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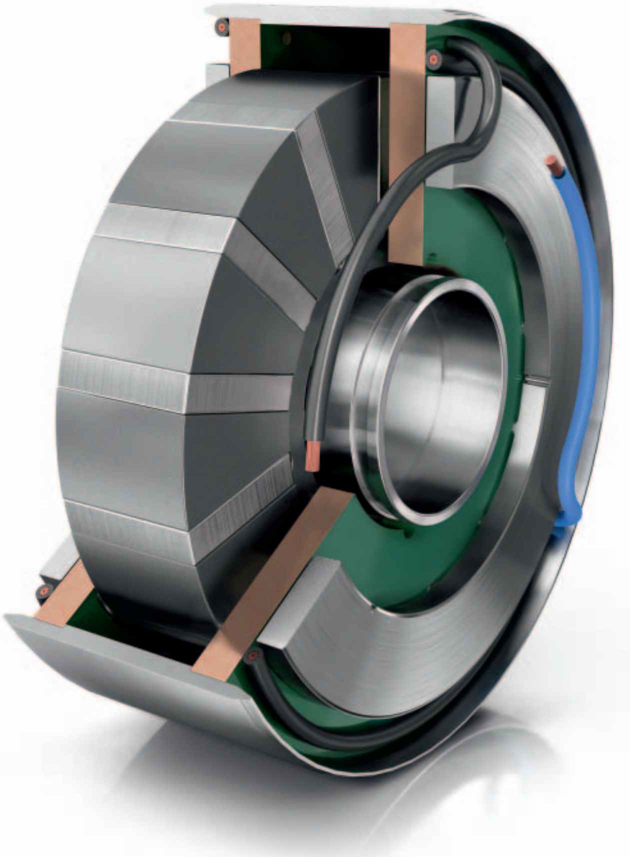


PCB Motors

Series UPRS

Foreword

UPRS motors as frameless axial flux machine

PCB motors (printed circuit board motor) of series UPRS from Schaeffler can be used to achieve highly compact, high-torque drives.

The highly specific motor development opens up new degrees of freedom for designers in the integration of drives in applications with a short axial installation space.

Innovative materials in the active components of the motor reduce the weight of the motors and increase their energy efficiency.
As is usual with frameless motors, the bearing arrangement in the adjacent construction is put to joint use here, thus saving additional weight and reducing the axial and radial installation space.

Increased plant productivity

The high performance values and low weight of the motor lead to good overall dynamics. High velocities permit short cycle times and thus contribute to an increase in plant productivity.

Individual component or system design

Motors of series UPRS can cover a multitude of applications.
The motors are designed for Schaeffler DuraWave precision strain wave gears. As a result, the motor, spherical plain bearings and gear unit are perfectly matched to each other in a pre-assembled drive unit.

For complete planning freedom, the motors can also be purchased separately as individual components.

Motor UPRS

Motor UPRS

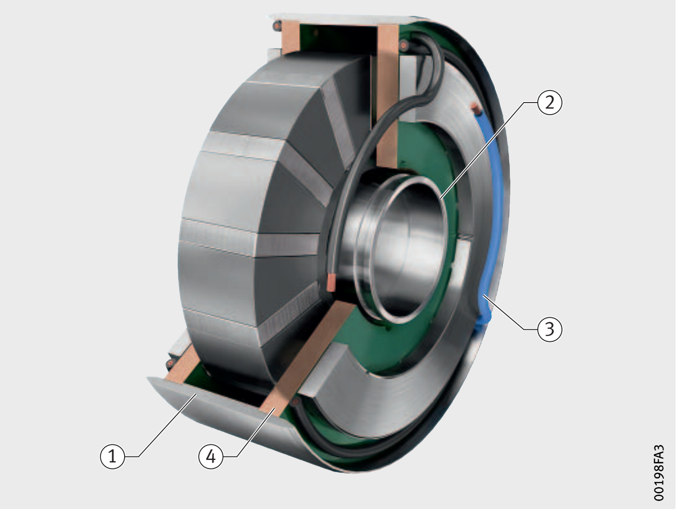
Features

UPRS motors are designed as frameless axial flux machines.

Design

The stator in a PCB motor (printed circuit board motor) consists of circuit board material with imprinted copper traces. The special circuit board design facilitates a high copper content per volume as well as good heat dissipation and energy efficiency. The high copper content and design as a permanently excited axial flux motor also impact positively on the torque, while the standstill losses associated with these motors are very low.

The bearing arrangement in the adjacent construction is put to joint use here, thus saving additional axial and radial installation space as well as weight.



① Stator
② Rotor
③ Cable
④ Winding

Figure 1
Motor UPRS

Technical characteristics

The special technical characteristics of this motor are:

- high torque density
- small design envelope
- high payload
- high positioning and repeat accuracy
- quiet and low-vibration operation

High performance and torque density

The high performance values and low weight lead to good overall motor dynamics, with high velocities resulting in short cycle times.

The high motor constants and limiting speeds enable high motor performance.

Zero cogging

As a result of the low cogging torques and torque fluctuations, the motors enable smooth and uniform operation. The predictable torque is essential for use in applications that place high demands on positioning and repeat accuracy.

Low noise level

The motors operate quietly and with low vibration, which is a particular advantage in noise-sensitive applications where the machines work in close proximity to operating personnel.

Temperature range

The motors are intended for use in the joints of collaborative robots. In this area of application, the housing temperature is typically limited to a range of $< +50$ °C. The interference fit of the motor in the housing must be designed for the anticipated motor and housing temperatures in the planned application, in order to prevent the motor from slipping in the housing.

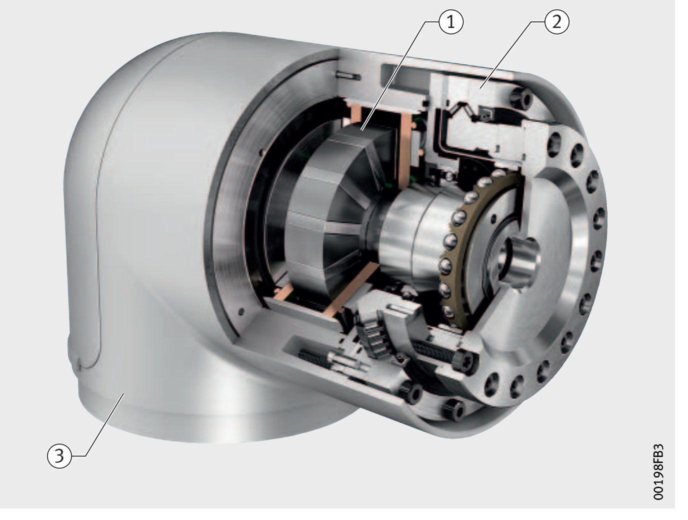
At its peak, the maximum winding temperature of the motor must not exceed +100 °C. The motor must be actively cooled as required, if high loads are to be driven continuously. As a result of the special coil design, the motors emit the generated heat to the surrounding housing.

Motor UPRS

Application
Individual component or system assembly

The motors are designed for Schaeffler DuraWave precision strain wave gears. As a result, the motor, spherical plain bearings and gear unit are matched to each other in a pre-assembled drive unit. The UPRS motors can be combined with various Schaeffler DuraWave strain wave gears of series RT1 and RT2. Please consult Schaeffler Application Engineering about your specific application.

The motors can also be purchased separately as individual components. To adapt the motors to customer-specific requirements, please contact Schaeffler.



① Motor UPRS
② Strain wave gear Schaeffler DuraWave
③ Housing

Figure 2
Motor UPRS
in the entire system

Areas of application

Typical applications include robotics, automation, medicine, industry and semiconductors.

As a result of their compact design, the motors are particularly suitable for applications with a short axial installation space. The special motor development is suitable for integration in articulated arms, in cardanic suspension arrangements for sensors or in unmanned aircraft.

As a result of their small space requirement, the motors can also be easily integrated into existing designs, thus reducing the outlay and effort involved in both the design and assembly stages. If you have any questions regarding integration, please contact Schaeffler.

Figure 3
Collaborative robot (cobot)

Performance

Performance data

The performance data of the motors are determined by the size, see *Figure 4* to *Figure 7*, page 9.

Reference values for I_p and I_r, see dimension table, page 12.

M = torque
n = speed
P = power
I_r = nominal current
I_p = peak current

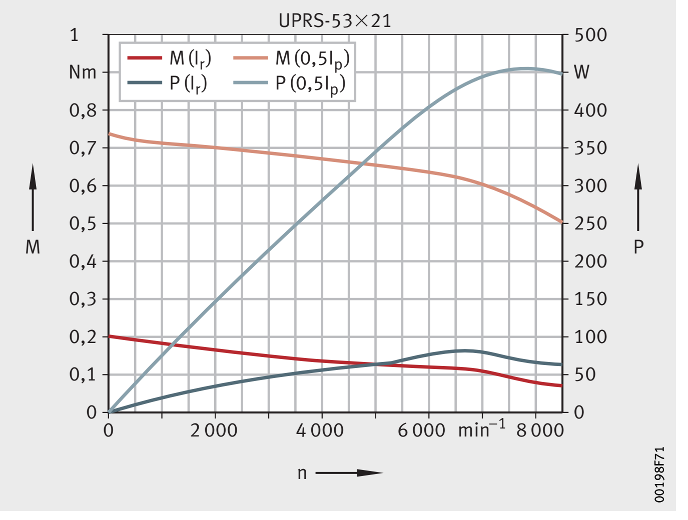


Figure 4
Motor power for UPRS-53×21

M = torque
n = speed
P = power
I_r = nominal current
I_p = peak current

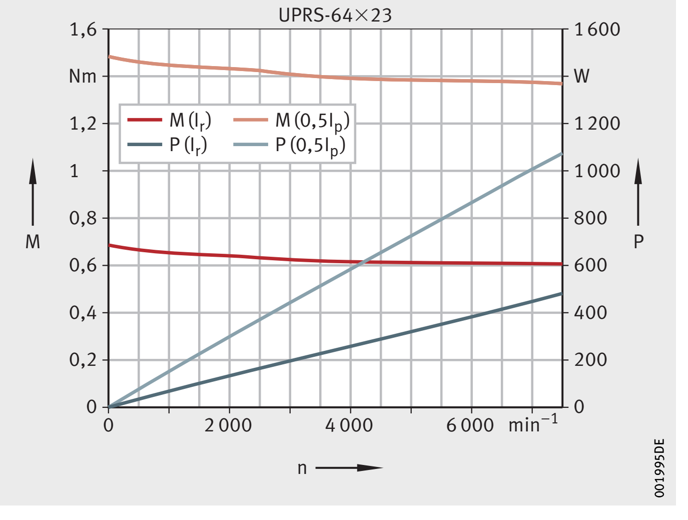


Figure 5
Motor power for UPRS-64×23

M = torque
n = speed
P = power
I_r = nominal current
I_p = peak current

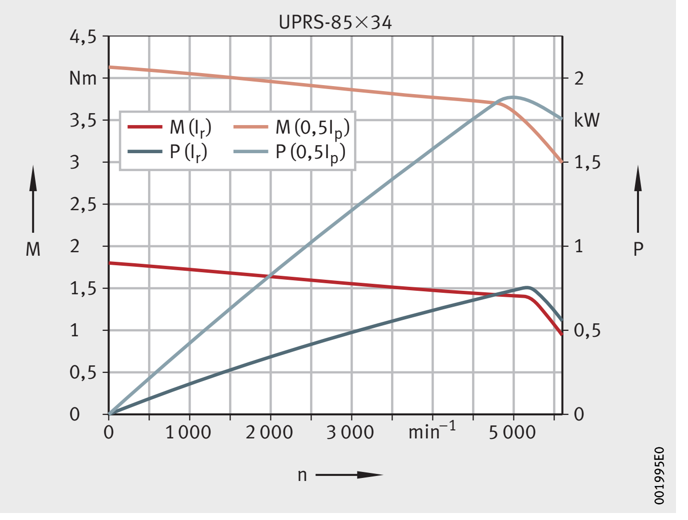


Figure 6
Motor power for
UPRS-85×34

M = torque
n = speed
P = power
I_r = nominal current
I_p = peak current

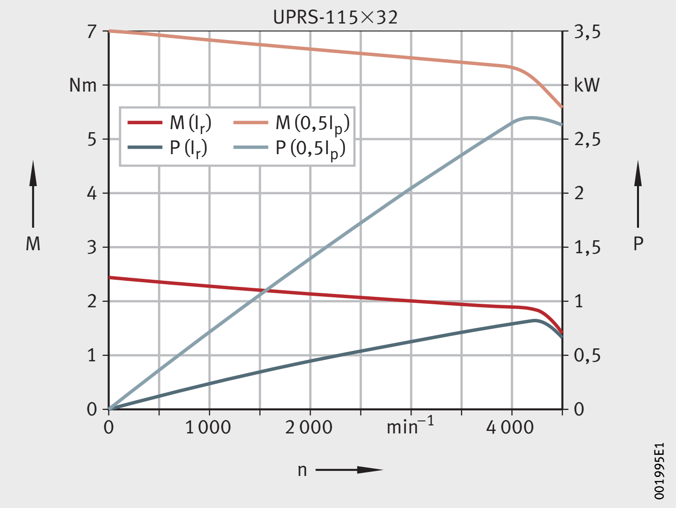


Figure 7
Motor power for
UPRS-115×32

Motor UPRS

Sinusoidal commutation

The motors are designed as permanently excited synchronous machines and are operated with sinusoidal commutation.
A rotor position sensor provided by the customer is required for correct commutation.

Operation outside the nominal range

When operating outside the nominal range, there is a risk of local overheating and consequential demagnetization or thermal destruction of the motor. It must therefore be ensured that the specified peak torque M_p is only approached for a short period of time and with a sufficiently cooled motor.

A peak load on a motor that is already very hot ($>$ +60 °C) should be avoided, as temperatures rise very quickly in the peak load range and local overheating zones can form in the motor.

Operating time

The operating time is determined by the installation and cooling situation. Suitable sensors must be used to prevent the motor from overheating.

Standstill operation

As the individual phase current at standstill can be higher by a factor of 1,4, depending on the rotor position, when the rms current is applied, the motor temperature must be monitored and adequate cooling ensured.

Electrical connections

The motor has a positive direction of rotation. Rotation takes place in a clockwise direction when the master (connection side) is visible and in an anti-clockwise direction when the slave (stator side without connection cables) is visible.

This is controlled automatically by evaluation of the measuring system. The motor has no Hall sensors.

A long motor cable and high rise (dU/dt) in the converter voltage can lead to voltage peaks at the motor terminals, which significantly exceed the DC intermediate circuit voltage and may destroy the motor winding. In these cases, additional filters should be used.

The motor has no over-temperature protection. To protect against over-temperature at the phase windings, the customer should use the control-side options for I^2t monitoring.

Motor constant

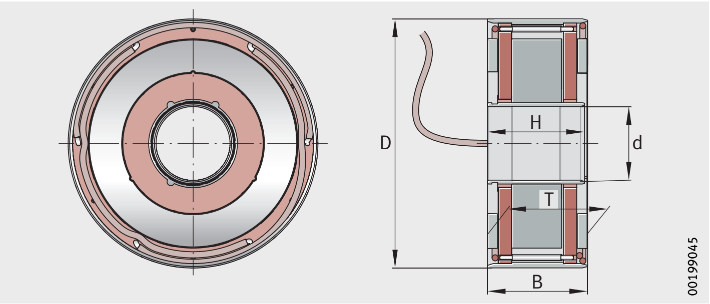
The motor constant shows the relationship between the generated torque and power loss and is dependent on temperature. As a purely theoretical value, it is, by definition, only valid for quasistatic operation within the linear range, i.e. when very small movements or positioning processes are performed at low speeds.

An increase in temperature indicates a rise in winding resistance, which leads to a reduction in the motor constant. If the current or torque are constant, the power loss in a motor which is already heated will be greater than that occurring in a motor which is still cold. This leads to an even higher motor temperature.

Explanation of symbols

B	mm
Width of the housing outer ring	
H	mm
Width of the motor shaft	
I_p	A
Peak current, root mean square value (RMS)	
I_r	A
Nominal current, RMS value, with cooled housing	
J	$kg \cdot cm^2$
Moment of inertia	
k_m	$Nm/\sqrt{W}$
Motor constant	
k_T	Nm/A
Torque constant, in relation to the root mean square value (RMS) of the current	
L	mH
Induction	
M_p	Nm
Peak torque Motor torque that can be generated with the peak current I_p (maximum duration of 0,5 s)	
M_r	Nm
Nominal torque Motor torque in nominal operation at I_r, with cooled housing	
M_{sw}	Nm
Standstill torque Motor torque that the motor can continuously generate while at a standstill	
n_{max}	min^{-1}
Limiting speed	
n_r	min^{-1}
Nominal speed	
P_r	W
Rated power	
R_{25}	Ω
Resistance at +25 °C	
s	mm
Total air gap	
T	mm
Total width of the motor	
U	V
Intermediate circuit voltage	

PCB motor



Dimension table · Dimensions in mm											
Designation	Mass	Dimensions					CAD data[1]	Performance data			
	≈ m	D	d	B	T	H		n_{max}	n_r	J	R_{25}
	kg							min^{-1}	min^{-1}	kg·cm[2]	Ω
UPRS-53×21	0,21	53	16,5	21	21,46	22,17	➤ *CAD*	8 500	3 300	0,18	0,088
UPRS-64×23	0,34	64	24	23	23,44	24,42	➤ *CAD*	7 500	7 500	0,506	0,088
UPRS-85×34	0,9	85	25,2	34	34,46	35,22	➤ *CAD*	5 600	5 000	3,1	0,08
UPRS-115×32	1,67	115	32	32	33,41	33,12	➤ *CAD*	4 500	4 200	10,3	0,044

Explanation of symbols, see page 11.

[1] ➤ *https://www.schaeffler.de/std/1F94*

[2] Root mean square value (RMS).

L mH	P_r W	M_r Nm	M_{sw} Nm	M_p Nm	k_m Nm/$\sqrt{W}$	k_T Nm/A	I_p 2) A	I_r 2) A	U V	s mm
0,023	69	0,2	0,21	1,46	0,057	0,021	65	9,6	48	0,655
0,035	497	0,63	0,68	2,96	0,094	0,034	86	18,5	48	0,64
0,051	737	1,4	1,8	8,42	0,218	0,076	86	18,5	48	0,66
0,04	822	1,86	2,44	14,04	0,345	0,089	118	21	48	1,605

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