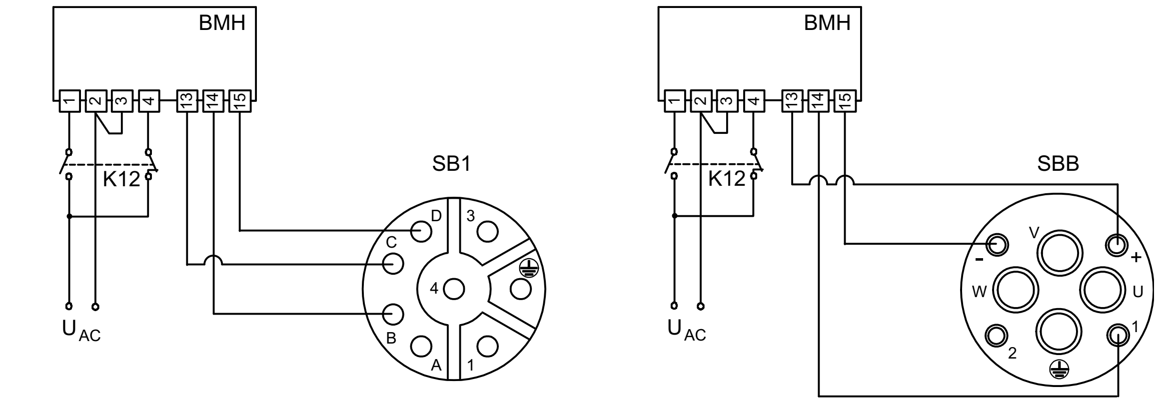
BMH brake rectifier

Cut-off in the AC circuit/normal application of the brake.



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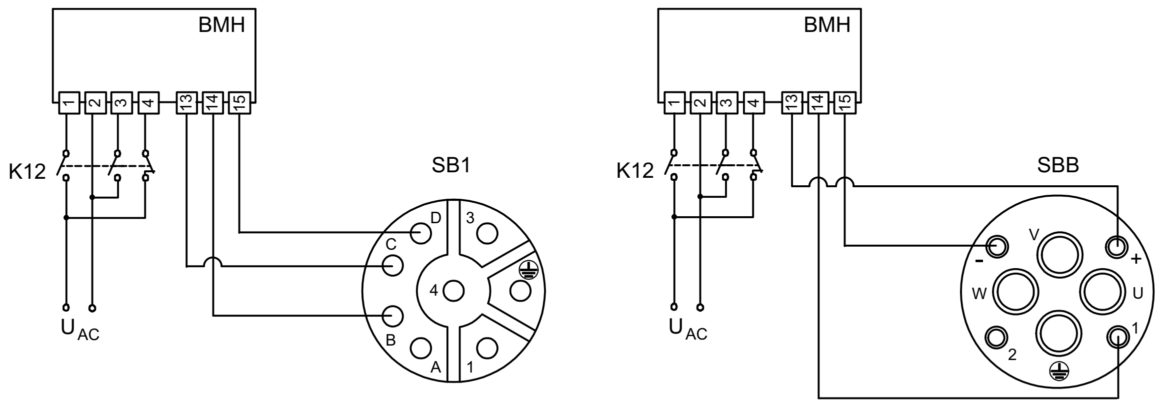
Cut-off in the DC and AC circuits/rapid application of the brake.



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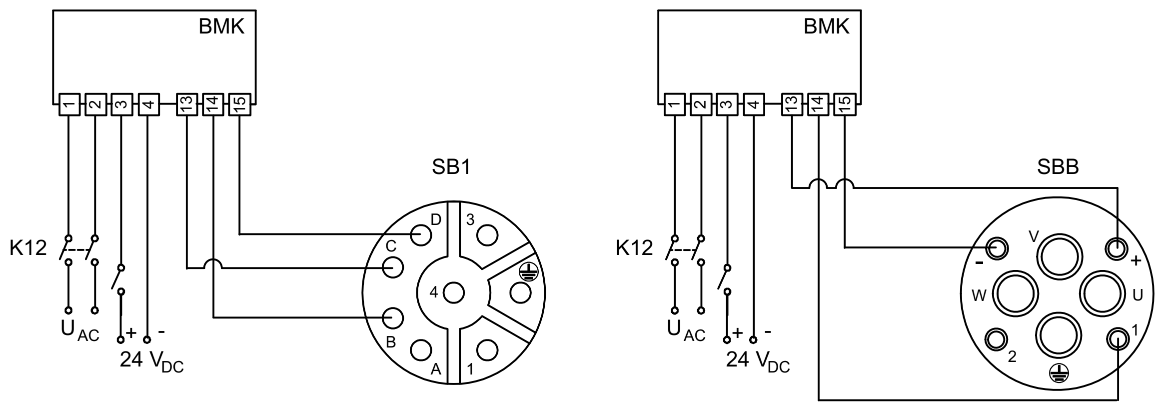
BMK brake rectifier

Cut-off in the DC and AC circuits/rapid application of the brake/integrated voltage relay/integrated DC 24 V control input.



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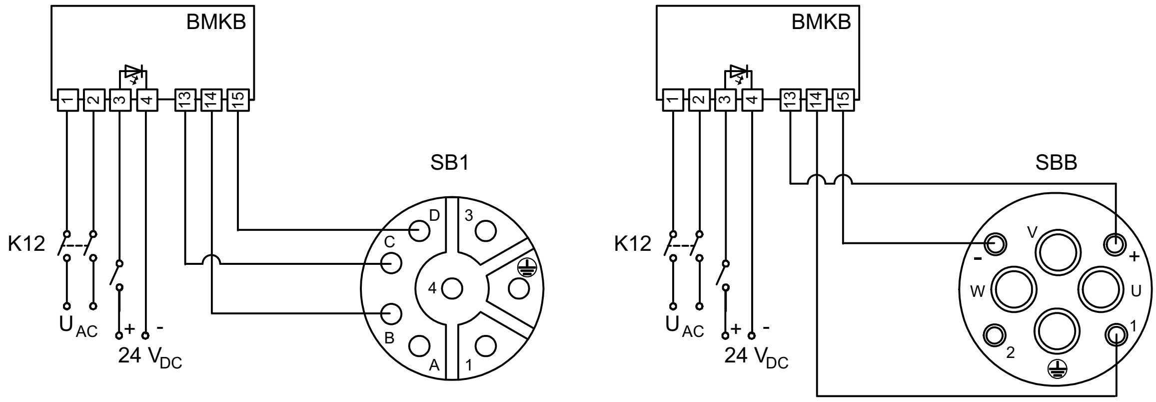
Connection 1, 2	Energy supply
Connection 3, 4	Signal (inverter)

BMKB brake rectifier

Cut-off in the DC and AC circuits/rapid application of the brake/integrated voltage relay/integrated DC 24 V control input/diode displays readiness for operation.



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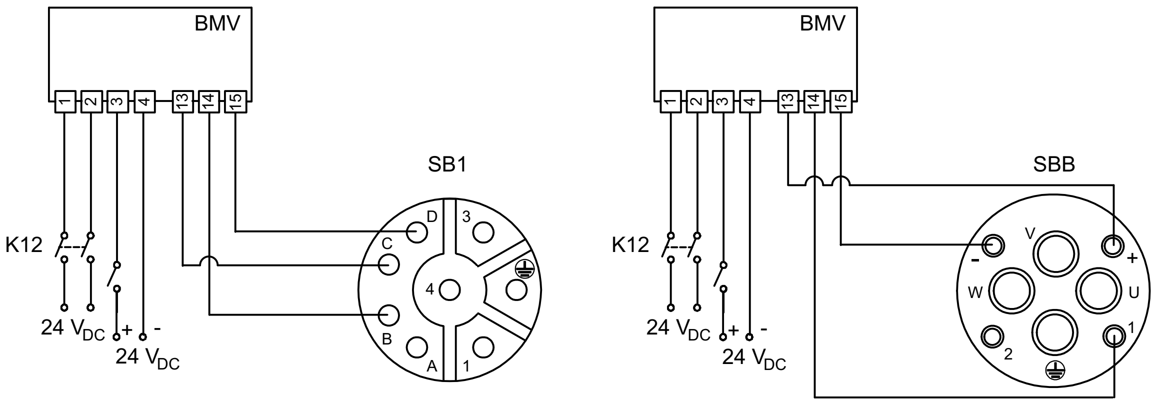
Connection 1, 2	Energy supply
Connection 3, 4	Signal (inverter)

BMV brake rectifier

Cut-off in the DC and AC circuits/rapid application of the brake/integrated DC 24 V control input.



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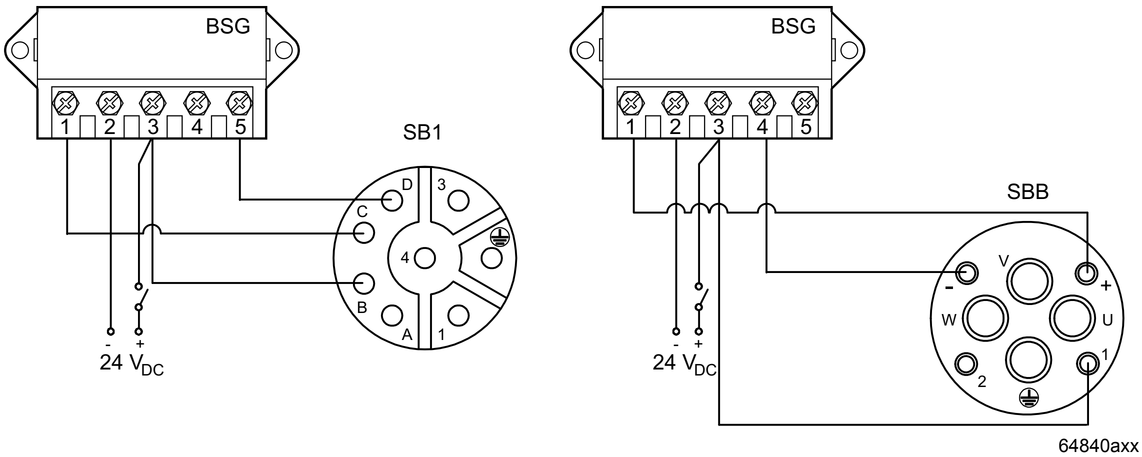
Connection 1, 2	Energy supply
Connection 3, 4	Signal (inverter)

BSG brake control unit

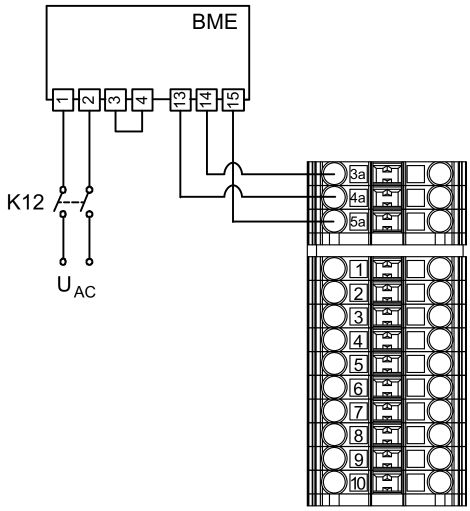
For DC voltage supply with DC 24 V.



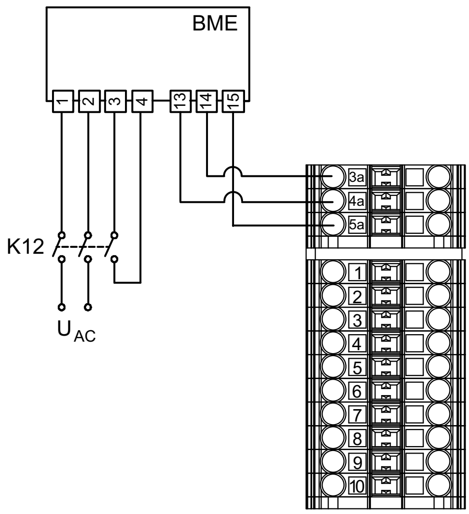
9.11 Block diagram of the brake control – terminal box

BME brake rectifier

Cut-off in the AC circuit/normal application of the brake.

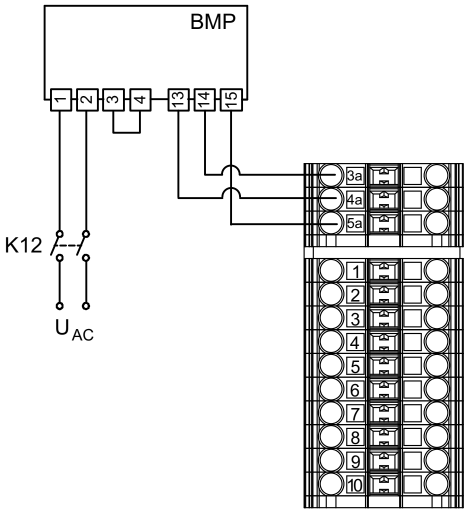


Cut-off in the DC and AC circuits/rapid application of the brake.



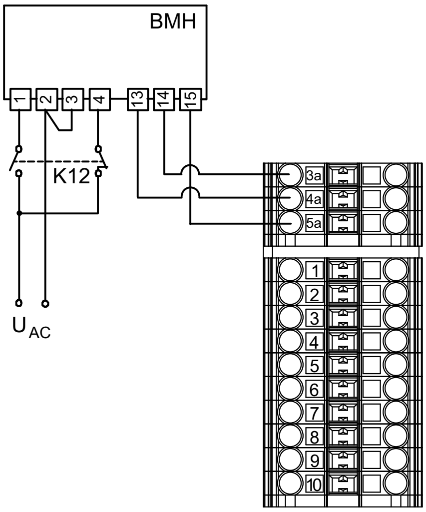
BMP brake rectifier

Cut-off in the DC and AC circuits/rapid application of the brake/integrated voltage relay.

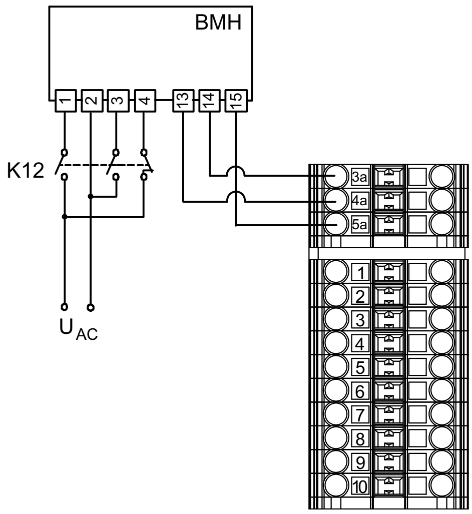


BMH brake rectifier

Cut-off in the AC circuit/normal application of the brake.

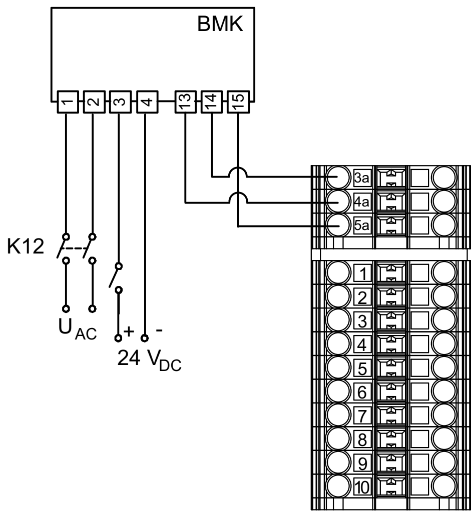


Cut-off in the DC and AC circuits/rapid application of the brake.



BMK brake rectifier

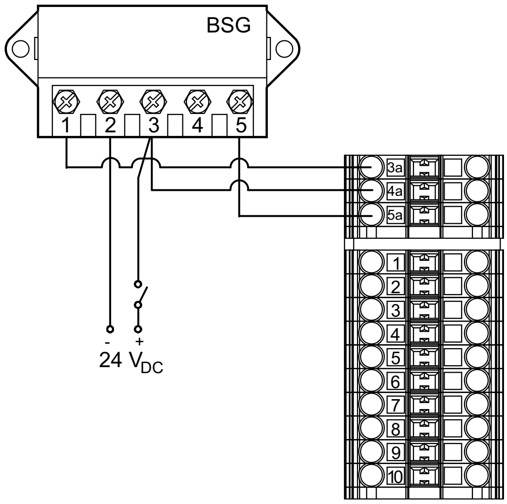
Cut-off in the DC and AC circuits/rapid application of the brake/integrated voltage relay.



Connection 1, 2	Energy supply
Connection 3, 4	Signal (inverter)

BSG brake control unit

For DC voltage supply with DC 24 V.



9.12 Technical data of the BY brake

The following tables list the technical data of the brakes. The type and number of brake springs determines the level of the braking torque. Maximum braking torque $M_{B\ max}$ is installed as standard, unless specified otherwise in the order. Other brake spring combinations can result in reduced braking torque values $M_{B\ red}$.

Brake type	M_{Bmax} [Nm]	$M_{B\ red}$ [Nm]	W_{insp} [10^3 kJ]	P [W]	t_1 [ms]	t_2 [ms]	t_3 [ms]
BY2	20	10	60	30	40	15	90
BY4	40	20	90	40	40	15	110
BY8	80	40	120	50	60	30	140

$M_{B\ max}$ = Maximum braking torque
$M_{B\ red}$ = Optional braking torque
W_{insp} = permitted total braking work (braking work until service)
P = Power consumption of the coil
t_1 = Response time
t_2 = Application time AC/DC
t_3 = Application time AC

INFORMATION

The response and application times are recommended values in relation to the maximum braking torque.

Motor assignment

The following table shows the standard assignments of motors and brakes:

Motor type	Brake type	M_{B1} [Nm]	M_{B2} [Nm]	Speed class
CMPZ71S	BY2	14	10	3000, 4500, 6000
CMPZ71M/L		20	14	
CMPZ80S	BY4	28	20	3000, 4500
CMPZ80M/L		40	28	
CMPZ100S	BY8	55	40	3000, 4500
CMPZ100M/L		80	55	

M_{B1} Preferred braking torque
M_{B2} Optional braking torque

Maximum permitted friction work

The following table shows the permitted friction work depending on the application speed the braking process is triggered at. The lower the speed, the higher the permitted braking work.

INFORMATION

For horizontal motion like in travel drive applications, higher braking work might be permitted per cycle in emergency stop situation under certain conditions. The specific wear of the brake lining significantly increases in an emergency stop situation and the real dynamic braking torque effective during the braking process reduces due to the increased temperature of the brake lining.

Consult SEW-EURODRIVE to obtain these values.

Rated speed [1/min]	Brake type	M_{Bmax} [Nm]	W_1 [kJ]
3000	BY2	7	20
		10	18
		14	14
		20	11
	BY4	14	20
		20	15
		28	10
		40	4.5
	BY8	28	36
		40	32
		55	18
		80	7
4500	BY2	7	16
		10	14
		14	10
		20	6
	BY4	14	15
		20	9
		28	5
		40	3
	BY8	28	22
		40	18
		55	11
		80	4
6000	BY2	7	14
		10	13
		14	8
		20	4.5

$M_{B\,max}$ = Maximum braking torque

W_1 = Permitted braking work per cycle

9.13 Operating currents for the BY brake

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

- Inrush current ratio I_B/I_H; I_B = accelerator current, I_H = holding current
- Holding current I_H
- Rated voltage V_N

The accelerator current I_B (= inrush current) only flows for a short time (ca. 120 ms) when the brake is released or during voltage dips below 70 % of rated voltage.

The values for the holding currents I_H are r.m.s. values (arithmetic mean value at DC 24 V). Use suitable measuring instruments for current measurements.

	BY2	BY4	BY8
Max. braking torque [Nm]	20	40	80
Braking power [W]	30	40	50
Inrush current ratio I_B/I_H	6	6.5	7

Rated voltage V_N							
V_{AC}	**V_{DC}**	**I_H [A_{AC}]**	**I_G [A_{DC}]**	**I_H [A_{AC}]**	**I_G [A_{DC}]**	**I_H [A_{AC}]**	**I_G [A_{DC}]**
	24 (21.6 - 26.4)	-	1.4	-	1.6	-	2.1
110 (99 - 121)		0.47	-	0.63	-	0.8	-
230 (218 - 243)		0.21	-	0.28	-	0.355	-
400 (380 - 431)		0.12	-	0.16	-	0.2	-
460 (432 - 484)		0.11	-	0.14	-	0.18	-

I_H Holding current, r.m.s. value in the supply cable to the SEW brake rectifier

I_G Direct current with direct DC voltage supply

V_N Rated voltage (rated voltage range)

9.14 Resistance of BY brake coils

	BY2	BY4	BY8
Max. braking torque [Nm]	20	40	80
Braking power [W]	30	40	50

Rated voltage V_N							
V_{AC}	**V_{DC}**	**R_B [Ω]**	**R_T [Ω]**	**R_B [Ω]**	**R_T [Ω]**	**R_B [Ω]**	**R_T [Ω]**
	24 (21.6 - 26.4)	3.9	18.85	2.6	13.91	1.9	11.05
110 (99 - 121)		12.3	59.6	8.1	43.98	6	34.94
230 (218 - 243)		61.6	298.7	40.6	220.4	30.1	175.1
400 (380 - 431)		194.8	944.6	128.4	697	95.2	553.7
460 (432 - 484)		245.2	1189.1	161.6	877.4	119.8	697.1

R_B Resistance of accelerator coil at 20 °C

R_T Coil section resistance at 20 °C

V_N Rated voltage (rated voltage range)

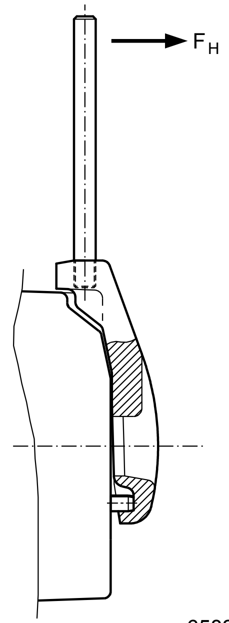
9.15 Braking work and braking torque

Brake Type	Braking work until Maintenance	Order number of pressure plate	Braking torque settings				
			Braking torque	Type and number of brake springs		Order number of brake springs	
	[10^6 J]		[Nm]	normal	Red	normal	Red
BY2	60	1644 3632	20	6	-	0186 6621	0183 7427
			14	4	2		
		1644 7824	10	3	-		
			7	2	2		
BY4	90	1644 5856	40	6	-	0186 663X	0184 0037
			28	4	2		
		1644 7840	20	3	-		
			14	2	2		
BY8	120	1644 4876	80	6	-	1644 6011	1644 6038
			55	4	2		
		1644 7859	40	3	-		
			28	2	2		

9.16 Manual brake release

In brakemotors with the ../HR "brake with self-re-engaging manual brake release", you can release the brake manually using the provided lever. The following table specifies the actuation force required at maximum braking torque to release the brake manually. The values are based on the assumption that you operate the lever at the upper end.

Brake type	Motor size	Actuation force F_H [N]
BY2	**CMPZ71**	50
BY4	**CMPZ80**	70
BY8	**CMPZ100**	90



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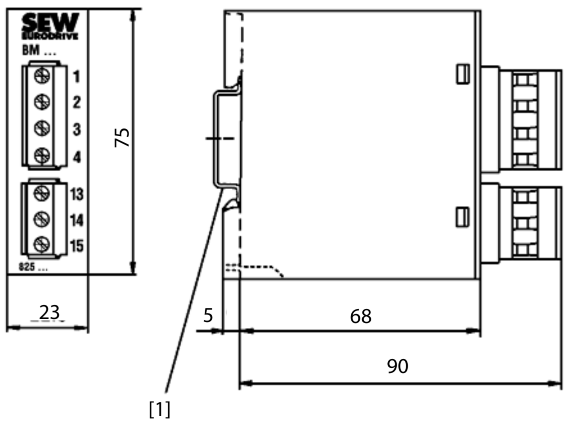
Retrofit set for manual brake release

The manual brake release of the BY brake can be retrofitted with the following retrofit kits:

Retrofit set	Part number
BY2	**1750 842 8**
BY4	**1750 852 5**
BY8	**1750 862 2**

9.17 Dimension drawings of the BY brake control

Dimension drawing BME, BMP, BMH, BMK, BMKB, BMV



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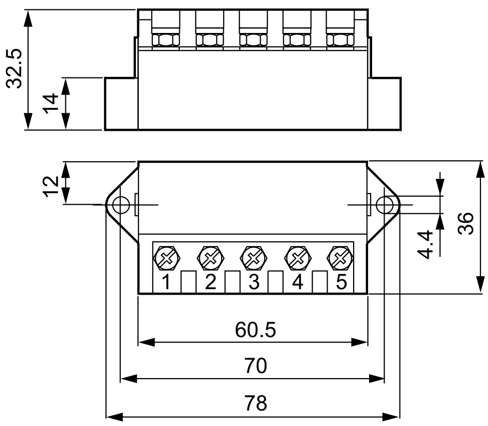
[1] DIN rail mounting EN 50022-35 x 7.5

Dimension drawing BSG



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