



ZF Friedrichshafen AG
Special Driveline Technology

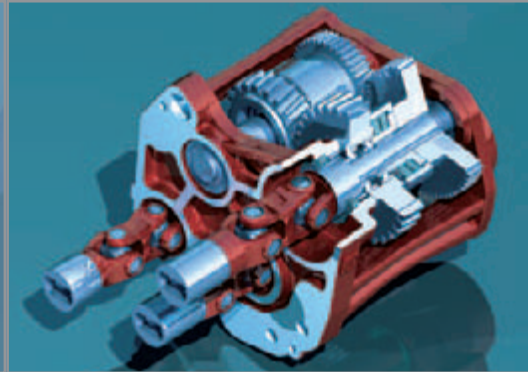
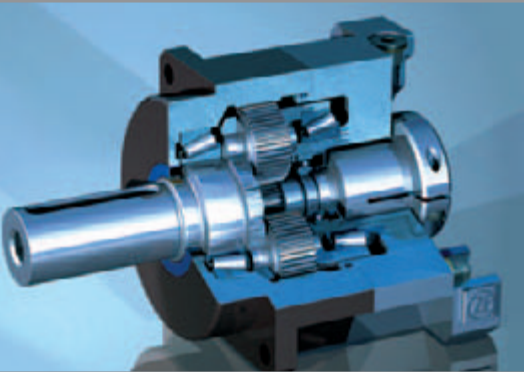
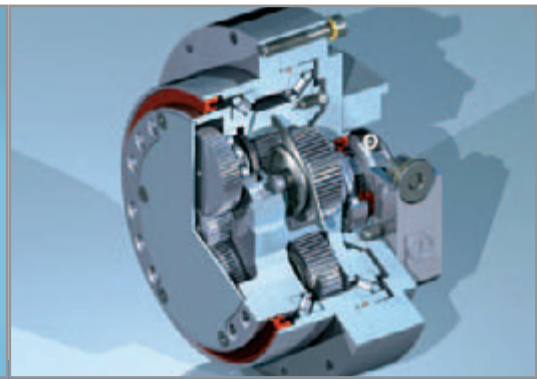
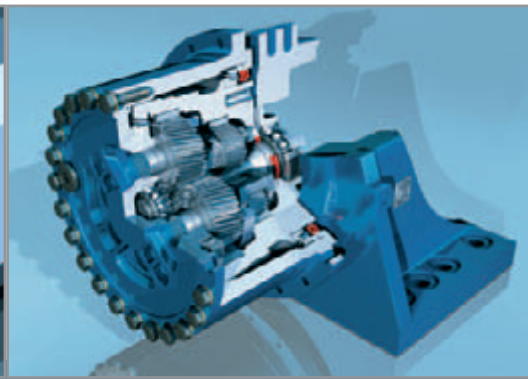
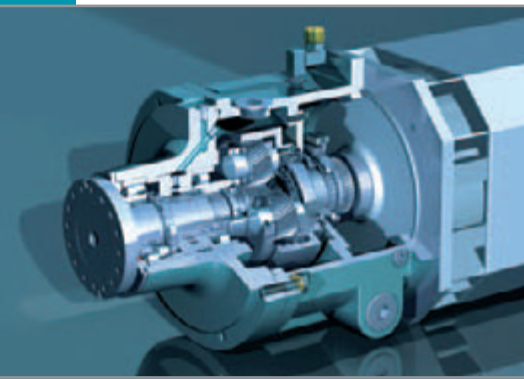


ZF-TIRATRON®

Hysteresis brakes

Hysteresis clutches

Electronic control unit



ZF-Servoplan CG
Compact Gearbox

ZF-Duoplan 2K
Two-speed Gearboxes

ZF-Ecolift
Elevator Gearboxes

ZF-Servoplan PG
Servogearboxes

Customer specific
Gearboxes



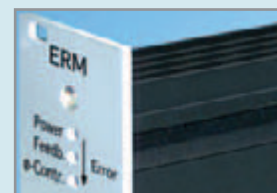
Z F - T i r a t r o n
H y s t e r e s i s B r a k e s

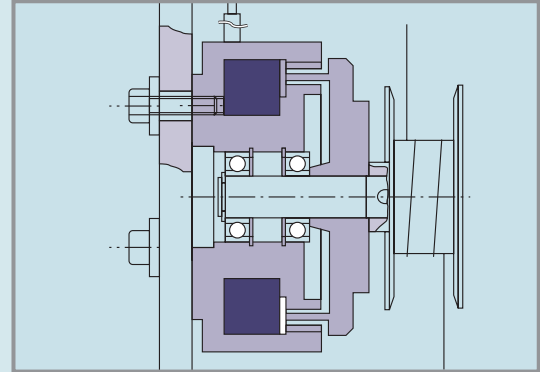
Precision in movement

The ZF Friedrichshafen division Special Driveline Technology is able to offer you a wide range of machine drives, brakes and clutches for applications in engineering as well as customer specific drive solutions.

Our development and production activities are focused on servo-assisted drives for automation engineering, two-speed drive gearboxes for machine tools as well as customer-specific drives, such as for printing machines, robot applications and elevator gearboxes.

Our innovative standard products range from low backlash servogearboxes (ZF-Servoplan), and robust two-speed gearboxes (ZF-Duoplan) to hysteresis clutches and brakes for non-contact web control (ZF-Tiratron).





ZF Hysteresis components are brakes, clutches and ERM electronic control unit.

ZF Tiratron, i.e. the combination of the brake with the electronic control unit or the clutch with the electronic control unit, enables the exact control of tensile forces as well as a defined setting of a torque.

Exemplary operation

The ZF hysteresis technology can be used and applied wherever products, such as paper, wire etc., are processed by winding. Loads can be simulated with Tiratron on test benches or in ergometers.

Non-contact torque transmission

The non-contact torque transmission via the airgap of the mechanical components brake or clutches, is continuously variable, then constant and free of any wear.

Continuously adjustable torque

The brake torque or the transferable torque depends only on the current. It is largely speed-independent and from zero to maximum speed constantly available.

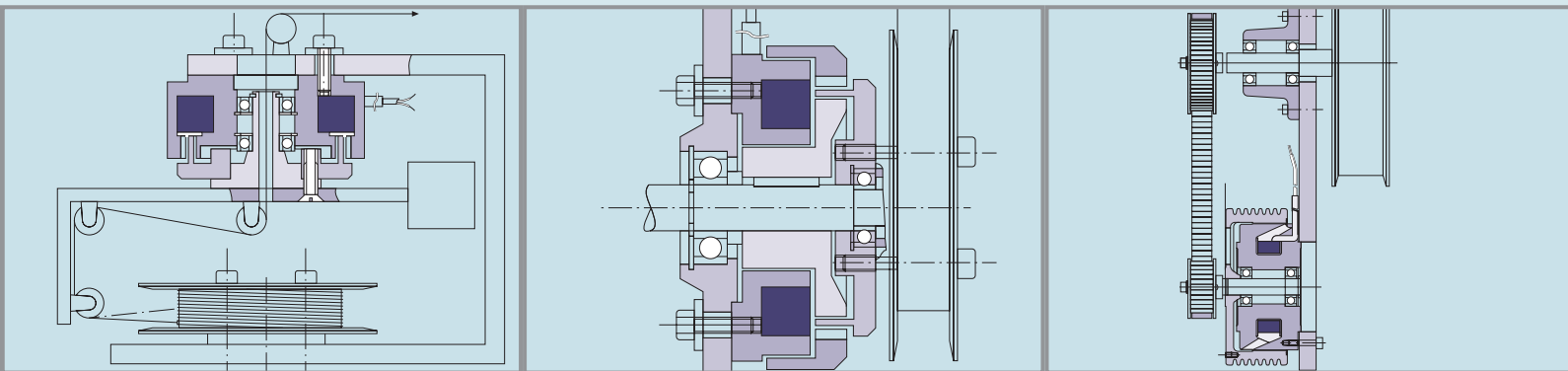
High slip power in continuous mode, overload capability

The brakes of the power optimized series can bear high slip power continuously. Overloads can be applied for a short-term period.

The system, consisting of the brake or clutch and the universal usable control unit, is standardized and can be used for most of the applications.

Operating principles

The operating principles of hysteresis brakes and clutches are based on the magnetic force effect of attracting poles in synchronous mode and on continuous magnetic reversal in slip mode.



Installation examples

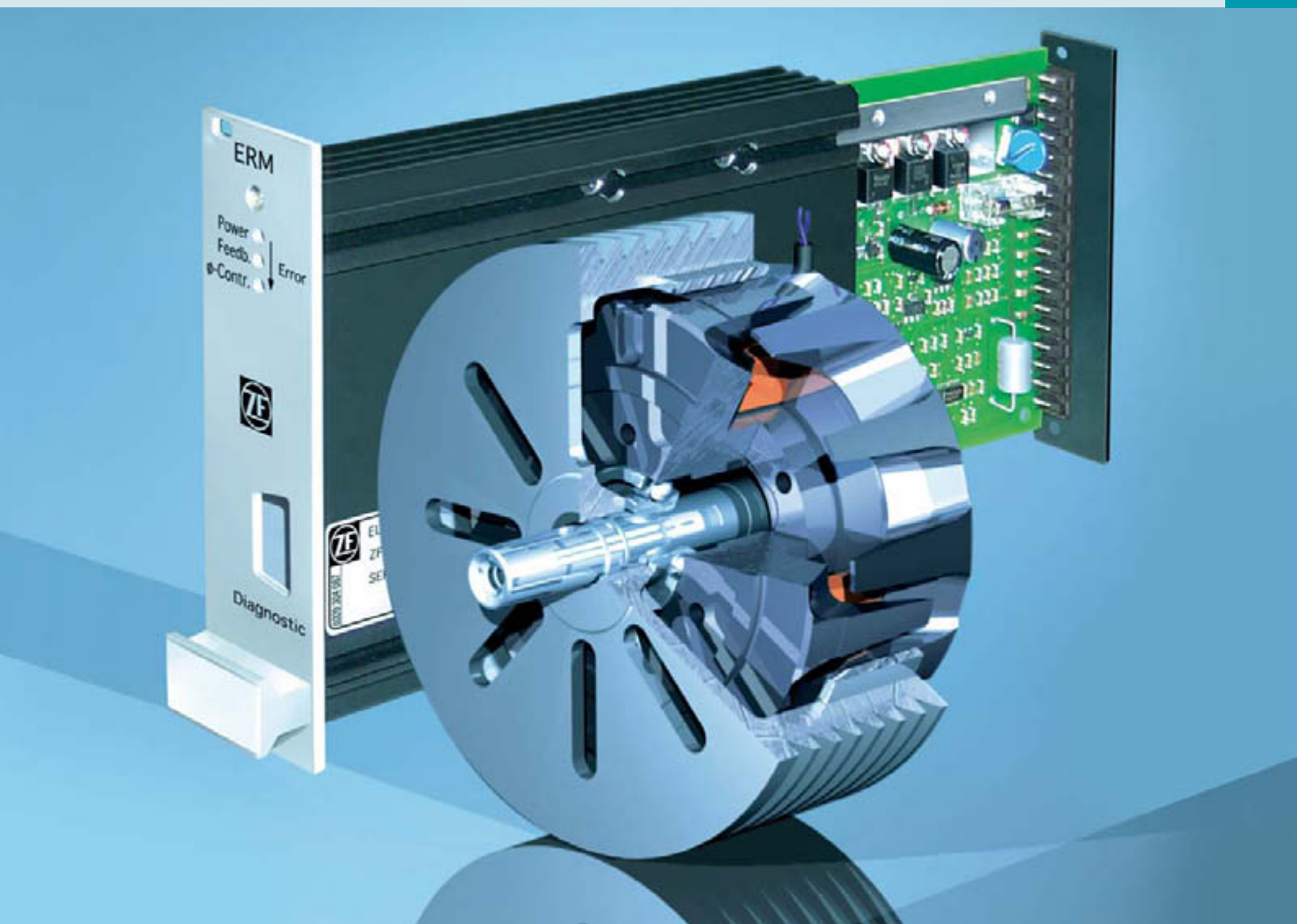
Abb.1: Hysteresis brakes to produce a defined thread tension.

Abb.2: Hysteresis brakes with flyer for unwinding flexible leads with constant tensile force.

Abb.3: Hysteresis clutches to wind up a foil with constant tensile force.

Abb.4: Hysteresis brake to unwind a tape with constant tensile force.

A toothed belt is used to produce a higher braking torque.



Hysteresis brakes

Types:

- Torque-optimized series
- Power-optimized series
- Power-optimized series with gearbox

The armature and the brake magnet are the individual components making up the ZF hysteresis brake.

ZF Hysteresis brakes are offered with a nominal torque ranging from 0.05 Nm to 520 Nm, depending on the size, available as bearing version with shaft end or non-bearing version as individual components.

The brakes have a power capacity of up to 2000 W during continuous operations and of 4000 W during short-term operations (interval operations).

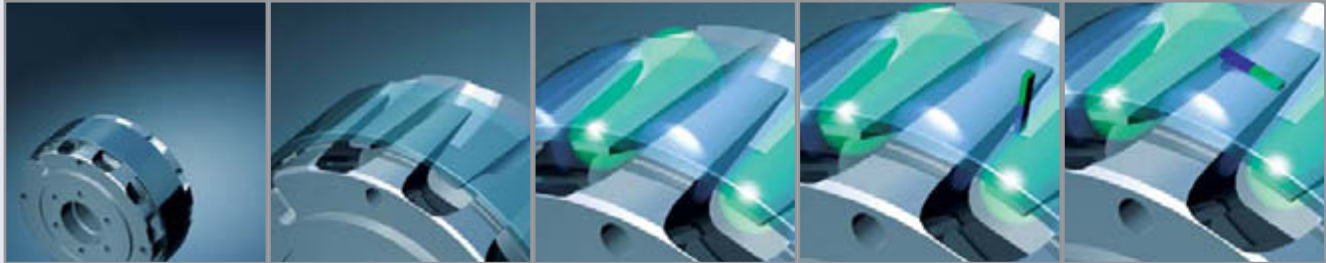
They can be used both in the slip mode range and as a holding brake.

Typical torque-current-diagram

Only the current preset in the magnet solenoid defines the slip and holding torque, which can be infinitely adjusted from zero to the maximum value.

The torque is almost independent from speed. Major temperature increases cause a slight reduction of torque.

Fig.: Reversal of magnetization



Slip power

During continuous slip mode, heat generation caused by slip power must also be taken into account. Permissible continuous slip power limits are included in the selection tables. Required continuous slip power is calculated as follows:

$$P_S = T_S \cdot \frac{n_S}{9.55} \text{ or } P_S = F \cdot v$$

P_S : Slip power in W

T_S : Slip torque in Nm

n_S : Slip speed in rpm

F : Tensile force in N

v : Band pull speed in m/s

Residual magnetism

Torque ripple occurs as a result of residual magnetism when the current is changed to below 50% of the initial value either abruptly or without turning the armature/rotor.

A reliable way to avoid torque ripple is to reduce the current while simultaneously turning the armature and rotor resp. brake solenoid during approx. 1 turn (relative).

Every following operation cycle is removing possible residual magnetism.

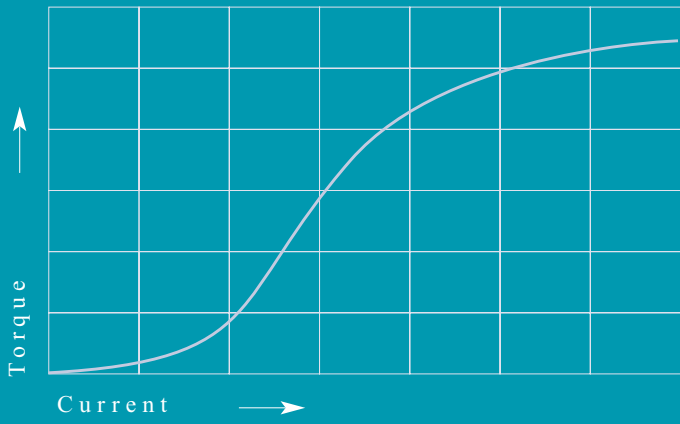
Manufacturing and torque tolerances:

When ordering the standard version according to the catalog, an individual unit's torque-current curve as well as its torque relative to nominal current may deviate slightly from the published data due to production tolerances.

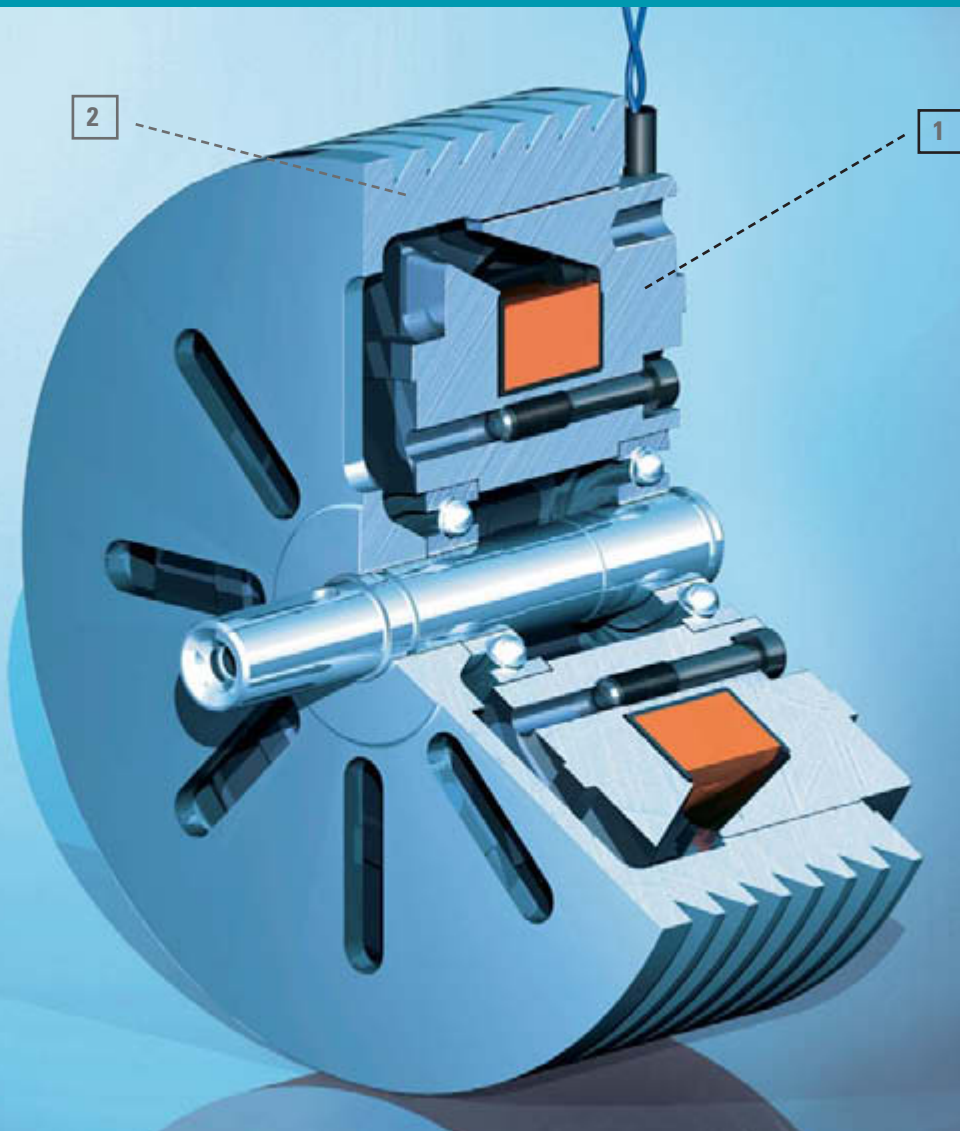
A typical deviation for individual units would be +/- 10 %.

Upon request, we can offer specially matched pairs for those applications requiring lower tolerances.

The actual torque-current curve for a specific unit is exactly reproducible under the same conditions.



1. Brake magnet with solenoid
 2. Armature with hysteresis ring
- Fig.: Bearing version with shaft



Power-optimized hysteresis brakes

Sizes :

Technical data :		EBU 250/1	EBU 500/3	EBU 1000/10	EBU 2000/30
Nominal torque*	T_N (Nm)	0.6	2.5	9	26
Nominal torque* at speed n	T_P (Nm)	0.75	3.0	12.5	38
Permitted speed in continuous mode at nominal torque	n (rpm)	3 200	1 500	750	500
Permitted slip power in continuous mode	P (W)	250	500	1 000	2 000
Max. slip power in short time mode	P_{max} (W)	500	1 000	2 000	4 000
Nominal current	I_N (A)	1.1	1.4	1.9	2.7
Nominal voltage	U_N (V)	24	24	24	24
Max. speed	n_{max} (rpm)	10 000	6 500	4 500	3 000
Shaft side inertia torque	J_W (kgcm ²)	4.8	33.5	244.5	1 157
Power consumption at coil temperature 70°C	P_{70} (W)	19	24	33	47
Mass	m (kg)	1.4	3.7	11	45

Dimensions (mm) :

	EBU 250/1	EBU 500/3	EBU 1000/10	EBU 2000/30
A ₁	55	68	92	122
B ₁	24.5	32	40	53.5
B ₂	25	32,5	41	54
B ₃	12.5	14.5	20.5	28
D ₁ h7	50	80	110	180
D ₂	75	112	168	233
D ₃	93	140	210	292
E	10.5	13	20	25
d ₁ k6	11	14	19	24
d ₂	M 4	M 5	M 6	M 8
d ₃	M 5	M 6	M 8	M 12
d ₄	60	100	130	215
d ₅ S7	12	15	20	25
d ₆ H7	28	35	52	80
a	3	4	4	6
b	2	2.5	3.5	4
c	7	8	12	16
e	11	13	15	20
l ₁	23	30	40	50
l ₂	18	22	28	36
l ₃	31	40.5	54	69.5
l ₄	32.5	41	52	71
l ₅	39.5	51	68.5	89
v P9	4	5	6	8
w +0.2	2.5	3	3.5	4
L _A DIN625	6 001	6 202	6 304	6 405

*Tolerances:

See Scattering/Torque tolerances

All bearing types balanced,
balance quality 6.3

Non-bearing types when supported
in d5: balance quality: 23.6

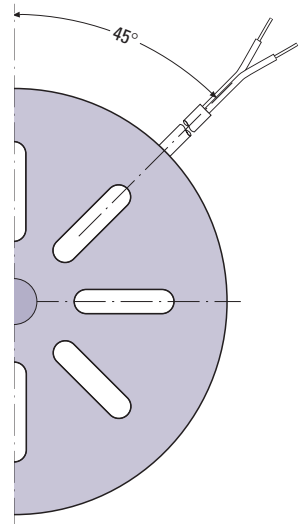
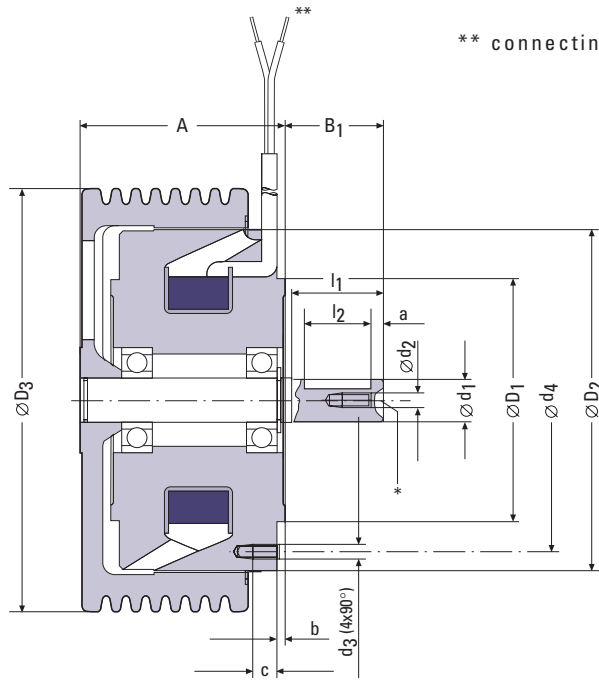
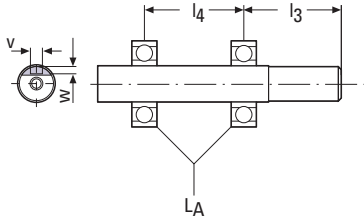
Ambient temperature up to 40°C

Available versions:

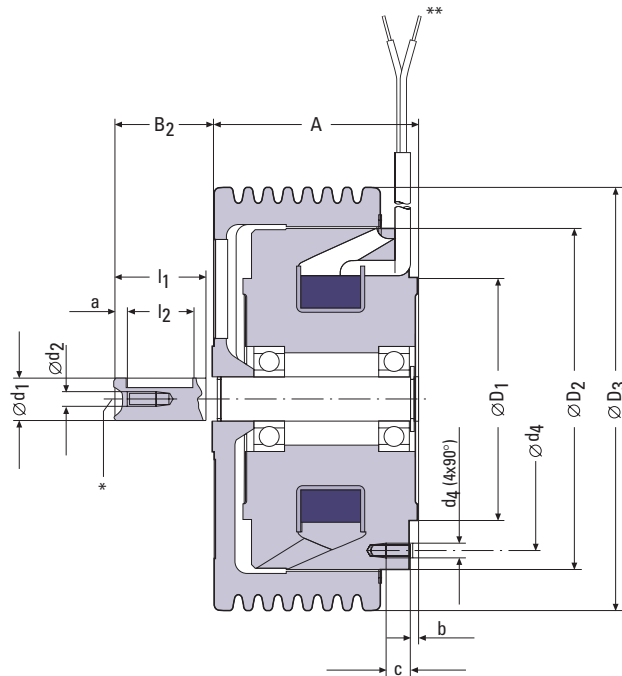
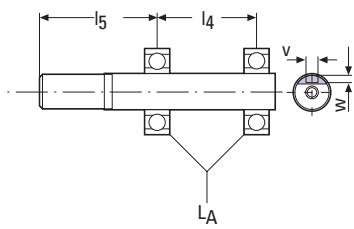
* Centering DIN 332 (D)

** connecting leads 0,5 mm², length 500 mm

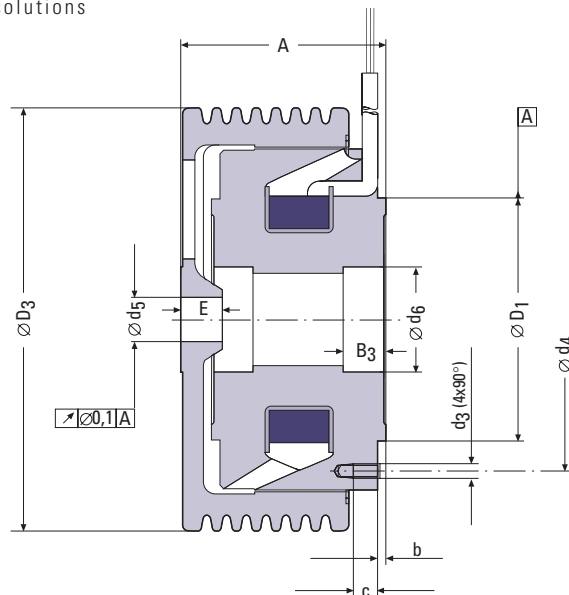
A: Bearing type, shaft right side



B: Bearing type, shaft left side



C: Non-bearing type for integrated solutions



Torque-optimized hysteresis brakes

Sizes:

Technical data:

		EBU 0,05 L	EBU 0,1 LA	EBU 0,1 LW
Nominal torque*	T_N (Nm)	0.08	0.15	0.15
Max. slip power in short time mode	P_{max} (W)	15	32	32
Nominal current	I_N (A)	0.225	0.4	0.4
Nominal voltage	U_N (V)	23	30	30
Max. speed	n_{max} (min ⁻¹)	15 000	15 000	15 000
Armature side inertia torque	J_{arm} (kgcm ²)	0.14	0.1	0.1
Power consumption at coil temperature 70°C	P_{70} (W)	4.8	10	10
Mass	m (kg)	0.37	0.5	0.5

Dimensions (mm):

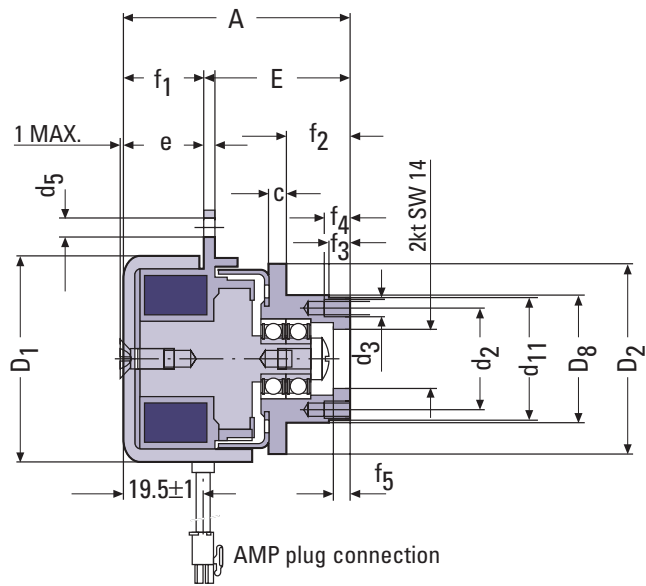
	EBU 0,05 L	EBU 0,1 LA	EBU 0,1 LW
A	53.5	51	49
C	-	35	-
D ₁	49	54	54
D ₂	45	-	-
D ₇	70	-	-
D ₈ h8	30	25	-
E	34.5	-	-
c	4	-	-
d _j 6	-	-	5
d ₂	24/2 x180	32/3 x120	-
d ₃	M 4	M 3	-
d ₄	62	40	40
d ₅	4.3	M 4	M 4
d ₁₁	29	-	-
e	3	5	6
f ₁	19 +/-0.5	-	-
f ₂	15	7.5	-
f ₃	5	-	-
f ₄	6	-	-
f ₅	4	-	-
l	-	-	30

*Tolerances:

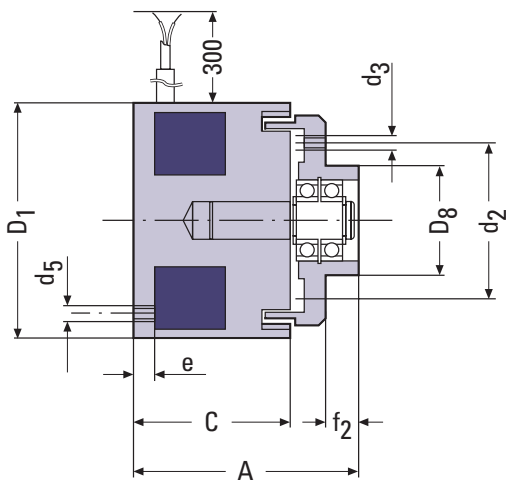
See Scattering/Torque tolerances

Ambient temperature up to 40°C

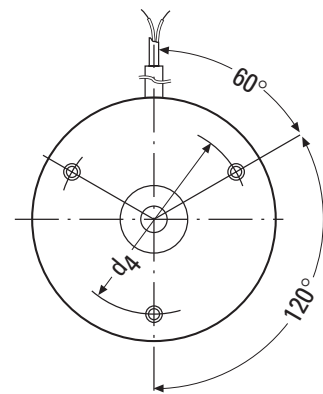
Available versions:



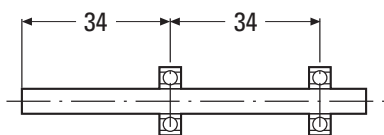
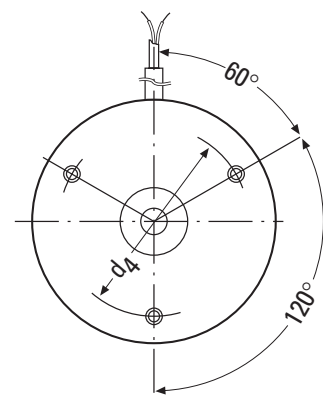
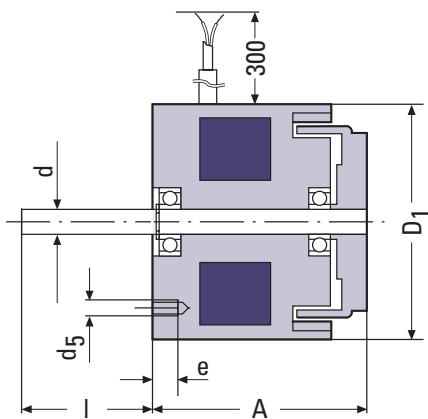
EBU
0,05L



EBU
0,1LA



EBU
0,1LW



Torque-optimized hysteresis brakes

Sizes:

Technical data:

		EBU 0,3 L	EBU 1 L	EBU 3 L	EBU 10 L	EBU 30 L
Nominal torque *	T_N (Nm)	0.4	1.1	3.3	12	39
Max. slip power	P_{max} (W)	63	125	250	500	1 000
Nominal current	I_N (A)	0.75	1.25	1.25	1.5	2.2
Nominal voltage	U_N (V)	30	30	30	30	30
Max. speed	n_{max} (min ⁻¹)	10 000	6 500	4 500	3 000	2 000
Armature side inertia torque	J_{arm} (kgcm ²)	1	3	13	81	404
Power consumption at coil temperature 70°C	P_{70} (W)	18	30	30	36	53
Mass	m (kg)	1.1	2.2	5.6	18	47

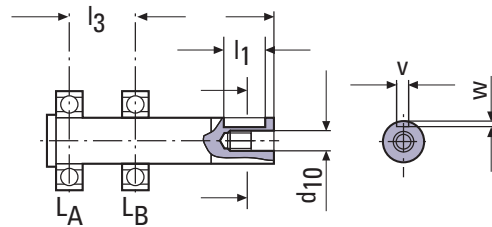
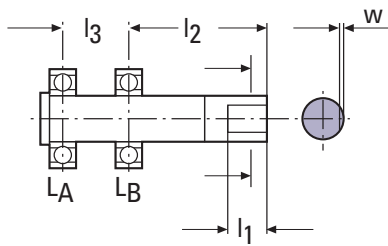
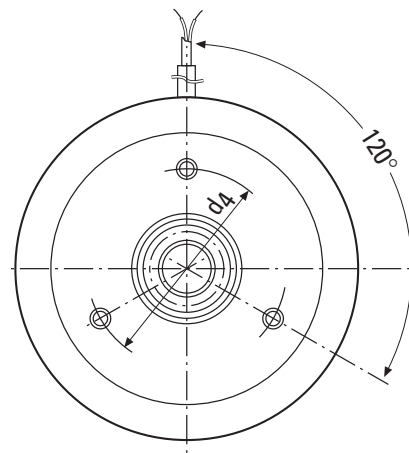
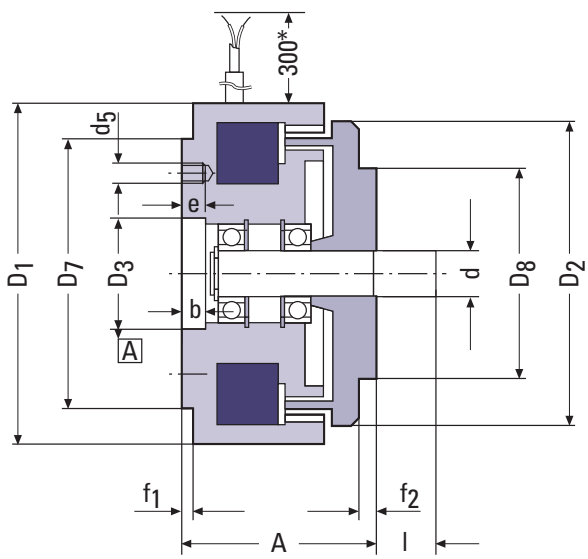
Dimensions (mm):

	EBU 0,3 L	EBU 1L	EBU 3 L	EBU 10 L	EBU 30 L
A	58	56.5	76.5	102	136
D ₁	74	102	138	210	310
D ₂	62	91	120	180	266
D ₃	22 K7	35 H7	42 K6	80 H7	140 H7
D ₇	-	-	131 f7	160 h8	240 h8
D ₈	55	64	95	-	-
L _A DIN625	608	6 201	6 004	6 006	6 209
L _B DIN625	6 000	6 201	6 004	6 006	6 209
b	2	4	2	6	8
d	7 h7	9 h7	14 h7	24 h7	38 h7
d ₄	50	60	60	106	170
d ₅	M 5	M 5	M 6	M 8	M 8
d ₁₀	-	-	M 5x12.5	M 8x19	M10x
e	7	7	14.5	20	30
f ₁	-	-	2.5	5	4
f ₂	3	5	5	2.5	-
l	16	20	30	50	80
l ₁	8	10	22	40	63
l ₂	34	43.7	57	82.5	132.5
l ₃	32.5	20.8	38	51	59
v x w	-	-	5 x 3	8 x 4	10 x 5
w	1	1	-	-	-

*Tolerances:

See Scattering/Torque tolerances

Ambient temperature up to 40°C



Torque-optimized hysteresis brakes

Sizes :

Technical data :

		EBU 0,3	EBU 1	EBU 3	EBU 10	EBU 30
Nominal torque *	T_N (Nm)	0.4	1.1	3.3	12	39
Max. slip power	P_{max} (W)	63	125	250	500	1 000
Nominal current	I_N (A)	0.75	1.25	1.25	1.5	2.2
Nominal voltage	U_N (V)	30	30	30	30	30
Max. speed	n_{max} (min ⁻¹)	10 000	6 500	4 500	3 000	2 000
Armature side inertia torque	J_{arm} (kgcm ²)	0.7	2	9.1	59	340
Power consumption at coil temperature 70°C	P_{70} (W)	18	30	30	36	53
Mass	m (kg)	1.0	1.8	5.0	16	42

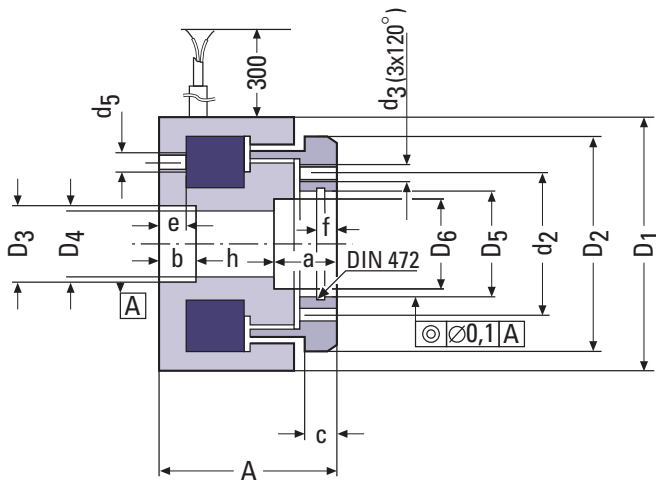
Dimensions (mm) :

	EBU 0.3	EBU 1	EBU 3	EBU 10	EBU 30
A	55	51.5	71.5	102	136
D ₁	74	102	138	210	310
D ₂	62	91	120	180	266
D ₃	22 K7	35 H7	42 K6	80 H7	140 H7
D ₄	19	32 K6	42 K6	80	140
D ₅	32 K7	42 K7	52 K7	90 H7	110 H7
D ₆	26 K7	-	-	202	300
D ₇	-	-	131 f7	160 h8	240 h8
a	19	17	16.5	26	43
b	11	4	-	47	57
c	10	15	16.5	10	14
d ₂	42	50	80	105 +/-0.1	130 +/-0.1
d ₃	M 4	M 5	M 5	M 8	M 8
d ₄	50	60	60	106 +/-0.2	170 +/-0.2
d ₅	M 5	M 5	M 6	M 8	M 8
d ₆	-	-	-	186 +/-0.2	275 +/-0.2
d ₇	-	-	-	M 8	M 10
e	7	7	11	20	20
f	5.2 +0.1	10.7 +0.1	12.0 +0.1	-	-
g	-	18.2	19.2	12	11
h	25	8.4	22.8	-	-
f ₁	-	-	2.5	5	4

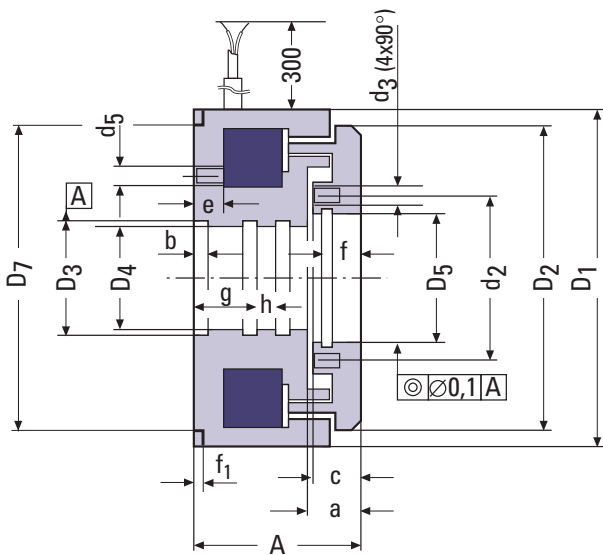
*Tolerances:

See Scattering/Torque tolerances

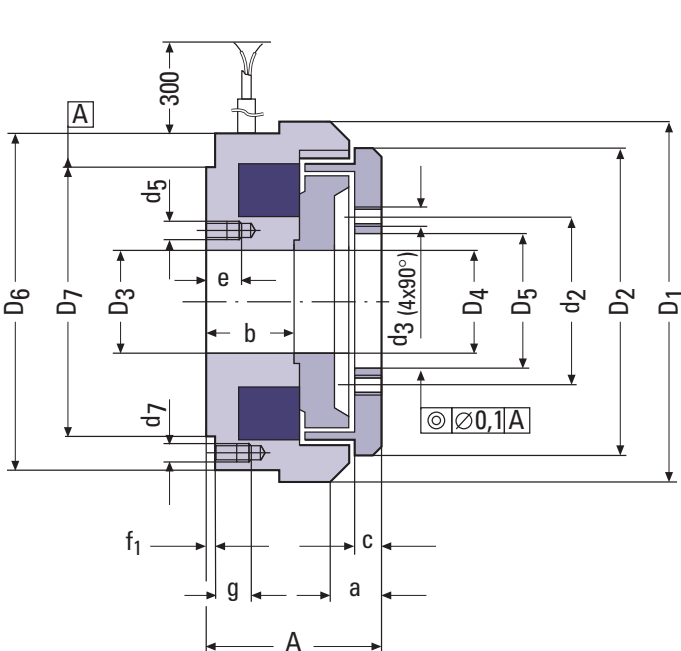
Ambient temperature up to 40°C



EBU
0,3



EBU1
EBU3



EBU10
EBU30

Power-optimized brakes with gearbox

Sizes :

Technical data :

		EBU 500/30 G	EBU 1000/100 G	EBU 2000/300 G	EBU 2000/600 G
Ratio	i^{**}	10	10	10	20
Nominal torque*	T_N (Nm)	25	90	260	520
Nominal torque* for speed n	T_P (Nm)	30	125	380	760
Idling torque	T_L (Nm)	0.5	1	3	5
Permitted speed in continuous mode	n (rpm)	150	75	50	25
Max. slip power in continuous mode	P (W)	500	1 000	2 000	2 000
Max. slip power in short time mode	P_{max} (W)	1 000	2 000	4 000	4 000
Nominal current	I_N (A)	1.4	1.9	2.7	2.7
Nominal voltage	U_N (V)	24	24	24	24
Max. speed	n_{max} (rpm)	600	400	300	100
Shaft side inertia torque	J_W (kgcm ²)	350	24 500	116 000	232 000
Power consumption at coil temperature 70°C	P_{70} (W)	29	40	60	60
Mass	m (kg)	6.5	18	60	82

Dimensions (mm) :

	EBU 500/30 G	EBU 1000/100 G	EBU 2000/300 G	EBU 2000/600 G
A	236	330	412	522
B	155	222	270	380
D ₃	140	210	292	292
D ₁₁	59.5	89.5	111.5	144.5
d ₁ k6	16	32	40	55
e ₁	75	120	165	215
f ₁	70	110	141	200
s ₁	5.5	9	11	14
a	3	4	5	5
b	8	12	15	26
c ₂	5	5	5	5
l ₁	28	58	82	82
l ₂	33	65	87	88
l ₃	48	88	112	119
l ₆	22	50	70	70
v P9	5	10	12	16
w +0.2	3	5	5	6
Z ₂ h7	60	90	112	145

*Tolerances:

See Scattering/Torque tolerances

Ambient temperature up to 40°C

**Other ratios on request

Z F - Type :

Brake EBU
Gear PG

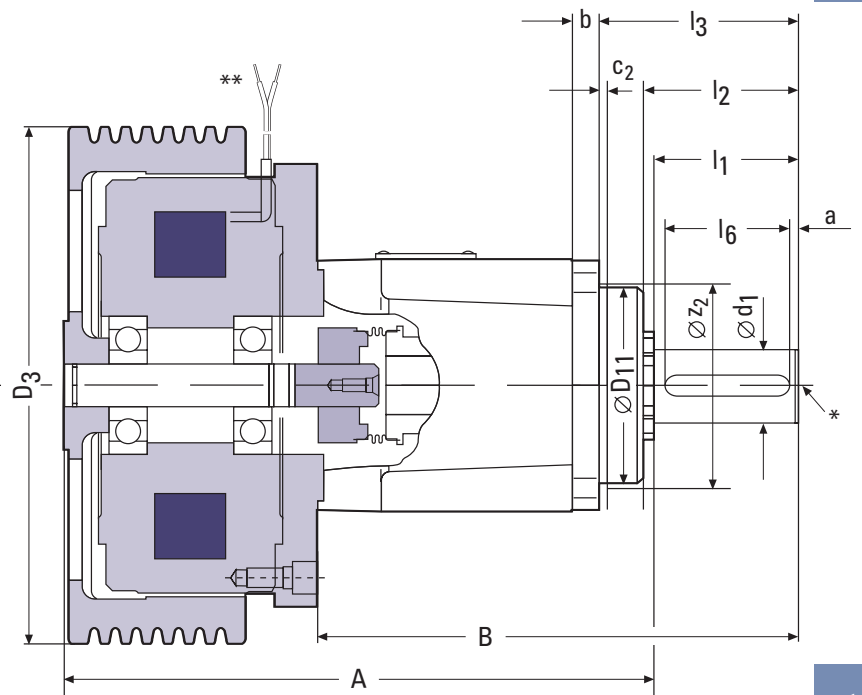
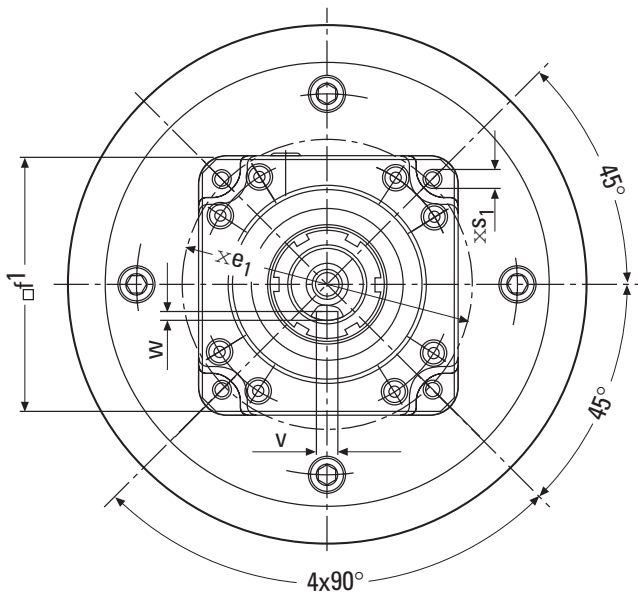
Sizes :

EBU 500/30 G	EBU 1000/100 G	EBU 2000/300 G	EBU 2000/600 G
500/3	1000/10	2000/30	2000/30
50	200	500	500/1200

Available versions:

* Centering DIN 332

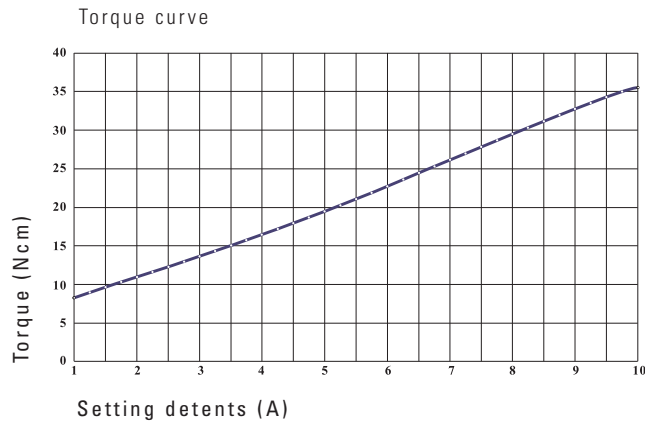
** connecting leads 0,5 mm², length 500 mm



EBU
G

Permanent magnet hysteresis brake

Remarkable features of the permanent magnet (PM) hysteresis brake are its high nominal torque with a compact design. The brakes permanent magnet excitation makes it independent of any power supply. The torque values can be set and reproduced easily and in a user-friendly fashion with the 37-times detented setting ring. The tolerance of the nominal torque amounts to +/- 5 %.



*Tolerances:
See Scattering/Torque tolerances

Ambient temperature up to 40°C

Size:

DBU
0,2 L

Technical data:

Max. nominal torque *	T_{Nmax} (Nm)	0.35
Min. nominal torque *	T_{Nmin} (Nm)	0.08
Number of detens		37
Permitted slip power in continuous mode	P (W)	20
Max. speed	n_{max} (min ⁻¹)	10 000
Inertia torque	J_w (kgcm ²)	0.63
Mass	m (kg)	0.36
Bearing type	LA DIN625	6 000

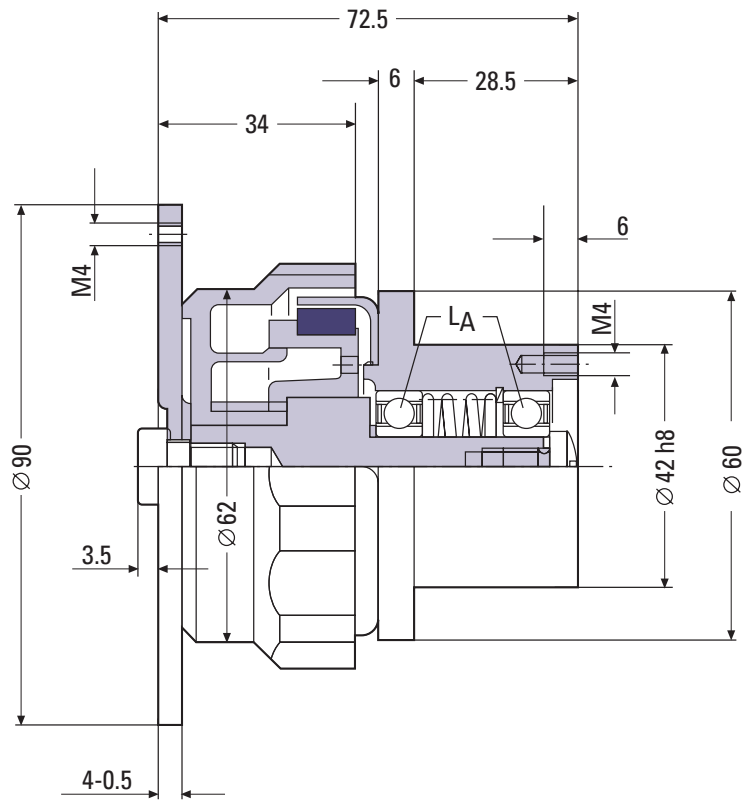
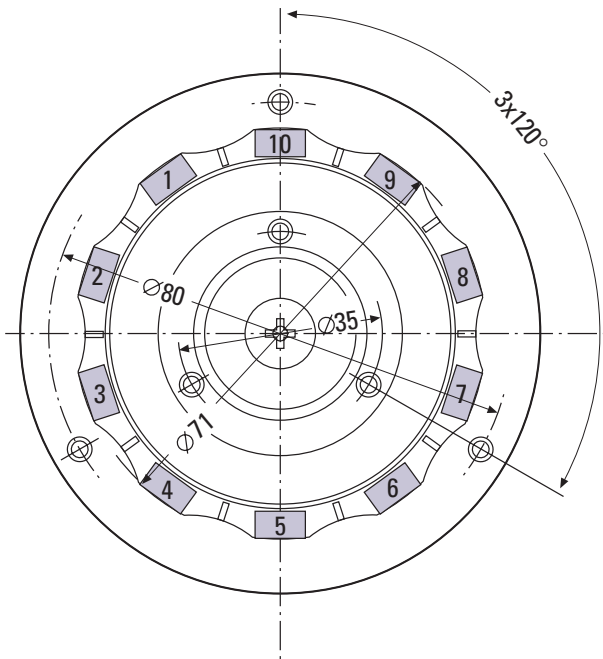
Available version:

Torque-adjustment

37 Detents (1-1.25-1.5- ... -9.5-9.75-10)

10 marked numbers (1-2- ... -9-10)

10 intermediate numbers (1.5-2.5- ... -9.5)



All dimensions in mm

DBU
0,2 L

Hysteresis clutches

Rotor, armature and clutch magnet are the components that make up the ZF hysteresis clutch.

The nominal torque as offered ranges from 0.4 Nm to 12 Nm.

The maximum continuous slip power of the hysteresis clutch amounts to 500 W.

The ZF hysteresis clutch distinguishes itself by a stepless transition from synchronous to slip operations.

The magnitude of scattering and torque tolerances correspond to the values of the ZF hysteresis brakes.

As is the case with the brakes, special series are available on demand.



Slip power

During continuous slip mode, heat generation caused by slip power must also be taken into account.

Permissible continuous slip power limits are included in the selection tables.

Required continuous slip power is calculated as follows:

$$P_S = T_S \cdot \frac{n_S}{9.55} \text{ or } P_S = F \cdot v$$

P_S : Slip power in W

T_S : Slip torque in Nm

n_S : Slip speed in rpm

F : Tensile force in N

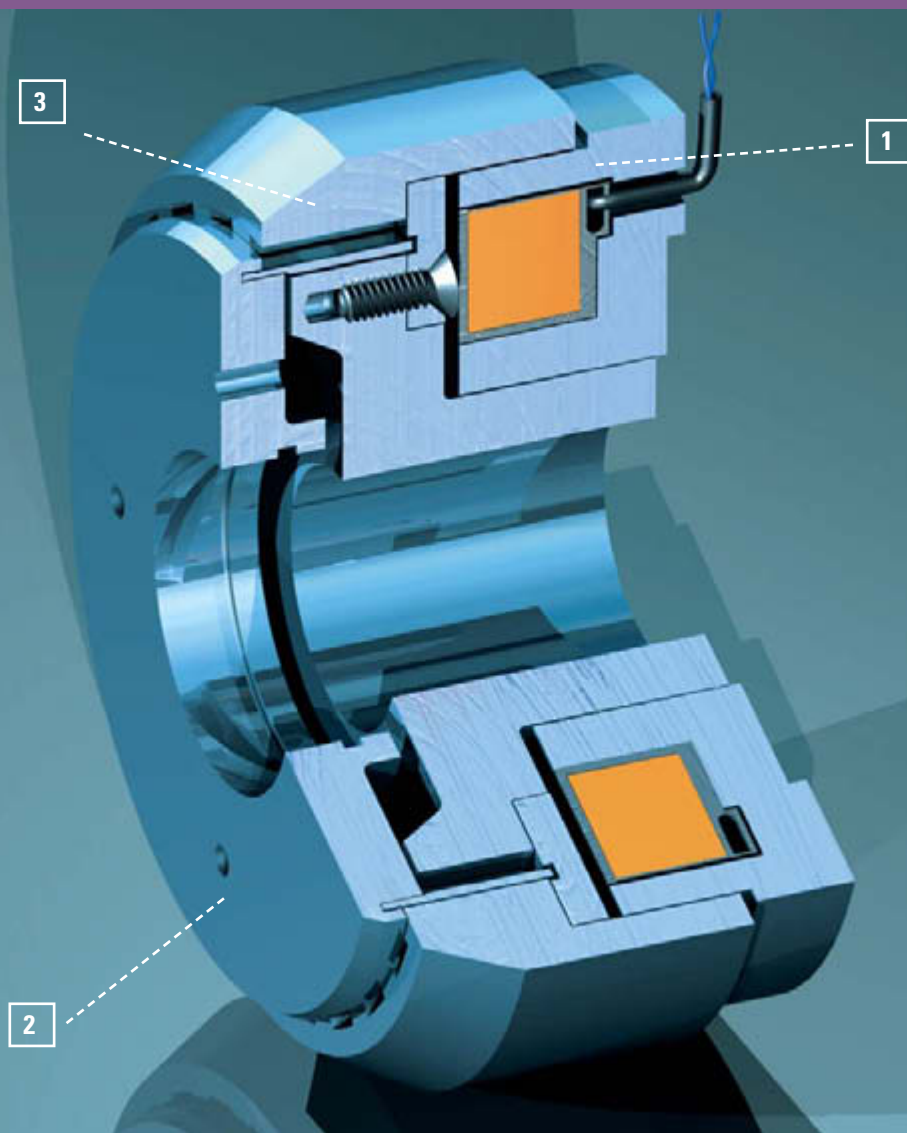
v : Band pull speed in m/s

Residual magnetism

Torque ripple occurs as a result of residual magnetism when the current is changed to below 50% of the initial value either abruptly or without turning the armature/rotor.

A reliable way to avoid torque ripple is to reduce the current while simultaneously turning the armature and rotor resp. brake solenoid during approx. 1 turn (relative).

1. Clutch magnet with solenoid
2. Armature with hysteresis ring, usually output
3. Rotor, usually input



Hysteresis clutches

Sizes :

Technical data :

		EKU 0,3	EKU 1	EKU 3	EKU 10
Nominal torque*	T_N (Nm)	0.4	1	3	12
Max. slip power	P_{max} (W)	63	125	250	500
Nominal current	I_N (A)	0.9	1.3	1.5	1.8
Nominal voltage	U_N (V)	30	30	30	30
Max. speed	n_{max} (min ⁻¹)	10 000	6 500	4 500	3 000
Side inertia torque Rotor	J_{Rotor} (kgcm ²)	5.7	16.2	79.0	830.0
Armature side inertia torque	J_{arm} (kgcm ²)	0.7	2.0	9.1	59.0
Power consumption at coil temperature 70°C	P_{70} (W)	22	31	36	43
Mass	m (kg)	1.5	2.4	5.9	19.2

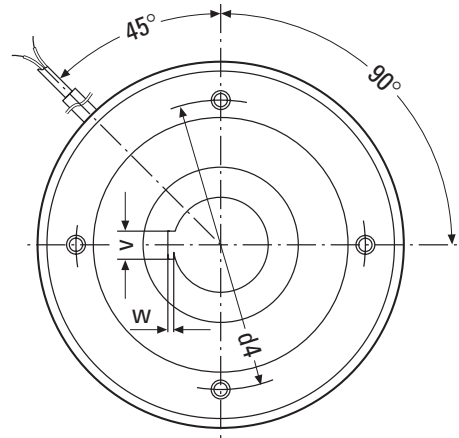
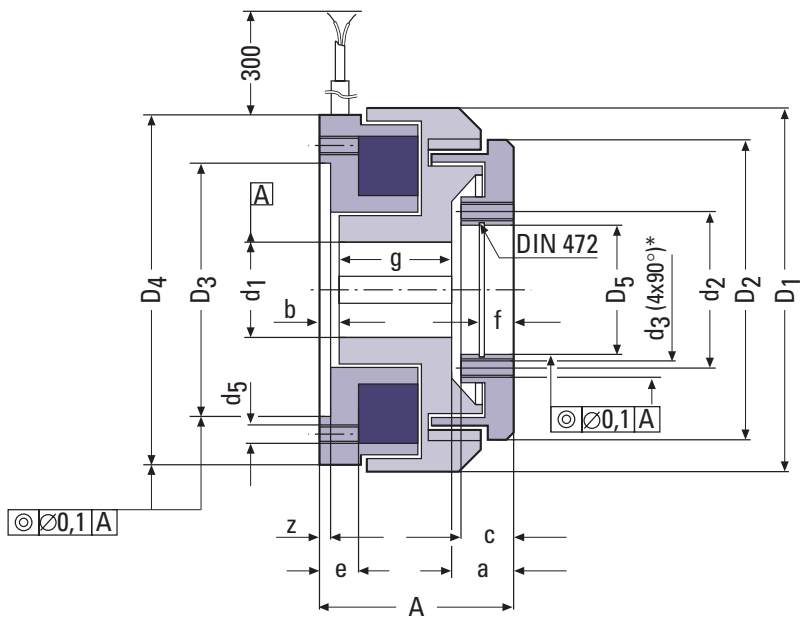
Dimensions (mm) :

	EKU 0,3	EKU 1	EKU 3	EKU 10
A	60	59	79	118
D ₁	82	110	148	225
D ₂	62	91	119	180
D ₃ H8	50	80	100	150
D ₄ h8	80	107	140	205
D ₅	32 K7	42 K7	52 K7	90 H7
d ₂ +/-0.1	42	50	80	105
d ₃	M 4	M 5	M 5	M 8
d ₄ +/-0.1	62	92	116	174
d ₅	M 4	M 5	M 6	M 8
a	17	18	25	32
b +/-0.5	3	3	4	6
c	10	15	16.5	10
e	5	7	12	20
f +0.1	5.2	10.7	12.0	-
g	40	38	50	80
z	3	3	3	4
d ₁ H7	15	30	40	50
v x w	5x1.3	8x1.7	12x2.1	14x2.6
d ₁ H7	12	25	30	40
v x w	4x1.1	8x1.7	8x1.7	12x2.1
d ₁ H7	12	20	20	30
v x w	-	6x1.7	6x1.7	8x1.7

*Tolerances:

See Scattering/Torque tolerances

Ambient temperature up to 40°C

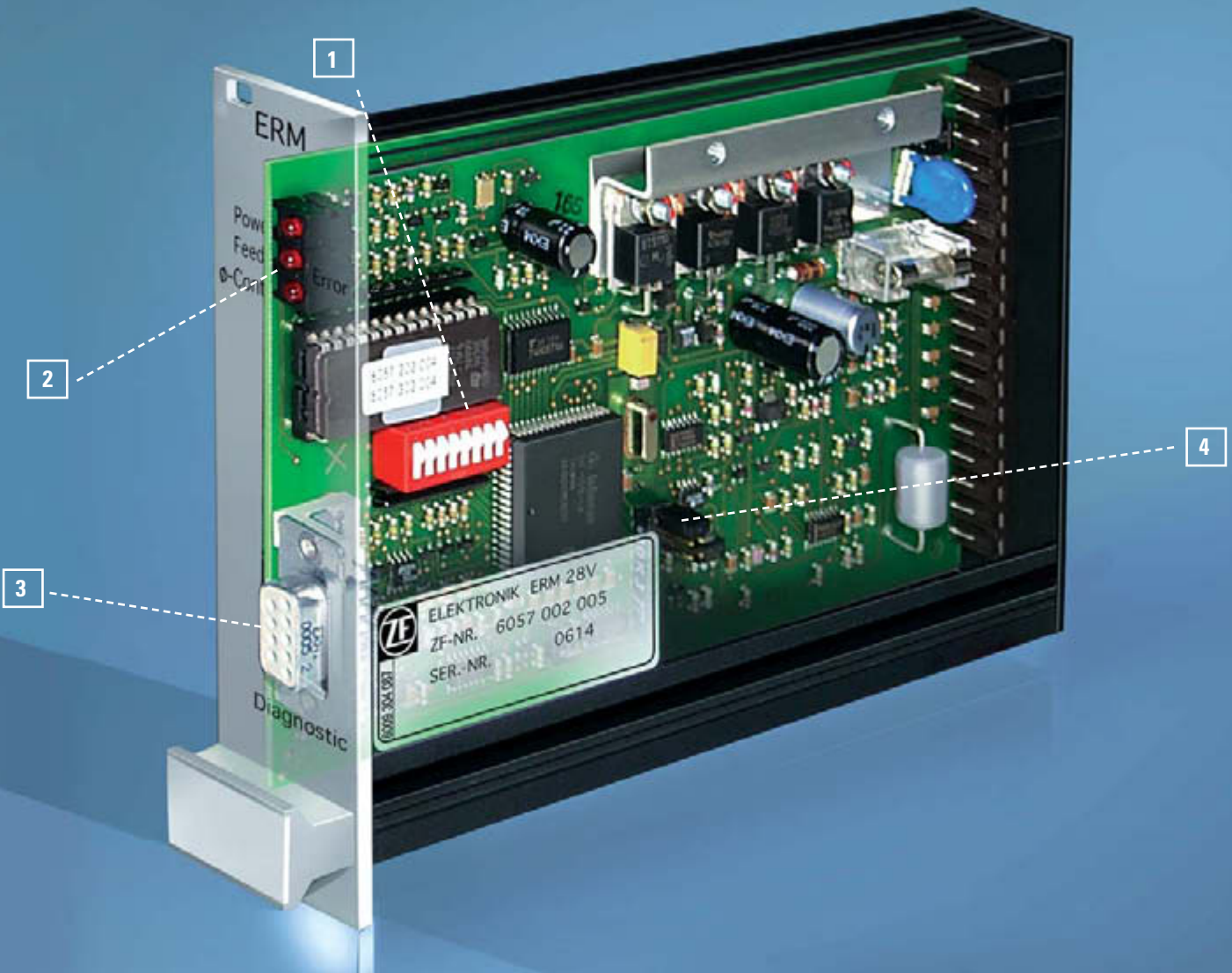


*EKU 0,3: d_3 (3 x 120°)

The ZF hysteresis electronic control unit makes it possible to set individual operating modes for the most diverse applications. The programming variations allow the electronic control unit to be used for all brake and clutch types.

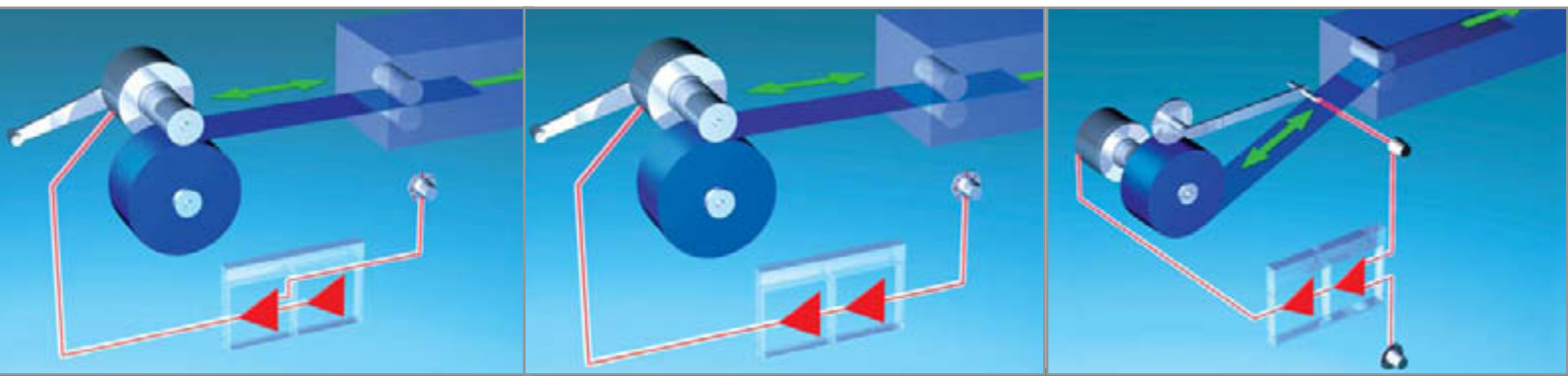


1. DIL switch for coding sizes and functions
2. LED function and error indicators
3. Diagnosis interface (Mobi Dig 200)
4. Jumper



Electronic control unit ERM

ZF hysteresis clutches and brakes can be controlled in open or closed loop with the ZF electronic control unit, depending on their application in different operating modes. The electronic components are micro-processor controlled and have programming, operating and diagnosis interfaces. The ERM electronic control unit has been set so as to feed the ZF hysteresis clutches and the ZF hysteresis brakes in an optimal way.



Open-loop control
(current)

Open-loop control
(torque)

Open-loop control
with θ -sensing

ERM operating modes:

Open loop control:

- current
- torque
- \emptyset -sensing
- \emptyset -calculation

Closed loop control:

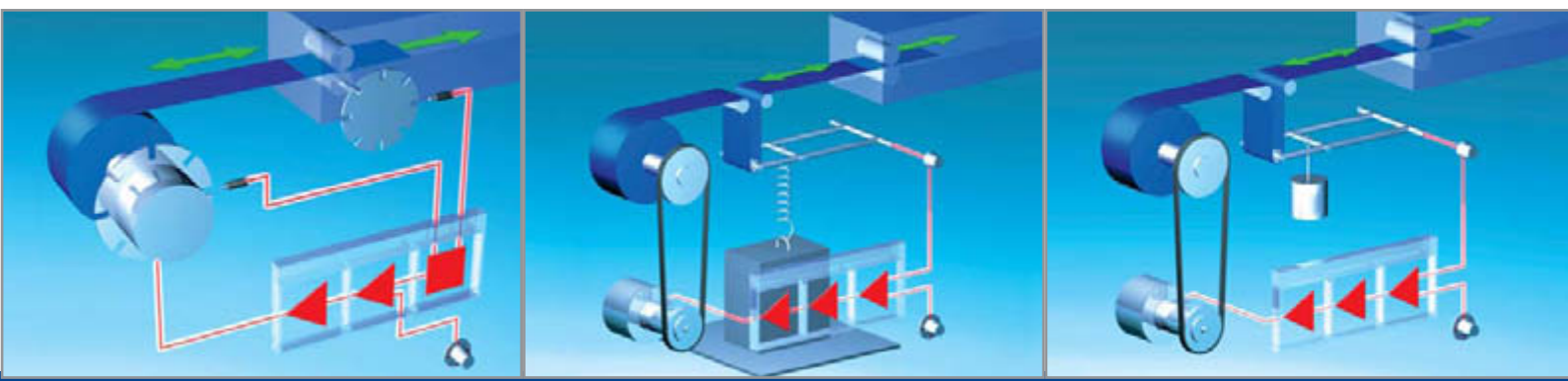
- PD position control
- PI force control
- PID mixed control
- freely programmable (with diagnosis device Mobi Dig)

The ERM also offers the following special functions, depending on the operating mode:

- Maximum current: Output of the nominal current, depending on the size
- Zero current: the power output is set to zero
- Web-break detector in the operating mode \emptyset -calculation
- Compensation of the friction existing in the system

Open-loop controlled operating modes with a size codification are less suitable for the power-optimized brake series.

Please refer to the ERM operating manual for further information on the functions, connections etc.



Open-loop controlled
with \emptyset -calculation

Closed-loop controlled -
with dancer force control

Closed-loop controlled -
with storage/position
control

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