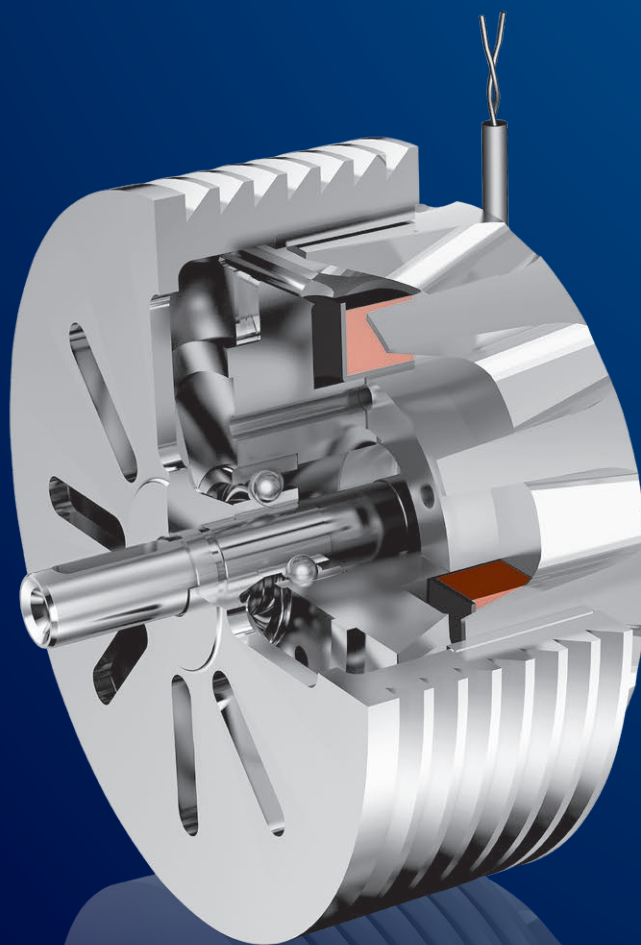




# Products of Great Value

Hysteresis Brakes and Hysteresis Clutches

**Tiratron**



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# The expert for the Industry !

Our enthusiasm for innovative products and processes and our uncompromising pursuit of quality have made us a global leader in driveline and chassis technology. We are contributing towards a sustainable future by producing advanced technology solutions with the goal of improving mobility, increasing the efficiency of our products and systems, and conserving resources. Our customers in the automotive and industrial sectors welcome our determined focus on products and services, which provide great customer value.

# Hysteresis Products

ZF's Hysteresis Components are Brakes and Clutches of different designs.

Controlling the hysteresis brakes or clutches with a current-controllable source enables both the precise regulation of tensile forces and a defined torque setting.

## Exemplary operation

The Hysteresis Technology can be used and applied wherever products such as paper, wire etc. are processed by winding. Loads can be simulated with ZF 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. With normal operating conditions, no maintenance is required.

## 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.

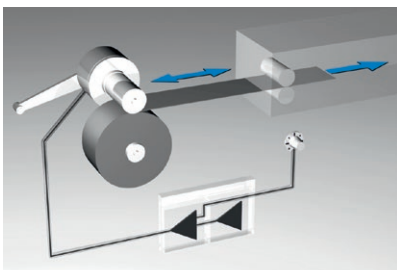
## High slip power in continuous mode, overload capability

The brakes of the power optimized series can bear high slip power continuously. Additionally, short-term overload is also possible in this model range.

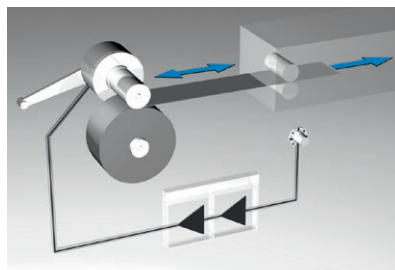
The operating principles of hysteresis brakes and clutches are based on the magnetic force effect of attracting poles in synchronous mode and on continuous magnetic reversal in slip mode.

## Application as holding brake

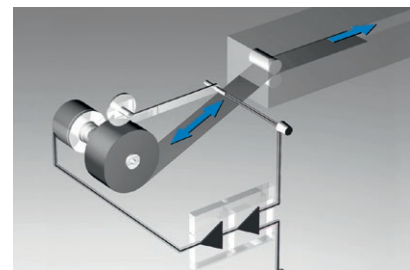
Hysteresis brakes can also be used as holding brakes without (differential) speed. An initial twisting/displacement of the rotor relative to the brake solenoid of around 5-10° is required for this. This also applies to the reversal of the rotational direction.



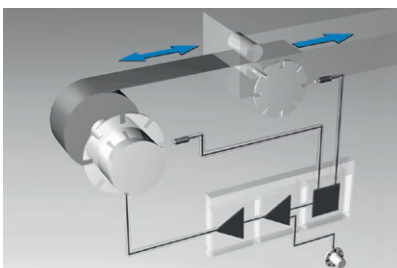
Open-loop control (current)



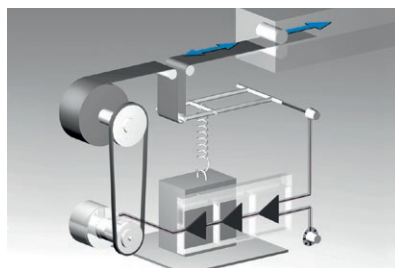
Open-loop control (torque)



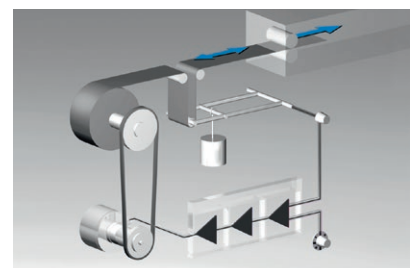
Open-loop controlled with Ø-sensing



Open-loop controlled with Ø-calculation

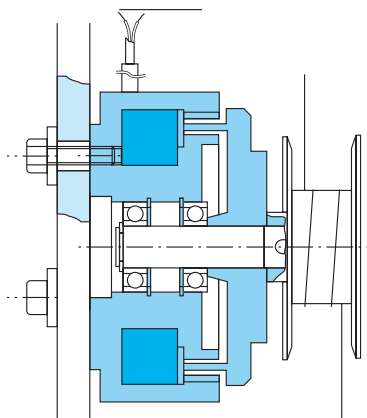


Closed-loop controlled with dancer force control

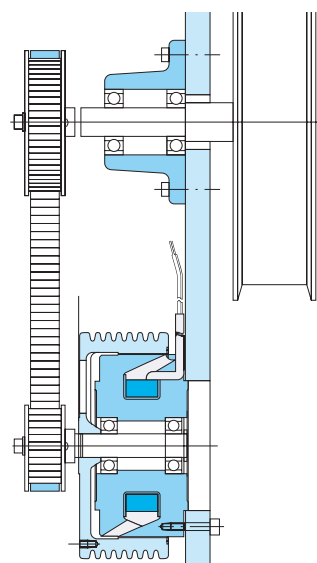


Closed-loop controlled with storage/position control

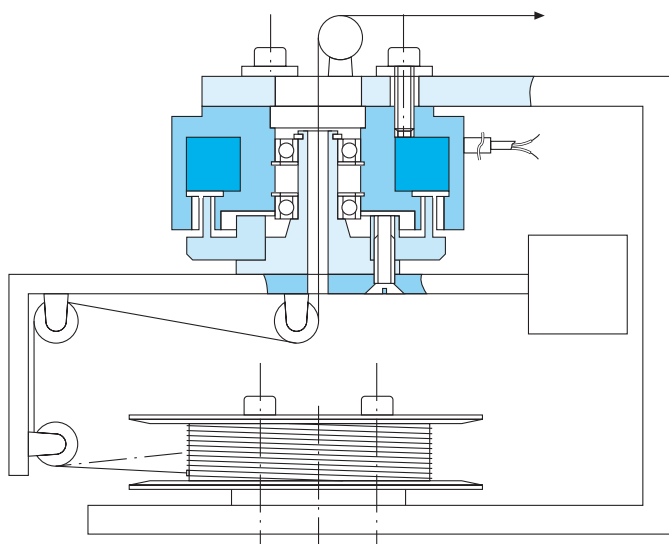
## Installation Examples



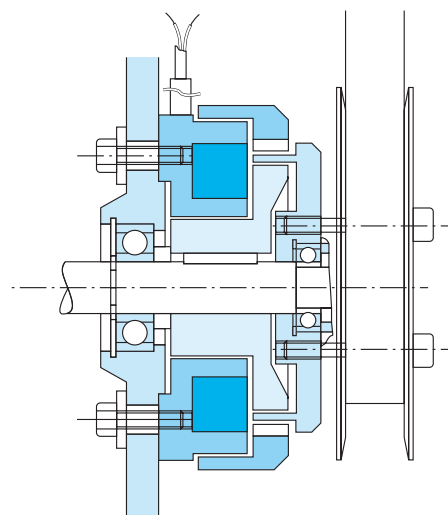
Hysteresis brakes to produce a defined thread tension.



Hysteresis brake to unwind a tape with constant tensile force. A toothed belt is used to produce a higher braking torque.

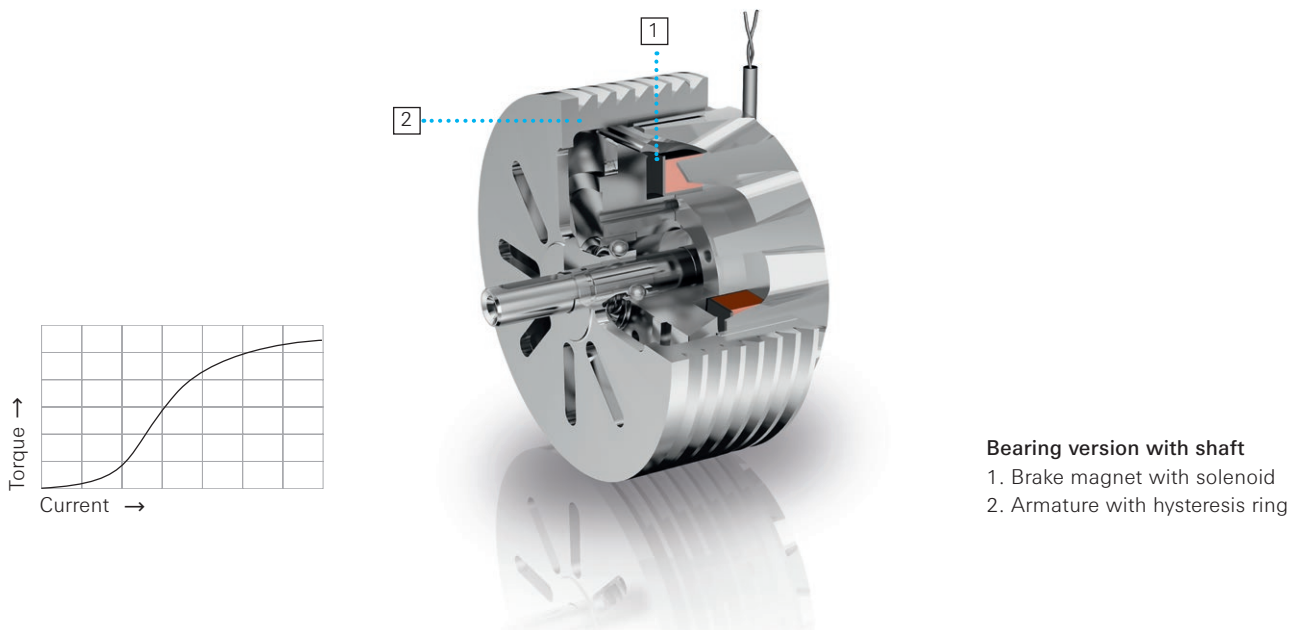


Hysteresis brakes with flyer for unwinding flexible leads with constant tensile force.



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

# Hysteresis Brakes



**Bearing version with shaft**  
 1. Brake magnet with solenoid  
 2. Armature with hysteresis ring

The armature and the brake magnet are the individual components making up the ZF Hysteresis Brake. Types: Torque-optimized series and power-optimized series.

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 2 000 W during continuous operations and of 4 000 W during short-term operations (interval operations). They can be used both in the slip mode range and as holding brake.

## 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:

$$P_s = T_s \cdot \frac{n_s}{9.55} \quad \text{or} \quad P_s = F \cdot v$$

$P_s$ : Slip power in W

$T_s$ : Slip torque in Nm

$n_s$ : Slip speed in rpm

$F$ : Tensile force in N

$v$ : Bandpullspeed in m/s

## Residual magnetism

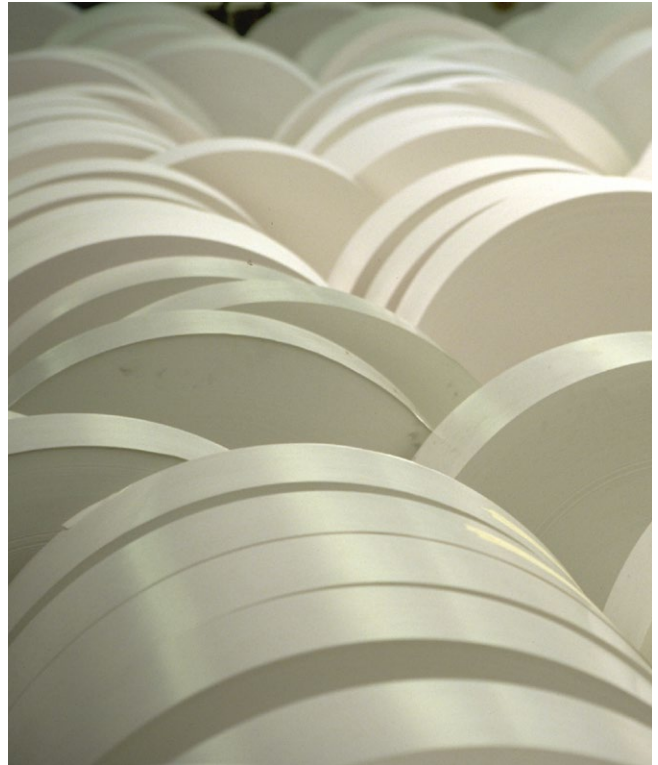
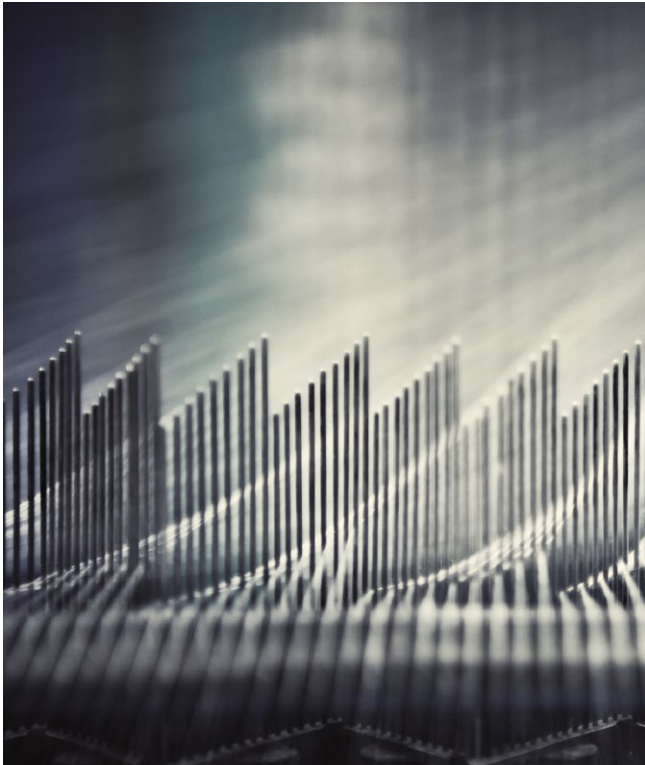
Torque ripple occurs as a result of residual magnetism when the current is changed to below 50% of the initial value either abruptly or without turning the armature/rotor. A reliable way to avoid torque ripple is to reduce the current while simultaneously turning the armature and rotor resp. brake solenoid 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.





**Application examples:**

Weaving, Winding, Twisting, Labeling.

## Torque Optimized Hysteresis Brakes

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	$P_{max}$ [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	$n_{max}$ [rpm]	15 000	15 000	15 000
Armature side inertia torque	$J_{arm}$ [kgcm <sup>2</sup> ]	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

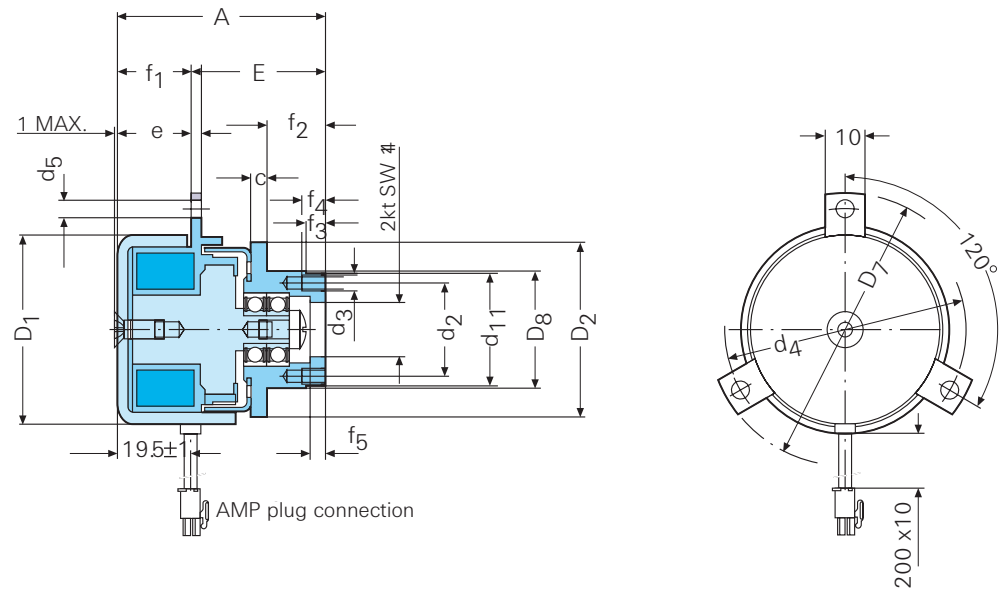
\* Tolerances: See Scattering/Torque tolerances  
Ambient temperature up to 40° C

Dimensions [mm]		EBU 0.05 L	EBU 0.1 LA	EBU 0.1 LW
	A	53.5	51	49
	C	-	35	-
	D <sub>1</sub>	49	54	54
	D <sub>2</sub>	45	-	-
	D <sub>7</sub>	70	-	-
	D <sub>8</sub> h8	30	25	-
	E	34.5	-	-
	c	4	-	-
	d <sub>j</sub> 6	-	-	5
	d <sub>2</sub>	24/2x180	32/3x120	-
	d <sub>3</sub>	M4	M3	-
	d <sub>4</sub>	62	40	40
	d <sub>5</sub>	4.3	M4	M4
	d <sub>11</sub>	29	-	-
	e	3	5	6
	f <sub>1</sub>	19 +/-0.5	-	-
	f <sub>2</sub>	15	7.5	-
	f <sub>3</sub>	5	-	-
	f <sub>4</sub>	6	-	-
	f <sub>5</sub>	4	-	-
	l	-	-	30

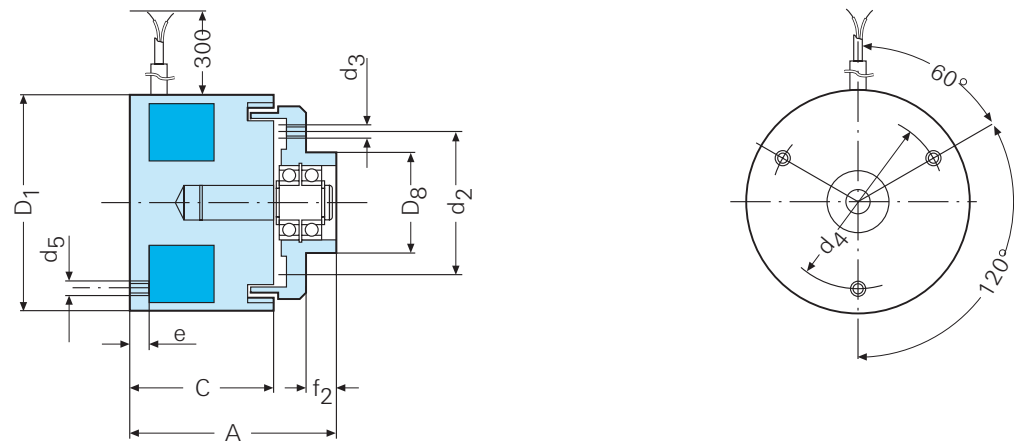


Available versions

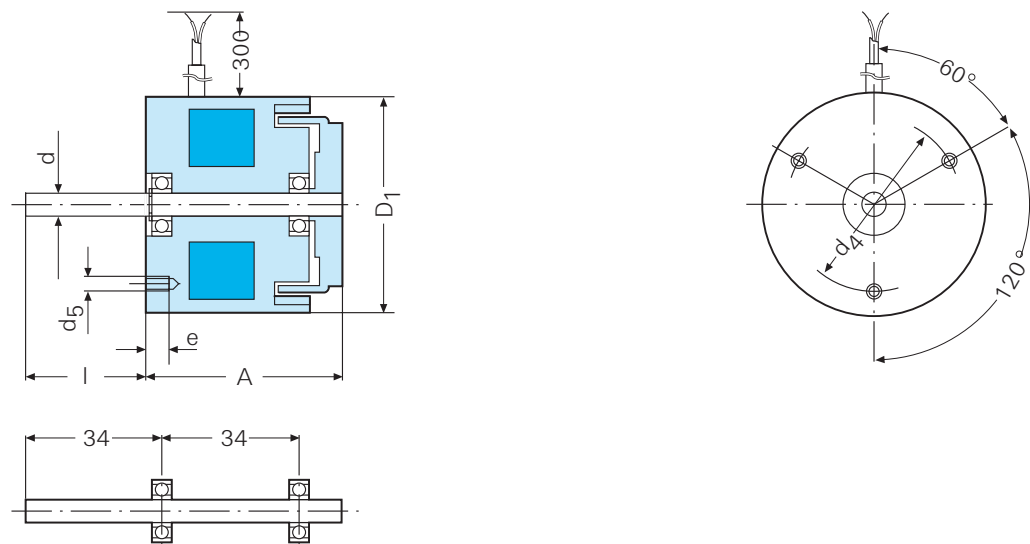
EBU 0.05 L



EBU 0.1 LA



EBU 0.1 LW



## Torque Optimized Hysteresis Brakes

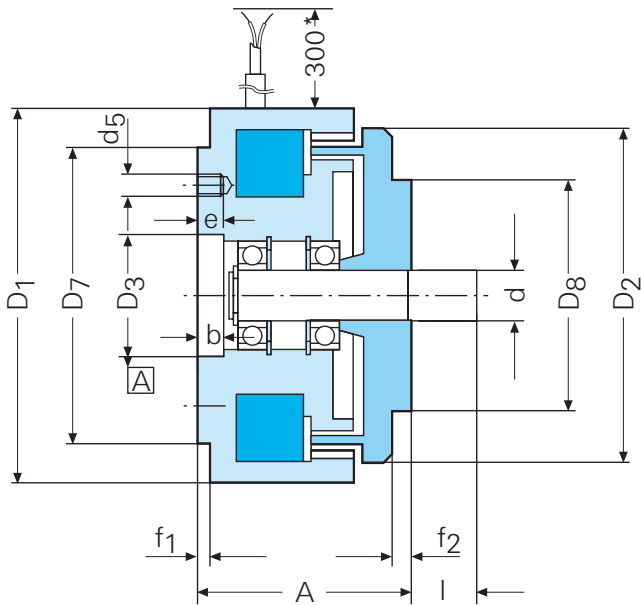
Technical Data		EBU 0.3 L	EBU 1 L	EBU 3 L	EBU 10 L	EBU 30 L
Nominal torque*	$T_N$ [Nm]	0.4	1.1	3.3	12	39
Max. slip power	$P_{max}$ [W]	63	125	250	500	1 000
Nominal current	$I_N$ [A]	0.75	1.25	1.25	1.5	2.2
Nominal voltage	$U_N$ [V]	30	30	30	30	30
Max. speed	$n_{max}$ [rpm]	10 000	6 500	4 500	3 000	2 000
Armature side inertia torque	$J_{arm}$ [kgcm <sup>2</sup> ]	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

\* Tolerances: See Scattering/Torque tolerances  
Ambient temperature up to 40° C

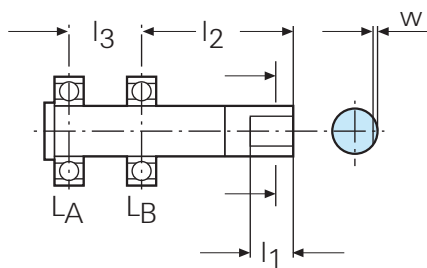
Dimensions [mm]		EBU 0.3 L	EBU 1 L	EBU 3 L	EBU 10 L	EBU 30 L
	A	58	56.5	76.5	102	136
	D <sub>1</sub>	74	102	138	210	310
	D <sub>2</sub>	62	91	120	180	266
	D <sub>3</sub>	22 K7	35 H7	42 K6	80 H7	140 H7
	D <sub>7</sub>	-	-	131 f7	160 h8	240 h8
	D <sub>8</sub>	55	64	95	-	-
	L <sub>A</sub> DIN625	608	6 201	6 004	6 006	6 209
	L <sub>B</sub> 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 <sub>4</sub>	50	60	60	106	170
	d <sub>5</sub>	M 5	M 5	M 6	M 8	M 8
	d <sub>10</sub>	-	-	M5 x 125	M8 x 19	M12 x 24.5
	e	7	7	14.5	20	30
	f <sub>1</sub>	-	-	2.5	5	4
	f <sub>2</sub>	3	5	5	-	-
	l	16	20	30	50	80
	l <sub>1</sub>	8	10	22	40	63
	l <sub>2</sub>	34	43.7	57	82.5	132.5
	l <sub>3</sub>	32.5	20.8	38	51	59
	v x w	-	-	5 x 3	8 x 4	10 x 5
	w	1	1	-	-	-

Version

EBU 0.3 L -  
30 L

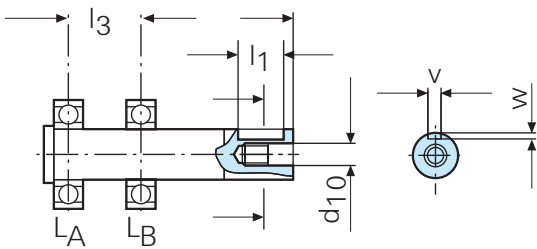


EBU 0.3 L  
1 L



Sketch Shaft / Bearings

EBU 3 L  
10 L  
30 L



## Torque Optimized Hysteresis Brakes

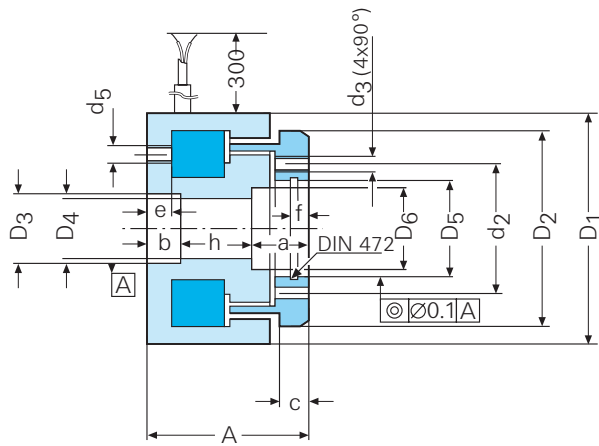
Technical Data		EBU 0.3	EBU 1	EBU 3	EBU 10	EBU 30
Nominal torque*	$T_N$ [Nm]	0.4	1.1	3.3	12	39
Max. slip power	$P_{max}$ [W]	63	125	250	500	1 000
Nominal current	$I_N$ [A]	0.75	1.25	1.25	1.5	2.2
Nominal voltage	$U_N$ [V]	30	30	30	30	30
Max. speed	$n_{max}$ [rpm]	10 000	6 500	4 500	3 000	2 000
Armature side inertia torque	$J_{arm}$ [kgcm <sup>2</sup> ]	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

\* Tolerances: See Scattering/Torque tolerances  
Ambient temperature up to 40° C

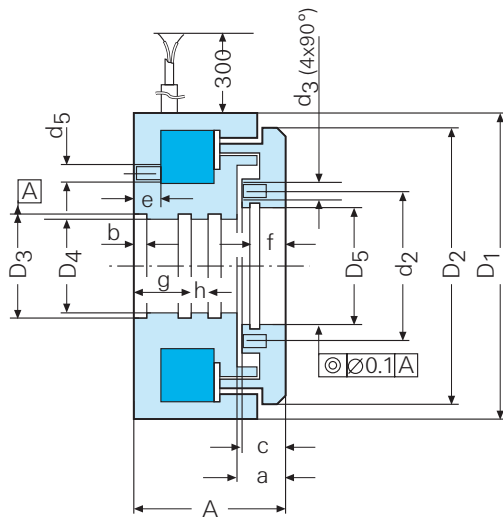
Dimensions [mm]		EBU 0.3	EBU 1	EBU 3	EBU 10	EBU 30
	A	55	51.5	71.5	102	136
	D <sub>1</sub>	74	102	138	210	310
	D <sub>2</sub>	62	91	120	180	266
	D <sub>3</sub>	22 K7	35 H7	42 K6	80 H7	140 H7
	D <sub>4</sub>	19	32 K6	42 K6	80	140
	D <sub>5</sub>	32 K7	42 K7	52 K7	90 H7	110 H7
	D <sub>6</sub>	26 K7	-	-	202	300
	D <sub>7</sub>	-	-	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 <sub>2</sub>	42	50	80	105 +/- 0.1	130 +/- 0.1
	d <sub>3</sub>	M 4	M 5	M 5	M 8	M 8
	d <sub>4</sub>	50	60	60	106 +/- 0.2	170 +/- 0.2
	d <sub>5</sub>	M 5	M 5	M 6	M 8	M 8
	d <sub>6</sub>	-	-	-	186 +/-0.2	275 +/-0.2
	d <sub>7</sub>	-	-	-	M8	M10
	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 <sub>1</sub>	-	-	2.5	5	4

Available versions

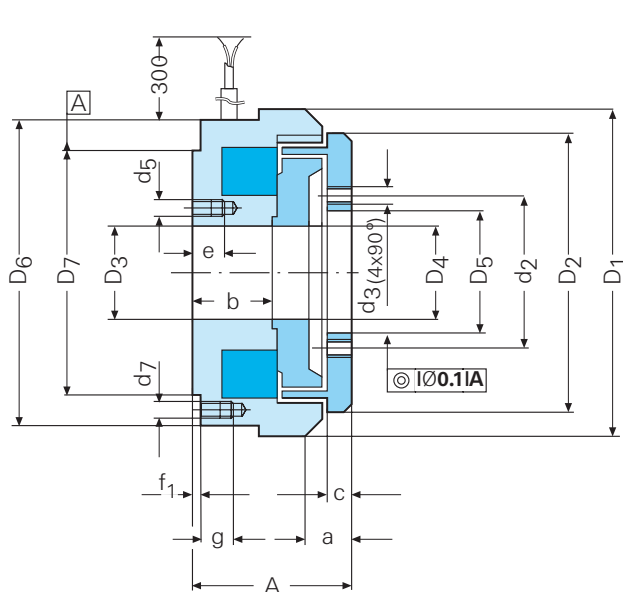
EBU 0.3



EBU 1  
EBU 3



EBU 10  
EBU 30



## Power Optimized Hysteresis Brakes

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 $T_P$	n [rpm]	3 200	1 500	750	500
Max. 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 <sup>2</sup> ]	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	31

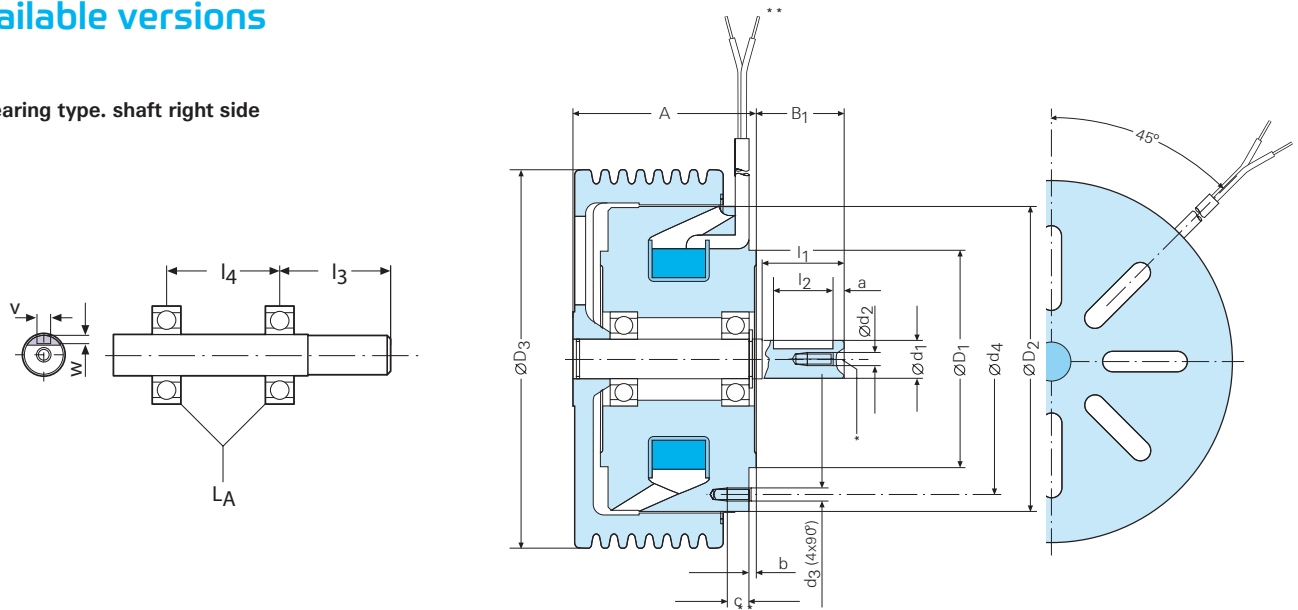
\* Tolerances: See Scattering/Torque tolerances  
Ambient temperature up to 40° C

Dimensions [mm]		EBU 250/1	EBU 500/3	EBU 1000/10	EBU 2000/30
All bearing types balanced, balanced quality 6.3	$A_1$	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
Non-bearing types when supported in d5: balance quality 23.6	$D_1h7$	50	80	110	180
	$D_2$	75	112	168	233
	$D_3$	93	140	210	292
	E	10.5	13	20	25
	$d_1k6$	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
	$d_5S7$	12	15	20	25
	$d_6H7$	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

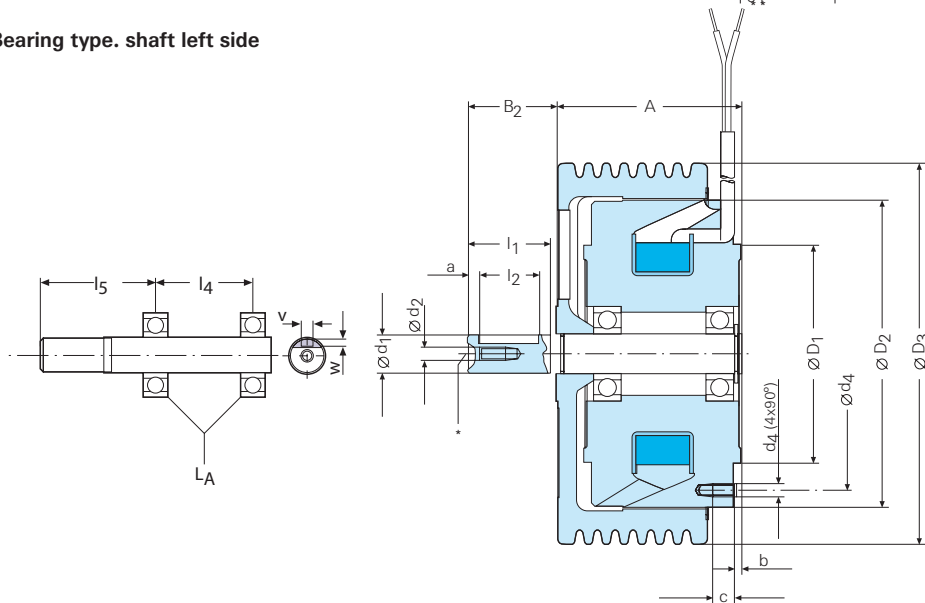


## Available versions

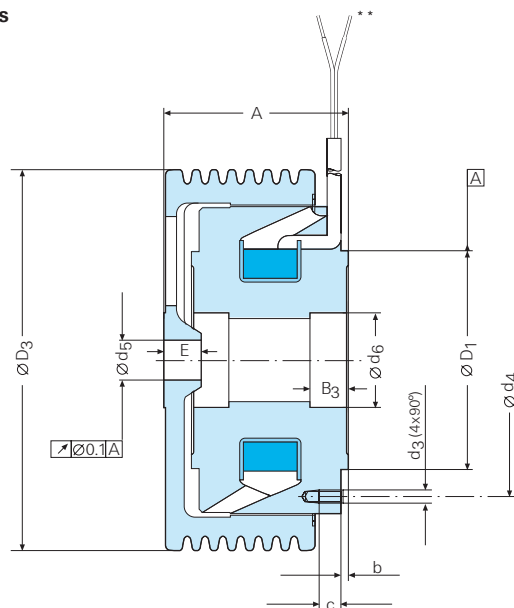
**A: Bearing type. shaft right side**



**B: Bearing type. shaft left side**



**C: Non-bearing type. for integrated solutions**

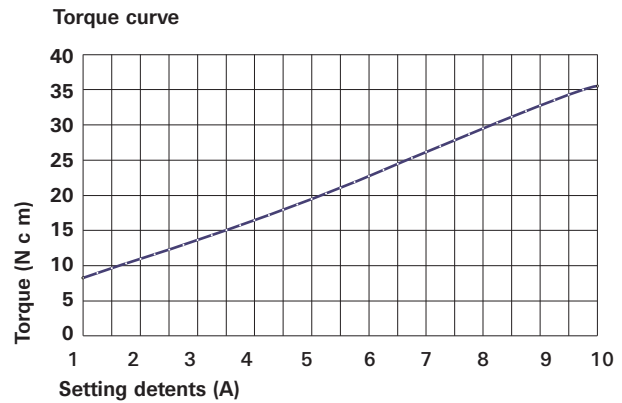


\* Centering DIN 332 (D)

\*\* Connection leads 0.5 mm<sup>2</sup>, length 500 mm

## Permanent Magnet Hysteresis Brake

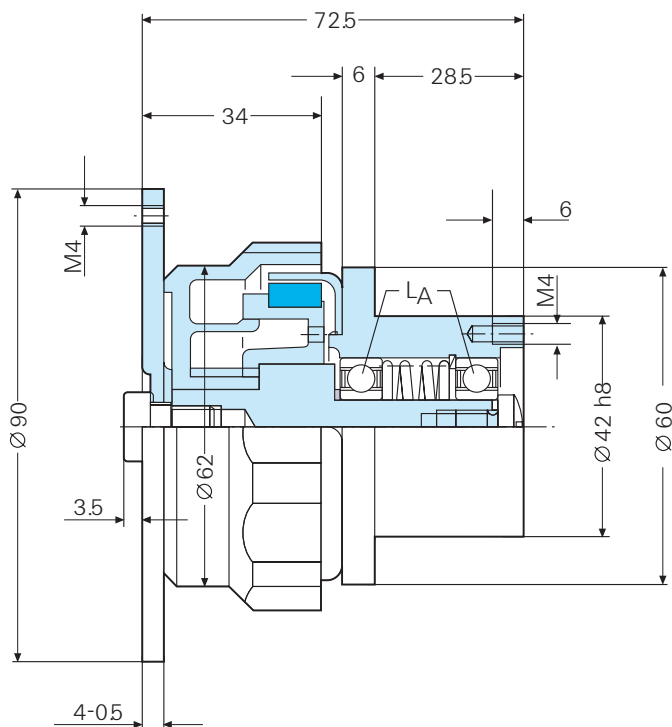
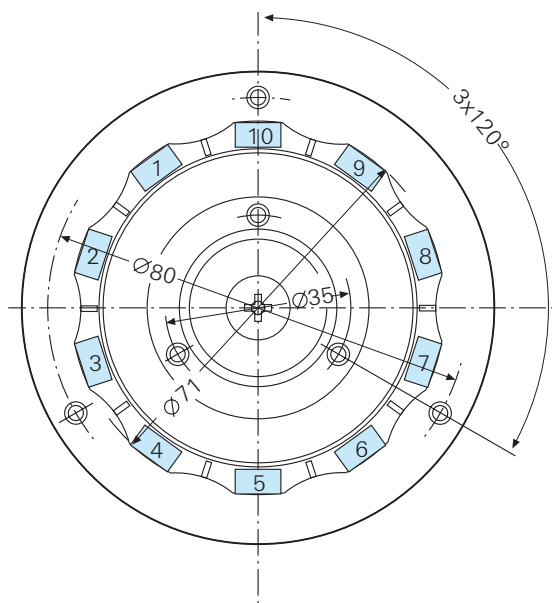
Remarkable features of the permanent magnet (PM) hysteresis brake are its high nominal torque with a compact design. The brakes permanent magnet excitation makes it independent of any power supply. The torque values can be set and reproduced easily and in a user-friendly fashion with the 37-times detented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



Technical Data		DBU 0.2 L
Max. nominal torque*	$T_{Nmax}$ [Nm]	0.35
Min. nominal torque*	$T_{Nmin}$ [Nm]	0.08
Number of detents	A	37
Permitted slip power in continuous mode	P [W]	20
Max. speed	$n_{max}$ [rpm]	10 000
Intertia torque	$J_W$ [kgcm <sup>2</sup> ]	0.63
Mass	m [kg]	0.36
Bearing type	LA DIN625	6 000

\* Tolerances: See Scattering/Torque tolerances  
Ambient temperature up to 40° C

## Version



### Torque-adjustment

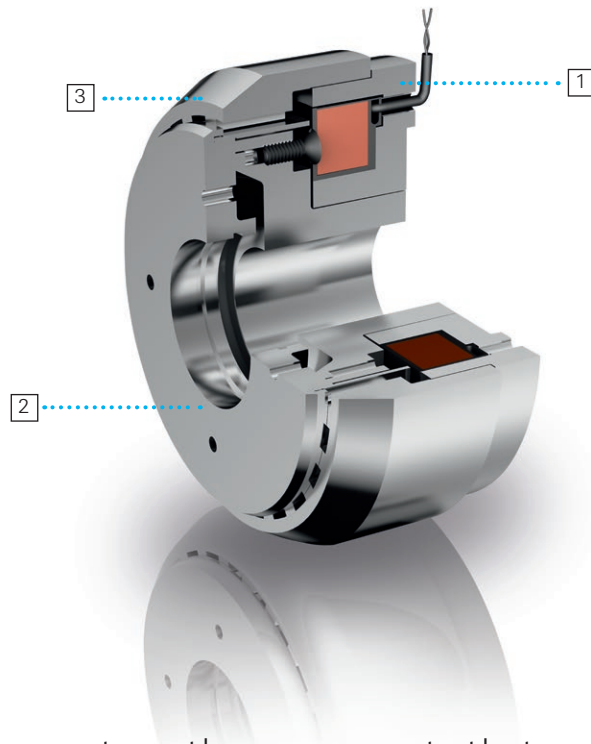
37 detents

10 marked numbers

10 intermediate numbers

All dimensions in mm

# Hysteresis Clutches



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

Rotor, armature and clutch magnet are the components that make up the ZF Hysteresis Clutch. The nominal torque covers a range 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:

$$P_s = T_s \cdot \frac{n_s}{9.55} \quad \text{or} \quad P_s = F \cdot v$$

## 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). Each following operating cycle eliminates any possible remanence.

$P_s$ : 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



**Application example:**

Tiratron Hysteresis brake EBU 3L  
Labeling machine for PET filling line

## Hysteresis Clutches

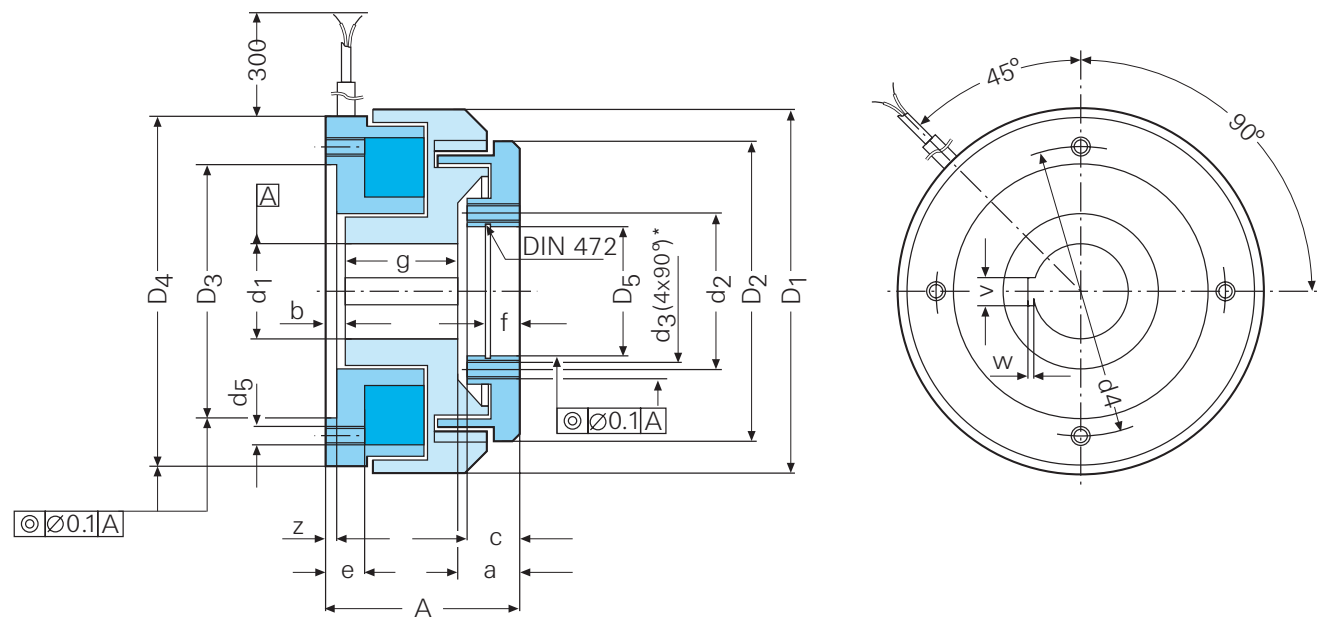
Technical Data		EKU 0.3	EKU 1	EKU 3	EKU 10
Nominal torque*	$T_N$ [Nm]	0.4	1	3	12
Max. slip power	$P_{\max}$ [W]	63	125	250	500
Nominal current	$I_N$ [A]	0.9	1.3	1.5	1.8
Nominal voltage	$U_N$ [V]	30	30	30	30
Max. speed	$n_{\max}$ [rpm]	10 000	6 500	4 500	3 000
Rotor side inertia torque	$J_{\text{Rotor}}$ [kgcm <sup>2</sup> ]	5.7	16.2	79.0	830.0
Armature side inertia torque	$J_{\text{arm}}$ [kgcm <sup>2</sup> ]	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

\* Tolerances: See Scattering/Torque tolerances  
Ambient temperature up to 40° C

Dimensions [mm]		EKU 0.3	EKU 1	EKU 3	EKU 10
	A	60	59	79	118
	D <sub>1</sub>	82	110	148	225
	D <sub>2</sub>	62	91	119	180
	D <sub>3</sub> H8	50	80	100	150
	D <sub>4</sub> h8	80	107	140	205
	D <sub>5</sub>	32 K7	42 K7	52 K7	90 H7
	d <sub>2</sub> +/-0.1	42	50	80	105
	d <sub>3</sub>	M 4	M 5	M 5	M 8
	d <sub>4</sub> +/-0.1	62	92	116	174
	d <sub>5</sub>	M 4	M 5	M 6	M 8
	a	17	18	25	32
	b +1/-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 <sub>1</sub> H7	15	30	40	50
	v x w	5 x 1.3	8 x 1.7	12 x 2.1	14 x 2.6
	d <sub>1</sub> H7	12	25	30	40
	v x w	4 x 1.1	8 x 1.7	8 x 1.7	12 x 2.1
	d <sub>1</sub> H7	12	20	20	30
	v x w	-	6 x 1.7	6 x 1.7	8 x 1.7



Version



\* ECU 0.3:  $d_3$  (3 x  $120^\circ$ )



# Excellentlly networked worldwide

ZF offers you a comprehensive and attractive range of products and services to ensure mobility anywhere, at any time. Proximity to the customer is an essential element of the corporate performance.

The quality of innovative transmission systems is also a question of experience. For many decades, ZF transmissions have been a major impetus for on and off-road driving and technological progress.

ZF provides comprehensive system solutions all from a single source. The transmission components are perfectly harmonized with one another. The range of available power/ performance is, in each case, tailored to the specific demands of the market and manufacturers.

The result: Every ZF transmission system is a brand name product known for its reliability around the world.

Around the world, around the clock: ZF's service specialists are available anywhere and at any time.

# The ZF Group

## Shaping the future responsibly

Our enthusiasm for innovative products and processes and our uncompromising pursuit of quality have made us a global leader in driveline and chassis technology. We are contributing towards a sustainable future by producing advanced technology solutions with the goal of improving mobility, increasing the efficiency of our products and systems, and conserving resources.

Our customers in the automotive and industrial sectors welcome our determined focus on products and services, which provide great customer value. Improvements in energy efficiency, cost-effectiveness, dynamics, safety, and comfort are key to our work. Simultaneously, we are aiming for continuous improvement in our business processes and the services we provide. As a globally active company, we react quickly and flexibly to changing regional market demands with the goal of always providing a competitive price/performance ratio.

Our independence and financial security form the basis of our long-term business success. Our profitability allows us to make the necessary investments in new products, technologies, and markets thus securing the future of our company on behalf of our customers, market affiliates, employees, and the owners of ZF.

Our tradition and values strengthen our managerial decisions. Together, they are both an obligation and an incentive to maintain a reliable and respectful relationship with customers, market affiliates, and employees. Our worldwide compliance organization ensures that locally applicable laws and regulations are adhered to. We accept our responsibility towards society and will protect the environment at all of our locations.

Our employees worldwide recognize us as a fair employer, focusing on the future and offering attractive career prospects. We value the varied cultural backgrounds of our employees, their competencies, and their diligence and motivation. Their goal-oriented dedication to ZF, beyond the borders of their own field of work and location, shapes our company culture and is the key to our success.

**ZF Group**

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