

BERGER LAHR

Catalogue

Stepper Motors VRDM, ExRDM



3-phase stepper motors

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Explosion-proof 3-phase stepper motors

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2-phase stepper motors

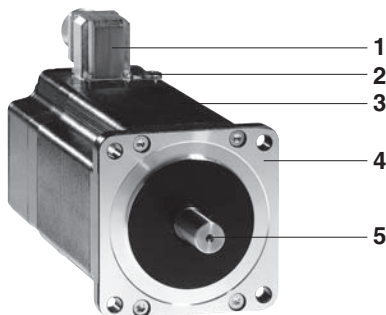
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Stepper motor drive system



Product description

The 3-phase stepper motors from Berger Lahr are extremely robust, maintenance-free motors. They carry out precise stepper movements that are controlled by a stepper drive. A stepper motor drive consists of a stepper motor and the matching stepper drive. The maximum power can be reached only if motor and electronics are optimally matched.

The 3-phase stepper motors can be operated at very high resolutions depending on the stepper motor controller.

Options such as rotation monitoring and holding brake with robust, low-play planetary gears extend the application options.

There are also 3-phase stepper motors by Berger Lahr in normal and explosion-proof types (explosion degree of protection EEx d IIC T4).

Special features

Quiet

Due to the sinus-commutation of the drive and the special mechanical construction of the motors, the result is a very quiet stepper motor that runs virtually resonance-free.

Strong

The optimised internal geometry of the motor offers a high power density; i.e. up to 50% greater torque compared to conventional stepper motors of comparable size.

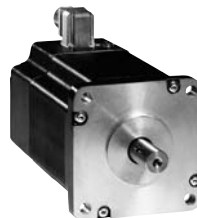
Flexible

It is possible to manufacture and supply a wide variety of motor types due to their flexible modular system and modern version management.

Design

- (1) Motor connection, here versions with an offset connector
- (2) Additional terminal for protective conductor
- (3) Housing, with black protective coating
- (4) Axial flange with four mounting points as per DIN 42918
- (5) Smooth shaft end as per DIN 42918

Product overview

3-phase stepper motors		VRDM 36•	VRDM 39•	VRDM 311•	ExRDM 39• (explosion-proof motors)
					
Size		6	9	11	9
Max. torque M_{max}	Nm	0.45 ... 1.50	1.7 ... 6.0	12.0 ... 16.5	4.0 ... 5.8
Holding torque M_H	Nm	0.51 ... 1.70	1.92 ... 6.78	13.5 ... 19.7	4.5 ... 6.55
Steps per revolution $z^{1)}$		200 / 500 / 1000 / 2000 / 4000 / 5000 / 10000			
Step angle $\alpha^{1)}$	°	1.8 / 0.9 / 0.72 / 0.36 / 0.18 / 0.09 / 0.072 / 0.036			

¹⁾ Depending on controller

Motor types

Gear ¹⁾	Shaft model	Centring collar	Size (Flange dimension)	Length (Dimension without shaft)	Winding ²⁾	Motor connection ³⁾	Options ⁴⁾
VRDM 36•							
PLE 40	smooth	Ø 6.35 mm	Ø 38.1 mm	6 (57.2 mm)	H	Braided wires	2nd shaft end Holding brake Encoder
PLE 60					N	Terminal box	
PLS 70					W	Plug	
		Ø 8 mm			H		
					N		
					W		
VRDM 39•							
PLE 80	smooth with woodruff key	Ø 9.5 mm ⁵⁾	Ø 60 mm	9 (85 mm)	H	Braided wires	2nd shaft end Holding brake Encoder
PLE 90		Ø 12 mm	Ø 73 mm	10 (98 mm)	N	Terminal box	
		Ø 14 mm		13 (128 mm)	W	Plug	
VRDM 311•							
PLE 120	with parallel key	Ø 19 mm	Ø 56 mm	11 (110 mm)	W	Terminal box	2nd shaft end Holding brake Encoders
PLS 115				22 (228 mm)		Plug	
ExRDM 39•							
PL 50/100/ATEX	with woodruff key	Ø 14 mm	Ø 60 mm	9 (85 mm)	W	Terminal box	Holding brake Encoder

¹⁾ Planetary gears each available in the gear ratios 3:1, 5:1 and 8:1. The gear PL 50/100/ATEX is available in the gear ratios 3:1 and 5:1

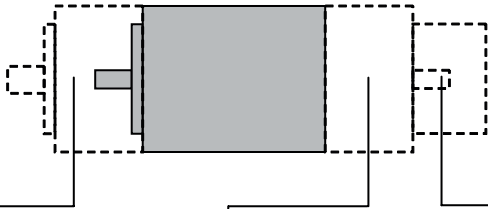
²⁾ Nominal voltage: H = 24 / 35 V_{DC}; N = 130 V_{DC}; W = 325 V_{DC}

³⁾ Motors with W-winding are not available with braids. For motors with terminal box there is a strip terminal within the motor; the screwed cable gland is sealed and EMC-tested.

⁴⁾ Alternative: 2nd shaft end or holding brake. Motors with encoder are only available with plug; 2nd shaft end or holding brake are not possible then.

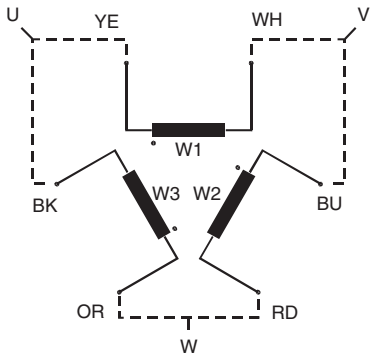
⁵⁾ Ø 9.5 mm and Ø 12 mm at VRDM 397 and VRDM 3910; Ø 14 mm at VRDM 3913

Degree of protection

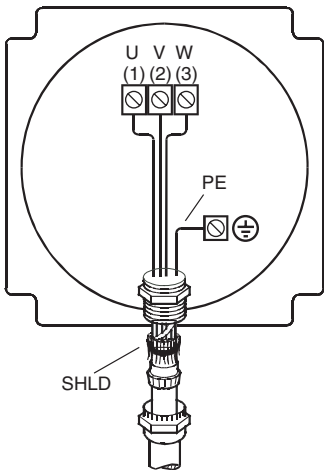


Front of motor		Motor connection		Rear of motor	
Gearbox		Shaft bushing	Braided wires	Terminal box Plug	2nd shaft end
PL, PLE	PLS				Holding brake Encoder
IP 54	IP 65	IP 41 IP 56 (optional with VRDM 39x and VRDM 311x) IP 44 for ExRDM 39x	IP 41	IP 56	IP 41
					IP 56

Motor connection

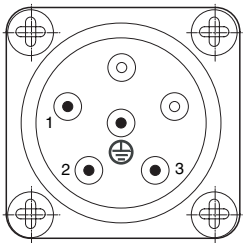


Motor connection in braided wire version		
Designation	Motor braided wire colour as per DIN IEC 757	Motor braided wire colour
U	BK and YE	black and yellow
V	WH and BU	white and blue
W	OR and RD	orange and red



Motor connection in terminal box version			
Designation	Pin	Wire colour as per DIN IEC 757	Wire colour ¹⁾
U	1	BR	brown
V	2	BU	blue
W	3	BK	black
PE		GN/YE	green/yellow
SHLD	Shield		

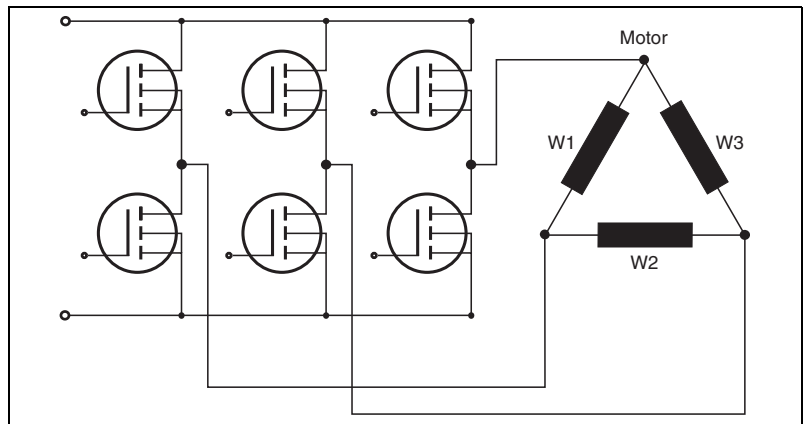
¹⁾ Berger Lahr motor cable



Motor connection in connector version	
Designation	Pin
U	1
V	2
W	3
PE	4

Control**3-phase stepper motors in triangle**

The windings of the 3-phase stepper motors are circuited internally to form a triangle. The control currents of the control electronics are impressed via three connections.

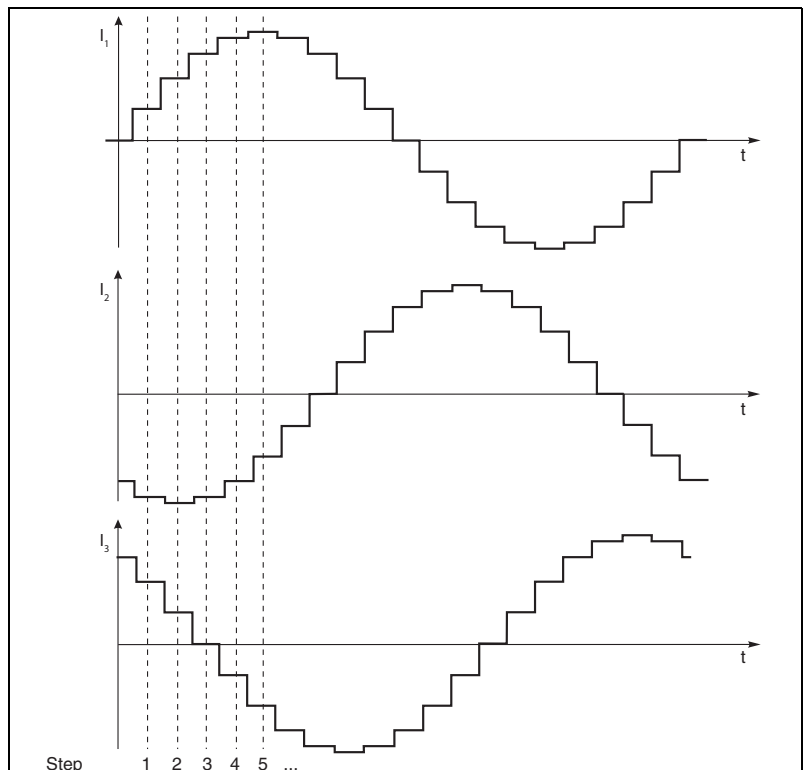


Control switch for 3-phase stepper motors

Micro-step procedure with sinusoidal control

The system consisting of a 3-phase stepper motor and control electronics works according to the bipolar delta connection (see control circuit). The current can be controlled via three half-bridges so that it can flow through each winding in both directions (bipolar).

This makes it possible to control the current according to a sinusoidal step function. Here each step corresponds to a motor step. The steps per revolution are determined by the number of the different current patterns per period and due to the number of pole pairs of the motor. Thus, any step count is possible. This procedure is known as the micro-step procedure.



Current pattern of the three motor connections at 1000 steps per revolution

Characteristic values of a stepper motor

In order to assess and select a stepper motor, certain characteristic values and characteristic curves are required. Each stepper motor with its control electronics has its own characteristics which are shown in characteristic curves. To better understand their content and statement, here the major characteristic values and the handling of the characteristic curves are explained. The terms used here correspond to DIN 42021.

Basic terms

Steps per revolution

Step count z is the number of the rotor-steps per revolution. The step count of the 3-phase stepper motor can be used on the control electronics.

Step angle

A step includes the procedure in which the motor shaft rotates around the step angle – due to a step angle α .

The step angle α is derived from the steps per revolution z as follows:

$$\alpha = 360^\circ / z$$

Holding torque

In this step position, the rotor is held into place due to the electrical d.c. operation of the windings if its holding torque M_H is not exceeded on the motor shaft.

Systematic angular tolerance

The systematic angular tolerance per step $\Delta\alpha_s$ indicates by how many angular minutes a step can have a maximum deviation from the step angle.

Control and pulse rate

With a continuous sequence of control pulses with a control frequency f_S , the motor shaft will also run a sequence of steps with the (same) pulse rate f_z .

Speed

From a certain control frequency – depending on the motor type and the mechanical load – the step-by-step movement of the motor shaft switches to a continuous rotary movement. Then the speed of rotation n of the motor applies:

$$n = \frac{\alpha}{360^\circ} \cdot f_S \cdot 60 \text{ min}^{-1}$$

f_S in Hz

Torques

If the rotating motor shaft is loaded with a load torque M_L , the motor of the control frequency continuous to run synchronously as long as the load moment does not exceed a certain limit which exceeds the pull-out torque M_{BM} . In this case, the rotor can no longer follow the control frequency. This case does not occur when the motor and the control is correctly selected.

Torque characteristic curves

The pull-out torque M_{BM} of a stepper motor depends primarily on the pulse rate in addition to its size and the type of electrical control. This procedure is indicated as a characteristic curve for each stepper motor system.

The motor can produce the maximum pulse rate M_{BM} at low pulse rates, with an increasing pulse rate, the pull-out torque decreases.

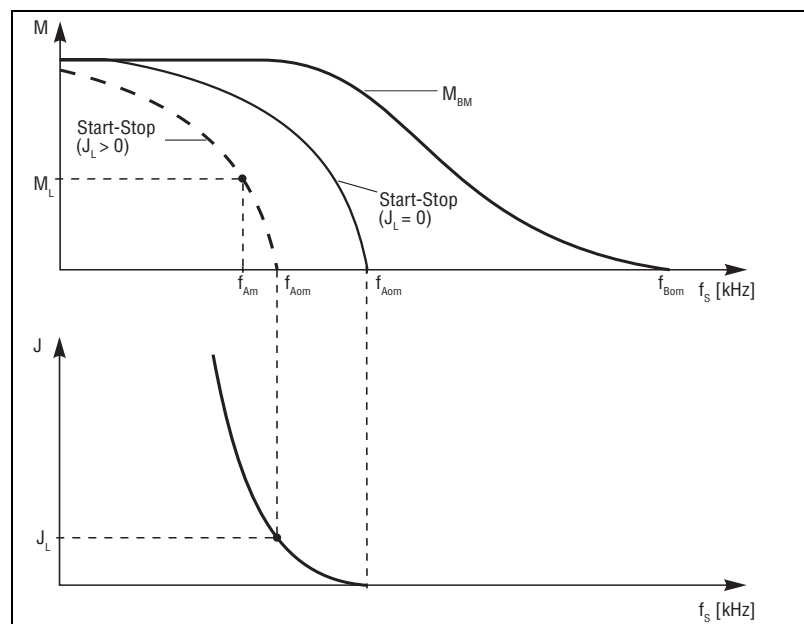
The operating range of the motor created by the pull-out torque is subdivided into the starting area and the acceleration range. In the starting area, the motor can follow, without a step error, a control frequency used erratically or which is interrupted.

The starting area is limited by the characteristic curve of the starting limit frequency f_{AM} (start-stop characteristic curve). Without a load, the motor can start with the maximum starting frequency f_{A0M} ; with a load, the starting frequency decreases.

The acceleration range is between the starting area of the start-stop characteristic curve and the pull-out torque curve. In the acceleration range, the control frequency can only be changed continuously (frequency ramp) so that the motor can follow the control frequency.

Mass moment of inertia of the load

The size of the starting area also depends on the load inertia which is in effect on the motor shaft J_L of the load. With an increasing J_L , the start-stop characteristic curve shifts to lower frequencies. The start-stop characteristic curve shows the dependency of the maximum starting frequency f_{A0M} on the load inertia J_L . If load inertia and load torque are present simultaneously, the starting limit frequency f_{AM} is determined by moving the stop-start characteristic curve in the torque graph parallel to the left until the maximum starting frequency f_{A0M} corresponds to the J_L -diagram (see Figure).



Stepper motor characteristic curve

M_{BM}	Pull-out torque
M_L	Load torque
M_H	Holding torque
f_s	Control frequency
f_{AM}	Starting limit frequency
f_{A0M}	Maximum starting frequency
f_{BOM}	Maximum operating frequency
J_L	Load inertia

VRDM 36•

Technical data

Motor type		VRDM 364	VRDM 366		VRDM 368		
Winding		H	H	N	H	N	W
Max. supply voltage U_{\max}	V_{AC}	25	25	92	25	92	230
Nominal voltage DC bus U_N	V_{DC}	24 / 35	24 / 35	130	24 / 35	130	325
Nominal torque M_N	Nm	0.45	0.90		1.50		
Holding torque M_H	Nm	0.51	1.02		1.70		
Rotor inertia J_R	kgcm ²	0.1	0.22		0.38		
Steps per revolution z ¹⁾		200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000					
Step angle α	°	1.8 / 0.9 / 0.72 / 0.36 / 0.18 / 0.09 / 0.072 / 0.036					
Systematic angular tolerance $\Delta\alpha_s$ ²⁾	'	±6					
Max. starting frequency f_{Aom}	kHz	8.5	8.0	8.0	6.0	8.5	8.5
Phase current I_N	A_{rms}	5.2	5.8	1.6	5.8	1.9	0.9
Winding resistance R_W	Ω	0.42	0.5	5.3	0.7	4.8	25
Rate-of-current rise time constant τ	ms	2.1	3.3		4.6		
Weight m ³⁾	kg	1.3	1.6		2.0		
Shaft load ⁴⁾							
• Max. radial force 1st shaft end ⁵⁾	N	24	24		50		
• Max. radial force 2nd shaft end (optional) ⁶⁾	N	25 / 40					
• Max. axial force pull	N	100					
• Max. axial force compression	N	8.4					
• Nominal bearing life L_{10h} ⁷⁾	h	20000					

1) Depending on controller

2) Measured at 1000 steps/revolution, unit: angular minutes

3) Weight of the motor version with cable retaining screws and connector

4) Conditions for shaft load: speed of rotation 600 1/min, 100% ED at nominal torque, ambient temperature 40 °C (storage temperature ≈ 80 °C)

5) Point of attack of radial force: in the middle of the shaft end

6) Point of attack of radial force: in the middle of the shaft end; 1st value: Motors with terminal boxes, connectors or encoder; 2nd value: Motors with braided wires

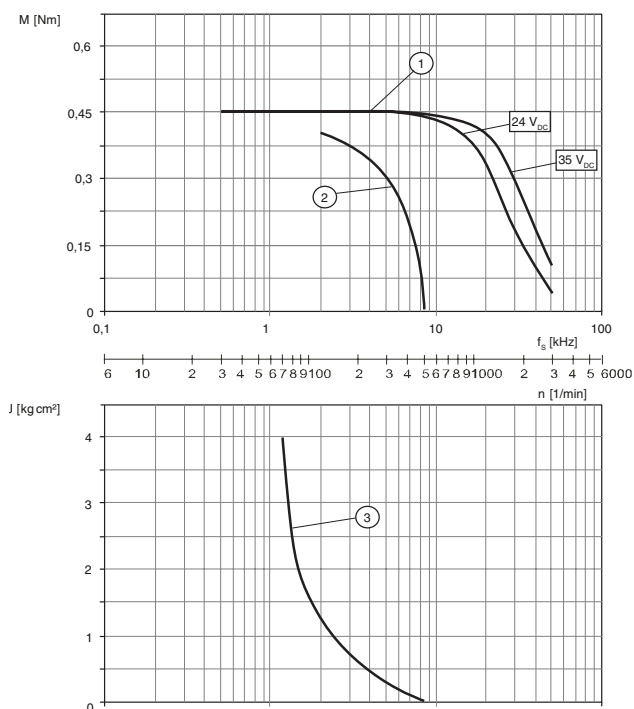
7) Operating hours at a failure probability of 10%

Environmental conditions

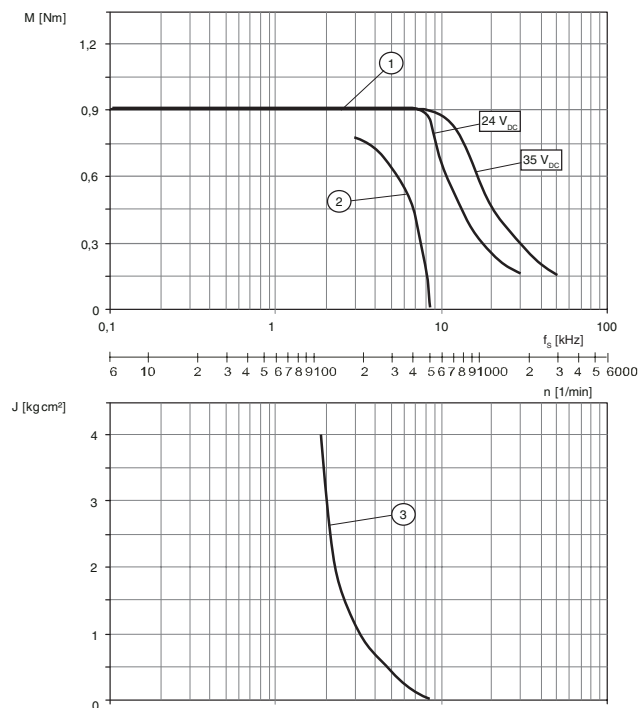
Ambient temperature	°C	-25 ... +40
Installation height without power reduction	m a. MSL	< 1000
Transport and storage temperature	°C	-25 ... +70
Relative humidity	%	5 ... 85; no condensation permissible
Vibration magnitude in operation as per EN 60034-14		A
Vibration strain as per DIN EN 60068-2-6	m/s ²	20
Degree of protection as per EN 60034-5		
• Total except shaft bushing		IP 56
• Shaft bushing without shaft seal ring		IP 41
Heat class as per EN 60034-1		155 (F)
Shaft wobble and axial precision		As per EN 50 347 (IEC 60072-1)
Maximum rotary acceleration	Wheel/s ²	200000

Characteristic curves

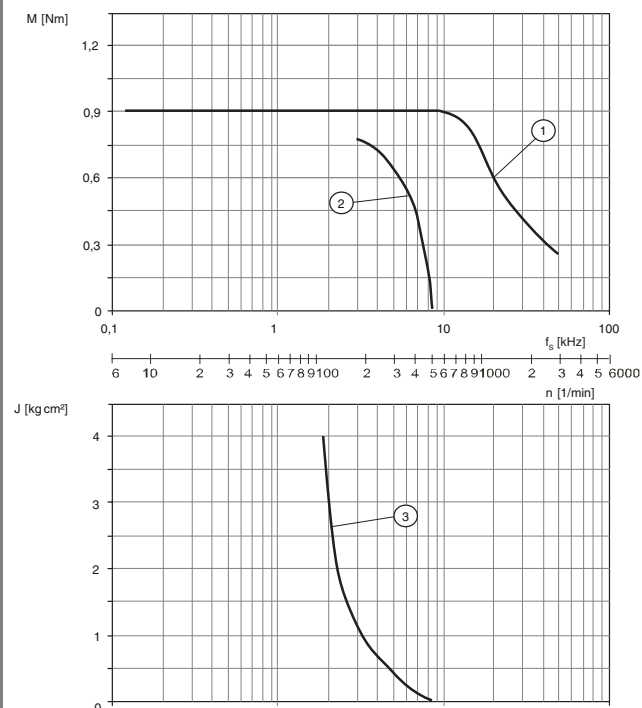
VRDM 364 / 50L H



VRDM 366 / 50L H



VRDM 366 / 50L N

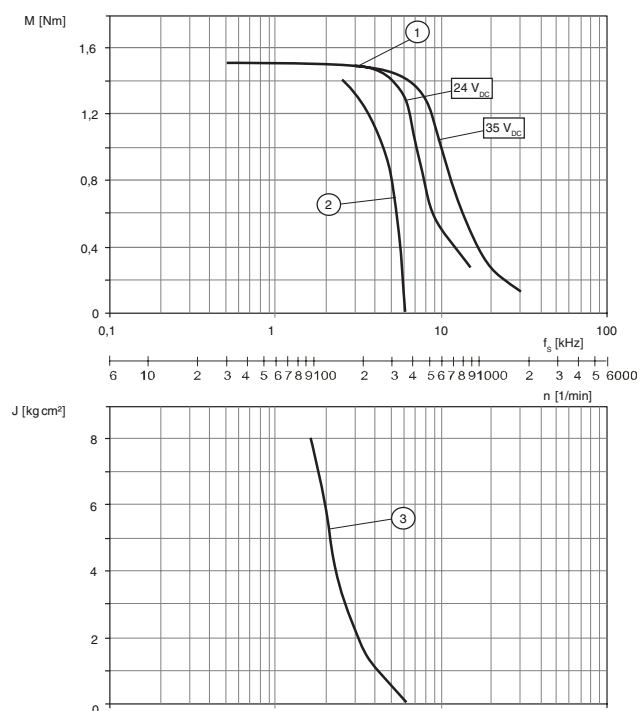


Measurement at 1000 steps/revolution, nominal voltage DC bus U_N and phase current I_N

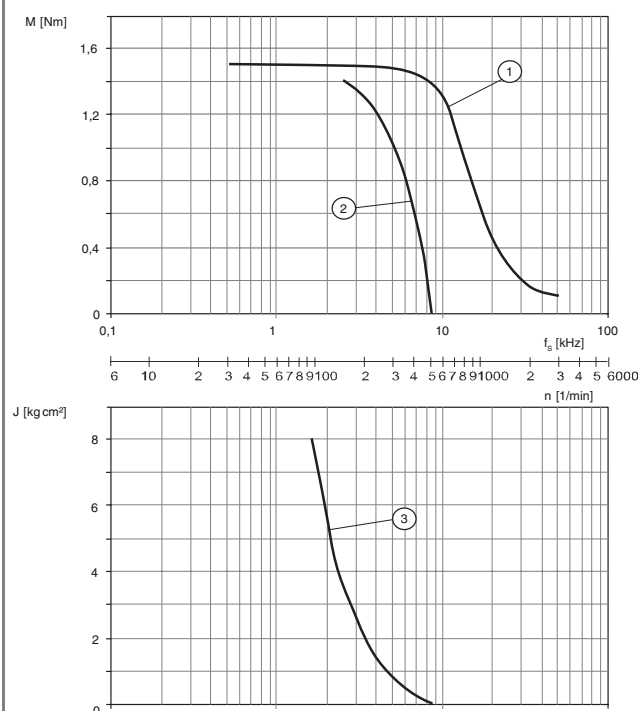
- (1) Pull-out torque
- (2) Start limit torque
- (3) Maximum load inertia

Characteristic curves

VRDM 368 / 50L H



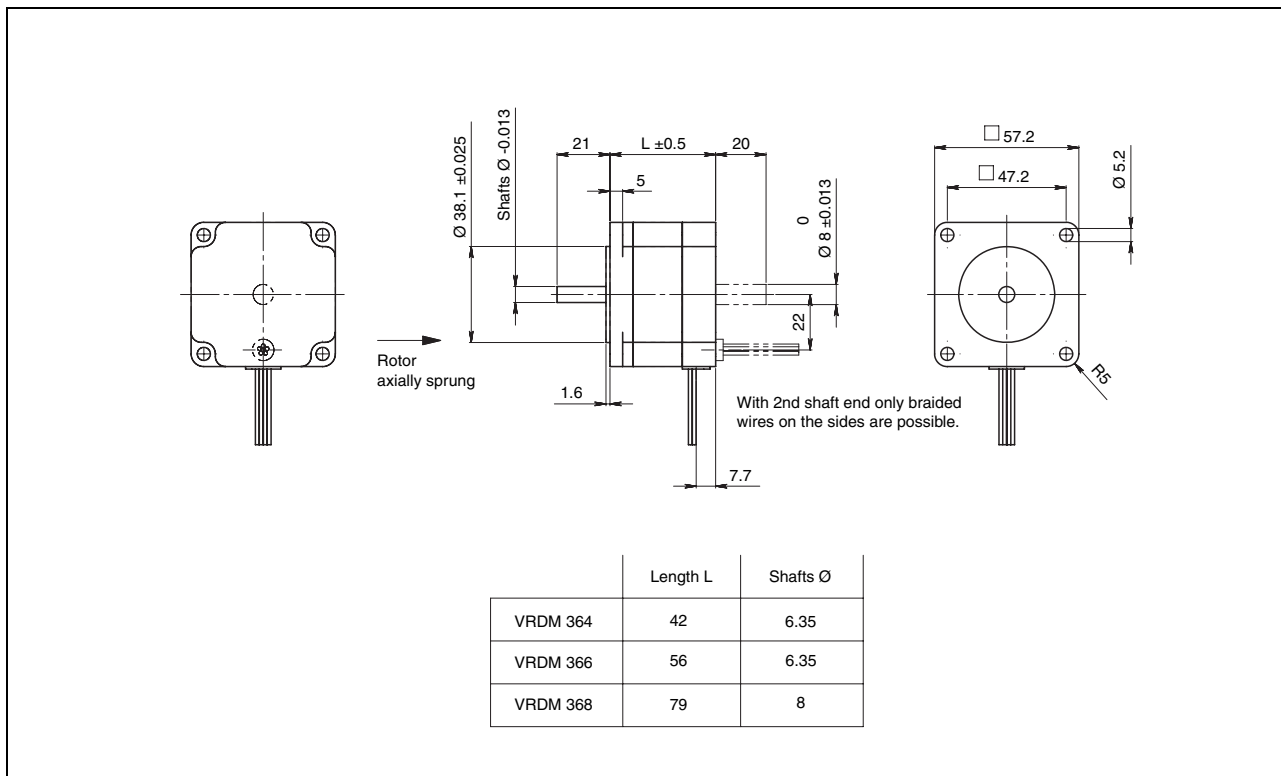
VRDM 368 / 50L N + W



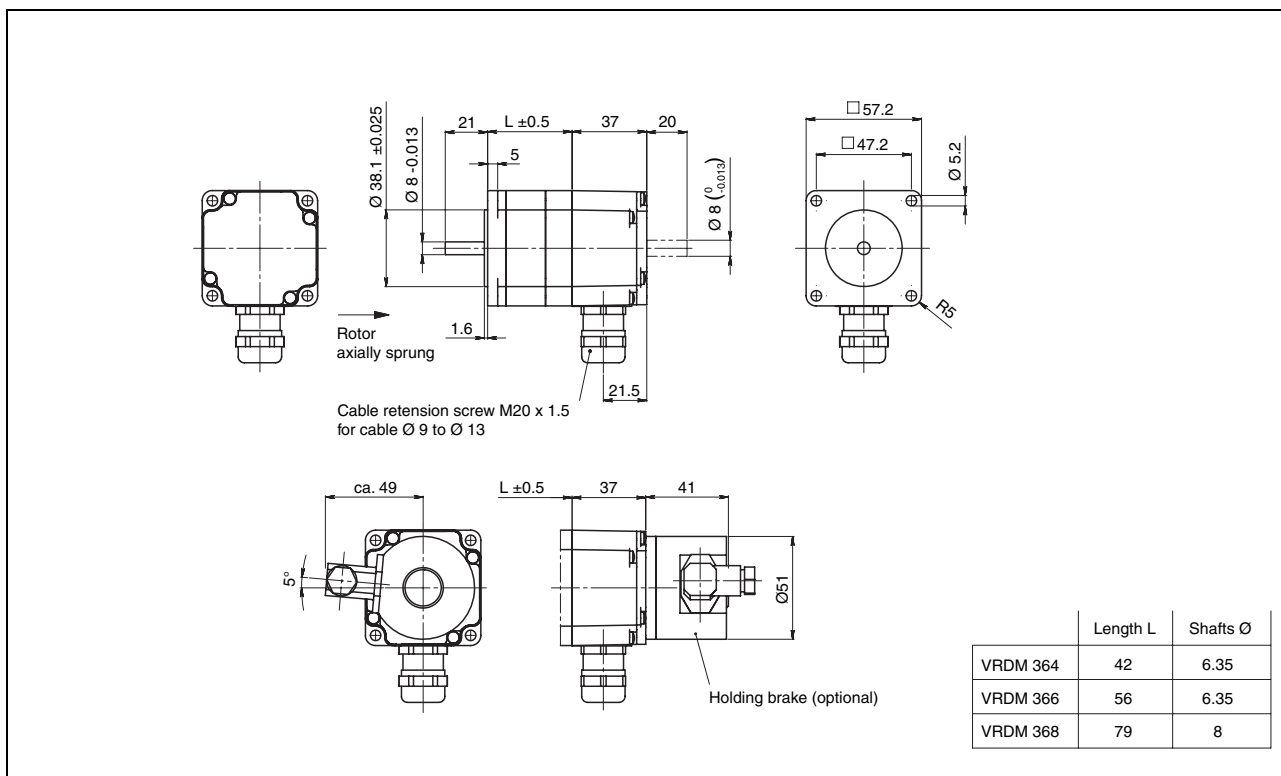
Measurement at 1000 steps/revolution, nominal voltage DC bus U_N and phase current I_N

- (1) Pull-out torque
- (2) Start limit torque
- (3) Maximum load inertia

Dimensional drawings

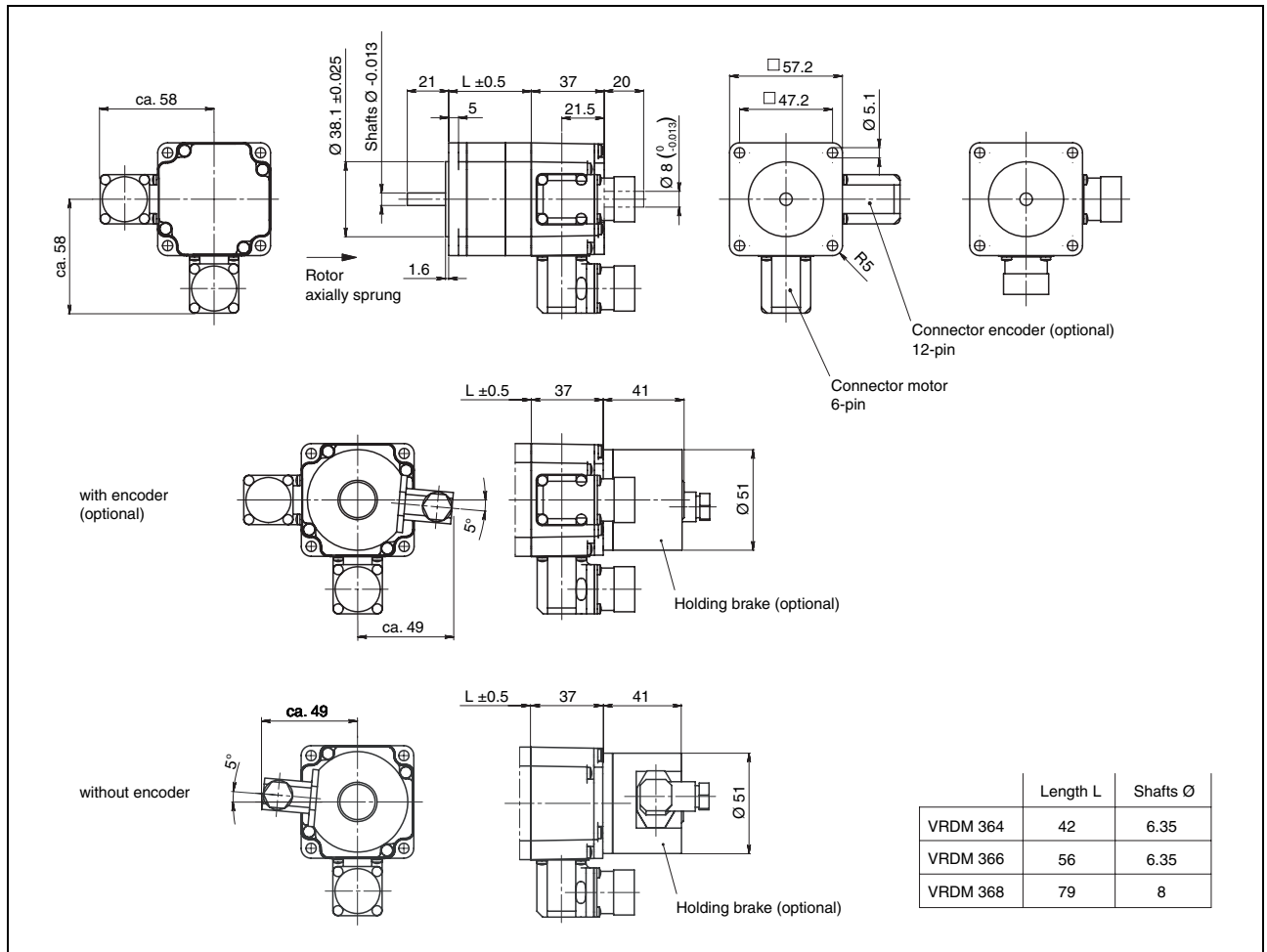


3-phase stepper motor VRDM 36• in braided wire version



3-phase stepper motor VRDM 36• in terminal box version

Dimensional drawings



3-phase stepper motor VRDM 36• in connector version

Type code																						
Example:	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Phase count 3	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Size (Flange) 6 = 57.2 mm	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Length 4 = 42 mm 6 = 56 mm 8 = 79 mm	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Number of pole pairs 50	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	B	OOO
Rotor L = Laminated rotor plate	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Maximum voltage H = 25 V _{AC} (35 V _{DC}) N = 92 V _{AC} (130 V _{DC}) W = 230 V _{AC} (325 V _{DC})	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	B	OOO
Connection type A = Braided wire B = Terminal box C = Connector	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Position capture E = Encoder (1000 increments/revolution) O = Without encoder	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Holding brake B = Brake O = Without brake	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Degree of protection IP41 = IP41 on shaft bushing	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Gearbox type O = Without gearbox 1 = PLE 40 2 = PLE 60 A = PLS 70	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Gear ratio O = Without gearbox 3 = 3:1 5 = 5:1 8 = 8:1	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Shaft diameter D6 = 6.35 mm D8 = 8 mm DO = With gearbox	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Shaft model front O = Smooth shaft or gearbox	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Centring collar 38 = 38.10 mm OO = With gearbox	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Second shaft: O = Without 2 = With	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Connection direction motor plug ¹⁾ O = Without, L = Left, R = Right B = Back, F = Front, S = Straight	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Connection direction encoder plug ¹⁾ O = Without, L = Left, R = Right B = Back, F = Front, S = Straight	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Braided wire output O = Without S = Side B = Back	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
Braided wire length OOO = No xxx = xxx mm (max. 400 mm)	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO

¹⁾ Connection direction viewed from front at 1st shaft end, connector up.

Note:

Please note the description of the possible motor types on page 3.

VRDM 39•**Technical data**

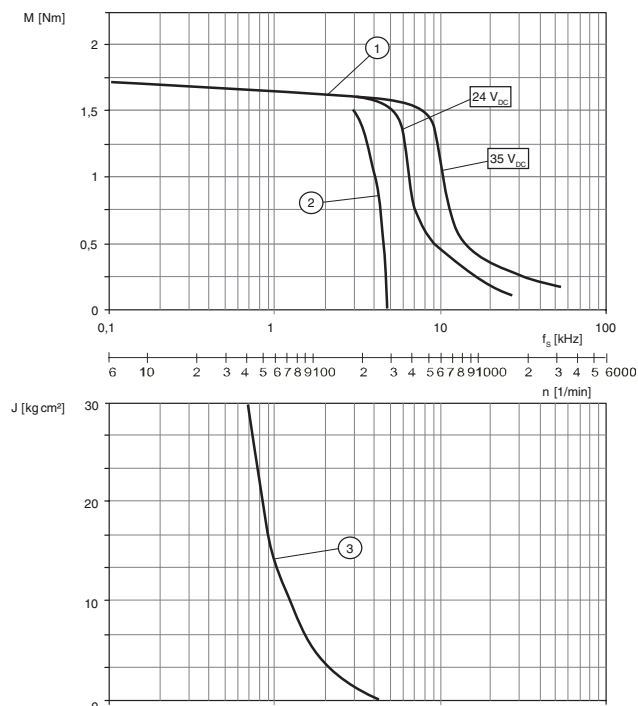
Motor type		VRDM 397			VRDM 3910			VRDM 3913		
Winding		H	N	W	H	N	W	H	N	W
Max. supply voltage U _{max}	V _{AC}	25	92	230	25	92	230	25	92	230
Nominal voltage DC bus U _N	V _{DC}	24 / 35	130	325	24 / 35	130	325	24 / 35	130	325
Nominal torque M _N	Nm	1.7	2	2	3.7	4	4	5	6	6
Holding torque M _H	Nm	1.92	2.26	2.26	4.18	4.52	4.52	5.65	6.78	6.78
Rotor inertia J _R	kgcm ²	1.1			2.2			3.3		
Steps per revolution z ¹⁾		200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000								
Step angle α	°	1.8 / 0.9 / 0.72 / 0.36 / 0.18 / 0.09 / 0.072 / 0.036								
Systematic angular tolerance Δα _s ²⁾	'	±6								
Max. starting frequency f _{Aom}	kHz	4.6	5.3	5.3	4.8	5.3	5.3	4.5	5.3	5.3
Phase current I _N	A _{rms}	5.8	4.4	1.75	5.8	5	2	5.8	5	2.25
Winding resistance R _W	Ω	0.35	1	6.5	0.55	1.2	5.8	0.63	1.3	6.5
Rate-of-current rise time constantτ	ms	~7			~9			~10		
Weight m ³⁾	kg	2.1			3.2			4.3		
Shaft load ⁴⁾										
• Max. radial force 1st shaft end ⁵⁾	N	100			100			110		
• Max. radial force 2nd shaft end (optional) ⁶⁾	N	50 / 75								
• Max. axial force pull	N	175								
• Max. axial force compression	N	30								
• Nominal bearing life L _{10h} ⁷⁾	h	20000								

¹⁾ Depending on controller²⁾ Measured at 1000 steps/revolution, unit: angular minutes³⁾ Weight of the motor version with cable retaining screws or connector⁴⁾ Conditions for shaft load: speed of rotation 600 1/min, 100% ED at nominal torque, ambient temperature 40 °C (storage temperature ≈ 80 °C)⁵⁾ Point of attack of radial force: in the middle of the shaft end⁶⁾ Point of attack of radial force: in the middle of the shaft end; 1st value: Motors with terminal boxes, connectors or encoder; 2nd value: Motors with braided wires⁷⁾ Operating hours at a failure probability of 10%**Environmental conditions**

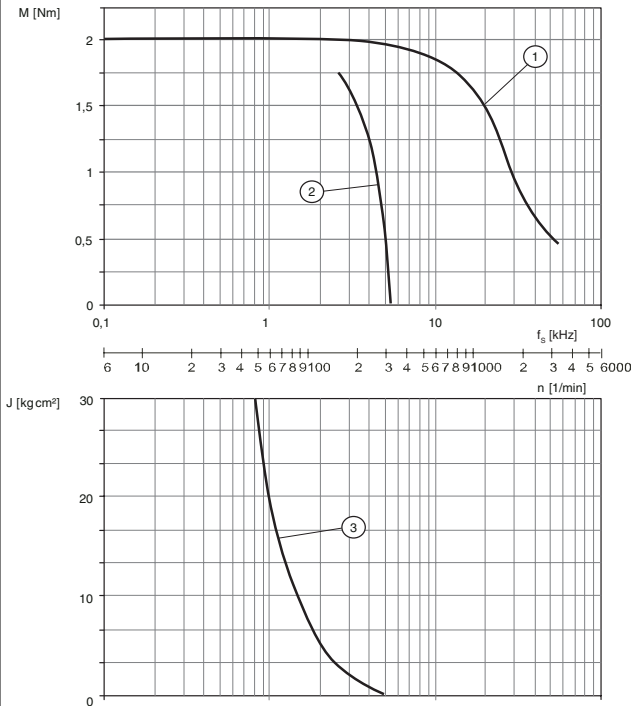
Ambient temperature	°C	-25 ... +40
Installation height without power reduction	m a. MSL	< 1000
Transport and storage temperature	°C	-25 ... +70
Relative humidity	%	5 ... 85; no condensation permissible
Vibration magnitude in operation as per EN 60034-14		A
Vibration strain as per DIN EN 60068-2-6	m/s ²	20
Degree of protection as per EN 60034-5		
• Total except shaft bushing		IP 56
• Shaft bushing without shaft seal ring		IP 41
Heat class as per EN 60034-1		155 (F)
Shaft wobble and axial precision		As per EN 50 347 (IEC 60072-1)
Maximum rotary acceleration	Wheel/s ²	200000

Characteristic curves

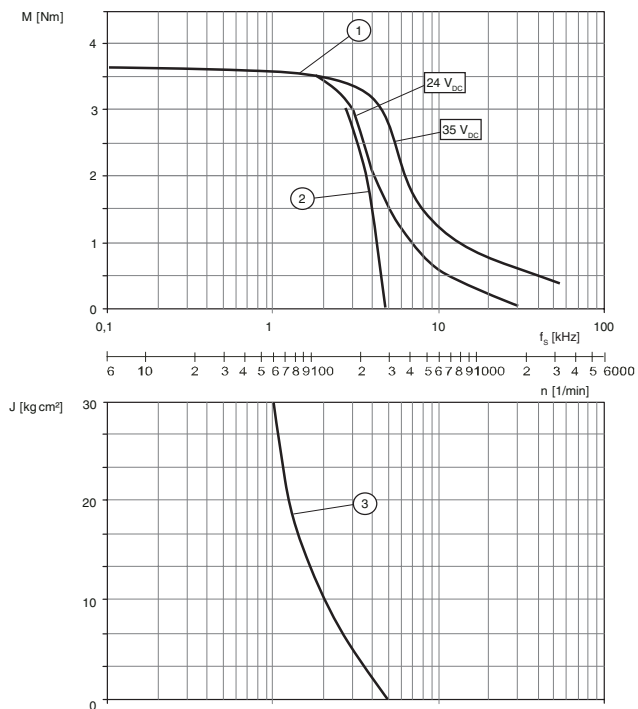
VRDM 397 / 50L H



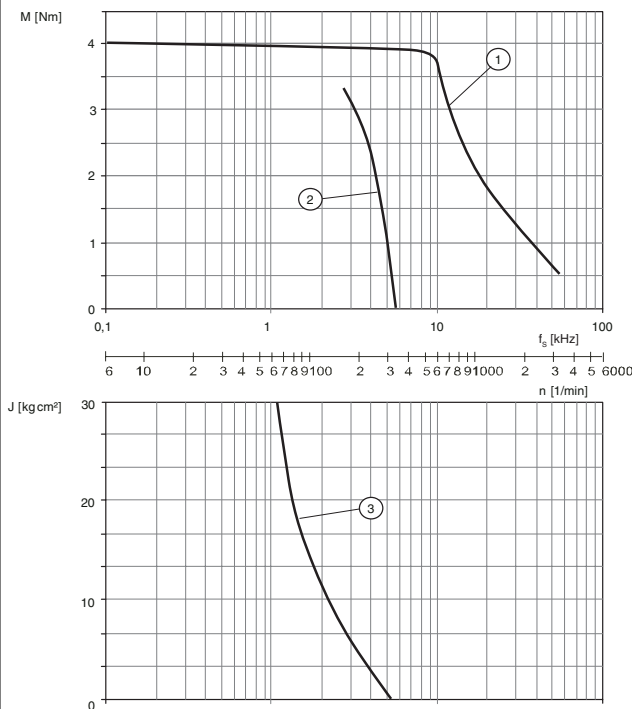
VRDM 397 / 50L N+ W



VRDM 3910 / 50L H



VRDM 3910 / 50L N+ W

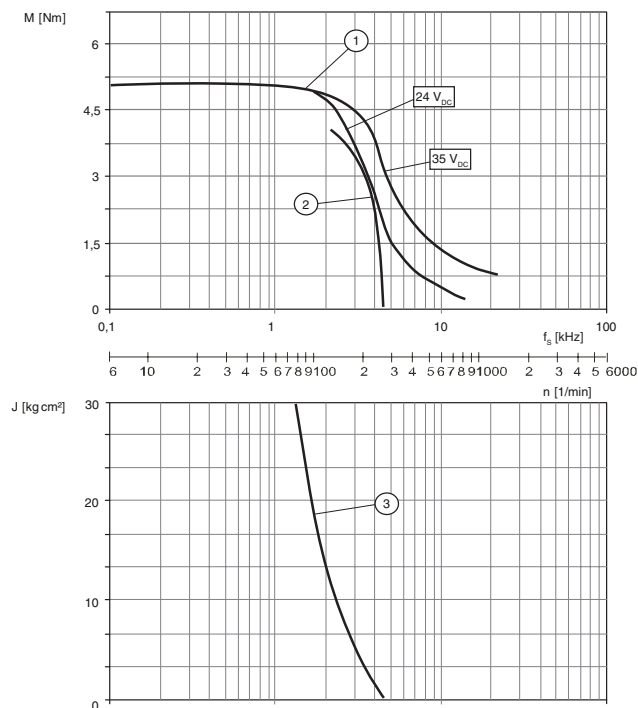


Measurement at 1000 steps/revolution, nominal voltage DC bus U_N and phase current I_N

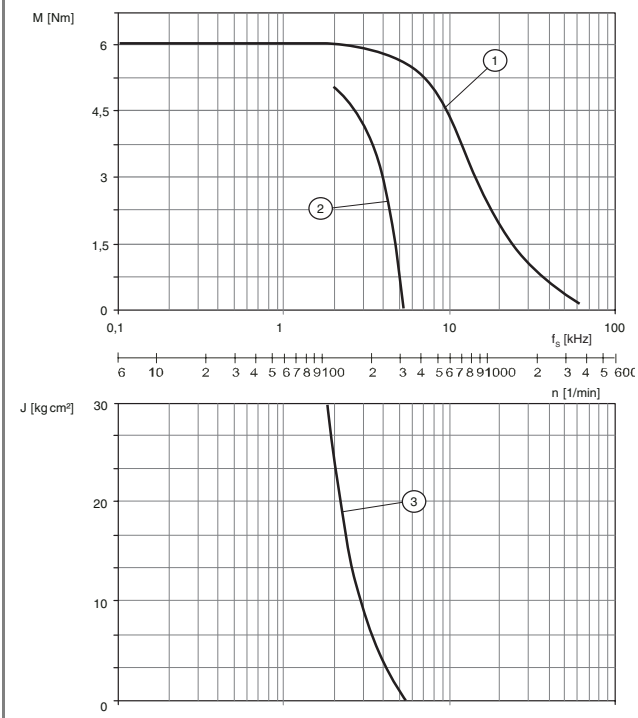
- (1) Pull-out torque
- (2) Start limit torque
- (3) Maximum load inertia

Characteristic curves

VRDM 3913 / 50L H



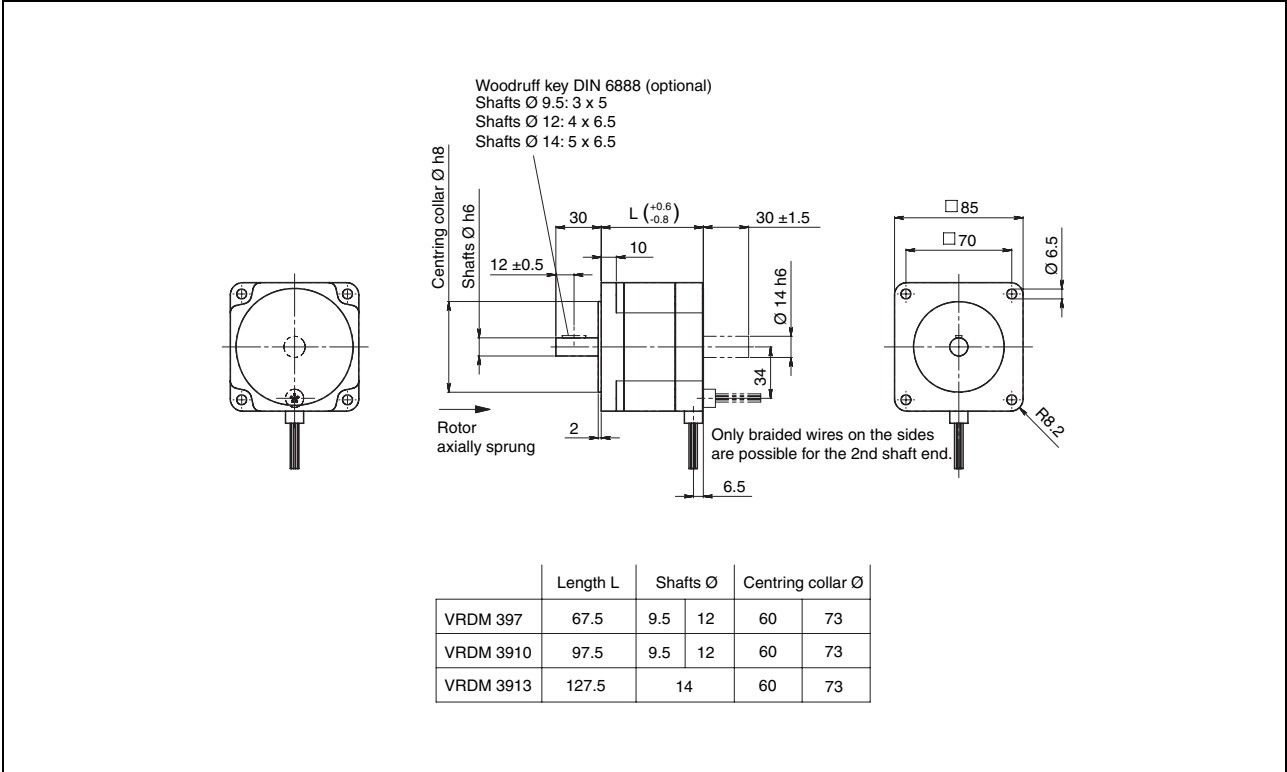
VRDM 3913 / 50L N + W



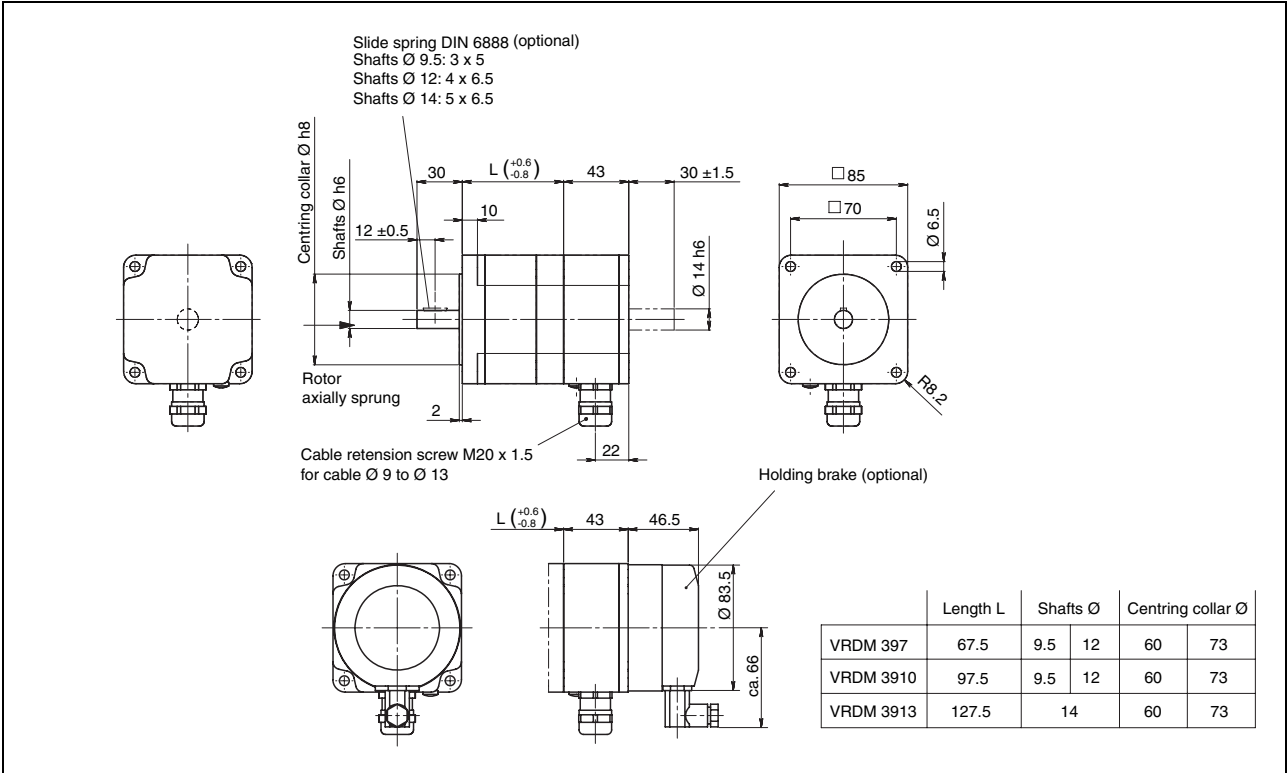
Measurement at 1000 steps/revolution, nominal voltage DC bus U_N and phase current I_N

- (1) Pull-out torque
- (2) Start limit torque
- (3) Maximum load inertia

Dimensional drawings

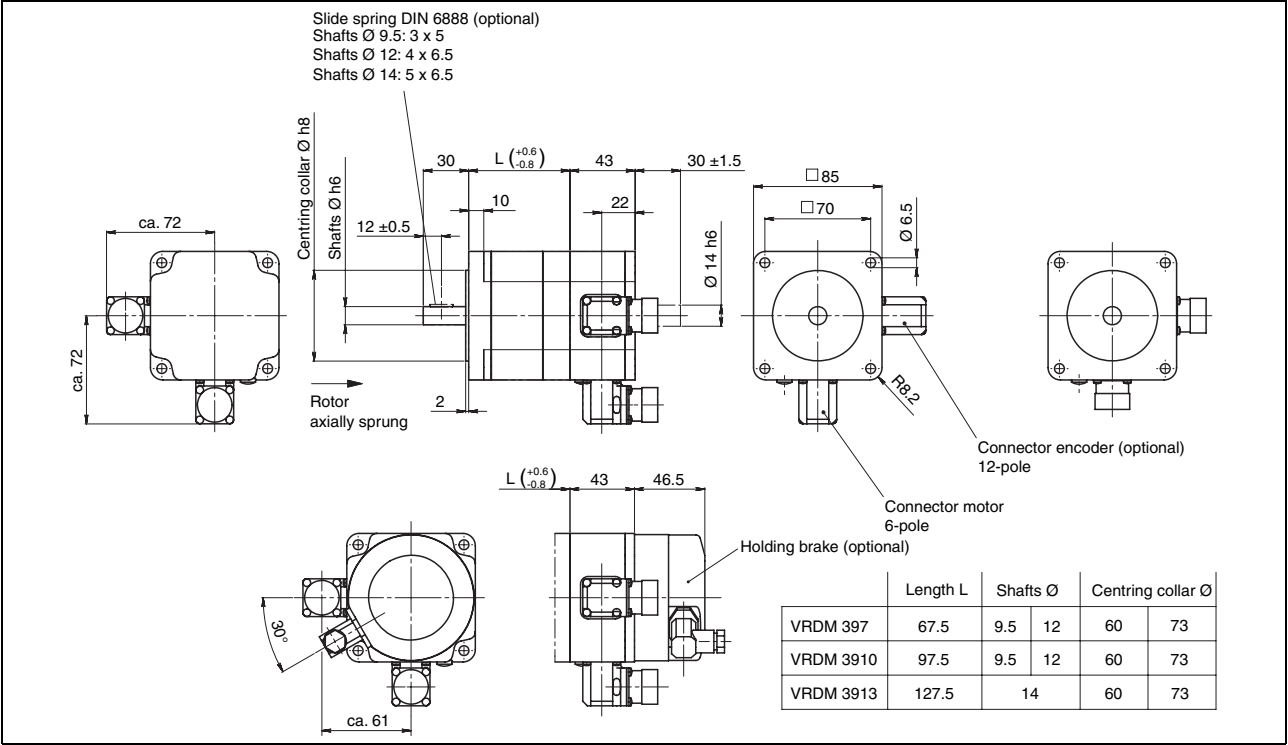


3-phase stepper motor VRDM 39• in braided wire version



3-phase stepper motor VRDM 39• in terminal box version

Dimensional drawings



3-phase stepper motor VRDM 39• in connector version

Type code																										
Example:	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Phase count 3	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Size (Flange) 9 = 85 mm	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Motor length 7 = 68 mm 10 = 98 mm 13 = 128 mm	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Number of pole pairs 50	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	B	OOO				
Rotor L = Laminated rotor plate	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Maximum voltage H = 25 V _{AC} (35 V _{DC}) N = 92 V _{AC} (130 V _{DC}) W = 230 V _{AC} (325 V _{DC})	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	B	OOO				
Connection type A = Braided wire B = Terminal box C = Connector	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Position capture E = Encoder (1000 increments/revolution) O = Without encoder	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Holding brake B = Brake O = Without brake	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Degree of protection IP41 = IP41 on shaft bushing IP56 = IP56 on shaft bushing front	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Gearbox type O = Without gearbox 3 = PLE 80 B = PLS 90	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Gear ratio O = Without gearbox 3 = 3:1 5 = 5:1 8 = 8:1	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Shaft diameter D9 = 9.5 mm D2 = 12 mm D4 = 14 mm DO = With gearbox	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Shaft model front O = Smooth shaft or gearbox K = Woodruff key per DIN 6888	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Centring collar 60 = 60 mm 73 = 73 mm OO = With gearbox	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Second shaft O = Without 2 = With	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Connection direction motor plug ¹⁾ O = Without, L = Left, R = Right B = Back, F = Front, S = Straight	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Connection direction encoder plug ¹⁾ O = Without, L = Left, R = Right B = Back, F = Front, S = Straight	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Braided wire output S = Side B = Back O = Without	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				
Braided wire length OOO = Without xxx = xxx mm (max. 400 mm)	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO				

¹⁾ Connection direction viewed from front at 1st shaft end, connector up.

Note:
Please note the description of the possible motor types on page 3.

VRDM 311•**Technical data**

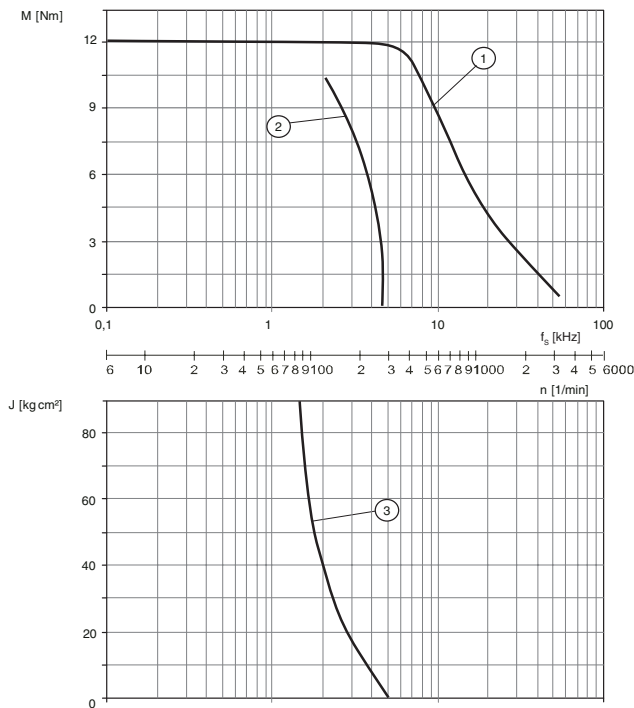
Motor type		VRDM 31117	VRDM 31122
Winding		W	W
Max. supply voltage U_{\max}	V_{AC}	230	230
Nominal voltage DC bus U_N	V_{DCDC}	325	325
Nominal torque M_N	Nm	12	16.5
Holding torque M_H	Nm	13.5	19.7
Rotor inertia J_R	$kgcm^2$	10.5	16
Steps per revolution z		200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000	
Step angle α ¹⁾	°	1.8 / 0.9 / 0.72 / 0.36 / 0.18 / 0.09 / 0.072 / 0.036	
Systematic angular tolerance $\Delta\alpha_s$ ²⁾	'	±6	
Max. starting frequency f_{Aom}	kHz	4.7	
Phase current I_N	A_{rms}	4.1	4.75
Winding resistance R_W	Ω	1.8	1.9
Rate-of-current rise time constant τ	ms	~22	~22
Weight m ³⁾	kg	8.2	11.2
Shaft load ⁴⁾			
• Max. radial force 1st shaft end ⁵⁾	N	300	
• Max. radial force 2nd shaft end (optional) ⁵⁾	N	150	
• Max. axial force pull	N	330	
• Max. axial force compression	N	60	
• Nominal bearing life L_{10h} ⁶⁾	h	20000	

¹⁾ Depending on the control²⁾ Measured at 1000 steps/revolution, unit: minutes of arc³⁾ Weight of the motor version with cable retaining screws or connector⁴⁾ Conditions for shaft load: speed of rotation 600 1/min, 100% ED at nominal torque, ambient temperature 40 °C (storage temperature ≈ 80 °C)⁵⁾ Point of attack of radial force: in the middle of the shaft end⁶⁾ Operating hours at a failure probability of 10%**Environmental conditions**

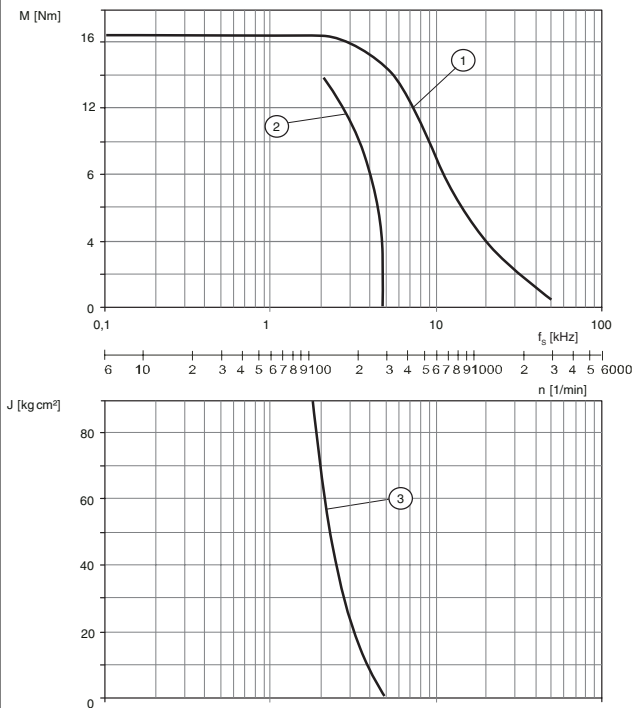
Ambient temperature	°C	-25 ... +40
Installation height without power reduction	m a. MSL	< 1000
Transport and storage temperature	°C	-25 ... +70
Relative humidity	%	5 ... 85; no condensation permissible
Vibration magnitude in operation as per EN 60034-14		A
Vibration strain as per DIN EN 60068-2-6	m/s^2	20
Degree of protection as per EN 60034-5		
• Total except shaft bushing		IP 56
• Shaft bushing without shaft seal ring		IP 41
Heat class as per EN 60034-1		155 (F)
Shaft wobble and axial precision		As per EN 50 347 (IEC 60072-1)
Maximum rotary acceleration	Wheel/ s^2	200000

Characteristic curves

VRDM 31117 / 50L W



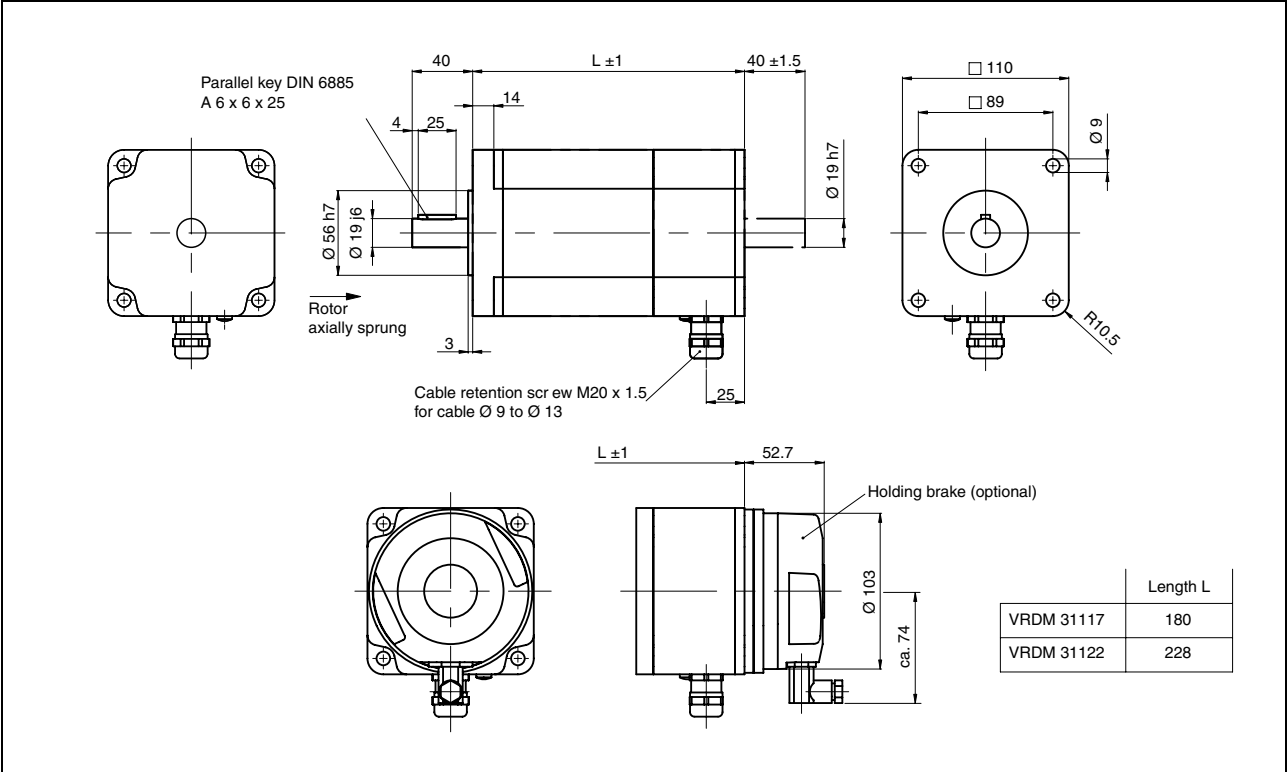
VRDM 31122 / 50L W



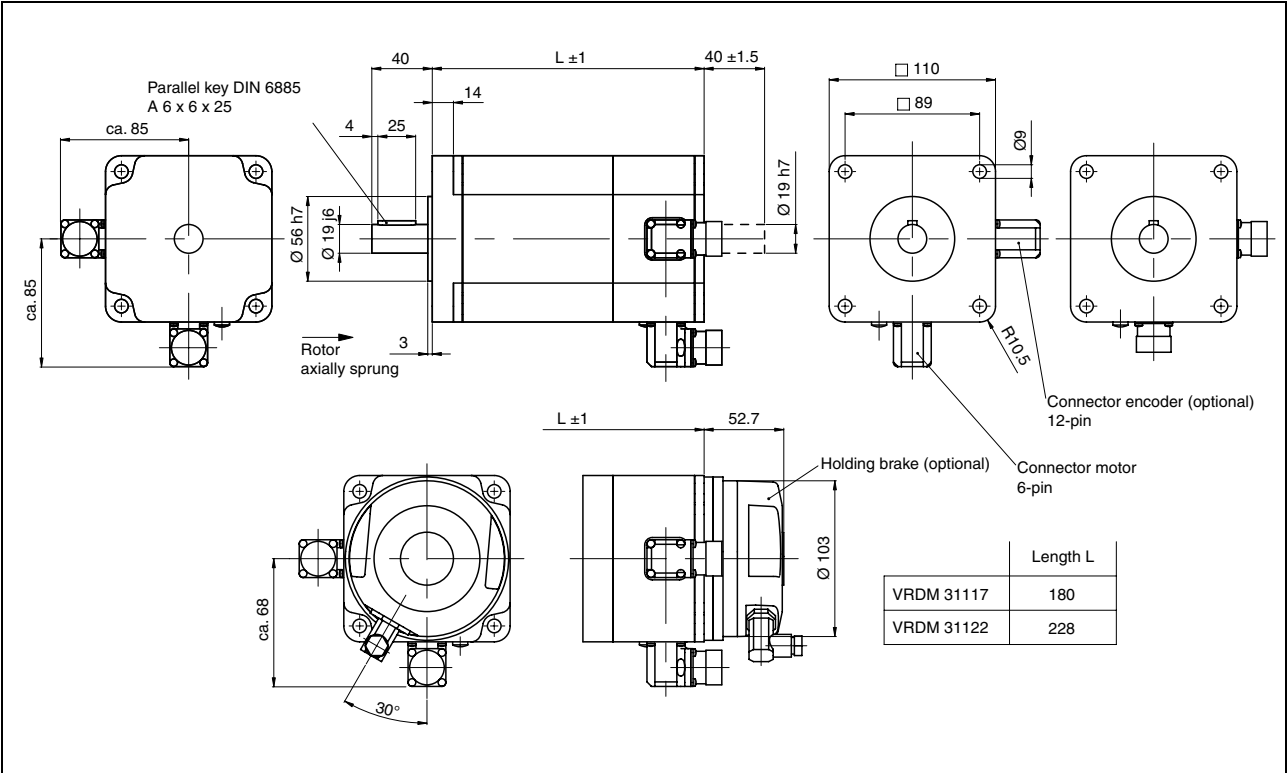
Measurement at 1000 steps/revolution, nominal voltage DC bus U_N and phase current I_N

- (1) Pull-out torque
- (2) Start limit torque
- (3) Maximum load inertia

Dimensional drawings



3-phase stepper motor VRDM 311• in terminal box version



3-phase stepper motor VRDM 311• in connector version

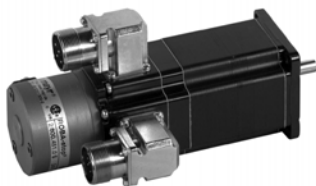
Type code

Example:	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Phase count 3	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Size (Flange) 11 = 110 mm	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Length 17 = 180 mm 22 = 228 mm	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Number of pole pairs 50	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	B	OOO
Rotor L = Laminated rotor plate	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Maximum voltage W = 230 V _{AC} (325 V _{DC})	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	B	OOO
Connection type B = Terminal box C = Connector	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Recording of position E = Encoder (1000 increments/revolution) O = Without encoder	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Holding Brake B = Brake O = Without brake	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Degree of protection IP41 = IP41 on shaft bushing IP56 = IP56 on shaft bushing front	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Gearbox type O = Without gearbox 4 = PLE 120 C = PLS 115	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Gear ratio O = Without gearbox 3 = 3:1 5 = 5:1 8 = 8:1	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Shaft diameter D9 = 19 mm DO = With gearbox	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Shaft model front O = With gearbox K = Parallel key as per DIN 6885	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Centring collar 56 = 56 mm OO = With gearbox	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Second shaft O = Without 2 = With	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Connection direction motor plug ¹⁾ O = Without, L = Left, R = Right B = Back, F = Front, S = Straight	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Connection direction encoder plug ¹⁾ O = Without, L = Left, R = Right B = Back, F = Front, S = Straight	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Braided wire output O = Without	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO
Braided wire length OOO = Without xxx = xxx mm (max. 400 mm)	VRDM	3	11	17	/	50	L	W	C	E	O	IP41	4	5	DO	O	OO	2	B	B	O	OOO

¹⁾ Connection direction viewed from front at 1st shaft end, connector up.

Note:

Please note the description of the possible motor types on page 3.



Options
Holding brake

The holding brake is an electromagnetic sprung brake and fixes the motor axis after switching off the motor current (e.g. in case of power failure or emergency stop). The shaft must be fixed with torque loads resulting from gravity, e.g. with Z-axes in handling technology.

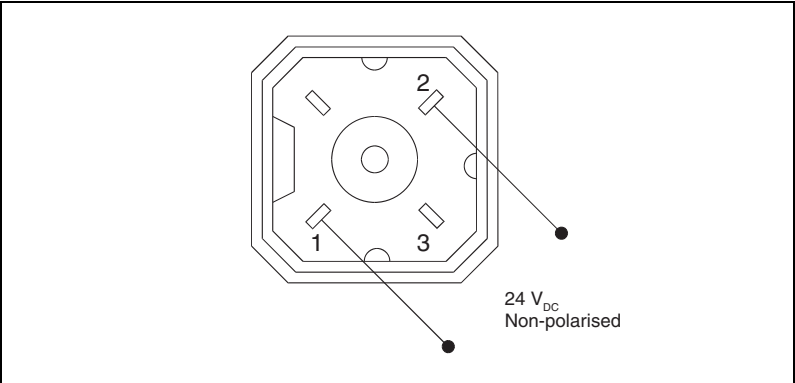
Technical Data

Holding brake for motor type		VRDM 36•	VRDM 39•	VRDM 311•
Nominal voltage	V	24	24	24
Holding torque	Nm	1	6	16
Pull-in power	W	8	24	28
Moment of inertia	kgcm ²	0.016	0.2	0.35
Energise time (release brake)	ms	58	40	60
Shutdown time (apply brake)	ms	14	20	30
Mass	kg	Approx. 0.5	Approx. 1.5	Approx. 2.0

Note: In order to ensure the safe function of the holding brake for Z-axes, the static load torque must be no greater than 25% of the holding torque of the motor.

Wiring diagram

The connector is a part of the scope of supply.
Connector name: Hirschmann Type G4 5M



Wiring diagram of the connector for the holding brake



Encoder

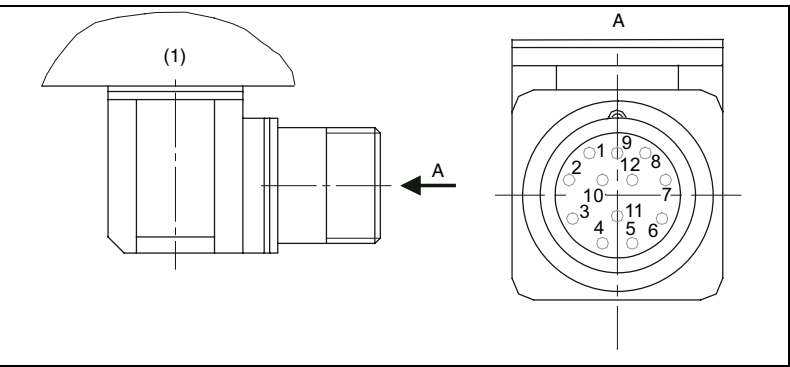
The 3-phase stepper motors from Berger Lahr can be equipped with an encoder. If the control electronics are equipped with rotation monitoring electronics, the encoder is used as a measurement system to acknowledge the actual position of the rotor. Rotation monitoring compares the set point and actual position of the motor and reports errors if the actual position deviates from the setpoint position. For example, a mechanical overload of the motor can thereby be recorded.

Note: An encoder can only be used in motors with a connector. A temperature sensor is integrated, which protects the encoder from high temperatures.

Technical Data

Resolution	Pulse/rpm.	1000
Index plus	Pulse/rpm.	1
Output		RS 422
Signals		A; B; I
Signal shape		Rectangular
Supply voltage	V	5 ± 5%
Max. power consumption	A	0.125 (VRDM 36•) 0.15 (VRDM 39• and 311•)
Temperature sensor	°C	100...105 (VRDM 39• and 311•)

Wiring diagram



Wiring diagram encoder plug on VRDM 3xx

(1) Motor housing

Pin	Designation
1	A
2	A negated
3	B
4	B negated
5	C, I
6	C negated, negated
7	5 V _{GND}
8	+ 5
9	– SENSE
10	+ SENSE
11	Temperature sensor
12	not assigned

Gearboxes



Stepper motors from Berger Lahr can also be supplied with a built-in planetary gear. The PLE gears are cost-effective planetary gears, which are sufficient to meet most precision requirements. The PLS gears are high-quality gears with a very low torsional backlash.

These gears can be supplied with one of three gear ratios: 3:1, 5:1 and 8:1.

The output torque of the gearbox is determined by multiplying the torque of the motor with the gear ratio and efficiency of the gearbox (0.96).

The following table shows the preferred gearboxes for the motors.

Motor type	Gearbox type	
VRDM 364	PLE 40, PLE 60	PLS 70
VRDM 366	PLE 60	PLS 70
VRDM 368	PLE 60	PLS 70
VRDM 39x	PLE 80	PLS 90
VRDM 31117	PLE 120	PLS 115
VRDM 31122		PLS 115

Technical data PLE gearboxes

PLE-gearbox general

Gear stages		1
Service life ¹⁾	h	10000
Efficiency at full load	%	96
Housing material		aluminium
Surface		black anodised
Shaft material		C 45
Bearings		roller bearing
Operating temperature ²⁾	°C	-25 ... +90, shortly +120
Degree of protection ³⁾		IP 54
Lubrication		life lubrication

¹⁾ Life time with an output speed at 100 1/min and T = 30 °C

²⁾ Referring to the housing surface

³⁾ With mounting position IM V3 (drive shaft vertical, shaft end upward) only degree of protection IP 41 is guaranteed

Size of PLE		40	60	80	120
Max. radial force ^{1) 2)}	N	200	500	950	2000
Max. axial force ¹⁾	N	200	600	1200	2800
Torsional play	arcmin	<30	<20	<12	<8
Max. drive speed	1/min	18000	13000	7000	6500
Recommended drive speed	1/min	4500	4000	4000	3500
Torsional stiffness	Nm/arcmin	1.0	2.3	6	12
Weight	kg	0.35	0.9	2.1	6.0

¹⁾ The information refers to min. 20000 h service life with an output speed of 100 1/min and application factor K = 100 min and S1-operating mode for electrical machines and T = 30 °C

²⁾ Refers to the centre of the drive shaft and 50% ED

Attention: the actual output torque must be less than the nominal output torque of the gearbox, otherwise the gearbox may be destroyed.

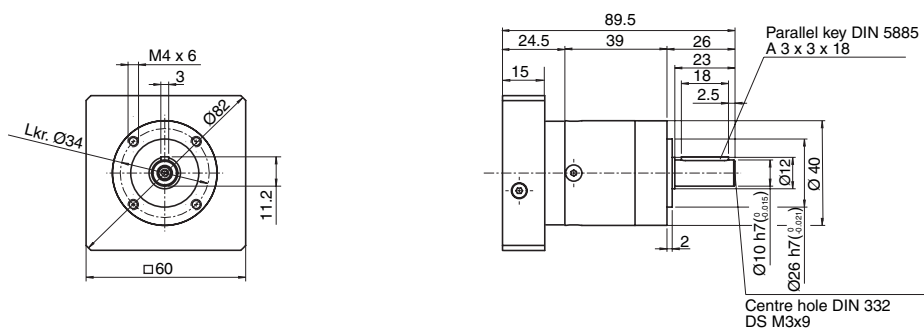
Technical data PLS gearboxes		
PLS gearbox general		
Gear ratios		1
Service life ¹⁾	h	20000
Efficiency at full load	%	98
Case material		aluminium
Surface		black anodised
Shaft material		C 45
Bearings		tapered roller bearings
Operating temperature ²⁾	°C	-25 ... +100, shortly +124
Degree of protection ³⁾		IP 65
Lubrication		life lubrication

¹⁾ Service life with an output speed of 100 1/min and T = 30°C
²⁾ Measured at the housing surface
³⁾ At mounting position IM V3 (drive shaft vertical, shaft end up) only degree of protection IP 41 is guaranteed

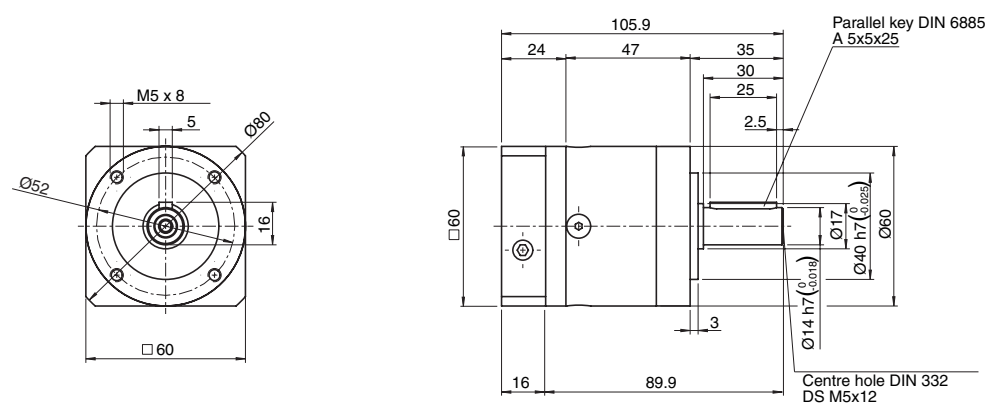
Size of PLS		70	90	115
Max. radial force ^{1) 2)}	N	3300	4300	4800
Max. axial force ¹⁾	N	4700	6400	8000
Torsional play	arcmin	<3	<3	<3
Max. drive speed	1/min	14000	10000	8500
Received drive speed	1/min	5000	4500	4000
Torsion rigidity	Nm/arcmin	6	9	20
Weight	kg	3.0	4.3	9.0

¹⁾ The details are based on min. 20000 h service life with an output speed of 100 1/min and application factor K = 100 min and S1-operating mode for electric machines and T = 30 °C
²⁾ Refers to the centre of the device shaft and 50% ED

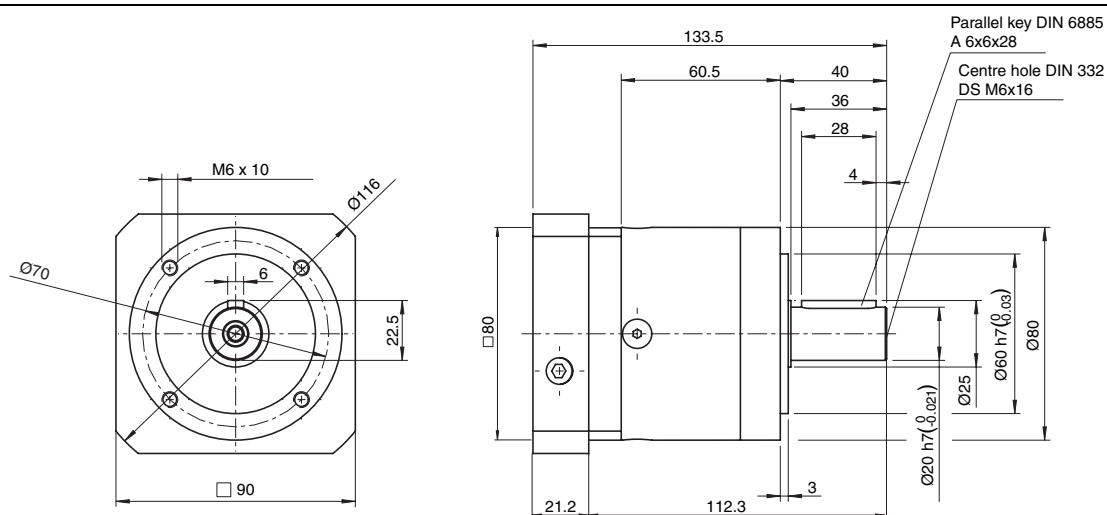
Dimensional drawings



PLE 40 gearbox, 1-stage

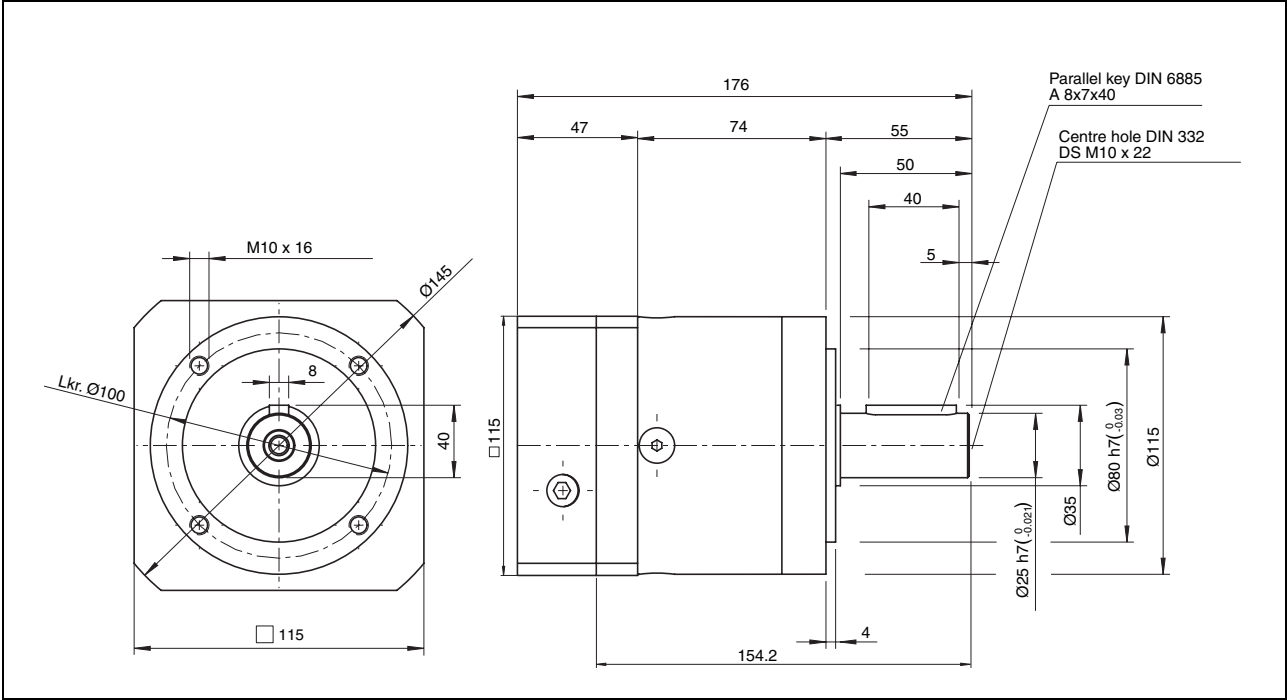


PLE 60 gearbox, 1-stage



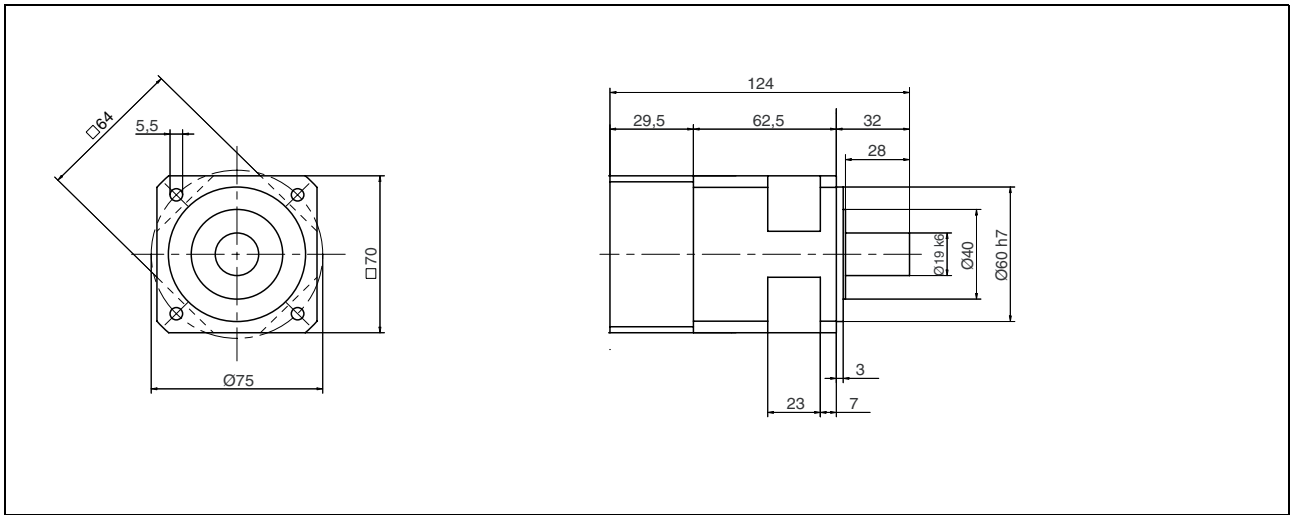
PLE 80 gearbox, 1-stage

Dimensional drawings

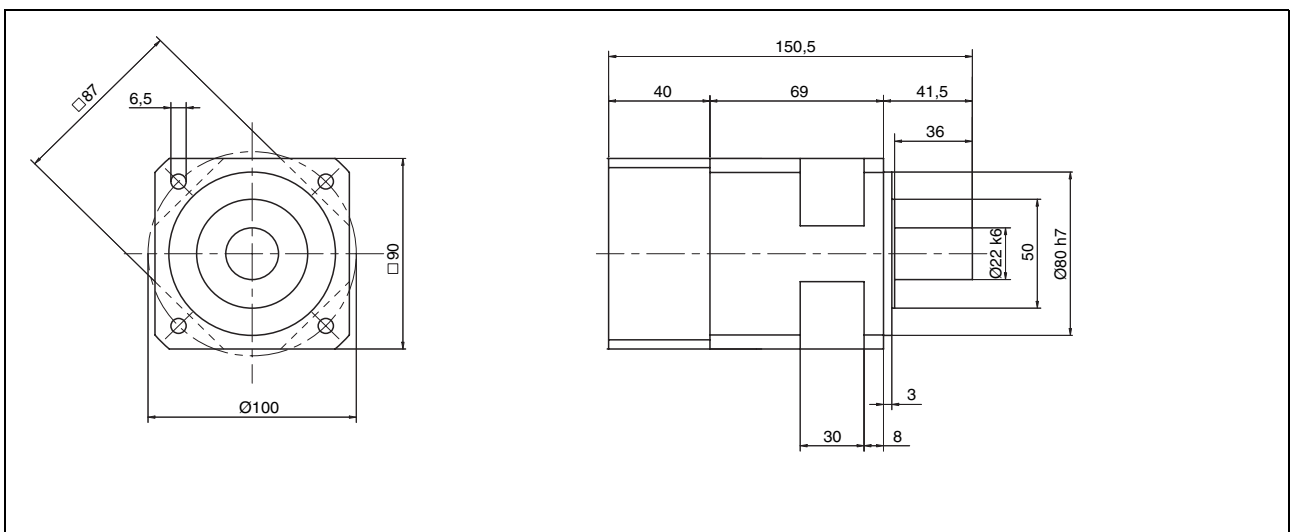


PLE 120 gearbox, 1-stage

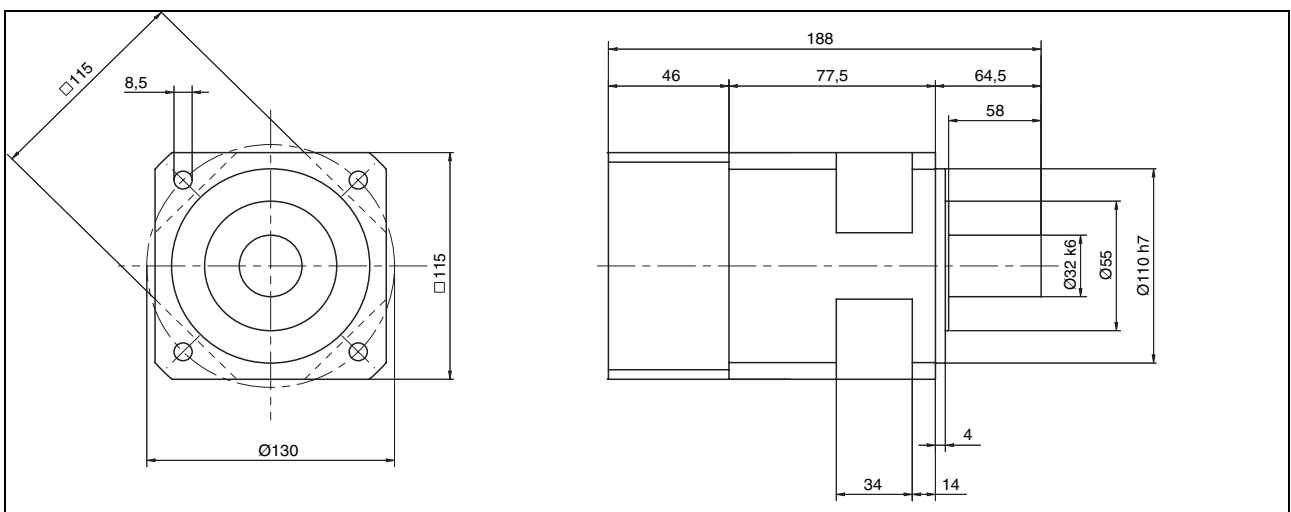
Dimensional drawings



PLS 70 gearbox



PLS 90 gearbox



PLS 115 gearbox



ExRDM 39•
Product description

For operation in potentially explosive areas, Berger Lahr offers the 3-phase stepper motors ExRDM 3910 and ExRDM 3913. The explosion-proof 3-phase stepper motors have a robust design and a high torque in relation to their size.

Special features

The motors have protection type EEx d IIC T4. The result is the following characteristics and conditions:

- Ex-protection as per European standards EN 50014 and EN 50018
- Registration as per UL 2279 or ATEX 94/9/EG (EC-type test certification PTB 02 ATEX 1134)
- Device group II
- Explosion group C
- Type of protection pressure-resistant encapsulation "d"
- Temperature class "T4" (135°C)
- Use in potentially explosive atmospheres of zones 1 and 2, device category 2G
- Tested thermistor monitoring devices are required for temperature monitoring.

Product overview

Motor type		ExRDM 3910	ExRDM 3913
Nominal torque M_N	Nm	4.0	5.8
Holding torque M_H	Nm	4.5	6.55
Steps per revolution z ¹⁾		200 / 500 / 1000 / 2000 / 4000 / 5000 / 10000	
Step angle α ¹⁾	°	1.8 / 0.9 / 0.72 / 0.36 / 0.18 / 0.09 / 0.072 / 0.036	

¹⁾ With appropriate control

Technical data				
Motor type		ExRDM 3910N ExRDM 3910NEi	ExRDM 3913N ExRDM 3913NEi	ExRDM 3913NEa
Max. supply voltage U_{\max}	V_{AC}	230	230	230
Nominal voltage DC bus U_N	V_{DC}	325	325	325
Max. voltage against PE	V_{AC}	250	250	250
Phase current in S1 operation $I_N^{1)}$	A_{eff}	1.6	1.6	1.6
Winding resistance R_W	Ω	7.5	9.3	9.3
Nominal torque M_N	Nm	4.0	5.8	5.8
Holding torque	Nm	4.5	6.55	6.55
Rotor inertia M_H	kgcm ²	2.2	3.3	3.3
Steps per revolution $z^{2)}$	1/min	200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000		
Step angle $\alpha^{2)}$	°	1.8 / 0.9 / 0.72 / 0.36 / 0.18 / 0.09 / 0.072 / 0.036		
Systematic angular tolerance $\Delta\alpha_s^{3)}$	'	±6	±6	±6
Max. starting frequency $f_{Aom}^{2)}$	kHz	5.3	5.3	5.3
Current rise time constant τ	ms	~9	~11	~11
Type of protection		EEx d IIC T4	EEx d IIC T4	EEx d IIC T4
Total length l	mm	194	224	250
Weight m	kg	7.4	9.5	9.8
Shaft load				
• Max. radial force F_R (1st shaft end, 100% ED) ⁴⁾	N	110	110	110
• Max. axial force pull F_A	N	170	170	170
• Max. axial force pressure F_A	N	30	30	30
• Press-on force	N	80	80	80
• Nominal bearing life L_{10h}	h	20000	20000	20000

1) S1 operation, as per DIN VDE 0530: continuous operation

2) Depending on controller

3) Measured at 1000 steps/revolution, unit in angular minutes

4) Point of attack of radial force: in the middle of the shaft end

Environmental conditions		
Ambient temperature	°C	-20 ... +50
Installation height without power reduction	m a. MSL	< 1000
Transport and storage temperature	°C	-25 ... +70
Relative humidity	%	5 ... 85; no condensation permissible
Vibration severity in operation as per DIN EN 60034-14		A
Max. vibration load	m/s ²	20
Degree of protection as per DIN EN 60034-5		
• Gear		IP 54
• Shaft bushing front		IP 44
• Terminal box		IP 56
Heat class as per EN 60034-1		155 (F)
Shaft wobble and axial precision		DIN EN 50347 (IEC 60072-1)
Max. rotary acceleration	Wheel/s ²	

Temperature monitoring

The explosion-proof motors ExRDM 3910 and ExRDM 3913 are operated with Berger Lahr stepper motor drives.

Tested thermistor monitoring devices are obligatory for temperature monitoring of the stepper motors ExRDM 3910 Nxx and ExRDM 3913 Nxx.

The devices are to be installed outside of the potentially explosive area.

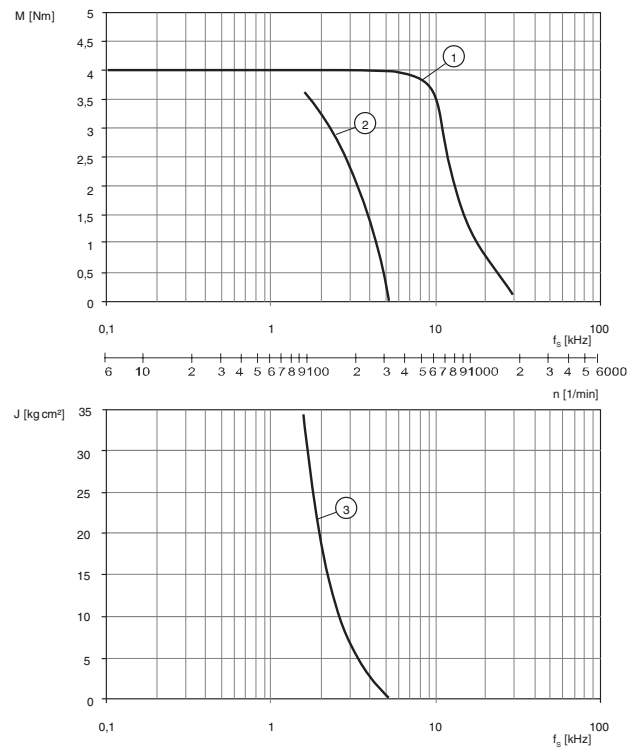
The following devices are recommended:

- Dold MK 9003.12/11120 ATEX 230 V_{AC}
- Möller EMT 6 DBK

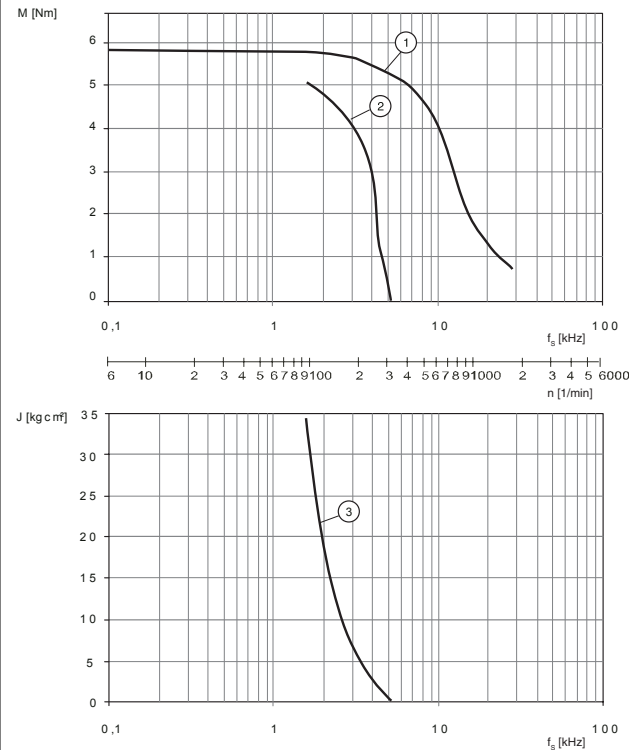
The devices can be purchased from their manufacturers.

Characteristic curves

ExRDM 3910



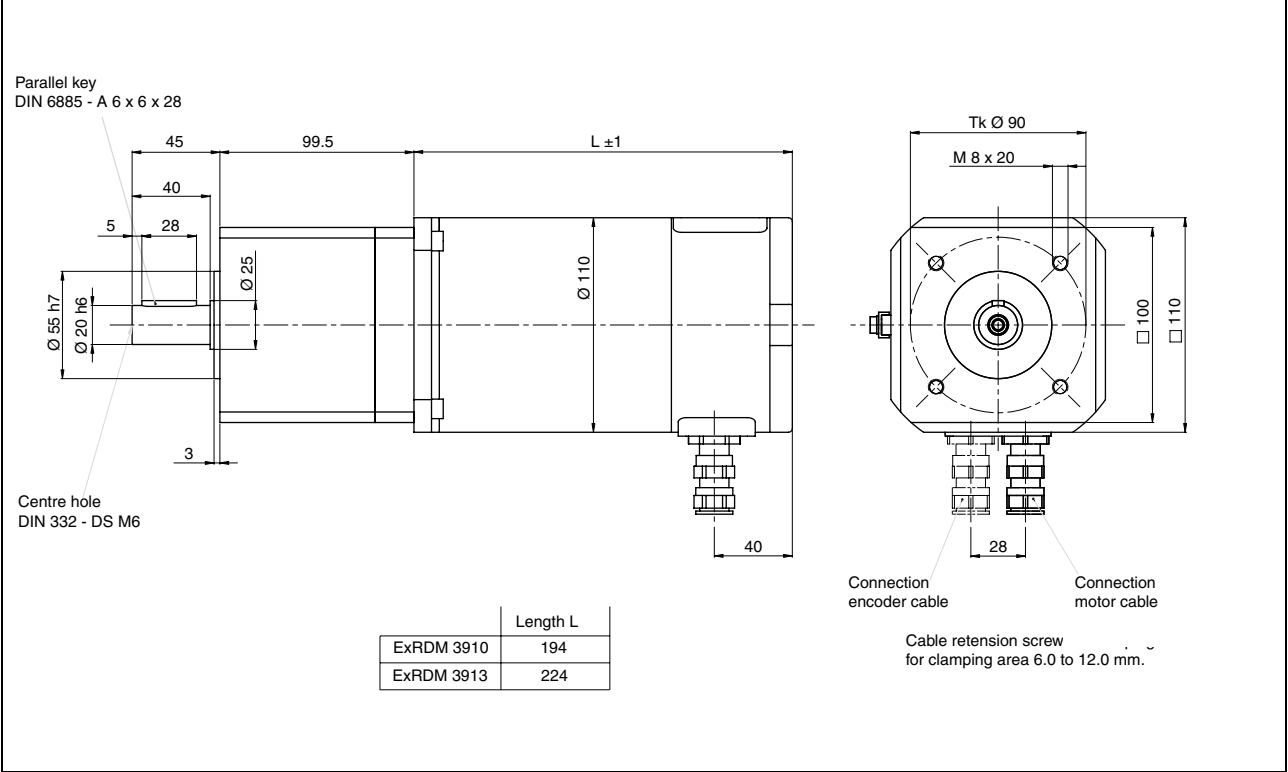
ExRDM 3913



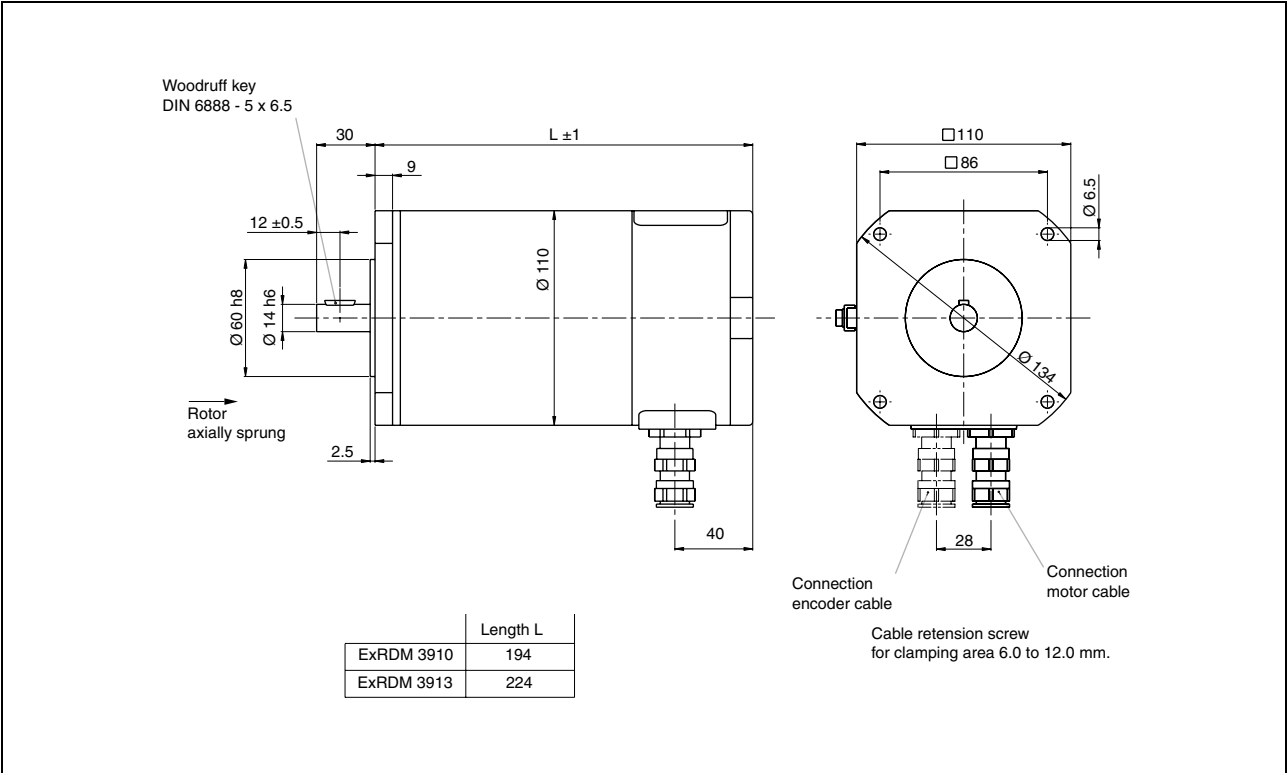
Measurement at 1000 steps/revolution, nominal voltage DC bus U_N and phase current I_N

- (1) Pull-out torque
- (2) Start limit torque
- (3) Maximum load inertia

Dimensional drawings

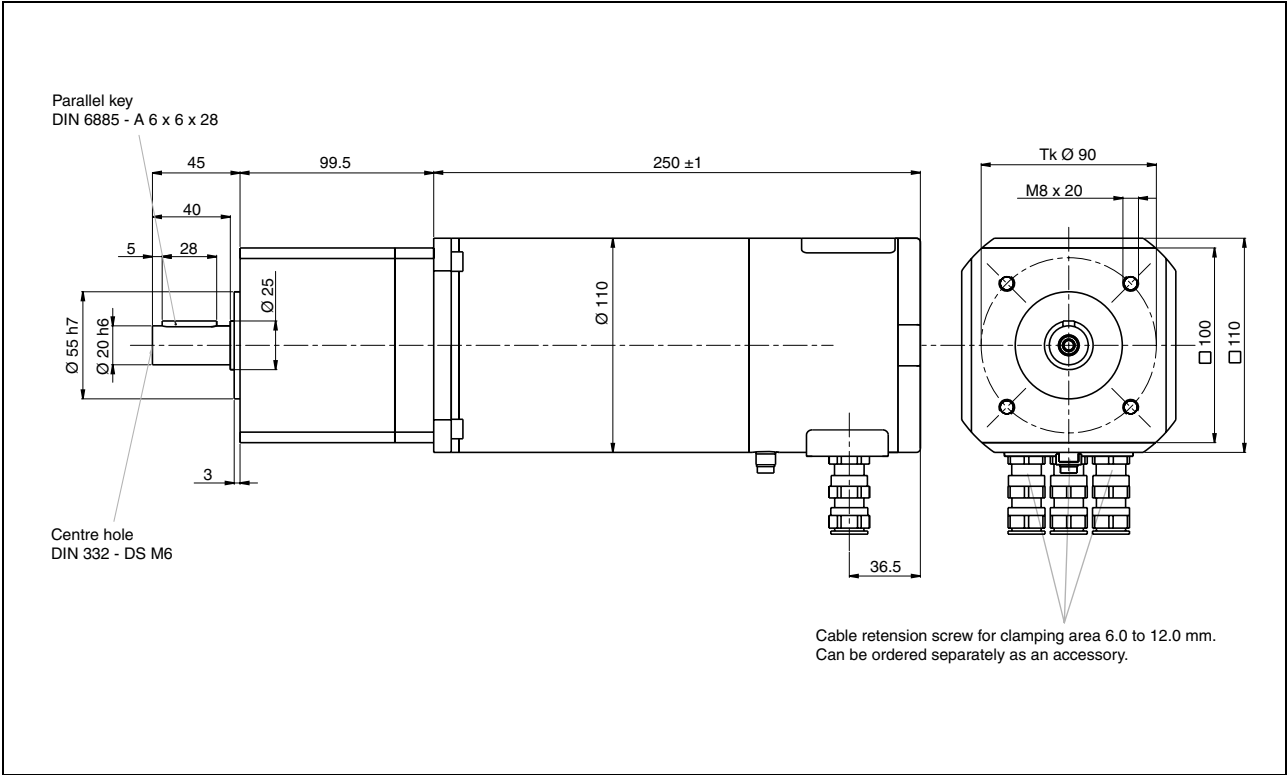


ExRDM 39•NE and ExRDM 39•NEi with gearbox

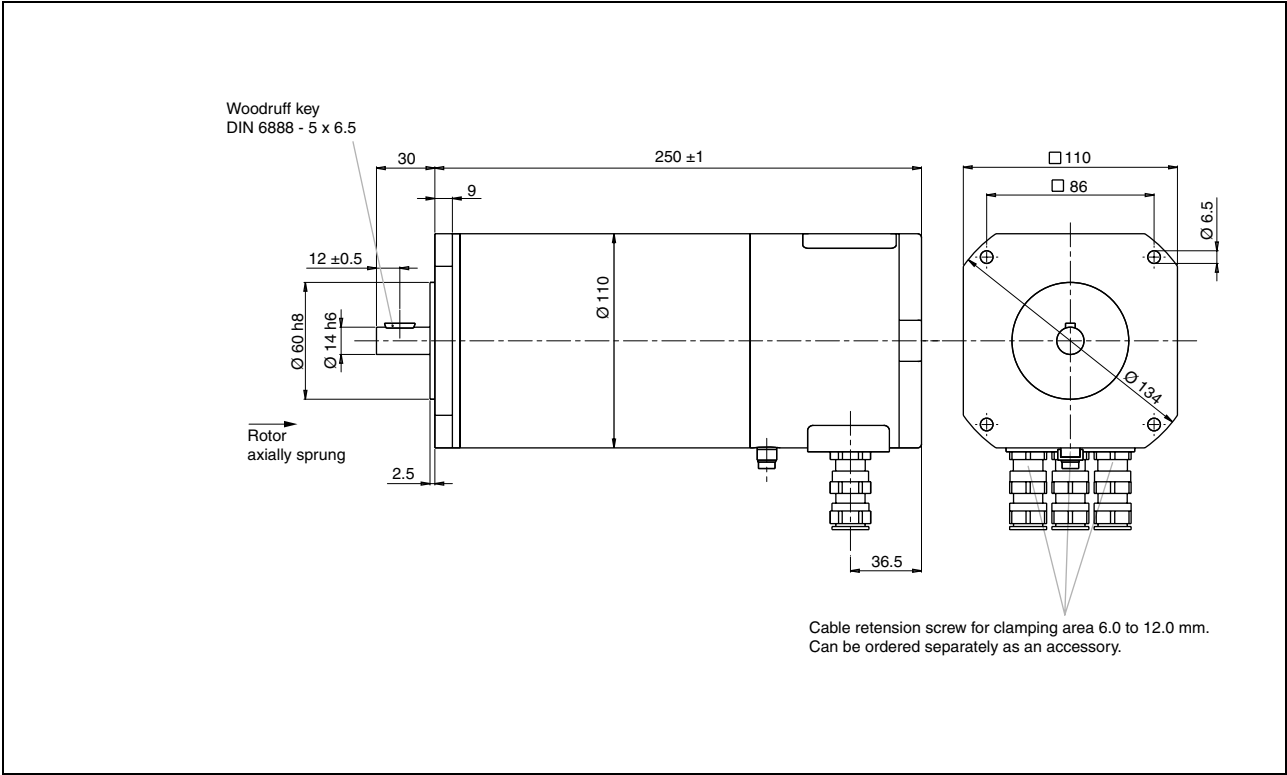


ExRDM 39•NE and ExRDM 39•NEi without gearbox

Dimensional drawings



ExRDM 39•NEa with gearbox



ExRDM 39•NEa without gearbox

Explosion-proof 3-phase stepper motors

ExRDM 39•
Type code

Type code																	
Example:	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Product family ExRDM = Explosion-protected motor	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Phase count 3	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Motor size (Flange) 9 = 85 mm	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Motor length 10 = 194 mm 13 = 224 mm	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Number of pole pairs 50	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
N = No meaning	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Encoders O = Without encoder E = With encoder	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Encoder type A = Absolute I = Incremental	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	5	D4	K	60
Winding (Motor voltage) 7 = 230 V _{AC} (325 V _{DC})	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Approval A = ATEX U = UL (only with length 13)	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Degree of protection IP44 = IP44 on shaft bushing	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Gearbox type O = Without gearbox U = Planetary gear PL 50/100 /ATEX	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Gear ratio O = Without gearbox 3 = 3:1 5 = 5:1	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Shaft diameter D4 = 14 mm DO = With gearbox	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Shaft model front K = Woodruff key as per DIN 6888 O = With gearbox	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60
Centring collar 60 = 60 mm OO = With gearbox	ExRDM	3	9	10	/	50	N	E	I	7	A	IP44	O	O	D4	K	60

Note:

Please note the description of the possible motor types on page 3.

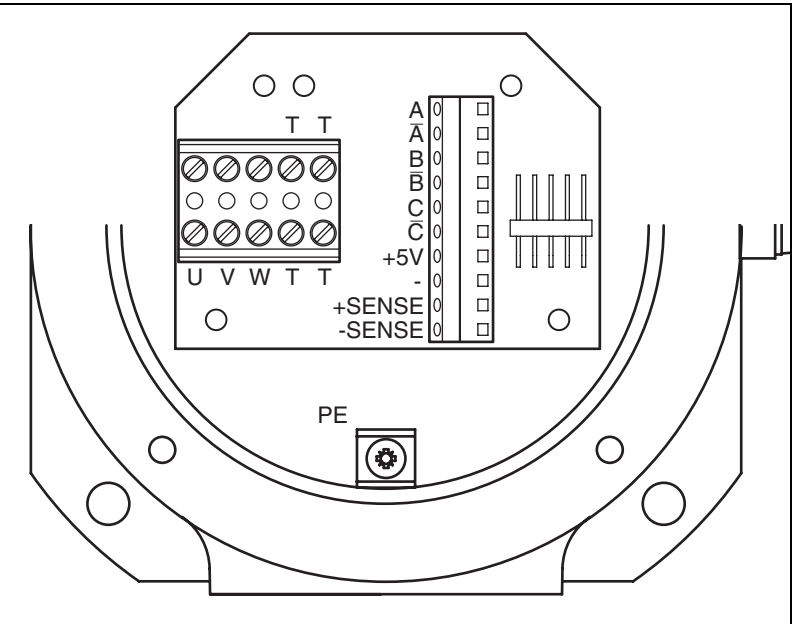
Options
Encoder

The 3-phase stepper motors from Berger Lahr can be equipped with an encoder. If the control electronics are equipped with rotation monitoring electronics, the encoder is used as a measurement system to acknowledge the actual position of the rotor. Rotation monitoring compares the set point and actual position of the motor and reports errors if the difference exceeds the tracking error limit. For example, a mechanical overload of the motor can thereby be recorded.

Incremental encoder for ExRDM 39•N- and ExRDM 39•NEi

Technical Data		
Resolution	Incr./rpm	1000
Index pulse	Pulse/rpm.	1
Output		RS 422
Signals		A, B, I
Signal shape		Rectangular
Supply voltage	V	5 ± 5%
Supply current	A	max. 0.125

Wiring diagram



Wiring diagram ExRDM 39•N and ExRDM 39•NEi with incremental encoder

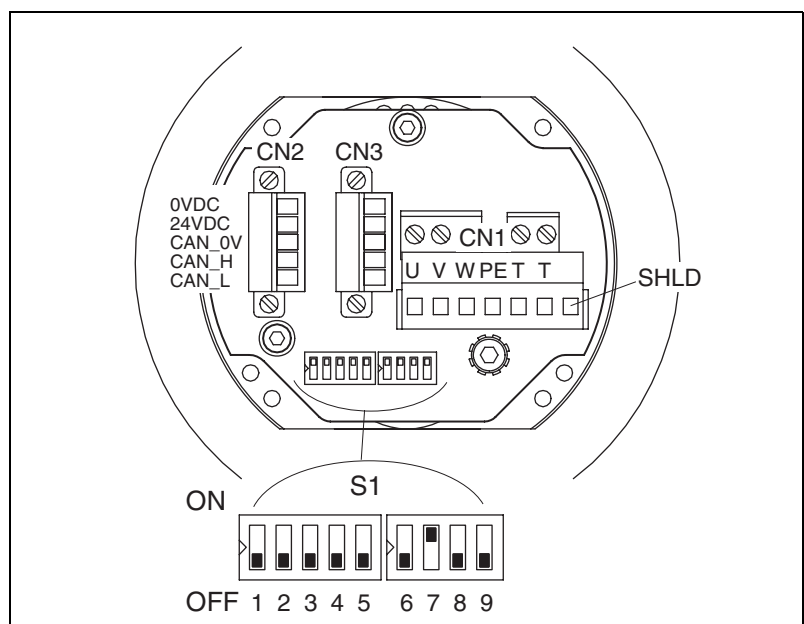
Absolute encoder for ExRDM 39•NEa

Unlike incremental encoders, the current position value is directly available for the absolute encoder. If this encoder is mechanically run in a shut-off state, the current position value can be read out directly after re-start of the power supply.

Technical Data

Supply voltage	V _{DC}	18 ... 30
Max. power consumption	A	< 0.12 at 18 V _{DC} , < 0.07 at 30 V _{DC}
Resolution	Incr./rpm	max. 8192 (13 Bit)
Measurement range	rpm	max. 4096 (12 Bit)
Baud rate	kBaud	250, line length to 250 m
	kBaud	500, line length to 100 m
Encoder interface		CAN-field bus interface (opto-isolated)
• Data transmission		CAN bus driver (ISO/DIS 11898)
• Protocol		CANopen device profile for encoder CiA DS-406 V2.0A
• Output code		Binary
Max. allowable speed	1/min	12000

Wiring diagram



Wiring diagram for ExRDM 39•NEa with absolute encoder

S1 (DIP switch)	Description
1-5	Base ID
6	Memory function 0: All parameters are stored 1: No parameter is stored. After power Off/On, the old values apply again.
7	Baud rate 0: 250 kBaud 1: 500 kBaud
8	Count direction 0: Bus parameter Index 6000 is valid 1: Bus parameter Index 6000 has inverse effect
9	CAN bus termination (terminating resistor 120 Ω ± 5%) 0: powered off 1: connected

Gearbox



Explosion-proof stepper motors by Berger Lahr can also be supplied with a built-in planetary gear PL 50/100/ATEX.
These gearboxes are available in a choice of two gear ratios: 3:1 and 5:1.
The output torque of the gearbox is obtained by multiplying the characteristic values of the motor by the reduction ratio and the efficiency of the gearbox (0.96).

Technical data

Gearbox		PL 50/100/ATEX	
Planetary gear, spur-toothed, suitable for group II as per ATEX 94/9/EC, category 2D/2G/3D/3G; S1-operation			
Gear ratio		3	5
Torsional play	arcmin	12	
Torsional stiffness	Nm/arcmin	5.8	
Nominal output torque ¹⁾	Nm	30	25
Moment of inertia	kgcm ²	0.65	0.15
Max. radial force F _R ²⁾	N	700	
Max. axial force F _A ³⁾	N	700	
Max. allowable press-on force	N	1000	
Weight	kg	2.9	
Gear stages		1	
Max. drive speed	1/min	7000	
Recommended drive speed ⁴⁾	1/min	4,500	
Efficiency for nominal load	%	90	
Min. operating temperature	°C	-20	
Max. operating temperature	°C	+80	
Bearings		Deep-groove ball bearing	
Degree of protection		IP 65	
Lubrication		Grease lubrication	
Service life	h	10000	

¹⁾ The actual output torque is calculated from the motor torque x gear ratio x efficiency of the gearbox.

²⁾ For N = 200 1/min, F_A = 0

³⁾ For N = 200 1/min, F_R = 0

⁴⁾ The recommended operating temperature may not be exceeded!

VRDM 26•

Technical data

Motor type		VRDM 264 / 50L		VRDM 266 / 50L			VRDM 268 / 50L	
Winding		5G4A	7G8A	7G8A	5G4A	3G8A	5G4A	3G8A
Max. supply voltage U _{max}	V _{AC}	24						
Nominal voltage DC bus U _N	V _{DC}	35						
Nominal torque M _N	Nm	0.40	0.40	0.85	0.87	0.85	1.30	1.40
Holding torque M _H	Nm	0.45	0.45	1.00	1.00	1.00	1.50	1.60
Rotor inertia J _R	kgcm ²	0.09	0.09	0.22	0.22	0.22	0.38	0.38
Steps per revolution z		200 / 400						
Step angle α	°	1.8 / 0.9						
Systematic angular tolerance Δα _s ¹⁾	'	±3						
Max. starting frequency full step f _{Aom}	kHz	1.8	1.7	1.35	1.5	1.6	1.1	1.2
Max. starting frequency half step f _{Aom}	kHz	3.4	3.2	2.6	2.9	3	2.1	2.1
Phase current I _W	A _{rms}	2.1	1	1	2.1	3	2.1	3
Winding resistance R _W	Ω	1	4.75	6.7	1.4	0.8	2	1.1
Rate-of-current rise time constant τ	ms	3.2	3.2	5.0	5.0	5.0	5.5	5.5
Number of connection wires		4	8	8	4	8	4	8
Weight m ²⁾	kg	0.5	0.5	0.7	0.7	0.7	1.05	1.05
Shaft load ³⁾								
• Max. radial force 1st shaft end ⁴⁾	N	24					50	
• Max. radial force 2nd shaft end (optional) ⁵⁾	N	25 / 40						
• Max. axial force pull	N	100						
• Max. axial force compression	N	8.4						
• Nominal bearing life L _{10h} ⁶⁾	h	20000						

¹⁾ Measured at 200 / 400 steps/revolution, unit: minutes of arc

²⁾ Weight of the motor version with braided wires

³⁾ Conditions for shaft load: speed of rotation 600 1/min, 100% ED at nominal torque, ambient temperature 40 °C (storage temperature ≈ 80 °C)

⁴⁾ Point of attack of radial force: in the middle of the shaft end

⁵⁾ Point of attack of radial force: in the middle of the shaft end; 1st value: Motors with terminal boxes, connectors or encoder; 2nd value: Motors with braided wires

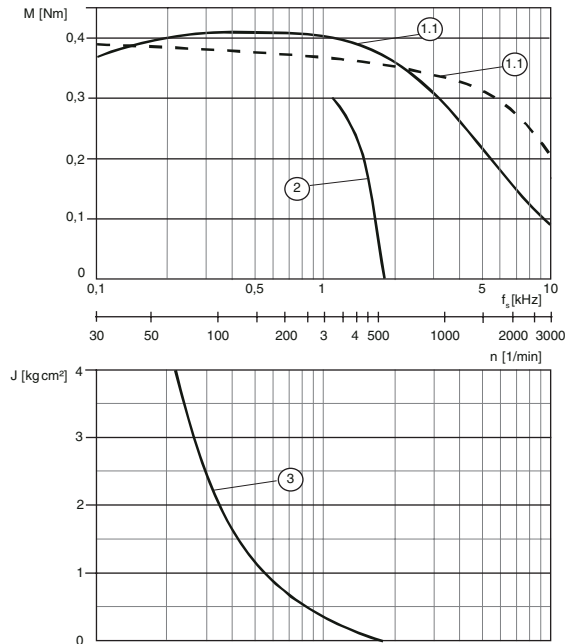
⁶⁾ Operating hours at a failure probability of 10%

Environmental conditions

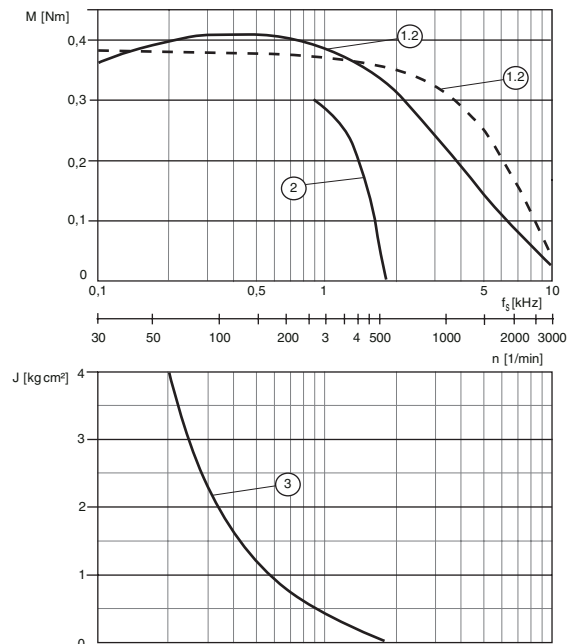
Ambient temperature	°C	-25 ... +40
Installation height without power reduction	m a. MSL	1000
Transport and storage temperature	°C	-25 ... +70
Relative humidity	%	5 ... 85; no condensation permissible
Vibration severity in operation as per DIN EN 60034-14		A
Max. vibration load	m/s ²	20
Degree of protection as per DIN EN 60034-5		
• Total except shaft bushing		IP 41
• Shaft bushing		IP 41
Heat class as per EN 60034-1		155 (F)
Shaft wobble and axial precision		DIN EN 50 347 (IEC 60072-1)
Max. rotary acceleration	Wheel/s ²	200000

Characteristic curves

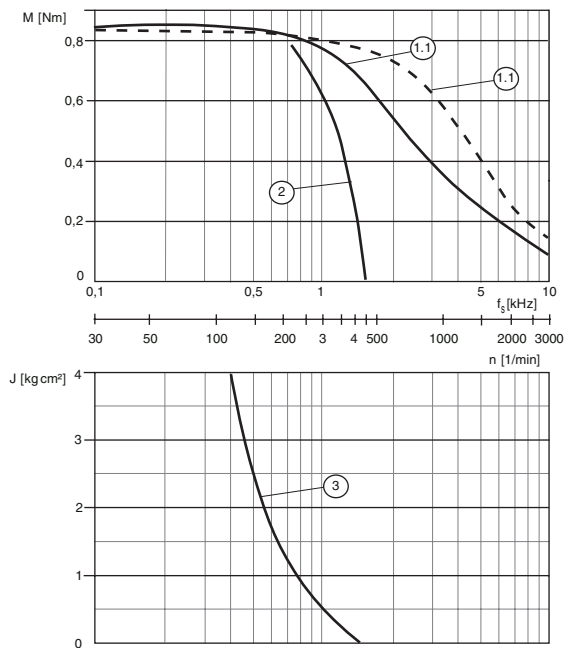
VRDM 264 / 50L 5G4A



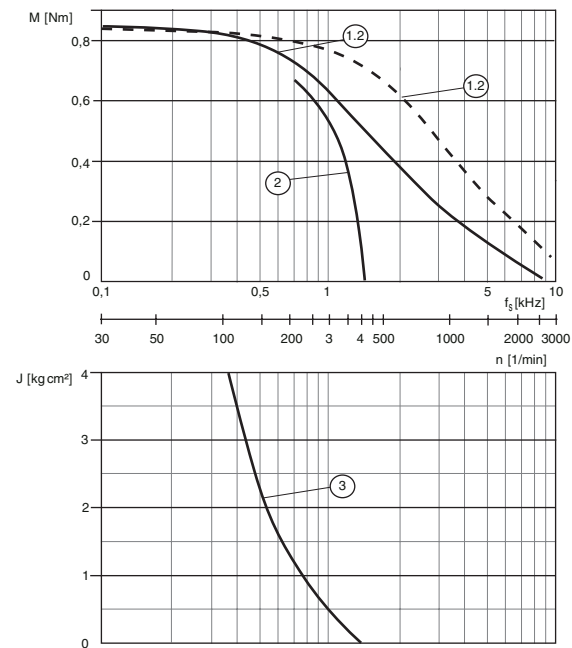
VRDM 264 / 50L 7G8A



VRDM 266 / 50L 5G4A



VRDM 266 / 50L 7G8A

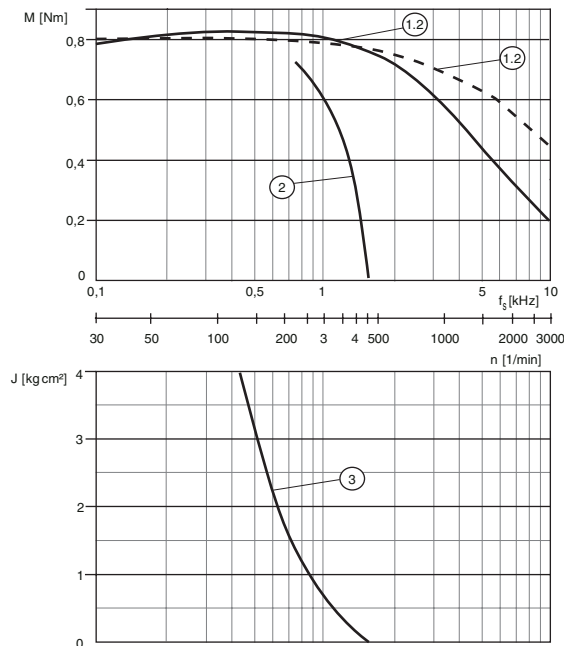


- (1.1) Pull-out torque at $U_N = 35 V_{DC}$ and $I_W = 2.1 A$
 (1.2) Pull-out torque at $U_N = 35 V_{DC}$ and $I_W' = 1.4 A$
 (The characteristic curve was measured with a bipolar parallel connection and the calculated current: $I_W' = I_W \cdot \sqrt{2}$, I_W' - Current setting on controller)
 (2) Start limit torque
 (3) Maximum load inertia

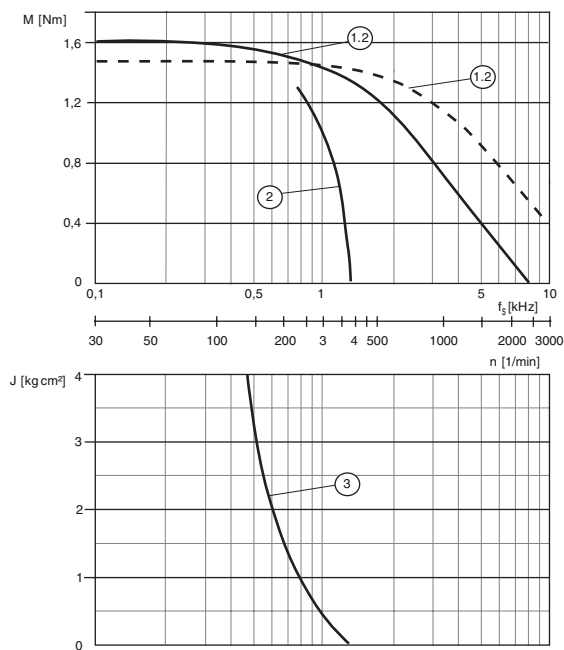
—: Measured at full step (200 steps per revolution)
 - - - : Measured at half step (400 steps per revolution)

Characteristic curves

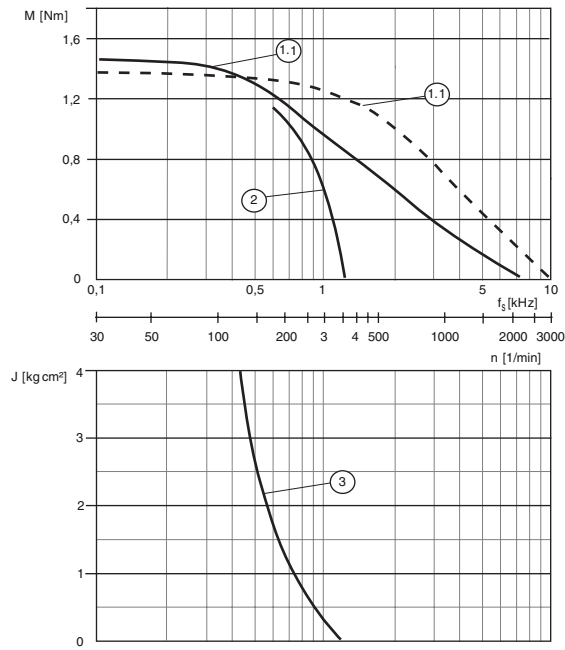
VRDM 266 / 50L 3G8A



VRDM 268 / 50L 3G8A



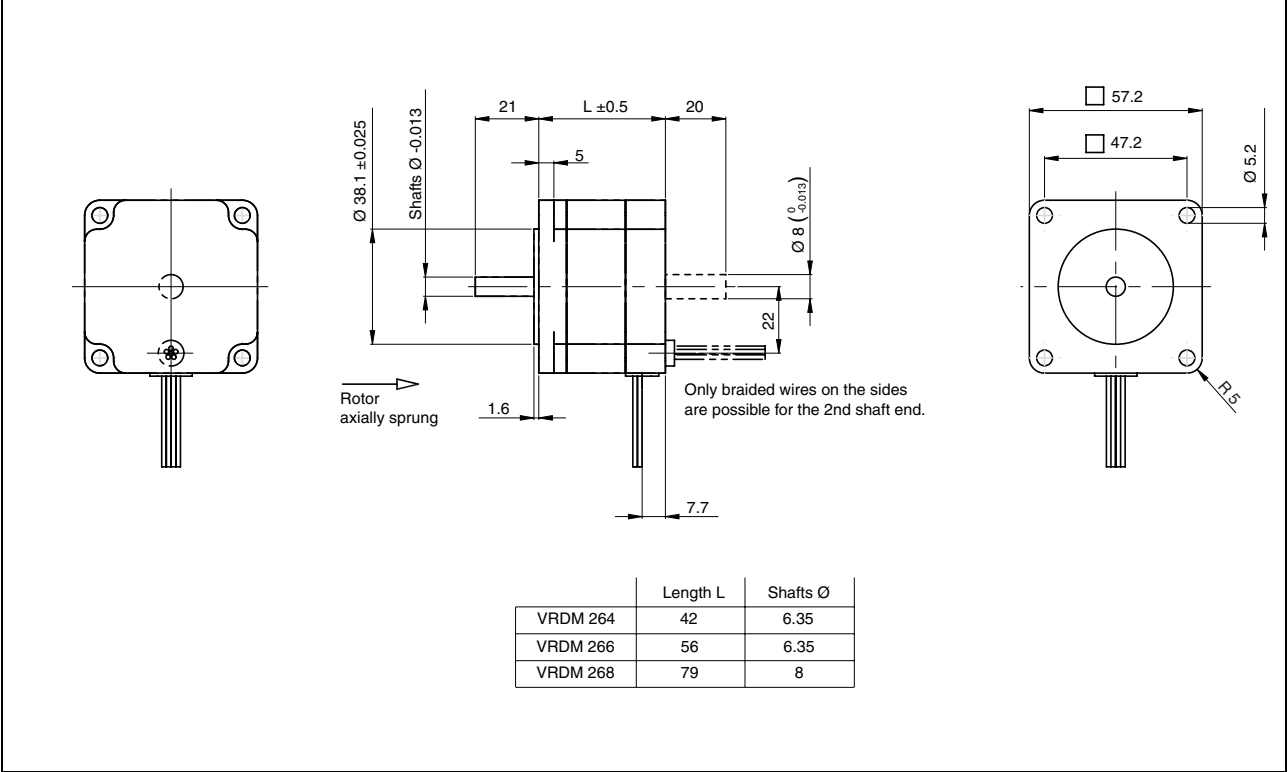
VRDM 268 / 50L 5G4A



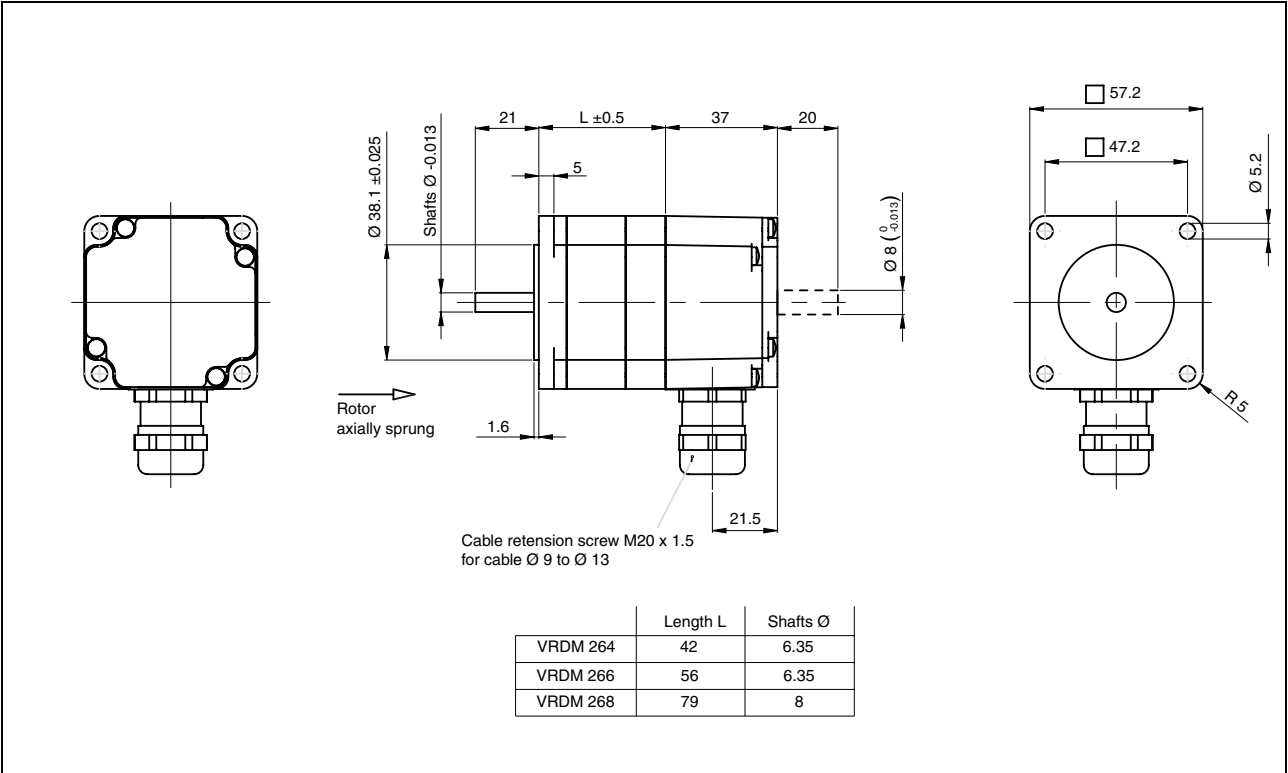
- (1.1) Pull-out torque at $U_N = 35 V_{DC}$ and $I_W = 2.1 A$
(1.2) Pull-out torque at $U_N = 35 V_{DC}$ and $I_W' = 4.2 A$
(The characteristic curve was measured with a bipolar parallel connection and the calculated current: $I_W' = I_W \cdot \sqrt{2}$, I_W' - Current setting on controller)
(2) Start limit torque
(3) Maximum load inertia

—: Measured at full step (200 steps per revolution)
---: Measured at half step (400 steps per revolution)

Dimensional drawings

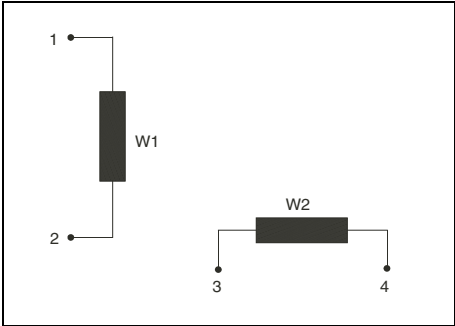


2-phase stepper motor VRDM 26• in braided wire version

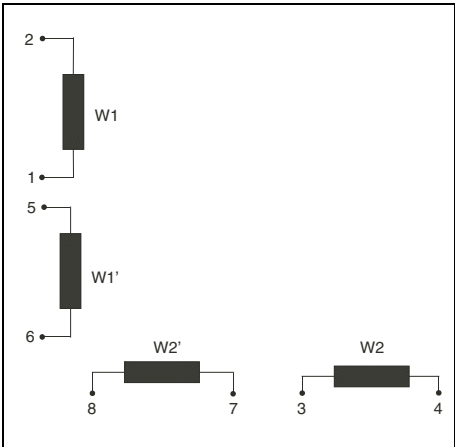


2-phase stepper motor VRDM 26• in terminal box version

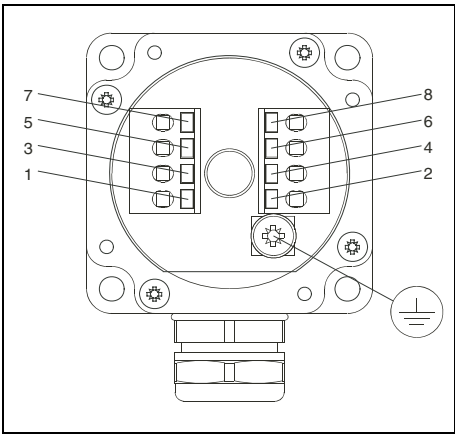
Motor connection



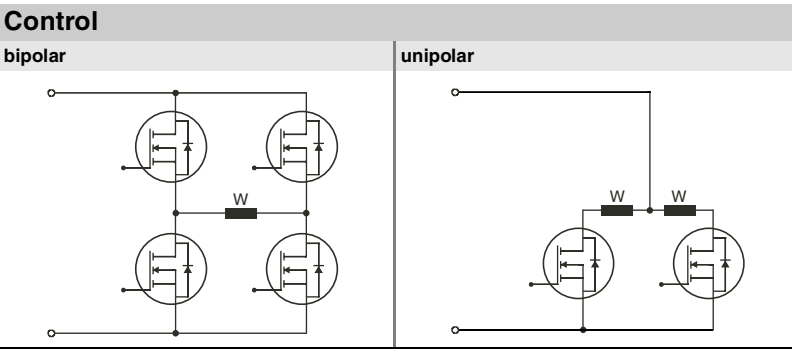
Motor connection in braided wire version with four connection wires		
Designation	Motor wire colour as per DIN IEC 757	Motor wire colour
1	BR	brown
2	BR/WH	brown and white
3	RD	red
4	RD/WH	red and white



Motor connection in braided wire version with eight connection wires		
Designation	Motor wire colour as per DIN IEC 757	Motor wire colour
1	BR	brown
2	BR/WH	brown and white
3	RD	red
4	RD/WH	red and white
5	OR	orange
6	OR/WH	orange and white
7	YE	yellow
8	YE/WH	yellow and white



Motor connection in terminal box version		
Designation	Wire colour as per DIN IEC 757	Wire colour
1	BR	brown
2	BR/WH	brown and white
3	RD	red
4	RD/WH	red and white
5	OR	orange
6	OR/WH	orange and white
7	YE	yellow
8	YE/WH	yellow and white



Type code																						
Example:	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Phase count 2	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Size (Flange) 6 (57.2mm)	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Length 4 = 42 mm 6 = 56 mm 8 = 79 mm	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Number of pole pairs 50	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Rotor L = Laminated rotor plate	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Winding variant 3; 5; 7	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Winding circuit G = General	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Connection type I 4 = 4 braided wires 8 = 8 braided wires	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Connection type II A = Braided wires B = Terminal box	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Degree of protection IP41 = IP41 on shaft bushing	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Gearbox type ¹⁾ O = Without gearbox 1 = PLE 40 2 = PLE 60 A = PLS 70	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Gear ratio O = Without gearbox 3 = 3 : 1 5 = 5 : 1 8 = 8 : 1	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Shaft diameter D6 = 6.35 mm D8 = 8 mm DO = With gearbox	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Shaft model front O = Without processing or with gearbox	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Centring collar 38 = 38.10 mm OO = With gearbox	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Second shaft O = Without 2 = With	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
O = Reserved	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
O = Reserved	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Braided wire output O = Without S = Side B = Back	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO
Braided wire length OOO = Without xxx = xxx mm (max. 400 mm)	VRDM	2	6	8	/	50	L	3	G	4	B	IP41	1	5	DO	O	OO	2	O	O	O	OOO

¹⁾ Description of gearbox see options VRDM 36x, page 27

Possible motor types

VRDM 264 / 50L 5G4 ...

VRDM 264 / 50L 7G8 ...

VRDM 266 / 50L 3G8 ...

VRDM 266 / 50L 5G4 ...

VRDM 266 / 50L 7G8 ...

VRDM 268 / 50L 3G8 ...

VRDM 268 / 50L 5G4 ...

Conversion tables

Rotor inertia										
	lb-in ²	lb-ft ²	lb-in-s ²	lb-ft-s ² slug-ft ²	kg-cm ²	kg-cm-s ²	g-cm ²	g-cm-s ²	oz-in ²	oz-in-s ²
lb-in ²	–	6.94×10^{-3}	2.59×10^{-3}	2.15×10^{-4}	2.926	2.98×10^{-3}	2.92×10^3	2.984	16	4.14×10^{-2}
lb-ft ²	144	–	0.3729	3.10×10^{-2}	421.40	0.4297	4.21×10^5	429.71	2304	5.967
lb-in-s ²	386.08	2.681	–	8.33×10^{-2}	1.129×10^3	1.152	1.129×10^6	1.152×10^3	6.177×10^3	16
lb-ft-s ² slug-ft ²	4.63×10^3	32.17	12	–	1.35×10^4	13.825	1.355×10^7	1.38×10^4	7.41×10^4	192
kg-cm ²	0.3417	2.37×10^{-3}	8.85×10^{-4}	7.37×10^{-6}	–	1.019×10^{-3}	1000	1.019	5.46	1.41×10^{-2}
kg-cm-s ²	335.1	2.327	0.8679	7.23×10^{-2}	980.66	–	9.8×10^5	1000	5.36×10^3	13.887
g-cm ²	3.417×10^{-4}	2.37×10^{-6}	8.85×10^{-7}	7.37×10^{-8}	1×10^{-3}	1.01×10^{-6}	–	1.01×10^{-3}	5.46×10^{-3}	1.41×10^{-6}
g-cm-s ²	0.335	2.32×10^{-3}	8.67×10^{-4}	7.23×10^{-5}	0.9806	1×10^{-3}	980.6	–	5.36	1.38×10^{-2}
oz-in ²	0.0625	4.3×10^{-4}	1.61×10^{-6}	1.34×10^{-6}	0.182	1.86×10^{-4}	182.9	0.186	–	2.59×10^{-3}
oz-in-s ²	24.13	0.1675	6.25×10^{-2}	5.20×10^{-3}	70.615	7.20×10^{-2}	7.06×10^4	72	386.08	–

Torque									
	lb-in	lb-ft	oz-in	Nm	kg-m	kg-cm	g-cm	dyne-cm	
lb-in	–	8.333×10^{-2}	16	0.113	1.152×10^{-2}	1.152	1.152×10^3	1.129×10^6	
lb-ft	12	–	192	1.355	0.138	13.825	1.382×10^4	1.355×10^7	
oz-in	6.25×10^{-2}	5.208×10^{-3}	–	7.061×10^{-3}	7.200×10^{-4}	7.200×10^{-2}	72.007	7.061×10^4	
Nm	8.850	0.737	141.612	–	0.102	10.197	1.019×10^4	1×10^7	
kg-m	86.796	7.233	1.388×10^3	9.806	–	100	1×10^5	9.806×10^7	
kg-cm	0.8679	7.233×10^{-2}	13.877	9.806×10^{-2}	10^{-2}	–	1000	9.806×10^5	
g-cm	8.679×10^{-4}	7.233×10^{-5}	1.388×10^{-2}	9.806×10^{-5}	1×10^{-5}	1×10^{-3}	–	980.665	
dyne-cm	8.850×10^{-7}	7.375×10^{-8}	1.416×10^{-5}	10^{-7}	1.019×10^{-8}	1.0197×10^{-6}	1.019×10^{-6}	–	

Power		
	H.P.	W
H.P.	–	745.7
W	1.31×10^{-3}	–

Length						
	in	ft	yd	m	cm	mm
in	–	0.0833	0.028	0.0254	2.54	25.4
ft	12	–	0.333	0.3048	30.48	304.8
yd	36	3	–	0.914	91.44	914.4
m	39.37	3.281	1.09	–	100	1000
cm	0.3937	0.03281	1.09×10^{-2}	0.01	–	10
mm	0.03937	0.00328	1.09×10^{-3}	0.001	0.1	–

Rotation			
	1/min (rpm)	rad/sec	deg./sec
1/min (rpm)	–	0.105	6.0
rad/sec	9.55	–	57.30
deg./sec	0.167	1.745×10^{-2}	–

Weight					
	lb	oz	slug	kg	g
lb	–	16	0.0311	0.453592	453.592
oz	6.35×10^{-2}	–	1.93×10^{-3}	0.028349	28.35
slug	32.17	514.8	–	14.5939	1.459×10^4
kg	2.20462	35.274	0.0685218	–	1000
g	2.205×10^{-3}	3.527×10^{-3}	6.852×10^{-5}	0.001	–

Temperature		
	°F	°C
°F	–	$(9 - 32) \cdot \frac{5}{9}$
°C	$9 \cdot \frac{9}{5} + 32$	–

Force					
	lb	oz	gf	dyne	N
lb	–	16	453.592	4.448×10^5	4.4482
oz	0.0625	–	28.35	2.780×10^4	0.27801
gf	2.205×10^{-3}	0.03527	–	980.665	N.A.
dyne	2.248×10^{-6}	3.59×10^{-6}	1.02×10^{-3}	–	0.0001
N	0.22481	3.5967	N.A.	100,000	–

Example for conversion:

Conversion of a 10 inch length measurement into metres. Look for the entry “in” (= inch) in the “Length” table in the left column and the entry “m” (= metre) in the header. The table cell at the point of intersection of the column and the row will show the conversion factor: “0.0254”. Multiply 10 inches by 0.0254 and you will get the value in metres: $10 \text{ in} \times 0.0254 = 0.254 \text{ m}$.



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