SCHAEFFLER

Torque motors

RIB

Catalogue

Contents

Contents

Foreword

The Schaeffler location in Suhl, Thuringia, with around 160 employees, develops highly sophisticated direct drives for the industry in both rotary and linear designs.

Over many years, we have developed our torque motor series to create optimised products that reach the boundaries of physical and economic feasibility. In addition to complex mechanical and thermal simulations of both the motor and rolling bearing arrangement, our tools for optimisation and further development also extend to the design of the magnetic and cooling circuits and magnet simulation. Each of our torque motor series has a specific combination of outstanding properties such as high torque density, very high speeds, excellent synchronous running and an optimised design for low power loss, allowing us to cover virtually all direct drive applications.

If a suitable motor cannot be found from our extensive selection, however, we will also develop a high-end positioning and drive system to meet customer requirements. Unlike any other company in the market, Schaeffler is able to determine the optimum motor topology in line with your specifications and develop a drive to exceptionally high standards. Due to the close reciprocal relationship between torque motor and associated bearing arrangement, you will benefit particularly from our expertise in rolling bearing arrangements. Not least for this reason, we also offer rolling bearing arrangements for our torque motors that are tailored to the respective machine type.

This "Torque Motors" catalogue provides you with a detailed overview of our range of rotary direct drives, their properties and possible applications. In particular, customers place their trust in direct drives from Schaeffler in the machine tool, medical equipment, automation, robotics, food machinery, packaging machinery, printing machinery, textile machinery, productronics and measuring equipment sectors.

1 Technical principles

1.1 Explanations

I	A	Motor current
$I_{c\,eff}$	A	Effective rated current, not cooled
$I_{c\,red}$	A	Reduced rated current
$I_{cw\,eff}$	A	Rated current, cooled
$I_{p\,eff}$	A	Effective peak current
$I_{pl\,eff}$	A	Effective peak current, linear range
$I_{u\,eff}$	A	Effective ultimate current
I	$kg \cdot m^2$	Mass moment of inertia
k_m	$Nm/\sqrt{W}$	Motor constant
k_T	Nm/A(eff)	Moment constant
n	min^{-1}	Speed
n_{Ic}	min^{-1}	Limiting speed at $I_{c\,eff}$ and U_{DCL}
n_{Ip}	min^{-1}	Limiting speed at $I_{p\,eff}$ and U_{DCL}
n_{lw}	min^{-1}	Knee speed
n_{lwS1}	min^{-1}	Rated speed (S1), cooled
n_{max}	min^{-1}	Max. speed
P_l	W	Power loss
R	Ω	Electrical resistance
t_b	s	Pause time
t_m	s	Movement time
t	s	Time
T	Nm	Torque
T_c	Nm	Rated torque, not cooled
T_{cw}	Nm	Rated torque, cooled
T_{eff}	Nm	Effective torque
T_F	Nm	Bearing frictional torque
T_{max}	Nm	Max. torque
T_p	Nm	Peak torque
T_{pl}	Nm	Peak torque, linear range
T_s	Nm	Stall torque
T_{sw}	Nm	Stall torque, cooled
T_u	Nm	Ultimate torque
T_W	Nm	Processing torque
T_Z	Nm	Weight force (additional torque)
U_{DCL}	V	DC link voltage
α	rad/s^2	Angular acceleration
$α_{max}$	rad/s^2	Max. angular acceleration
$α_{S1}$	rad/s^2	Angular acceleration in S1 operation
φ	°	Movement angle
ϑ	°C	Temperature
$ϑ_f$	°C	Current supply temperature
$ϑ_{max}$	°C	Max. permissible winding temperature
$ϑ_n$	°C	Rated response temperature
$ϑ_{nf}$	°C	Rated supply temperature
ω	rad/s	Angular velocity
$ω_{max}$	rad/s	Max. angular velocity

1.2 Advantages of torque motors

1.2.1 Performance capability

No distortion of the movement profile

There is no elasticity, play, friction or hysteresis in the drive train resulting from transmission or coupling elements.

Multi-pole motor

Extremely high torques are produced as a result of the multi-pole design. The torques can be used from the speed › 0 up the rated speed.

Thin, ring-shaped secondary part

The thin, ring-shaped design with a large, free inside diameter reduces motor inertia and yields a high acceleration rate.

Direct position measurement

High-precision, dynamic positioning operations are possible courtesy of the direct position measurement and rigid mechanical structure.

Controller compatibility

Torque motors from Schaeffler Industrial Drives can be operated with all standard controllers.

1.2.2 Operating costs

No additional moving parts

The assembly, adjustment and maintenance requirement for the drive assembly is reduced.

Minimal wear in the drive train

The drive train is extremely durable even under very high alternating loads. Machine downtime is reduced.

High availability

In addition to the an increased life and reduced wear, the robust design of the torque motors also increases the availability of the entire machine.

Energy efficiency

Heat is reduced to a minimum, resulting in energy savings in the converter and heat exchanger.

1.2.3 Design

Hollow shaft

The hollow shaft with large diameter makes the integration or passage of other assemblies possible, such as shafts, rotary distributors and media lines. Bearing level, force generation and effective working area can all be in close proximity to each other.

Installation of the primary part (stator)

The ring for the stator can be easily integrated into the machine construction due to the small space requirement.

Low section height

A highly compact and axially short construction with a high torque is made possible by the large, free inside diameter.

Few components

The highly engineered design makes it easier to incorporate the motor components into the machine assembly. The small number and robust design of the parts decreases the failure rate and increases the mean time between failures.

1.3 Characteristics of torque motors

Torque motors consist of a primary part (stator) and a secondary part (rotor). The stator contains an active coil system. The rotor contains a permanent magnet system. In a concentric arrangement, the rotor can be either the inner ring (internal rotor motor) or the outer ring (external rotor motor). If the stator is energised, the electromagnetic force generates a torque on the rotor.

In order to operate the motor, a suitable bearing component is needed to maintain the air gap between stator and rotor as well as an angular measuring system to detect the position of the rotor. The motor series are designed in accordance with requirements and differ in terms of their design for the stator and rotor on account of the physical and structural arrangements.

The torque motors are divided into slotted, slotless and ironless designs. They are further distinguished, for example, according to the position and structure of the rotor in the internal and external running motor or according to the magnet system, such as surface magnets and buried magnets (magnets in sheet metal pockets). The motors generate a consistently high torque over a wide speed range. The torque is determined by the active air gap face between stator and rotor and by the structure. The designer must select the motor assemblies in line with performance requirements. Unlike conventional electric motors, torque motors are classified on the basis of the required torque and not on a performance basis.

▦ 1 Characteristics of torque motors

Motor series	Characteristics	Design
RIB ➤32|2	Internal running motor with high torque density • Ø up to 1030 mm • T_p up to 40000 Nm • circumferential speed of up to 10 m/s • low cogging torque	

1.4 General motor characteristic values

1.4.1 Efficiency criteria

Power losses for torque motors are entered in the performance data according to winding and size ➤34|2.2. Although torque motors generate a high torque when stationary, they do not deliver any mechanical power. As a result, there is no reason to state the efficiency.

The motor constant k_m can be used for an efficiency comparison, however. The motor constant k_m defines the relationship between the torque and the generated power loss or temperature increase. Furthermore, the motor constant k_m is accurate for the linear dynamic range in a stationary state and at low speeds as well as at room temperature.

When the motor is subjected to a temperature increase, its efficiency decreases due to the increase in winding resistance. With increasing speeds, iron losses in the form of frequency-dependent core losses and eddy current losses are added to the copper losses. Although these are not included in the motor constant k_m, they are relevant in the limit speed range and should therefore be observed. The motor constant k_m only relates to the linear range of the torque/current characteristic curve ➤11|1.4.4.

_ƒ_ 1
Power loss

$$P_l = \left(\frac{T}{k_m}\right)^2$$

P_l	W	Power loss
T	Nm	Torque
k_m	Nm/√W	Motor constant

The motor constant k_m is dependent on the ohmic resistance and thus on the motor winding temperature. The motor constant k_m is stated in the performance data for +25 °C. The characteristic curve shows the motor constant as a function of the temperature.

001A479A

1 Motor constant k_m as a function of temperature ϑ

1	Related motor constant	ϑ	Temperature
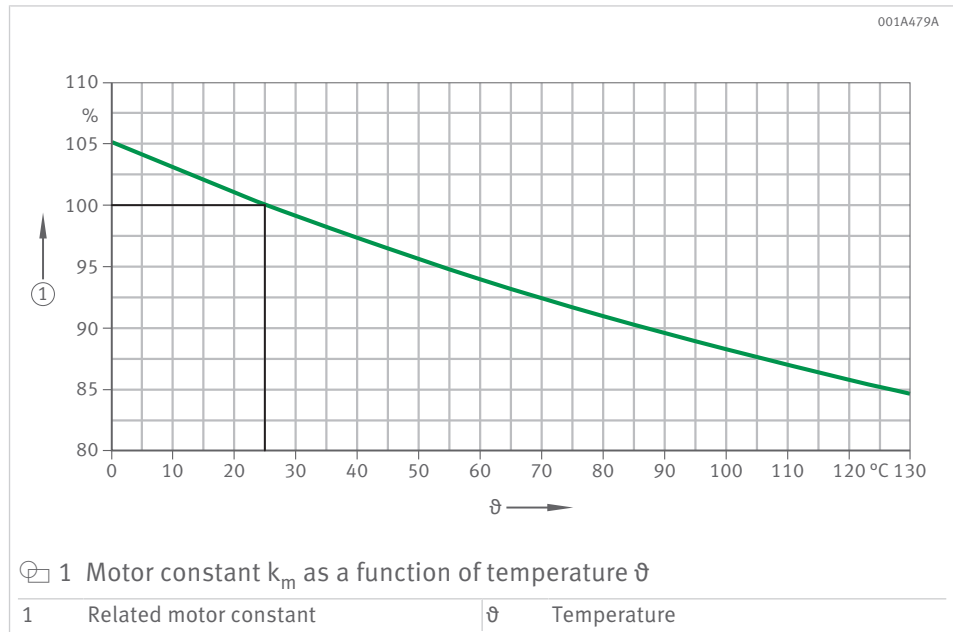
Thermal behaviour

An increase in temperature brings about in increase in winding resistance and has the effect of reducing the motor constant k_m. At +130 °C, the motor constant k_m falls to 0,85 times its normal value. At a constant current or torque, a higher power loss is generated in the motor that has already been subjected to a temperature increase compared with the motor that is cold. This power loss results in an even higher motor temperature.

1.4.2 Winding designs and dependencies

The achievable speeds of each torque motor are essentially dependent on the DC link voltage and winding design, in addition to the series and size. Voltage drops within the motor increase the voltage requirement with increasing speed. At the knee speed specified in the RIB performance data, the voltage requirement corresponds to the DC link voltage of the servo converter with field-oriented control, after which the speed falls off rapidly. The higher the DC link voltage and the smaller the voltage constants associated with the winding k_u, the higher the achievable limiting speeds. As there is a correlation between voltage constant and torque constant, the power requirement of the motor increases with higher speed requirements at the same torque. One or more standard windings are predefined for different limiting speeds and dynamic requirements at a fixed DC link voltage U_{DCL} for each motor size in the RIB motor performance data ➤34|2.2. At lower DC link voltages, the limiting speed decreases at an almost proportional rate. The torque at various operating points is derived from the torque/current characteristic curve. The torque/speed characteristic curves show the relationship between torque and speed at various operating points. The characteristic curves are available in data sheet form from the application engineers and sales function of Schaeffler Industrial Drives.

For further information, please contact: sales-sid@schaeffler.com

1.4.3 Torque/speed characteristic curve

The torque/speed characteristic curve shows the winding-specific speed limits as a function of the torque at a constant DC link voltage without field weakening. The characteristic curve does not describe the duty cycle and the associated thermal behaviour of the motor. The characteristic curve only represents the range that the motor can approach at a winding temperature of +25 °C.

Operating points at torques in excess of T_{cw} are subject to time restrictions, so as not to overheat the stator. When using T_u, demagnetisation may occur if the starting temperature of the rotor is too high.

At speeds in excess of n_{lwS1}, additional frequency-dependent losses call for a time restriction or a reduction in the current for continuous operation.

The limiting speed n_{lc} at $l_{c\,eff}$ and T_c is important for understanding the characteristic curve, but is not stated in the performance data due to its minor relevance.

Further information on the corresponding speed limits and the operating conditions for the corresponding torques can be found in the ➤70|.

001A47BA
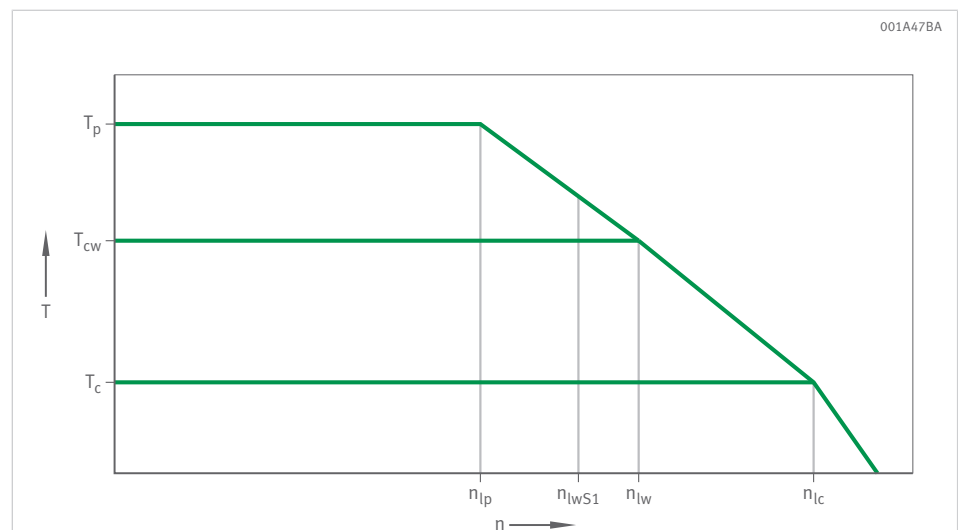
⊕ 2 Torque as a function of speed without field weakening at constant DC link voltage

n	Speed	T	Torque
T_p	Peak torque	T_{cw}	Rated torque, cooled
T_c	Rated torque, not cooled	n_{lp}	Limiting speed at $I_{p\,eff}$ and U_{DCL}
n_{lwS1}	Rated speed (S1), cooled	n_{lw}	Knee speed
n_{lc}	Limiting speed at I_n and U_{DCL}		

The winding-specific speed limits are roughly proportional to the DC link voltage.

n_{lwS1} can also correspond to the value of n_{lw} subject to the motor size and winding design.

1.4.4 Torque/current characteristic curve

Between 0 A and the linear ultimate current $I_{pl\,eff}$, torque motors exhibit a linear relationship between motor current and generated torque. The linear ultimate torque T_{pl} is the associated torque limit for $I_{pl\,eff}$. In this range, the motor constant k_m can be used to calculate the power loss. The moment constant k_T represents the slope of the characteristic curve. In this range, the moment constant k_T is used to calculate the torque on the basis of the current, or vice versa.

The magnitude of the linear ultimate current $I_{pl\,eff}$ is thermally independent and can be above or below the cooled rated current $I_{cw\,eff}$ depending on the series and winding.

The linear ultimate current $I_{pl\,eff}$ and the associated linear ultimate torque T_{pl} are important for understanding the characteristic curve, but are not stated in the performance data due to their minor relevance.

The non-linearity of the torque/current characteristic curve for large currents results from the saturation of a motor's magnetic circuits. In the performance data and in the characteristic curve illustrated below, the torque/current points (T_p, $I_{p\,eff}$) and (T_u, $I_{u\,eff}$) describe the curved characteristic range. The characteristic range has a variable and considerably lower slope than the motor constant k_T.

The motor can be operated briefly – for just a few seconds – up to the operating point (T_p, I_{eff}). This is the maximum operating point for acceleration processes. As the permanent magnets are at risk of demagnetisation, the limiting point (T_u, $I_{u\,eff}$) must not be exceeded.

001A488A
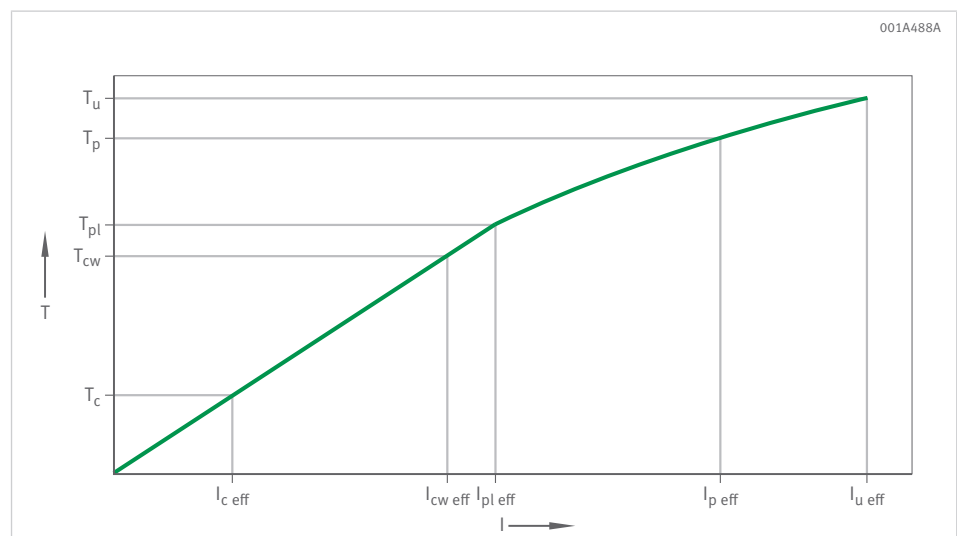
⊕ 3 Torque as a function of motor current

T	Torque	I	Motor current
T_u	Ultimate torque	T_p	Peak torque
T_{pl}	Peak torque, linear range	T_{cw}	Rated torque, cooled
T_c	Rated torque, not cooled	$I_{c\,eff}$	Rated current, not cooled
$I_{cw\,eff}$	Rated current, cooled	$I_{pl\,eff}$	Peak current, linear range
$I_{p\,eff}$	Peak current	$I_{u\,eff}$	Ultimate current

1.5 Thermal motor protection

1.5.1 Monitoring circuits I and II

Direct drives are frequently operated at their thermal performance limit. Furthermore, unforeseeable overloads can occur during operation, resulting in the development of an additional current load that exceeds the permissible rated current. For temporary overcurrents, the power electronics should be equipped with an overload protection feature or an I^2 motor protection model for the purpose of

controlling the motor current. The root mean square value (I^2t) of the motor current must not exceed the permissible motor rated current here. This method of indirect temperature monitoring is very fast and reliable. The user must ensure that I^2t monitoring is always switched on when commissioning the motor.

Motors from Schaeffler Industrial Drives must be protected by means of motor temperature monitoring. Monitoring circuit I of the standard version contains three PTC sensors, connected in series, on the three phase windings. Monitoring circuit II also includes a Pt1000 sensor on one phase in the motor. This sensor enables pre-warning thresholds.

001A47CA

⊕ 4 Standard connection PTC and Pt1000
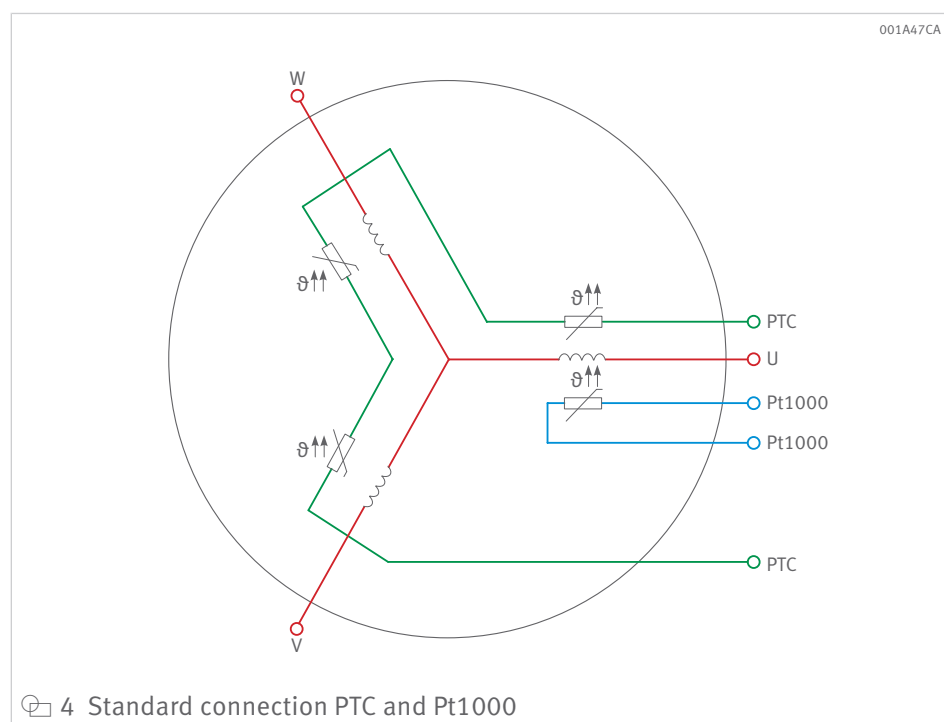
1.5.2 Monitoring circuit I

A PTC is a thermistor. When fitted, the thermal time constant of a PTC is less than 5 s. In contrast to the Pt1000, the resistance of the PTC rises very sharply when the nominal response temperature T_n is exceeded, increasing the resistance to a multiple of its cold value. When a triplet PTC (three PTC sensors connected in series) is used, the increase in resistance will also lead to a significant change in the overall resistance if just one sensor exceeds the response temperature T_n. The use of three PTC sensors ensures that the motor can still be shut down safely by a standard motor protection tripping unit under asymmetrical phase load, e.g. at standstill. The motor protection tripping unit typically triggers between 1,5 kΩ and 3,5 kΩ, bringing the controller to a stop.

The PTC sensors detect the excess temperature of each winding up to a deviation of a few degrees. The tripping unit also reacts if the resistance in the PTC circuit is too low, which may indicate a defect in the monitoring circuit. Safe galvanic isolation of the controller from the PTC sensors in the motor is also ensured by the tripping unit. The motor protection tripping unit is not included in the scope of delivery. PTC sensors are not suitable for temperature measurements. Monitoring circuit II should be used for this purpose.

001A486A
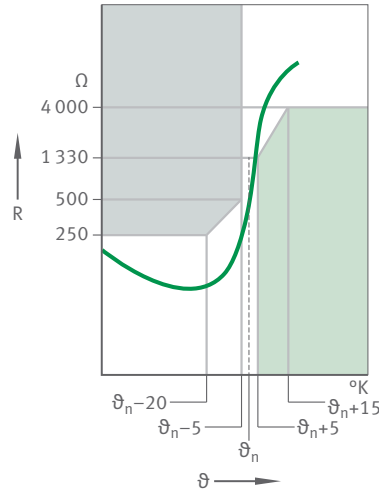
5 PTC temperature characteristics

R	Resistance	ϑ	Temperature
ϑ_n	Rated response temperature		

The PTC sensors used to protect the motor from excess temperatures must be analysed using a shut-off device that is connected to the servo converter.

1.5.3 Monitoring circuit II

The Pt1000 platinum measuring resistor is a temperature sensor that uses the influence of temperature on the electrical resistance of platinum. The sensor characteristics are standardised in EN 60751 and cover a temperature range of −200 °C to +850 °C. The sensor type used in the motor is specified for −55 °C to +190 °C. This allows the temperature sensor to perform reliable and precise measurements within the permissible operating temperature range of the motor at all times. The permissible operating temperature range is +10 °C up to a usual value of +110 °C. The temperature sensor measures with a delay according to motor type.

A pre-warning threshold and switch-off limit are set in the controller to protect the motor from overheating. The purpose of the pre-warning threshold is to prevent the motor from being shut down immediately by the motor protection tripping unit.

When the motor is stationary, constant currents flow through the windings. The magnitude of the constant currents is determined by the respective pole position. Due to the influence of the respective pole position on the constant currents, the motor is not heated homogenously, which can lead to the overheating of unmonitored windings. A Pt1000 sensor can only monitor one phase. For applications that regularly approach the load limit in a stationary state, it is therefore advisable to use and analyse three Pt1000 sensors in order to ensure that all phases are monitored.

The PTC and Pt1000 sensors have basic isolation from the motor. The PTC sensors are not suitable for direct connection to PELV circuits or SELV circuits to DIN EN 50178.

001A492C

6 Pt1000 temperature characteristics

R	Resistance	ϑ	Temperature
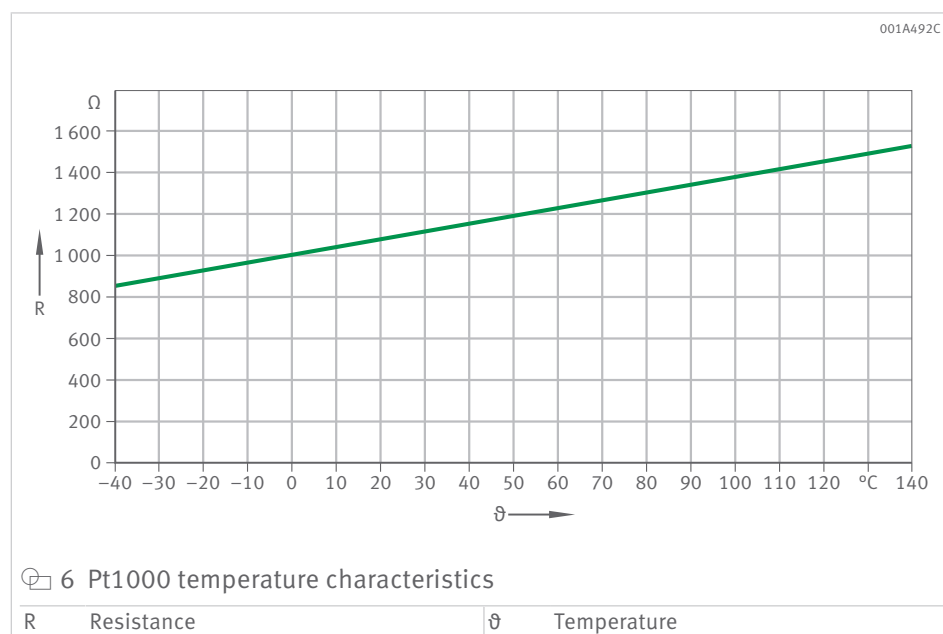
1.6 Electrical connection technology

1.6.1 Standard cable connections

Standard cable connections on motors from Schaeffler Industrial Drives are equipped with an axial screw connection. Their relative position to the cooling connections is specified in the drawings in the performance data ➤34|2.2. The cable length from the motor output is 1 m or is tailored to customer requirements. The cross-section of the power connection cable is dependent on the rated current of the motor and can be found in the following table. As standard, dimensioning is based on the rated current $I_{cw\,eff}$ at P_{lw} (cooled).

2 Standard cable connections

Cross-section	Continuous current	Diameter	Min. bending radius, fixed	Min. bending radius, flexible	Mass
	A	mm	mm	mm	g/m
Sensor 4×0,14	–	4,8	24	36	40
Sensor 7×0,14	–	5,7	29	43	67
4G0,75	10,4	8	40	80	95
4G1,5	16,1	9	45	90	140
4G2,5	22	10,5	52,5	105	210
4G4	30	12,5	62,5	125	296
4G6	37	14,5	72,5	145	416
4G10	52	17	85	170	644
4G16	70	20,5	102,5	205	997

Motor cables are available from a cross-section of 4G0,75 mm^2. The sensor cable enables temperature monitoring with the PTC and Pt1000 sensors. The cable ends are open with ferrules in the standard version. Axial, radial and tangential cable outlets can be used ➤32|2. The required cable outlet in each case is specifically defined when ordering. For motor currents over 70 A, the cable outlets are matched to the specific application.

Cable properties:

- shielded

- resistant to oil and coolant courtesy of polyurethane outside surface

- flame resistant

- suitable for drag chain use

⊞ 3 Motor pin connections

Motor	
1/U	Phase U
2/V	Phase V
3/W	Phase W
GNYE	PE

⊞ 4 Sensor pin connections

Sensor	
WH	PTC
BN	PTC
GN	Pt1000
YE	Pt1000

1.6.2 Positive direction of rotation of the motor

The electrically positive direction of rotation corresponds to a clockwise rotating field in all three-phase motors, i.e. the phase voltages are induced in a U, V, W sequence. Motors from Schaeffler Industrial Drives have this positive direction of rotation when the rotor is moving:

- anticlockwise when viewing the side of the cable outlet from above

- clockwise when viewing the side facing away from the cable outlet below.

001A661A

⊕ 7 Direction of rotation with the cable outlet at the top

1.6.3 Commutation

Synchronous motors should be operated with commutation where possible. Motors from Schaeffler Industrial Drives do not have Hall sensors as standard. Schaeffler recommends commutation that is based on the measuring system, since this is supported by modern servo converters and controllers.

1.6.4 Isolation strength and overvoltage phenomena

Motors from Schaeffler Industrial Drives are developed, designed and manufactured in accordance with the Low Voltage Directive 2014/35/EU (Electrical operating equipment for use within certain voltage limits). They also comply with Directive 2014/30/EU (Electromagnetic Compatibility) and are intended for authorised operation in a PDS (Power Drive System) in accordance with DIN EN 61800-5-1.

All motors are checked for electric strength of the isolation system before they are despatched. The isolation systems of the motors are designed to Overvoltage Category III and optimised for maximum life. Modern test methods, such as measuring the partial discharge inception voltage, ensure the life and performance of the motors over a long time period.

Once installed, the motor forms part of the PDS (Power Drive System), which consists of the motor, motor cable and converter components such as the supply module, regenerative modules, drive controller, filter. Undesirable and unforeseeable effects can occur within the system. Controller manufacturers usually provide recommendations and project planning information that the user should observe and adhere to. Non-compliance may result in premature failure of the isolation system in motors or converters.

Regardless of the converter, the user can ensure safe operation by taking the following preliminary measures:

- **Short cable length and extensive cable shielding coverage**
  This helps to avoid excessive voltage increases caused by HF reflection on the motor cable. The probability of this effect increases if connection cables measuring approx. 10 m or more in length are used between the motor and converter. Schaeffler Industrial Drives recommends measuring the voltage at the motor connection terminals using suitable high voltage technology upon commissioning the machine.

- **Selecting the right motor**
  Torque motor selection should be based on the DC link voltage of the converter. In most cases, the DC link voltage is 600 V. A lower DC link voltage reduces the dynamic response and maximum speed. A DC link voltage of 720 V and above requires a reinforced isolation system. Please contact us in such cases. Motors with inductances well in excess of 50 mH, measured from phase to phase, may only be used following individual checks by the manufacturer of the converter and Schaeffler Industrial Drives, otherwise voltage peaks may cause resonances in the PDS (Power Drive System) and damage to the isolation system.

The user must observe the instructions provided by the manufacturer for the converter. Particular attention is required in the following cases:

- Overvoltage protection during regenerative feedback from the motor to the converter, e.g. in the event of interference in field weakening operation. Here, the back EMF constant can be used to calculate the occurring voltage, which is subsequently compared with the maximum permissible voltages, and an overvoltage protection or voltage limiting module (VPM, Voltage Protection Module) can then be fitted as appropriate.

- Applications in which problems with increased isolation damage have been encountered in the past or for which countermeasures are already in place.

If one of the above points applies, please state this in the enquiry or include an on-site measurement of the transient overshoot in the commissioning process. At a DC link voltage of 600 V to 720 V, the transient overshoot should not exceed 1370 V.

1.7 Cooling and cooling circuit

1.7.1 Power loss and heat losses

The motor constant k_m describes the power loss. In addition to the power loss, iron losses in both the rotor and stator and magnetic losses in the rotor occur at pole change frequencies of 100 Hz and above. The iron and magnetic losses cause an increase in motor temperature. The iron losses do not increase on a linear basis with the pole change frequency and are dependent on the field weakening angle and current density.

At low pole change frequencies, motors with a high motor constant k_m generate less power loss than motors with a low motor constant k_m.

The motor assemblies transmit the power loss that occurs during motor operation to the machine. The overall system is designed to systematically influence and control this heat distribution. With liquid cooling, the rated torques of the motors are approximately 50 % higher than in uncooled operation. The configuration of the motors in the machine construction is determined by the installation space, accuracy requirements and cooling requirement.

Cooling is the preferred solution in production machines with a high capacity or very high dynamic characteristics and which are therefore subjected to considerable bearing loads. If there is complete thermal decoupling of the motor and machine, Schaeffler Industrial Drives also recommends tempering the adjacent construction. Among other things, this helps to prevent thermal distortion of the machine construction in precision machines. The actual cooling process is then referred to as main cooling or power cooling.

The liquid cooling method used for the motors is a jacket cooling system, which the user connects to the cooling circuit of a cooling unit. Schaeffler Industrial Drives offers the cooling jacket as an optional component of the motor. Customers can also integrate a cooling jacket into their machines.

The cooling medium travels from the inlet to the outlet over various levels via openings in the cooling ribs. The inlet and outlet can be assigned to the two connections in any order. The flow area is sealed to the outside with O-rings.

Water as a coolant requires additives that prevent corrosion and biological deposits in the cooling circuit.

1.7.2 Influence of nominal data on the supply temperature and cooling medium

The rated current $I_{cw\,eff}$ specified for cooled operation refers to the rated supply temperature ϑ_{nf} of the cooling water and is indicated in the performance data ➤34|2.2. Higher supply temperatures ϑ_f lead to a reduction in the cooling capacity and thus also in the rated current. The reduced rated current $I_{c\,red}$ is calculated from the following quadratic relationship:

♫ 2
Reduced rated current

$$\frac{I_{c\,red}}{I_{cw\,eff}} = \sqrt{\frac{\vartheta_{max} - \vartheta_f}{\vartheta_{max} - \vartheta_{nf}}}$$

$I_{c\,red}$	A	Reduced rated current
$I_{cw\,eff}$	A	Rated current, cooled
ϑ_{max}	°C	Max. permissible winding temperature
ϑ_{nf}	°C	Rated supply temperature
ϑ_f	°C	Current supply temperature

The use of customer-specific cooling media leads to a change in the dissipated power lost as heat and, consequently, to a change in the cooled rated torque that can be continuously obtained. Engineers at Schaeffler Industrial Drives will determine the effect of the cooling medium used on request and on specification of the material properties.

001A494C
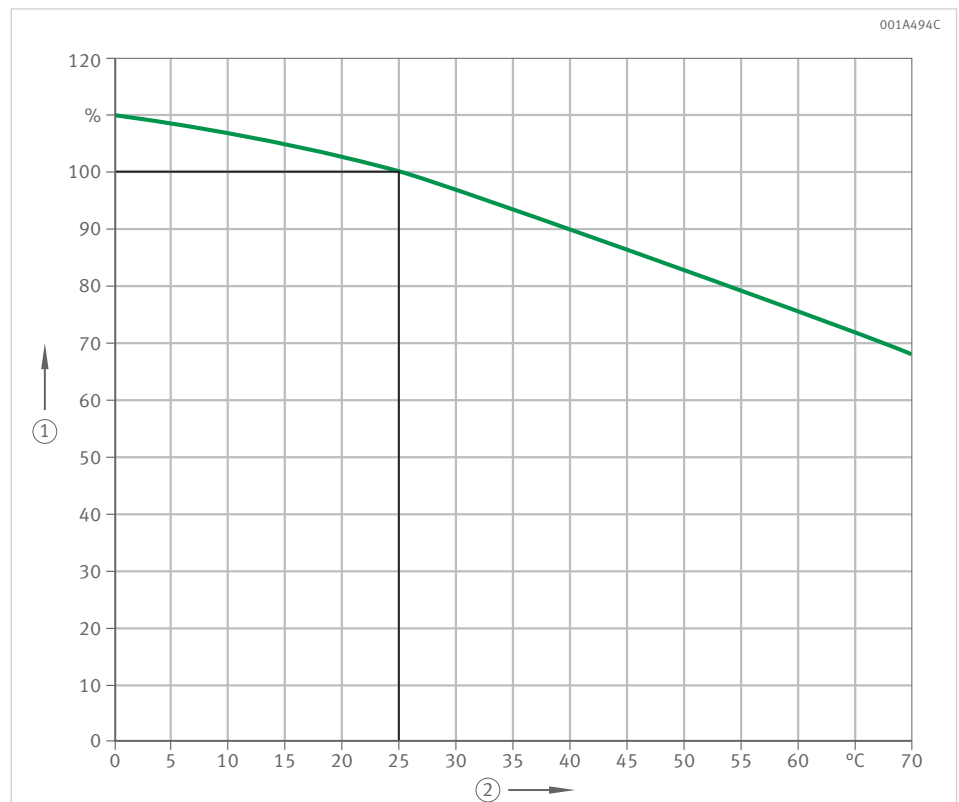
⊕ 8 Relative rated current $I_{c\,red}$ / $I_{cw\,eff}$ as a function of supply temperature ϑ_f ($\vartheta_{nf} = +25$ °C)

1	Relative rated current $I_{c\,red}$ / $I_{cw\,eff}$ in %	2	Current supply temperature ϑ_f
$I_{c\,red}$	Reduced rated current	ϑ_{nf}	Rated supply temperature
$I_{cw\,eff}$	Rated current, cooled		

1.8 Arrangement of motors

1.8.1 Operating several motors in parallel on one axis

In some applications, it is advisable to drive an axis with two or more synchronous motors at the same time. Such applications include pivot systems in five-axis machining centres, fork-type milling heads or machine spindles for hobbing machines. Motors of the same design can be connected in parallel and operated on a common converter.

1.8.2 Arrangement of motors

A distinction is made between the parallel tandem arrangement and the anti-parallel arrangement, i.e. mirrored Janus arrangement, of the stators.

Rotor alignment

001A496C

⊕ 9 Zero axis and rotary markings in alignment

1	Zero axis	2	Secondary part (rotor) marking
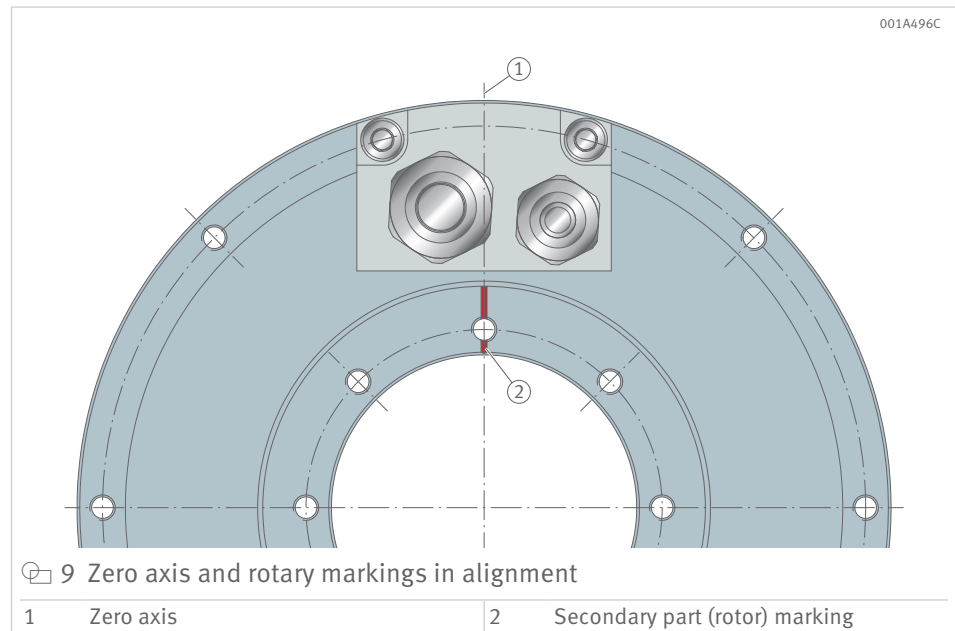
In parallel operation, rotors must be aligned in the same angular position, regardless of the arrangement. The respective rotor markings are used for this purpose.

Stator alignment

The aim is to align the coils of each phase in the same angular position. The stator is aligned using the zero axis. The zero axis is usually located between the holes in the cable clamp.

Customers, please contact our engineers before planning parallel operation.

Tandem arrangement

001A497D

🔲 10 Tandem arrangement
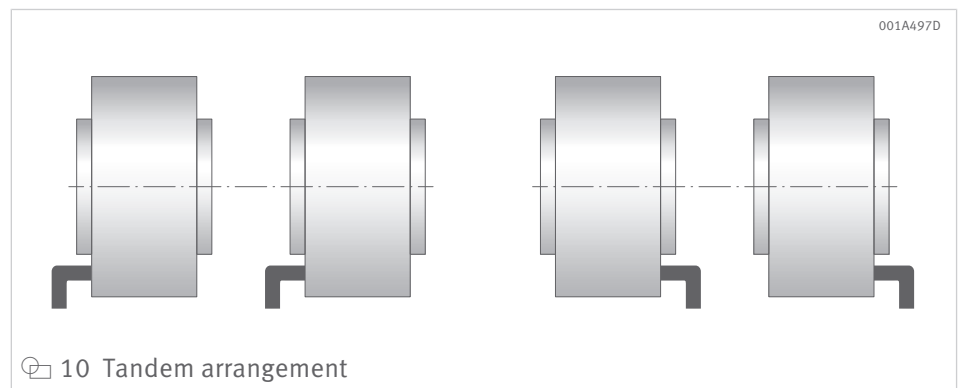
The cable outlets point in the same longitudinal direction.

001A497F

🔲 11 Tandem arrangement
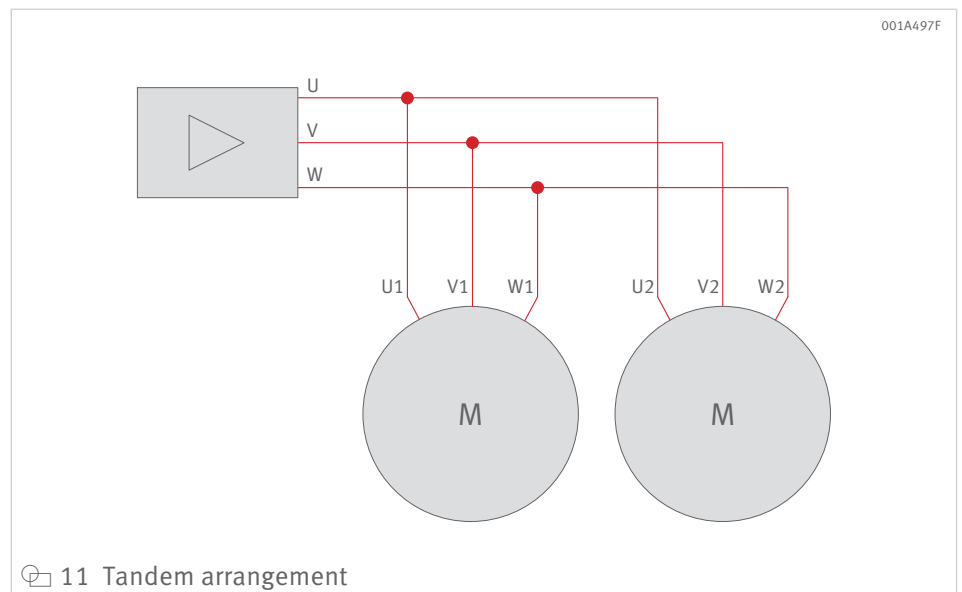
The zero axes of the stators are also aligned with the cable outlets. In the case of coaxially aligned cable outlets, the bolt circles are matched and the phase connections are combined with the same name.

Janus arrangement

001A4981

🔲 12 Janus arrangement
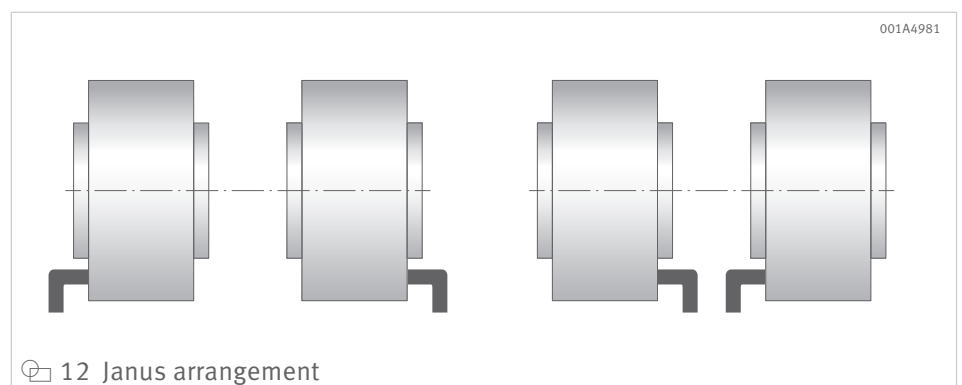
The cable outlets point in the opposite longitudinal direction.

001A4983

⊕ 13 Janus arrangement
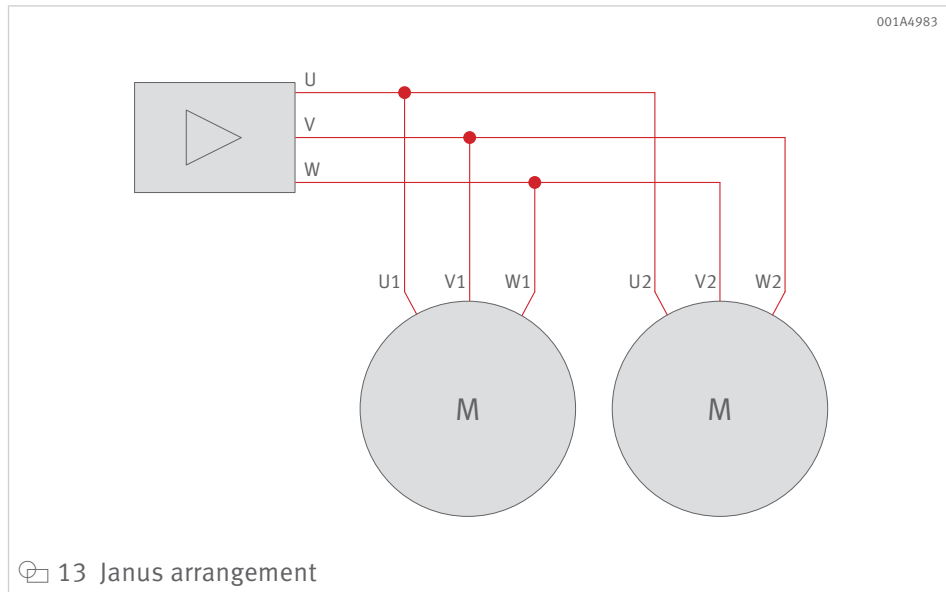
The zero axes must also match in the mirrored Janus arrangement. Depending on the position of the zero axis, it may be necessary to offset the bolt circles. Motors in a mirrored arrangement must work in the opposite direction of rotation. This involves swapping phases V and W on one of the two motors. As a result, phases U1 and U2, V1 and W2, and W1 and V2 are in mutual contact on the converter ➤22|⊕13.

1.9 Operating several motors in parallel on one axis

1.9.1 Displacement of the cable outlet

In all arrangements, the stators and thus the cable outlets can be twisted relative to each other within a specific grid. Particularly in the Janus arrangement with internal cable outlets, a shorter overall axis can be designed by twisting the stators. The grid corresponds to a pair of poles and must be multiplied by an integer factor.

The torsion angle is calculated as follows:

f 3
Torsion angle

$$\text{Torsion angle} = \frac{360°}{\text{Number of pole pairs}}$$

x   any integer factor

In some series, a favourable torsion angle is also achievable in the bolt circle, e.g. RIB11-3P-230xH:

f 4
Torsion angle in bolt circle

$$\text{Torsion angle} = \frac{360°}{22} \cdot 11 = 180°$$

1.9.2 Setting the phase coincidence

In all cases, it should be checked whether the parallel motors are aligned in phase with each other. If the phases do not correspond, there will be a speed-related decrease in torque constant and efficiency due to induced short-circuit currents.

In order to align the phases, the counter voltage of the motors is measured using a two-channel oscilloscope while simultaneously rotating the connected rotors. The phase offset of the two curves must not exceed ±5°, in order to ensure good static functionality of the interconnected motors. Any electrical phase offset between the motors can be eliminated by mechanically adjusting a rotor or a stator.

The following applies:

f 5
Mechanical angle theorem

$$\text{Mechanical angle set} = \frac{\text{Phase offset}}{\text{Number of pole pairs}}$$

When fitted correctly, a clearance of the bolt circle screw connection to medium tolerance class EN 20273is usually sufficient for a precision adjustment. If more than two motors are connected in parallel, one is defined as the master and thus as the reference point for aligning all of the remaining motors.

⊕ 14 Phase offset 22,5° between the counter voltages
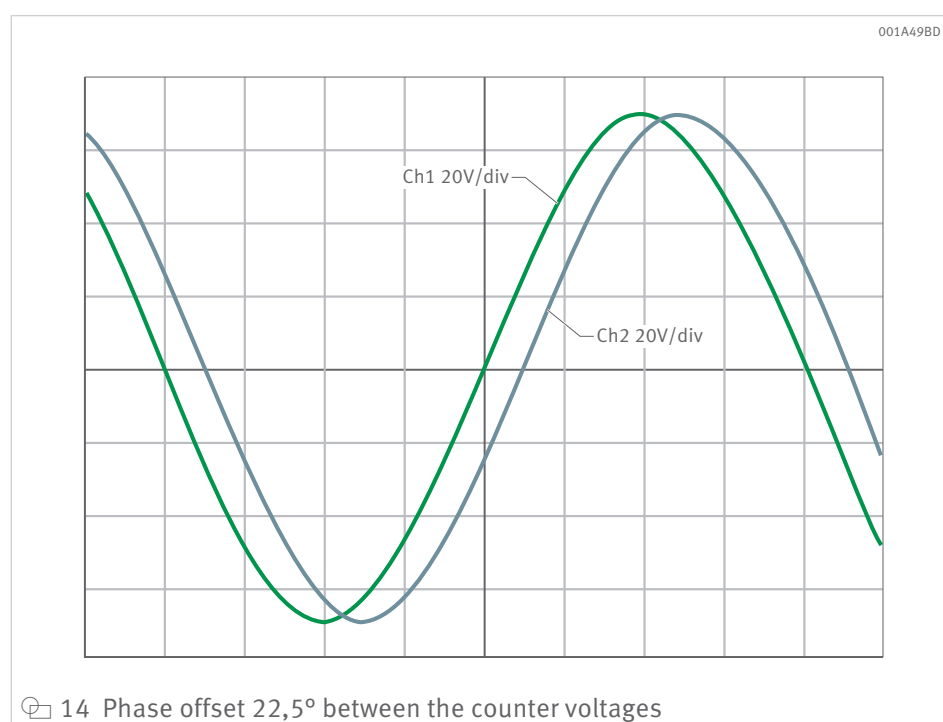
1.9.3 Evaluation of the temperature sensors

Faulty or incorrect alignment of the motors can lead to thermal overloading of the motor. Integrated PTC sensors serve to protect the motor. The PTC sensors for each motor in the arrangement are connected in series and evaluated by a motor protection tripping unit.

To prevent premature tripping of the motor protection system, Schaeffler Industrial Drives recommends using several or multi-channel motor protection tripping units in the event of three or more PTC monitoring circuits.

001A49CD

⊕ 15 Connection of temperature sensors for several motors
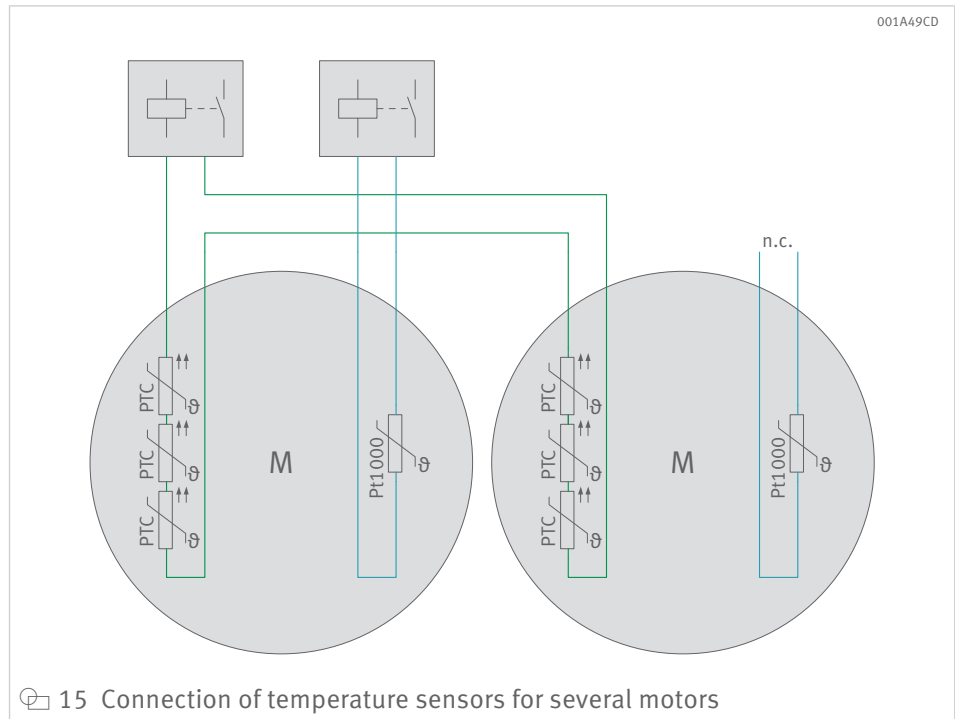
1.9.4 Resulting motor data

The parallel connection of structurally identical, individual motors results in new electrical data for the converter on the current replacement motor. The following can be easily established from the individual motor data:

- The number of pole pairs, torque constant, voltage constant, time constant and speeds remain unchanged.

- Currents, torques and damping constant multiply with the number of individual motors.

- Resistance and inductance are divided by the number of individual motors.

1.10 Selection of direct drives for rotary applications

1.10.1 Cycle applications

Cycle operation consists of successive positioning movements with movement pauses in between. A simple positioning action takes the form of a positively accelerated movement and subsequent braking. If the value for negative acceleration is the same, then the acceleration time and braking time are the same. The maximum angular velocity ω_{max} is reached at the end of an acceleration phase.

A clock cycle is described in the ω-t diagram. The ω-t diagram for cycle operation shows a forward/backward rotation with pauses.

001A49ED

⊞ 16 ω-t- diagram for cycle operation

ω	Angular velocity	t	Time
t_m	Movement time	t_b	Pause time
$ω_{max}$	Max. angular velocity		
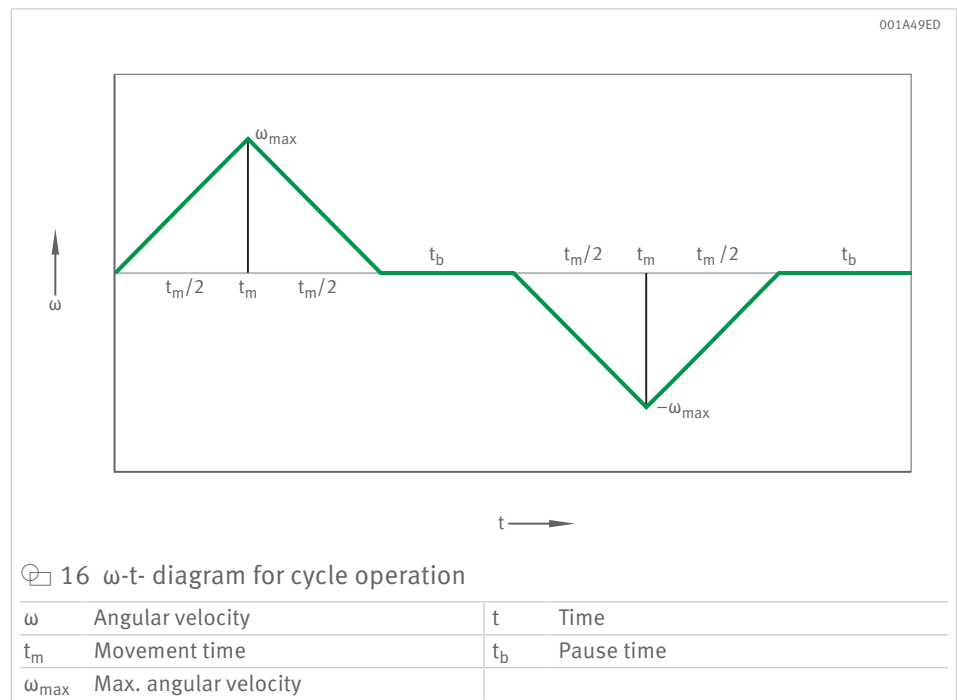
The α-t diagram for cycle operation and the curve of the torque required for the movement are obtained from the forward/backward rotation with pauses:

ƒ 6
Torque

$$T = J \cdot α$$

T	Nm	Torque
J	$kg \cdot m^2$	Mass moment of inertia
α	rad/s^2	Angular acceleration

Motor selection takes place on the basis of three criteria in accordance with the torque curve for a required clock cycle:

- Max. torque in cycle ≤ T_p according to the performance data ➤34|2.2

- Effective torque in cycle ≤ T_c (motor not cooled) or T_{cw} (water cooling) according to the performance data ➤34|2.2

- Max. speed in the cycle ≤ n_{lp} according to the performance data ➤34|2.2
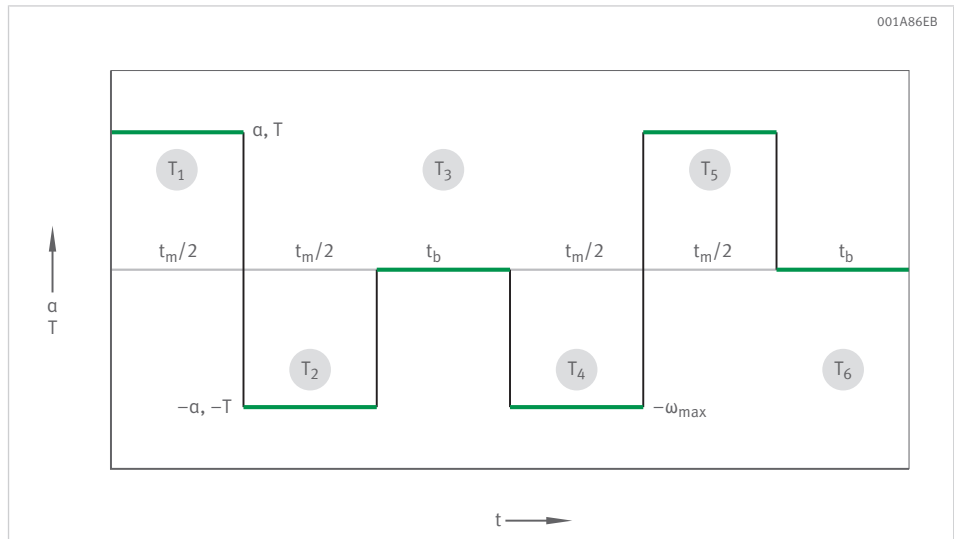
17 α-t- diagram for cycle operation

α	Angular acceleration	t	Time
t_m	Movement time	t_b	Pause time
ω_{max}	Max. angular velocity	T	Torque
T_1	Torque cycle 1 ($T_1 = T$)	T_2	Torque cycle 2 ($T_2 = -T$)
T_3	Torque cycle 3 ($T_3 = 0$)	T_4	Torque cycle 4 ($T_4 = -T$)
T_5	Torque cycle 5 ($T_5 = T$)	T_6	Torque cycle 6 ($T_6 = 0$)

The effective torque is equal to the root mean square of the torque curve (six torque cycles) in the clock cycle.

ƒ 7
Effective torque

$$T_{eff} = \sqrt{\frac{T_1{}^2 \cdot t_1 + T_2{}^2 \cdot t_2 + \ldots + T_6{}^2 \cdot t_6}{t_1 + t_2 + \ldots + t_6}}$$

T_{eff}	Nm	Effective torque
T_1	Nm	Torque cycle 1 ($T_1 = T$)
t_1	s	Movement time 1 ($t_1 = t_m/2$)
T_2	Nm	Torque cycle 2 ($T_2 = -T$)
t_2	s	Movement time 2 ($t_2 = t_m/2$)
T_6	Nm	Torque cycle 6 ($T_6 = 0$)
t_6	s	Movement time 6 ($t_6 = t_b$)

We recommend a safety factor of 1,4 for the torques. The safety factor takes into account conditions such as motor operation in the non-linear range of the torque/current characteristic curve, for which the calculation equation for T_{eff} only applies in approximate terms.

The effective torque is calculated using the following torques:

- $T_1 = T$
- $T_2 = -T$
- $T_3 = 0$
- $T_4 = -T$
- $T_5 = T$
- $T_6 = 0$

The effective torque is calculated using the following times:

- $t_1 = t_m/2$
- $t_2 = t_m/2$
- $t_3 = t_b$
- $t_4 = t_m/2$
- $t_5 = t_m/2$
- $t_6 = t_b$

∫ 8
Effective torque

$$T_{eff} = T \cdot \sqrt{\frac{t_m}{t_m + t_b}}$$

T_{eff}	Nm	Effective torque
T	Nm	Torque
t_m	s	Movement time
t_b	s	Pause time

∫ 9
Effective torque

$$T_{eff} = J \cdot \alpha \cdot \sqrt{\frac{t_m}{t_m + t_b}}$$

T_{eff}	Nm	Effective torque
J	$kg \cdot m^2$	Mass moment of inertia
α	rad/s^2	Angular acceleration
t_m	s	Movement time
t_b	s	Pause time

If only torques of the same magnitude take effect in the clock cycle, this equation applies to the effective torque ➤ 27 | ∫ 9. Mass moment of inertia and angular accelerations are constant. The movement time divided by the sum of the movement time and pause time goes underneath the root. The cycle time is included in the denominator.

The angular acceleration, max. angular velocity and maximum speed of a positioning movement are calculated using:

∫ 10
Angular acceleration

$$\alpha = \frac{4 \cdot \varphi}{t_m^{\,2}}$$

α	rad/s^2	Angular acceleration
φ	°	Movement angle
t_m	s	Movement time

∫ 11
Max. angular velocity

$$\omega_{max} = \frac{2 \cdot \varphi}{t_m}$$

t_m	s	Movement time

∫ 12
Max. speed

$$n_{max} = \frac{30}{\pi} \cdot \omega_{max}$$

The calculation method shown here is idealised and simplified. For example, the increase in angular acceleration is infinitely high. In practice, angular acceleration is limited by motor inductance or other components. In order to take account of these effects in the design, safety factors are used or, in the case of particularly dynamic movements, additional times of 15 ms to 20 ms per positioning operation are assumed.

1.10.2 Example of cycle applications

⊞ 5 Specified values

Specified values	Unit	Value
Movement angle φ	°	180
Movement time t_m	s	0,5
Cycle time $t_m + t_b$	s	1,35
Mass moment of inertia J	$kg \cdot m^2$	2,5
Frictional torque T_F	Nm	8
Safety factor SF	–	1,4

Calculation

Movement angle conversion:

𝄎 13
Movement angle conversion

$$\varphi = \frac{\pi}{180} \cdot 180 \text{ rad} = 3,142 \text{ rad}$$

φ	°	Movement angle

Max. angular velocity:

𝄎 14
Max. angular velocity

$$\omega_{max} = \frac{2 \cdot \varphi}{t_m} = \frac{2 \cdot 3,142}{0,5} \text{ rad/s} = 12,57 \text{ rad/s}$$

ω_{max}	rad/s	Max. angular velocity
φ	°	Movement angle
t_m	s	Movement time

Max. speed:

𝄎 15
Max. speed

$$n_{max} = \frac{30}{\pi} \cdot \omega_{max} = \frac{30}{\pi} \cdot 12,57 \text{ 1/s} = 120 \text{ min}^{-1}$$

n_{max}	min^{-1}	Max. speed
ω_{max}	rad/s	Max. angular velocity

Angular acceleration:

𝄎 16
Angular acceleration

$$\alpha = \frac{4 \cdot \varphi}{t_m^2} = \frac{4 \cdot 3,142}{0,5^2} \text{ rad/s}^2 = 50,27 \text{ rad/s}^2$$

α	rad/s^2	Angular acceleration
φ	°	Movement angle
t_m	s	Movement time

Taking into account the bearing frictional torque T_F, a maximum torque is produced:

𝄎 17
Max. torque

$$T_{max} = (J \cdot \alpha) + T_F = (2,5 \cdot 50,27) + 8 = 133,68 \text{ Nm}$$

T_{max}	Nm	Max. torque
J	$kg \cdot m^2$	Mass moment of inertia
α	rad/s^2	Angular acceleration
T_F	Nm	Bearing frictional torque

Effective torque, taking into account the bearing frictional torque T_F:

ƒ 18
Effective torque, taking into
account the bearing frictional
torque

$$T_{eff} = \left(J \cdot \alpha \cdot \sqrt{\frac{t_m}{t_m + t_b}} \right) + T_F = \left(2,5 \cdot 50,27 \cdot \sqrt{\frac{0,5}{1,35}} \right) + 8 = 84,48 \text{ Nm}$$

T_{eff}	Nm	Effective torque
J	kg · m²	Mass moment of inertia
α	rad/s²	Angular acceleration
t_m	s	Movement time
t_b	s	Pause time
T_F	Nm	Bearing frictional torque

The motor is selected with the following requirements in due accordance with the safety factor SF.

$1,4 \times T_{max} \leq T_P$
$1,4 \times T_{eff} \leq T_{cw}$
$n_{max} \leq n_{lp}$

When selecting a motor with the calculated operating points T_{max} and n_{max}, work should be carried out at the speed without a safety factor, otherwise the drive will be significantly overdimensioned in the application in mechanical performance terms. Overdimensioning: safety speed 1,4 x safety torque 1,4 = overall safety 1,96. Alternatively, the operating point can also be interpreted using the torque/speed diagram. Customers, please contact our specialists for further information.

The calculation results in the following motor requirements:

Without safety factor:

- T_p = 133,68 Nm
- T_{cw} = 84,48 Nm

With safety factor:

- T_p = 187,15 Nm
- T_{cw} = 118,27 Nm

Motor RIB17-3P-168x50-Z0.7 with T_p = 233 Nm, T_{cw} = 123 Nm and n_{lp} = 150 min⁻¹ meets the requirement in the sample calculation in full.

1.10.3 NC rotary table applications

For water-cooled rotary table applications, the speed n, moment of inertia J, processing torque T_W (in motion), stall torque T_{sw} and the angular accelerations α in S1 operation and $α_{max}$ in S6 operation are usually known. Although the effective times of the torques change on a frequent basis, it is still necessary to determine the effective torque as a continuous torque and the maximum torque as precisely as possible, in order to select the optimum motor and prevent the maximum permissible winding temperature from being exceeded. All load torques occurring during motor operation are incorporated into the torque calculation.

1.10.4 Example of NC rotary table applications

⊞ 6 Specified values

Specified values	Unit	Value
Speed n	min⁻¹	60
Mass moment of inertia J	kg · m²	4
Processing torque T_W	Nm	300

Specified values	Unit	Value
Frictional torque T_F	Nm	50
Weight force (additional torque) T_Z	Nm	0
Angular acceleration in S1 operation α_{S1}	°/s²	9000
Max. angular acceleration in S6 operation for 3 s α_{max}	°/s²	20000
Safety factor SF	–	1,4

Calculation

Conversion of angular acceleration into rad/s²:

ƒ 19
Angular acceleration

$$\alpha_{S1} = \frac{\pi}{180} \cdot \alpha_{S1}\left[°/s^2\right] = \frac{\pi}{180} \cdot 9000 = 157 \text{ rad/s}^2$$

α_{S1}	rad/s²	Angular acceleration in S1 operation

ƒ 20
Max. angular acceleration

$$\alpha_{max} = \frac{\pi}{180} \cdot \alpha_{max}\left[°/s^2\right] = \frac{\pi}{180} \cdot 20000 = 349 \text{ rad/s}^2$$

α_{max}	rad/s²	Max. angular acceleration

Motor selection is based on the cooled stall torque T_{sw} and on the torques in motion for S1 operation (T_{cw}) and S6 operation (T_p). The safety factor SF of 1,4 ensures that the position can be reliably maintained and that the control system responds reliably to deviations.

ƒ 21
Cooled stall torque, with water cooling

$$T_{sw} = \left(T_W + T_F + T_Z\right) \cdot 1,4 = 490 \text{ Nm}$$

T_{sw}	Nm	Stall torque, cooled
T_W	Nm	Processing torque
T_F	Nm	Bearing frictional torque
T_Z	Nm	Weight force (additional torque)

ƒ 22
Cooled rated torque, with water cooling

$$T_{cw} = \left(J \cdot \alpha_{S1} + T_W + T_F + T_Z\right) \cdot 1.4 = 1369 \text{ Nm}$$

T_{cw}	Nm	Rated torque, cooled
J	kg · m²	Mass moment of inertia
α_{S1}	rad/s²	Angular acceleration in S1 operation
T_W	Nm	Processing torque
T_F	Nm	Bearing frictional torque
T_Z	Nm	Weight force (additional torque)

ƒ 23
Peak torque

$$T_p = \left(J \cdot \alpha_{max} + T_W + T_F + T_Z\right) \cdot 1,4 = 2444 \text{ Nm}$$

T_p	Nm	Peak torque
J	kg · m²	Mass moment of inertia
α_{max}	rad/s²	Max. angular acceleration
T_W	Nm	Processing torque
T_F	Nm	Bearing frictional torque
T_Z	Nm	Weight force (additional torque)

The calculation results in the following motor requirements:

T_p = 2444 Nm

T_{cw} = 1369 Nm

Motor RIB13-3P-690×50-Z4.2 with T_p = 3627 Nm, T_{cw} = 2166 Nm and n_{lp} = 61 min⁻¹ meets the requirements in the sample calculation in full.

In the above example, the NC rotary table should first run up to a defined speed (speed control). Machining is then carried out by the NC rotary table at this speed.

If an additional positioning operation is required, for example in the case of turners used in position control, the requisite speed at T_P must be applied with a certainty of 10 % to 20 %. The limiting speed n_{lp} of the motor must then be greater than the calculated speed complete with additional value.

2 Torque motors

RIB torque motors are permanently excited synchronous motors which operate as internal running motors.

The primary part is a fully cast stator with external liquid cooling. The rotor comprises an interference ring with a large internal diameter and permanent magnets attached on the outside.

This motor series is optimised for maximum efficiency, with high torque and low power losses at rated speed. The usable torque is available over a very large range. RIB torque motors are designed for circumferential speeds of up to 10 m/s. The low torque fluctuations allow the motors to be used for precision applications.

RIB torque motors have the following features:

- torque-effective stator heights in increments of 25-mm
- various standard windings for different speeds
- available in standard sizes

⊞ 7 Cable outlets

Standard	Option	Option
Axial cable outlet	Tangential cable outlet	Radial cable outlet

Benefits:

- optimised for low power loss
- high dynamic response and rigidity
- compact design
- maintenance-free
- good synchronisation characteristics
- reduced energy consumption courtesy of converter-based and application-based winding designs
- cost savings possible through downsizing
- high machine accuracy due to reduced heat from the motor

Applications:

- machine tools
- NC rotary tables
- indexing tables
- radial precision tracking units
- automation technology
- printing machinery
- packaging machinery
- servo presses

See also

2.1 type designation

001A8BDC

RIB XX – 3P – D×H – XX – P – O – M – PRIM

Short designation, motor
RIB   Rotary, internal, Generation B

Type code
XX   Type code

Number of motor phases
3P   3-phase

Size
D×H   Effective air gap diameter × active height

Winding type
XX   Application-specific

Temperature monitoring
P   3 PTC and 1 Pt1000
T   3 PTC and 3 Pt1000

Commutation type
O   Without sensors, measuring system commutated

Design variant
M   Standard built-in component
K   With cooling in the ring
     Note: additional ring provided by
     Schaeffler Industrial Drives

Motor part
PRIM   Primary part

⊕ 18 RIB series, primary part (stator)

001A8B4C

RI XX – 3P – D×H – M – SEK

Short designation, motor
RI   Rotary, internal

Type code
XX   Type code

Number of motor phases
3P   3-phase

Size
D×H   Effective air gap diameter × active height

Design variant
M   Standard built-in component

Motor part
SEK   Secondary part

⊕ 19 RIB series, secondary part (rotor)

2.2 Product tables

2.2.1 Explanations

$\Delta\vartheta$	K	Cooling water temperature difference
dV/dt	l/min	Cooling water flow
F_a	kN	Axial attraction
F_r	kN/mm	Radial attraction
H_P	mm	Stator height
H_S	mm	Rotor height
$I_{c\,eff}$	A	Effective rated current, not cooled
$I_{cw\,eff}$	A	Effective rated current, cooled
$I_{p\,eff}$	A	Effective peak current
$I_{sw\,eff}$	A	Effective stall current, cooled
$I_{u\,eff}$	A	Effective ultimate current
J	$kg \cdot m^2$	Moment of inertia of rotor
k_m	$Nm/\sqrt{W}$	Motor constant
k_T	Nm/A(eff)	Moment constant
k_u	V/(rad/s)	Back EMF constant, phase to phase
L	mH	Inductance, phase to phase
m_P	kg	Stator mass
m_S	kg	Rotor mass
n_{lp}	min^{-1}	Limiting speed at $I_{p\,eff}$ and U_{DCL}
n_{lw}	min^{-1}	Knee speed
n_{lwS1}	min^{-1}	Rated speed (S1), cooled
n_P	–	Stator thread number
n_{PC}	–	Stator thread number, cable side
n_S	–	Rotor thread number
P	–	Number of pole pairs
P_{lc}	W	Power loss at T_c
P_{lp}	W	Power loss at T_p
P_{lw}	W	Power loss at T_{cw}
R_{25}	Ω	Electrical resistance, phase to phase
T_c	Nm	Rated torque, not cooled
T_{cog}	Nm	Cogging torque
T_{cw}	Nm	Rated torque, cooled
TD_P	–	Stator thread depth
TD_{PC}	–	Stator thread depth, cable side
TD_S	–	Rotor thread depth
T_p	Nm	Peak torque
TP_P	°	Stator thread pitch
TP_{PC}	°	Stator thread pitch, cable side
TP_S	°	Rotor thread pitch
TS_P	–	Stator thread size
TS_{PC}	–	Stator thread size, cable side
TS_S	–	Rotor thread size
T_{sw}	Nm	Stall torque, cooled
T_u	Nm	Ultimate torque
U_{DCL}	V	DC link voltage
ϑ_{PTC}	°C	Motor temperature switch-off threshold

Tolerance range of the values: ±10 %.

Binding data and drawings will be made available by agreement. We recommend obtaining support from our engineers in the motor design phase.

2.2.2   RIB11-3P-89xH
Geometric data

Size			89×25
Rotor mass	m_S	kg	0,5
Stator mass	m_P	kg	5,1
Rotor height	H_S	mm	26
Stator height	H_P	mm	70
Rotor thread	$TS_S \times TD_S$	–	M5×10
Rotor thread, number×pitch	$n_S \times TP_S$	°	8×45
Stator thread, cable side	$TS_{PC} \times TD_{PC}$	–	M5×10
Stator thread, cable side, number×pitch	$n_{PC} \times TP_{PC}$	°	15×22,5
Stator thread	$TS_P \times TD_P$	–	M5×10
Stator thread, number×pitch	$n_P \times TP_P$	°	16×22,5

001A4A74

001A4A76
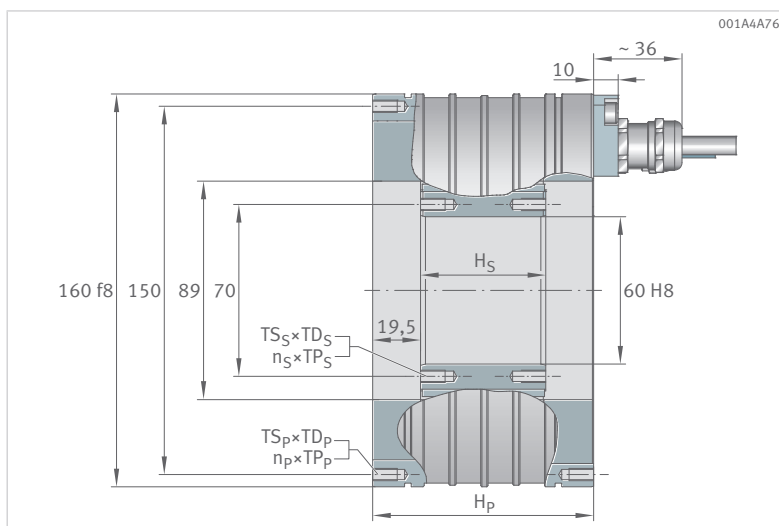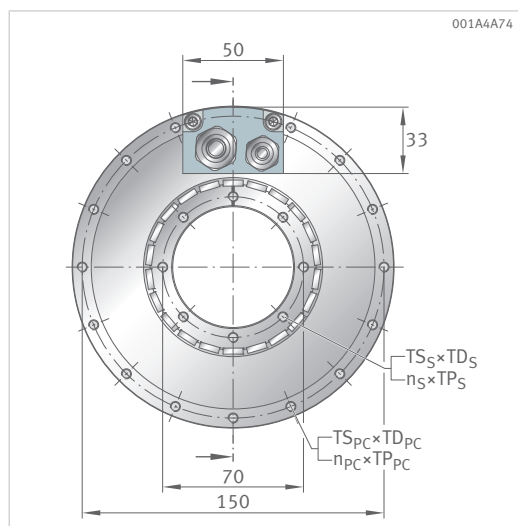
89×50	89×75	89×100	89×125	89×150
1,1	1,6	2,2	2,7	3,2
7,2	9,3	11,8	14,1	16,3
51	76	101	126	151
90	110	140	165	190
M5×10	M5×10	M5×10	M5×10	M5×10
8×45	8×45	16×22,5	16×22,5	16×22,5
M5×10	M5×10	M5×10	M5×10	M5×10
15×22,5	15×22,5	15×22,5	15×22,5	15×22,5
M5×10	M5×10	M5×10	M5×10	M5×10
16×22,5	16×22,5	16×22,5	16×22,5	16×22,5

2.2.3 RIB11-3P-89xH
Performance data

Size			89×25	89×25	89×50
Winding variant			**Z0.9**	**Z1.7**	**Z0.9**
Mass moment of inertia, rotor	J	kg · m^2	0,00075	0,00075	0,0015
Axial attraction	F_a	kN	0,1	0,1	0,1
Radial attraction	F_r	kN/mm	0,5	0,5	1
Number of pole pairs	P		11	11	11
Ultimate torque	T_u	Nm	33	33	72
Peak torque	T_p	Nm	30	30	67
Rated torque, cooled	T_{cw}	Nm	19	19	42
Rated torque, not cooled	T_c	Nm	7	7	15
Stall torque, cooled	T_{sw}	Nm	14	14	32
Cogging torque	T_{cog}	Nm	0,1	0,1	0,21
Knee speed	n_{lw}	min^{-1}	1668	3419	790
Rated speed (S1), cooled	n_{lwS1}	min^{-1}	682	682	682
Limiting speed at $I_{p\,eff}$ and U_{DCL}	n_{lp}	min^{-1}	1174	2465	538
Effective ultimate current	$I_{u\,eff}$	A	21,1	42,2	21,1
Effective peak current	$I_{p\,eff}$	A	16,9	33,8	16,9
Effective rated current, cooled	$I_{cw\,eff}$	A	7,7	15,4	8,4
Effective rated current, not cooled	$I_{c\,eff}$	A	2,5	5,1	2,9
Effective stall current, cooled	$I_{sw\,eff}$	A	5,6	11,1	6,1
Power loss at T_p	P_{lp}	W	1971	1971	2957
Power loss at T_{cw}	P_{lw}	W	556	556	995
Power loss at T_c	P_{lc}	W	44	44	89
Motor constant	k_m	Nm/√W	0,99	0,99	1,61
Moment constant	k_T	Nm/A(eff)	2,6	1,3	5,2
Back EMF constant, phase to phase	k_u	V/(rad/s)	2,1	1,1	4,2
Electrical resistance, phase to phase	R_{25}	Ohm	4,6	1,2	6,9
Inductance, phase to phase	L	mH	25	6,3	47,5
Cooling water flow	dV/dt	l/min	1,6	1,6	2,9
Cooling water temperature difference	$\Delta\vartheta$	K	5	5	5
Motor temperature switch-off threshold	ϑ_{PTC}	°C	110	110	110
DC link voltage	U_{DCL}	V	600	600	600

Cooling water temperature: +20 °C
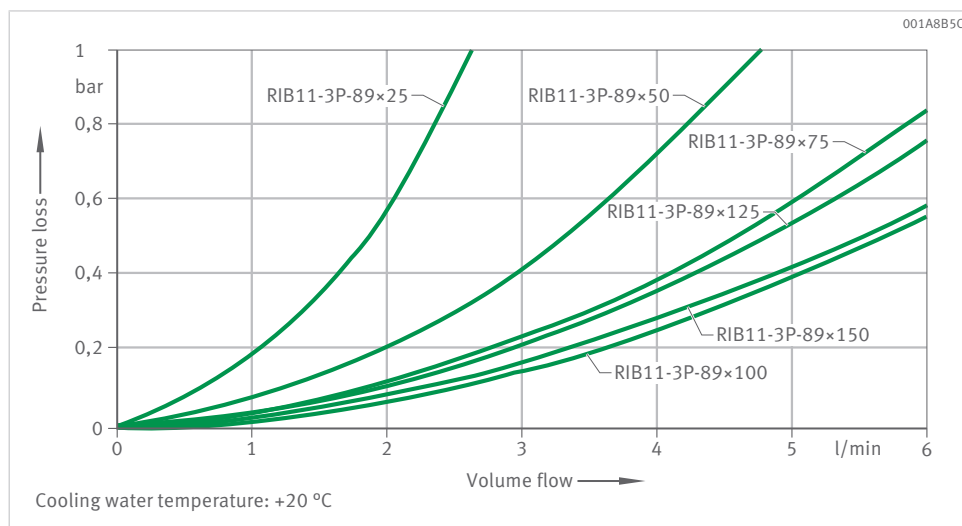
89×50	89×75	89×75	89×100	89×100	89×125	89×125	89×150	89×150
Z1.7	**Z0.9**	**Z1.7**	**Z1.4**	**Z2.7**	**Z1.4**	**Z2.7**	**Z1.4**	**Z2.7**
0,0015	0,00225	0,00225	0,003	0,003	0,00375	0,00375	0,0045	0,0045
0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
1	1,5	1,5	2	2	2,4	2,4	2,9	2,9
11	11	11	11	11	11	11	11	11
72	110	110	147	147	184	184	221	221
67	102	102	134	134	167	167	200	200
42	62	62	79	79	100	100	121	121
15	23	23	31	31	40	40	49	49
32	46	46	60	60	76	76	91	91
0,21	0,32	0,32	0,43	0,43	0,53	0,53	0,64	0,64
1647	512	1091	682	1430	532	1127	434	928
682	512	682	682	682	532	682	434	682
1164	323	742	439	967	336	761	268	625
42,2	21,1	42,2	35,5	70,9	35,5	70,9	35,5	70,9
33,8	16,9	33,8	28,4	56,7	28,4	56,7	28,4	56,7
16,9	8,3	16,5	13,4	26,8	13,5	27,1	13,6	27,3
5,8	3	5,9	5	10	5,1	10,3	5,3	10,5
12,1	5,9	11,9	9,6	19,3	9,8	19,5	9,8	19,7
2957	4337	4337	5723	5723	6783	6783	7737	7737
995	1401	1401	1725	1725	2090	2090	2419	2419
89	133	133	177	177	221	221	266	266
1,61	2	2	2,32	2,32	2,67	2,67	3	3
2,6	7,8	3,9	6,2	3,1	7,7	3,9	9,3	4,6
2,1	6,4	3,2	5,1	2,5	6,3	3,2	7,6	3,8
1,7	10,1	2,5	4,7	1,2	5,6	1,4	6,4	1,6
11,9	71,3	17,8	33,7	8,4	42,1	10,5	50,5	12,6
2,9	4	4	4,9	4,9	6	6	6,9	6,9
5	5	5	5	5	5	5	5	5
110	110	110	110	110	110	110	110	110
600	600	600	600	600	600	600	600	600

2.2.4   RIB11-3P-120xH
Geometric data

Size			120×25
Rotor mass	m_S	kg	0,9
Stator mass	m_P	kg	7,9
Rotor height	H_S	mm	26
Stator height	H_P	mm	80
Rotor thread	$TS_S \times TD_S$	–	M5×10
Rotor thread, number×pitch	$n_S \times TP_S$	°	16×22,5
Stator thread, cable side	$TS_{PC} \times TD_{PC}$	–	M5×10
Stator thread, cable side, number×pitch	$n_{PC} \times TP_{PC}$	°	8×45
Stator thread	$TS_P \times TD_P$	–	M5×10
Stator thread, number×pitch	$n_P \times TP_P$	°	8×45
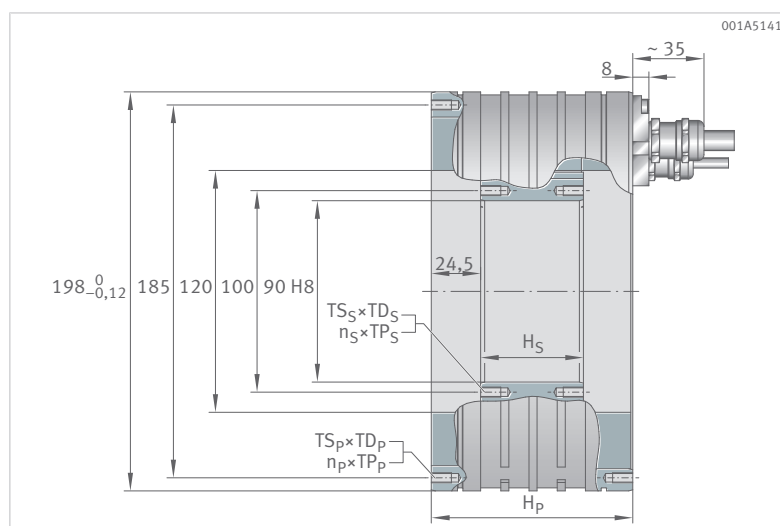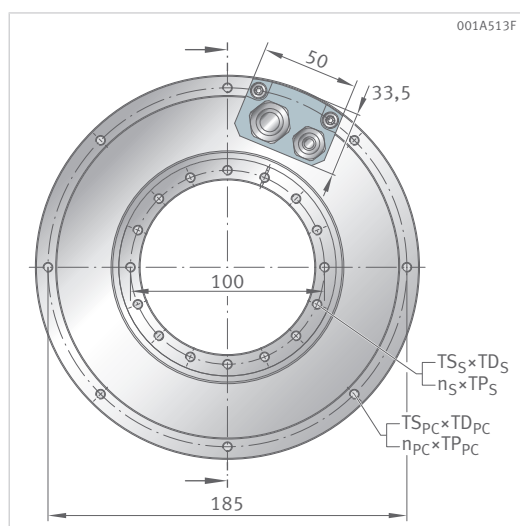
120×50	120×75	120×100	120×125	120×150
1,7	2,6	3,4	4,3	5,1
10,8	13,7	17,2	20,4	23,6
51	76	101	126	151
100	120	150	175	200
M5×10	M5×10	M6×10	M6×10	M6×10
16×22,5	16×22,5	16×22,5	16×22,5	16×22,5
M5×10	M5×10	M5×10	M5×10	M5×10
8×45	8×45	15×22,5	15×22,5	15×22,5
M5×10	M5×10	M5×10	M5×10	M5×10
8×45	8×45	16×22,5	16×22,5	16×22,5

2.2.5   RIB11-3P-120xH
Performance data

Size			120×25	120×25	120×50
Winding variant			**Z0.7**	**Z1.5**	**Z1.5**
Mass moment of inertia, rotor	J	kg · m^2	0,0046	0,0046	0,0092
Axial attraction	F_a	kN	0,16	0,16	0,16
Radial attraction	F_r	kN/mm	0,5	0,5	0,9
Number of pole pairs	P		11	11	11
Ultimate torque	T_u	Nm	68	68	157
Peak torque	T_p	Nm	62	62	139
Rated torque, cooled	T_{cw}	Nm	32	32	77
Rated torque, not cooled	T_c	Nm	10	10	26
Stall torque, cooled	T_{sw}	Nm	25	25	59
Cogging torque	T_{cog}	Nm	0,21	0,21	0,42
Knee speed	n_{lw}	min^{-1}	886	1843	849
Rated speed (S1), cooled	n_{lwS1}	min^{-1}	682	682	682
Limiting speed at $I_{p\,eff}$ and U_{DCL}	n_{lp}	min^{-1}	541	1169	566
Effective ultimate current	$I_{u\,eff}$	A	18	36,1	36,1
Effective peak current	$I_{p\,eff}$	A	14,4	28,8	28,8
Effective rated current, cooled	$I_{cw\,eff}$	A	6,4	12,7	14,1
Effective rated current, not cooled	$I_{c\,eff}$	A	1,9	3,7	4,7
Effective stall current, cooled	$I_{sw\,eff}$	A	4,8	9,6	10,6
Power loss at T_p	P_{lp}	W	2472	2472	3794
Power loss at T_{cw}	P_{lw}	W	651	651	1222
Power loss at T_c	P_{lc}	W	41	41	102
Motor constant	k_m	Nm/√W	1,51	1,51	2,62
Moment constant	k_T	Nm/A(eff)	5,2	2,6	5,6
Back EMF constant, phase to phase	k_u	V/(rad/s)	4,2	2,1	4,6
Electrical resistance, phase to phase	R_{25}	Ohm	7,9	2	3
Inductance, phase to phase	L	mH	51,4	12,8	23,5
Cooling water flow	dV/dt	l/min	1,9	1,9	3,5
Cooling water temperature difference	$\Delta\vartheta$	K	5	5	5
Motor temperature switch-off threshold	ϑ_{PTC}	°C	110	110	110
DC link voltage	U_{DCL}	V	600	600	600

RIB11-3P-120×25
RIB11-3P-120×50
RIB11-3P-120×150
RIB11-3P-120×100
RIB11-3P-120×125
RIB11-3P-120×75

Cooling water temperature: +20 °C
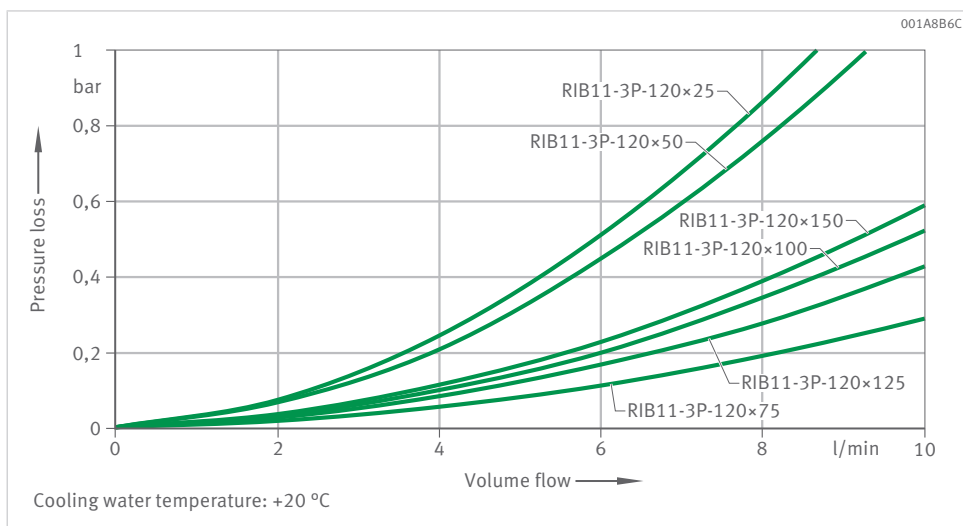
120×75	120×75	120×100	120×100	120×125	120×125	120×150	120×150
Z1.4	Z2.9	Z1.4	Z2.9	Z1.4	Z2.9	Z1.5	Z2.9
0,0138	0,0138	0,0184	0,0184	0,023	0,023	0,0276	0,0276
0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16
1,4	1,4	1,8	1,8	2,2	2,2	2,7	2,7
11	11	11	11	11	11	11	11
236	236	314	314	393	393	471	471
208	208	277	277	346	346	416	416
126	126	171	171	219	219	250	264
45	45	62	62	80	80	92	98
97	97	131	131	167	167	191	202
0,63	0,63	0,84	0,84	1,05	1,05	1,26	1,26
479	1005	356	758	276	598	260	495
479	682	356	682	276	598	260	495
331	719	245	549	188	437	167	362
32,2	64,5	32,2	64,5	32,2	64,5	36,1	64,5
25,8	51,6	25,8	51,6	25,8	51,6	28,8	51,6
13,7	27,5	13,9	27,9	14,3	28,6	15,2	28,8
4,8	9,6	5	10	5,1	10,2	5,5	10,4
10,3	20,6	10,5	20,9	10,7	21,4	11,4	21,6
4425	4425	5454	5454	6483	6483	8393	7512
1697	1697	2153	2153	2688	2688	3158	3158
153	153	205	205	256	256	307	307
3,63	3,63	4,36	4,36	5	5	5,28	5,58
9,4	4,7	12,5	6,2	15,6	7,8	16,8	9,4
7,7	3,8	10,2	5,1	12,8	6,4	13,7	7,7
4,4	1,1	5,5	1,4	6,5	1,6	6,7	1,9
42,8	10,7	54,1	13,5	66,2	16,5	62,1	19,4
4,9	4,9	6,2	6,2	7,7	7,7	9	9
5	5	5	5	5	5	5	5
110	110	110	110	110	110	110	110
600	600	600	600	600	600	600	600

2.2.6 RIB17-3P-168xH
Geometric data

Size			168×25
Rotor mass	m_S	kg	1,2
Stator mass	m_P	kg	7,2
Rotor height	H_S	mm	26
Stator height	H_P	mm	70
Rotor thread	$TS_S \times TD_S$	–	M5×10
Rotor thread, number×pitch	$n_S \times TP_S$	°	12×30
Stator thread, cable side	$TS_{PC} \times TD_{PC}$	–	M5×10
Stator thread, cable side, number×pitch	$n_{PC} \times TP_{PC}$	°	11×30
Stator thread	$TS_P \times TD_P$	–	M5×10
Stator thread, number×pitch	$n_P \times TP_P$	°	12×30

001A5466

001A5469

168×50	168×75	168×100	168×125	168×150	168×175
2,4	3,6	4,8	6	7,2	8,4
10,1	13,3	16,5	19,8	23	26,2
51	76	101	126	151	176
90	115	140	165	190	215
M5×10	M5×10	M5×10	M5×10	M6×10	M6×10
12×30	24×15	24×15	24×15	24×15	24×15
M5×10	M5×10	M5×10	M5×10	M5×10	M5×10
11×30	21×15	21×15	21×15	21×15	21×15
M5×10	M5×10	M5×10	M5×10	M5×10	M5×10
12×30	24×15	24×15	24×15	24×15	24×15

2.2.7   RIB17-3P-168xH
Performance data

Size			168×25	168×25	168×50	168×50
Winding variant			**Z0.7**	**Z1.4**	**Z0.7**	**Z1.4**
Mass moment of inertia, rotor	J	$kg \cdot m^2$	0,0071	0,0071	0,0141	0,0141
Axial attraction	F_a	kN	0,28	0,28	0,28	0,28
Radial attraction	F_r	kN/mm	1	1	2	2
Number of pole pairs	P		17	17	17	17
Ultimate torque	T_u	Nm	130	130	272	272
Peak torque	T_p	Nm	112	112	233	233
Rated torque, cooled	T_{cw}	Nm	58	58	123	123
Rated torque, not cooled	T_c	Nm	16	16	37	37
Stall torque, cooled	T_{sw}	Nm	43	43	90	90
Cogging torque	T_{cog}	Nm	0,59	0,59	1,16	1,16
Knee speed	n_{lw}	min^{-1}	585	1242	272	602
Rated speed (S1), cooled	n_{lwS1}	min^{-1}	441	441	272	441
Limiting speed at $I_{p\,eff}$ and U_{DCL}	n_{lp}	min^{-1}	372	843	160	406
Effective ultimate current	$I_{u\,eff}$	A	19,3	38,7	19,3	38,7
Effective peak current	$I_{p\,eff}$	A	15,5	30,9	15,5	30,9
Effective rated current, cooled	$I_{cw\,eff}$	A	6,9	13,8	7,2	14,5
Effective rated current, not cooled	$I_{c\,eff}$	A	1,9	3,7	2,2	4,3
Effective stall current, cooled	$I_{sw\,eff}$	A	5	10	5,3	10,5
Power loss at T_p	P_{lp}	W	3402	3402	5053	5053
Power loss at T_{cw}	P_{lw}	W	912	912	1487	1487
Power loss at T_c	P_{lc}	W	50	50	99	99
Motor constant	k_m	Nm/√W	2,25	2,25	3,73	3,73
Moment constant	k_T	Nm/A(eff)	8,5	4,2	17,1	8,6
Back EMF constant, phase to phase	k_u	V/(rad/s)	6,9	3,5	14	7
Electrical resistance, phase to phase	R_{25}	Ohm	9,5	2,4	14,1	3,5
Inductance, phase to phase	L	mH	37,3	9,3	69,3	17,3
Cooling water flow	dV/dt	l/min	2,6	2,6	4,3	4,3
Cooling water temperature difference	$\Delta\vartheta$	K	5	5	5	5
Motor temperature switch-off threshold	ϑ_{PTC}	°C	110	110	110	110
DC link voltage	U_{DCL}	V	600	600	600	600
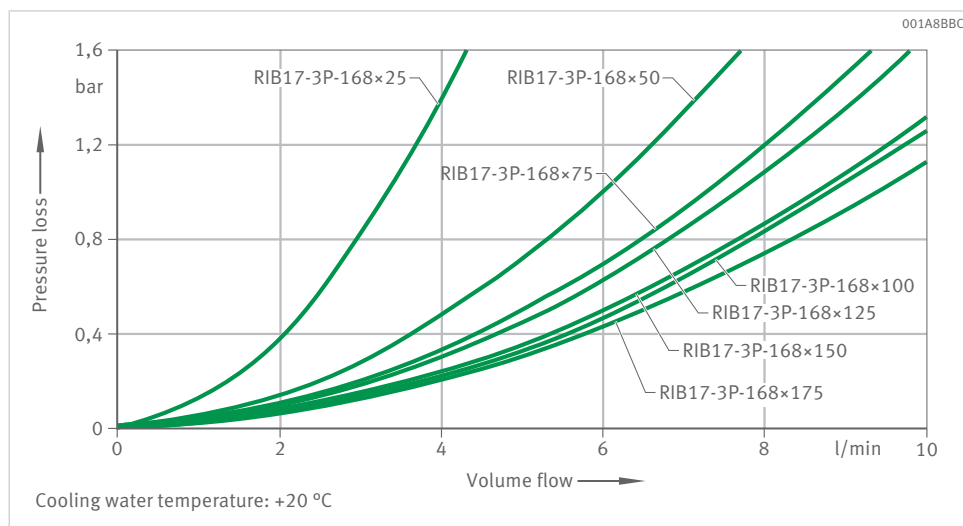
001A8BBC

Chart — Pressure loss (bar) vs Volume flow (l/min):
- RIB17-3P-168×25
- RIB17-3P-168×50
- RIB17-3P-168×75
- RIB17-3P-168×100
- RIB17-3P-168×125
- RIB17-3P-168×150
- RIB17-3P-168×175

Cooling water temperature: +20 °C

168×75	168×75	168×100	168×100	168×125	168×125	168×150	168×150	168×175	168×175
Z1.8	Z3.4	Z1.8	Z3.4	Z1.8	Z3.4	Z1.8	Z3.4	Z1.8	Z3.4
0,0211	0,0211	0,0282	0,0282	0,0353	0,0353	0,0424	0,0424	0,0494	0,0494
0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28
3	3	3,9	3,9	4,9	4,9	5,9	5,9	6,8	6,8
17	17	17	17	17	17	17	17	17	17
408	408	544	544	690	690	816	816	951	951
350	350	467	467	591	591	700	700	817	817
185	185	249	249	305	305	372	372	429	429
58	58	80	80	100	100	126	126	144	144
137	137	184	184	221	221	273	273	314	314
1,69	1,69	2,25	2,25	2,81	2,81	3,57	3,57	3,94	3,94
504	1061	370	790	282	611	231	509	191	430
441	441	370	441	282	441	231	441	191	430
338	747	244	558	171	405	140	348	106	286
48,6	97,3	48,6	97,3	48,6	97,3	48,6	97,3	48,6	97,3
38,9	77,8	38,9	77,8	38,9	77,8	38,9	77,8	38,9	77,8
18,4	36,8	18,6	37,3	18,3	36,5	18,4	36,7	18,2	36,3
5,7	11,4	5,9	11,8	6	11,9	6,2	12,3	6	12,1
13,4	26,7	13,5	27	13,3	26,5	13,3	26,7	13,2	26,4
6975	6975	8643	8643	10579	10579	11914	11914	14450	14450
2098	2098	2662	2662	3131	3131	3564	3564	4226	4226
149	149	199	199	249	249	298	298	348	348
4,76	4,76	5,71	5,71	6,32	6,32	7,29	7,29	7,72	7,72
10,2	5,1	13,6	6,8	16,7	8,4	20,5	10,2	23,9	11,9
8,3	4,2	11,1	5,6	13,6	6,8	16,7	8,4	19,5	9,7
3,1	0,8	3,8	1	4,7	1,2	5,2	1,3	6,4	1,6
16,1	4	20,8	5,2	28,6	7,1	32,3	8,1	37,8	9,5
6	6	7,8	7,8	9	9	10,3	10,3	12,5	12,5
5	5	5	5	5	5	5	5	5	5
110	110	110	110	110	110	110	110	110	110
600	600	600	600	600	600	600	600	600	600

2.2.8   RIB11-3P-230xH
Geometric data

Size			230×25
Rotor mass	m_S	kg	1,8
Stator mass	m_P	kg	13,2
Rotor height	H_S	mm	26
Stator height	H_P	mm	80
Rotor thread	$TS_S{\times}TD_S$	–	M5×10
Rotor thread, number×pitch	$n_S{\times}TP_S$	°	24×15
Stator thread, cable side	$TS_{PC}{\times}TD_{PC}$	–	M5×10
Stator thread, cable side, number×pitch	$n_{PC}{\times}TP_{PC}$	°	23×15
Stator thread	$TS_P{\times}TD_P$	–	M5×10
Stator thread, number×pitch	$n_P{\times}TP_P$	°	24×15

001A55C6

001A55C8
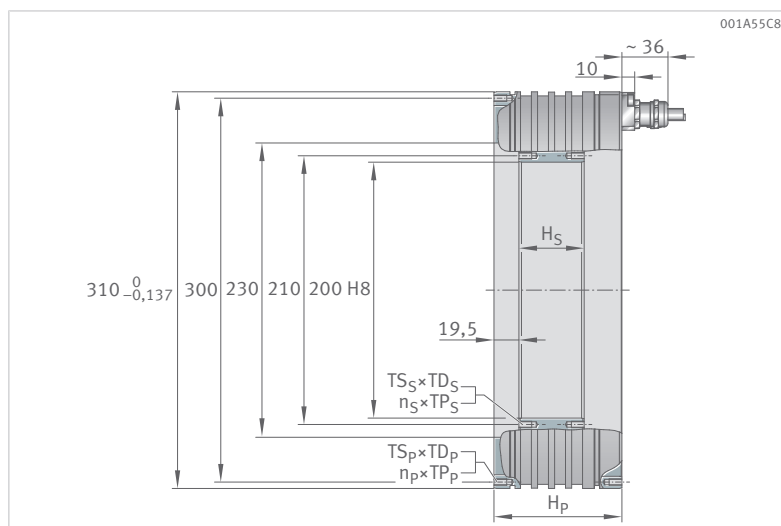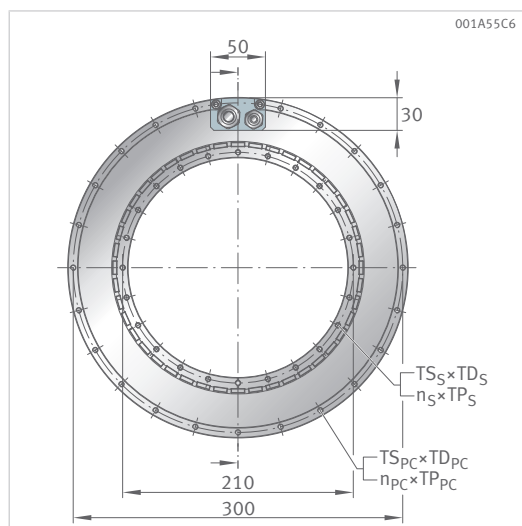
230×50	230×75	230×100	230×125	230×150	230×175
3,5	5,3	7	8,8	10,5	12,3
17,9	22,7	28,4	33,7	39	44,4
51	76	101	126	151	176
100	120	150	175	200	225
M5×10	M5×10	M5×10	M5×10	M5×10	M5×10
24×15	24×15	48×7,5	48×7,5	48×7,5	48×7,5
M5×10	M5×10	M5×10	M5×10	M5×10	M5×10
23×15	23×15	45×7,5	45×7,5	45×7,5	45×7,5
M5×10	M5×10	M5×10	M5×10	M5×10	M5×10
24×15	24×15	48×7,5	48×7,5	48×7,5	48×7,5

2.2.9   RIB11-3P-230xH
Performance data

Size			230×25	230×25	230×50	230×50
Winding variant			**Z1.8**	**Z3.3**	**Z1.8**	**Z3.3**
Mass moment of inertia, rotor	J	kg · m^2	0,0192	0,0192	0,0384	0,0384
Axial attraction	F_a	kN	0,35	0,35	0,35	0,35
Radial attraction	F_r	kN/mm	1	1	2	2
Number of pole pairs	P		22	22	22	22
Ultimate torque	T_u	Nm	239	239	501	501
Peak torque	T_p	Nm	219	219	457	457
Rated torque, cooled	T_{cw}	Nm	130	130	277	277
Rated torque, not cooled	T_c	Nm	39	39	92	92
Stall torque, cooled	T_{sw}	Nm	106	106	225	225
Cogging torque	T_{cog}	Nm	0,42	0,42	0,83	0,83
Knee speed	n_{lw}	min^{-1}	555	1143	255	534
Rated speed (S1), cooled	n_{lwS1}	min^{-1}	341	341	255	341
Limiting speed at $I_{p\,eff}$ and U_{DCL}	n_{lp}	min^{-1}	392	831	174	383
Effective ultimate current	$I_{u\,eff}$	A	42,7	85,4	42,7	85,4
Effective peak current	$I_{p\,eff}$	A	34,2	68,3	34,2	68,3
Effective rated current, cooled	$I_{cw\,eff}$	A	16,3	32,6	16,8	33,6
Effective rated current, not cooled	$I_{c\,eff}$	A	4,3	8,7	5	10,1
Effective stall current, cooled	$I_{sw\,eff}$	A	12,4	24,8	12,8	25,5
Power loss at T_p	P_{lp}	W	4252	4252	6336	6336
Power loss at T_{cw}	P_{lw}	W	1337	1337	2114	2114
Power loss at T_c	P_{lc}	W	69	69	137	137
Motor constant	k_m	Nm/√W	4,66	4,66	7,87	7,87
Moment constant	k_T	Nm/A(eff)	8,9	4,4	18,3	9,2
Back EMF constant, phase to phase	k_u	V/(rad/s)	7,3	3,6	15	7,5
Electrical resistance, phase to phase	R_{25}	Ohm	2,4	0,6	3,6	0,9
Inductance, phase to phase	L	mH	16,5	4,1	34,6	8,7
Cooling water flow	dV/dt	l/min	3,9	3,9	6,1	6,1
Cooling water temperature difference	$\Delta\vartheta$	K	5	5	5	5
Motor temperature switch-off threshold	ϑ_{PTC}	°C	120	120	120	120
DC link voltage	U_{DCL}	V	600	600	600	600

001A8B7C

Cooling water temperature: +20 °C
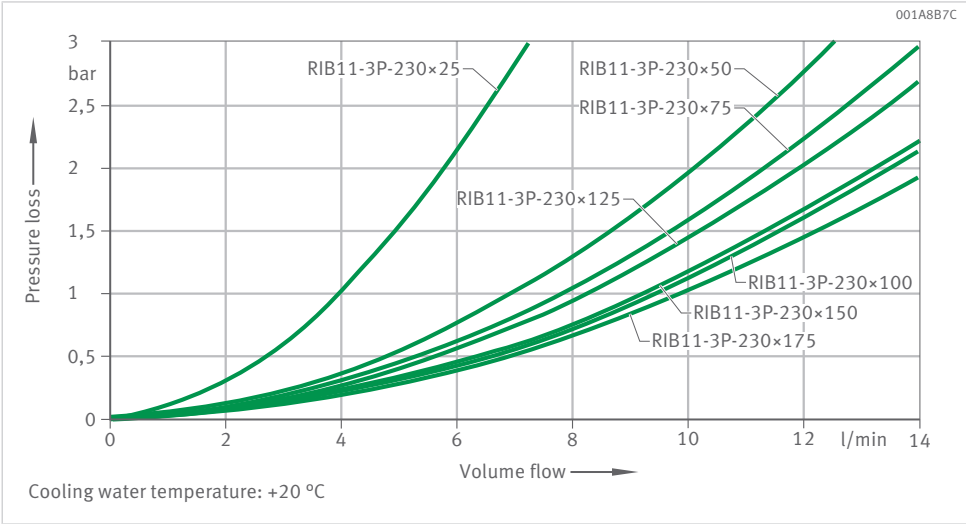
230×75	230×75	230×100	230×100	230×125	230×125	230×150	230×150	230×175	230×175
Z1.8	Z3.3	Z1.8	Z3.3	Z3.0	Z4.5	Z3.0	Z4.5	Z3.0	Z4.5
0,0576	0,0576	0,0768	0,0768	0,096	0,096	0,1152	0,1152	0,1344	0,1344
0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35
3	3	4	4	5	5	6	6	7	7
22	22	22	22	22	22	22	22	22	22
774	774	1032	1032	1289	1289	1550	1550	1809	1809
703	703	938	938	1172	1172	1409	1409	1644	1644
422	422	567	567	702	702	852	852	997	997
147	147	202	202	254	254	312	312	368	368
342	342	460	460	569	569	691	691	808	808
1,25	1,25	1,67	1,67	2,08	2,08	2,5	2,5	2,92	2,92
166	355	122	266	182	386	148	317	124	269
166	341	122	266	182	341	148	317	124	269
108	251	76	188	123	279	98	228	79	192
42,7	85,4	42,7	85,4	74,7	149,4	74,7	149,4	74,7	149,4
34,2	68,3	34,2	68,3	59,8	119,6	59,8	119,6	59,8	119,6
17,1	34,2	17,2	34,4	29,8	59,6	30,1	60,2	30,2	60,4
5,4	10,7	5,5	11,1	9,7	19,5	9,9	19,9	10	20,1
13	26	13,1	26,2	22,7	45,3	22,9	45,8	23	45,9
8379	8379	10463	10463	12941	12941	14916	14916	17017	17017
2891	2891	3668	3668	4445	4445	5222	5222	5999	5999
206	206	274	274	343	343	411	411	480	480
10,25	10,25	12,22	12,22	13,74	13,74	15,39	15,39	16,81	16,81
27,5	13,7	36,6	18,3	26,1	13,1	31,4	15,7	36,7	18,3
22,4	11,2	29,9	14,9	21,3	10,7	25,7	12,8	29,9	15
4,8	1,2	6	1,5	2,4	0,6	2,8	0,7	3,2	0,8
49,9	12,5	63,4	15,8	25,3	6,3	30,5	7,6	35,6	8,9
8,3	8,3	10,5	10,5	12,7	12,7	15	15	17,2	17,2
5	5	5	5	5	5	5	5	5	5
120	120	120	120	120	120	120	120	120	120
600	600	600	600	600	600	600	600	600	600

2.2.10   RIB13-3P-298xH
Geometric data

Size			298×25	298×50
Rotor mass	m_S	kg	2,6	5,1
Stator mass	m_P	kg	20,9	28,2
Rotor height	H_S	mm	26	51
Stator height	H_P	mm	90	110
Rotor thread	$TS_S{\times}TD_S$	–	M6×12	M6×12
Rotor thread, number×pitch	$n_S{\times}TP_S$	°	24×15	24×15
Stator thread, cable side	$TS_{PC}{\times}TD_{PC}$	–	M6×12	M6×12
Stator thread, cable side, number×pitch	$n_{PC}{\times}TP_{PC}$	°	23×15	23×15
Stator thread	$TS_P{\times}TD_P$	–	M6×12	M6×12
Stator thread, number×pitch	$n_P{\times}TP_P$	°	24×15	24×15

001A5848

001A584A
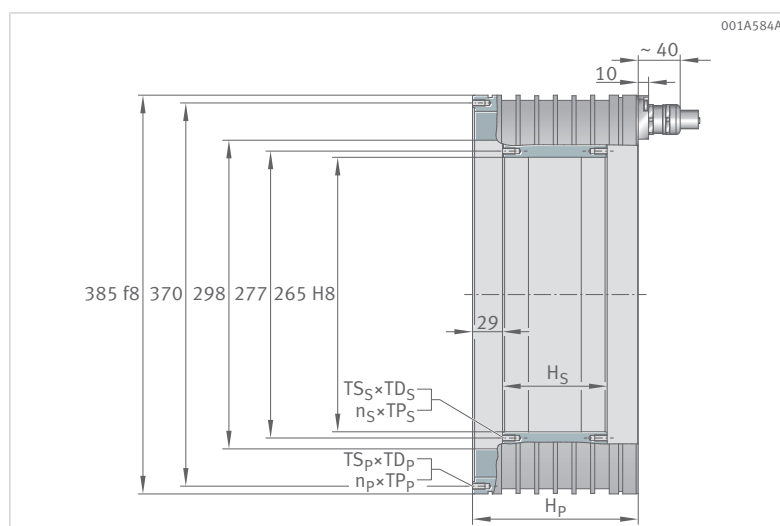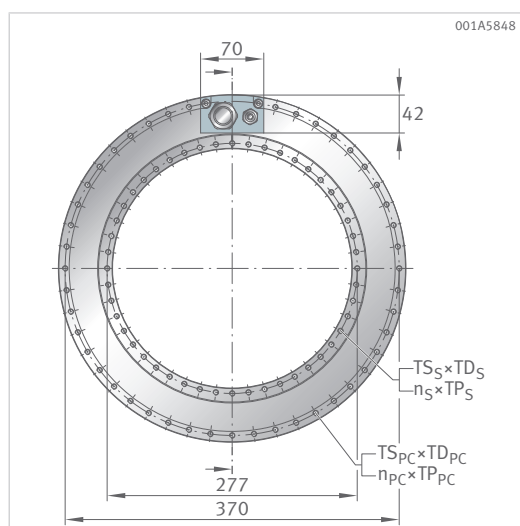
298×75	298×100	298×125	298×150	298×175
7,7	10,2	12,8	15,3	17,9
35,2	44,2	51,9	59,7	67,6
76	101	126	151	176
130	160	185	210	235
M6×12	M6×12	M6×12	M6×12	M6×12
24×15	48×7,5	48×7,5	48×7,5	48×7,5
M6×12	M6×12	M6×12	M6×12	M6×12
23×15	45×7,5	45×7,5	45×7,5	45×7,5
M6×12	M6×12	M6×12	M6×12	M6×12
24×15	48×7,5	48×7,5	48×7,5	48×7,5

2.2.11   RIB13-3P-298xH
Performance data

Size			298×25	298×25	298×25	298×50	298×50
Winding variant			**Z1.7**	**Z2.9**	**Z3.8**	**Z1.7**	**Z2.9**
Mass moment of inertia, rotor	J	$kg \cdot m^2$	0,05	0,05	0,05	0,1	0,1
Axial attraction	F_a	kN	0,48	0,48	0,48	0,48	0,48
Radial attraction	F_r	kN/mm	1,3	1,3	1,3	2,6	2,6
Number of pole pairs	P		26	26	26	26	26
Ultimate torque	T_u	Nm	353	353	353	754	754
Peak torque	T_p	Nm	312	312	312	664	664
Rated torque, cooled	T_{cw}	Nm	177	183	180	421	434
Rated torque, not cooled	T_c	Nm	60	62	61	144	148
Stall torque, cooled	T_{sw}	Nm	140	144	142	332	343
Cogging torque	T_{cog}	Nm	0,42	0,42	0,42	0,83	0,83
Knee speed	n_{lw}	min^{-1}	393	644	1097	181	300
Rated speed (S1), cooled	n_{lwS1}	min^{-1}	288	288	288	189	288
Limiting speed at $I_{p\,eff}$ and U_{DCL}	n_{lp}	min^{-1}	269	455	777	132	228
Effective ultimate current	$I_{u\,eff}$	A	37,1	60	100	37,1	60
Effective peak current	$I_{p\,eff}$	A	29,7	48	80	29,7	48
Effective rated current, cooled	$I_{cw\,eff}$	A	15,3	25,5	41,8	17,2	28,7
Effective rated current, not cooled	$I_{c\,eff}$	A	5	8,3	13,6	5,6	9,3
Effective stall current, cooled	$I_{sw\,eff}$	A	11,5	19,1	31,4	12,9	21,5
Power loss at T_p	P_{lp}	W	3770	3542	3654	4795	4506
Power loss at T_{cw}	P_{lw}	W	1350	1350	1350	2178	2178
Power loss at T_c	P_{lc}	W	105	105	105	170	170
Motor constant	k_m	Nm/√W	5,9	6,09	6	11,03	11,38
Moment constant	k_T	Nm/A(eff)	12,2	7,5	4,5	25,7	15,9
Back EMF constant, phase to phase	k_u	V/(rad/s)	10	6,2	3,7	21	13
Electrical resistance, phase to phase	R_{25}	Ohm	2,8	1	0,4	3,6	1,3
Inductance, phase to phase	L	mH	20,2	7,7	2,8	37,6	14,4
Cooling water flow	dV/dt	l/min	3,9	3,9	3,9	6,4	6,4
Cooling water temperature difference	$\Delta\vartheta$	K	5	5	5	5	5
Motor temperature switch-off threshold	ϑ_{PTC}	°C	110	110	110	110	110
DC link voltage	U_{DCL}	V	600	600	600	600	600

001A8B9C

Pressure loss (bar) vs Volume flow (l/min)

RIB13-3P-298×25
RIB13-3P-298×75
RIB13-3P-298×50
RIB13-3P-298×100
RIB13-3P-298×125
RIB13-3P-298×150
RIB13-3P-298×175

Cooling water temperature: +20 °C
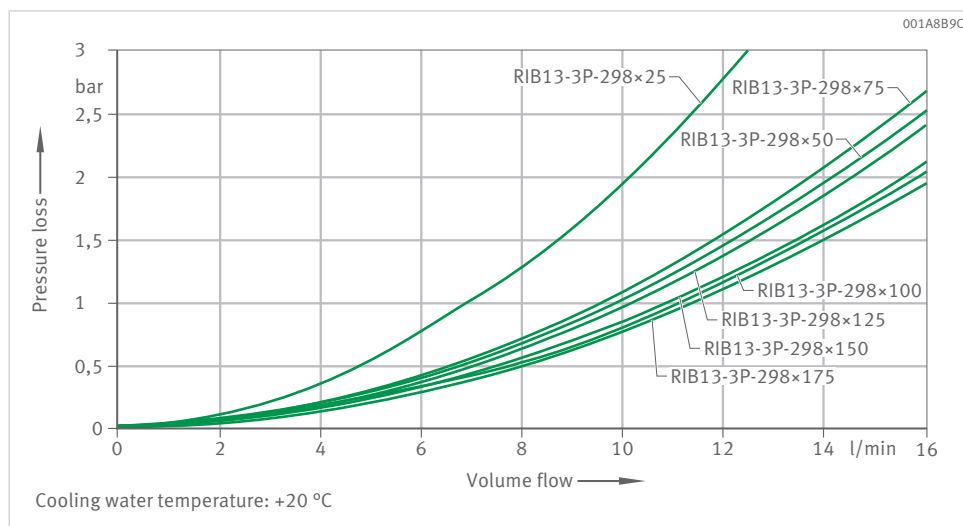
| 298×50 | 298×75 | 298×75 | 298×75 | 298×100 | 298×100 | 298×100 | 298×125 | 298×125 | 298×150 | 298×150 | 298×175 | 298×175 |
Z3.8	Z1.7	Z2.9	Z3.8	Z1.7	Z2.9	Z3.8	Z2.9	Z3.8	Z2.9	Z3.8	Z2.9	Z3.8
0,1	0,15	0,15	0,15	0,2	0,2	0,2	0,25	0,25	0,3	0,3	0,35	0,35
0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48
2,6	3,8	3,8	3,8	5,1	5,1	5,1	6,4	6,4	7,6	7,6	8,9	8,9
26	26	26	26	26	26	26	26	26	26	26	26	26
754	1130	1130	1130	1507	1507	1507	1884	1884	2261	2261	2637	2637
664	996	996	996	1328	1328	1328	1660	1660	1992	1992	2324	2324
427	631	651	641	852	879	865	1101	1084	1317	1296	1552	1528
146	247	254	250	343	354	349	455	448	557	549	659	649
337	488	503	496	659	680	669	852	839	1019	1003	1200	1182
0,83	1,25	1,25	1,25	1,67	1,67	1,67	2,08	2,08	2,5	2,5	2,92	2,92
516	121	205	356	86	150	262	118	209	97	173	81	146
288	121	205	288	86	150	262	118	209	97	173	81	146
393	86	157	275	60	113	203	88	161	71	132	59	111
100	37,1	60	100	37,1	60	100	60	100	60	100	60	100
80	29,7	48	80	29,7	48	80	48	80	48	80	48	80
47,1	17,2	28,7	47,1	17,5	29,1	47,7	29,2	47,9	29,1	47,7	29,4	48,2
15,3	6,4	10,7	17,5	6,7	11,1	18,3	11,5	18,8	11,7	19,2	11,9	19,5
35,3	12,9	21,5	35,4	13,1	21,8	35,8	21,9	35,9	21,8	35,8	22	36,1
4647	6785	6376	6577	8293	7793	8038	9210	9500	10627	10961	12044	12422
2178	3085	3085	3085	3867	3867	3867	4593	4593	5262	5262	6085	6085
170	315	315	315	420	420	420	525	525	629	629	734	734
11,2	13,9	14,33	14,11	16,76	17,29	17,02	19,88	19,57	22,21	21,87	24,34	23,96
9,5	38,5	23,8	14,3	51,4	31,8	19,1	39,7	23,8	47,7	28,6	55,6	33,4
7,8	31,4	19,5	11,7	41,9	26	15,6	32,4	19,5	38,9	23,4	45,4	27,3
0,5	5,1	1,8	0,7	6,3	2,3	0,8	2,7	1	3,1	1,1	3,5	1,3
5,2	50,4	19,3	7	67,2	25,8	9,3	31,5	11,4	37,5	13,5	43,3	15,6
6,4	8,8	8,8	8,8	11,1	11,1	11,1	13,2	13,2	15,1	15,1	17,4	17,4
5	5	5	5	5	5	5	5	5	5	5	5	5
110	110	110	110	110	110	110	110	110	110	110	110	110
600	600	600	600	600	600	600	600	600	600	600	600	600

2.2.12   RIB11-3P-384xH
Geometric data

Size			384×25
Rotor mass	m_S	kg	4
Stator mass	m_P	kg	30,3
Rotor height	H_S	mm	26
Stator height	H_P	mm	90
Rotor thread	$TS_S×TD_S$	–	M8×16
Rotor thread, number×pitch	$n_S×TP_S$	°	12×30
Stator thread, cable side	$TS_{PC}×TD_{PC}$	–	M8×16
Stator thread, cable side, number×pitch	$n_{PC}×TP_{PC}$	°	11×30
Stator thread	$TS_P×TD_P$	–	M8×16
Stator thread, number×pitch	$n_P×TP_P$	°	12×30

001A5889

001A588C

384×50	384×75	384×100	384×125	384×150	384×175
8	12	16	20	24	28
41	52	65,7	78,6	91,4	104,1
51	76	101	126	151	176
110	130	160	185	210	235
M8×16	M8×16	M8×16	M8×16	M8×16	M8×16
12×30	12×30	24×15	24×15	24×15	48×7,5
M8×16	M8×16	M8×16	M8×16	M8×16	M8×16
11×30	11×30	23×15	23×15	23×15	45×7,5
M8×16	M8×16	M8×16	M8×16	M8×16	M8×16
12×30	12×30	24×15	24×15	24×15	48×7,5

2.2.13   RIB11-3P-384xH
Performance data

Size			384×25	384×25	384×25	384×50	384×50
Winding variant			**Z1.7**	**Z2.5**	**Z3.7**	**Z1.7**	**Z2.5**
Mass moment of inertia, rotor	J	$kg \cdot m^2$	0,13	0,13	0,13	0,26	0,26
Axial attraction	F_a	kN	0,67	0,67	0,67	0,67	0,67
Radial attraction	F_r	kN/mm	1,8	1,8	1,8	3,6	3,6
Number of pole pairs	P		33	33	33	33	33
Ultimate torque	T_u	Nm	573	573	573	1182	1182
Peak torque	T_p	Nm	512	512	512	1057	1057
Rated torque, cooled	T_{cw}	Nm	307	307	302	655	655
Rated torque, not cooled	T_c	Nm	97	97	95	233	233
Stall torque, cooled	T_{sw}	Nm	233	233	230	498	498
Cogging torque	T_{cog}	Nm	1,54	1,54	1,54	3,07	3,07
Knee speed	n_{lw}	min^{-1}	213	328	599	108	169
Rated speed (S1), cooled	n_{lwS1}	min^{-1}	213	227	227	108	169
Limiting speed at $I_{p\,eff}$ and U_{DCL}	n_{lp}	min^{-1}	143	226	415	73	121
Effective ultimate current	$I_{u\,eff}$	A	40,7	61,1	108,4	40,7	61,1
Effective peak current	$I_{p\,eff}$	A	32,6	48,9	86,7	32,6	48,9
Effective rated current, cooled	$I_{cw\,eff}$	A	16,3	24,5	42,7	16,9	25,3
Effective rated current, not cooled	$I_{c\,eff}$	A	4,7	7	12,3	5,5	8,2
Effective stall current, cooled	$I_{sw\,eff}$	A	11,8	17,6	30,8	12,2	18,2
Power loss at T_p	P_{lp}	W	5163	5163	5327	7599	7599
Power loss at T_{cw}	P_{lw}	W	1737	1737	1737	2735	2735
Power loss at T_c	P_{lc}	W	107	107	107	213	213
Motor constant	k_m	Nm/√W	9,38	9,38	9,23	15,95	15,95
Moment constant	k_T	Nm/A(eff)	20,7	13,8	7,8	42,7	28,4
Back EMF constant, phase to phase	k_u	V/(rad/s)	16,9	11,3	6,3	34,8	23,2
Electrical resistance, phase to phase	R_{25}	Ohm	3,2	1,4	0,5	4,8	2,1
Inductance, phase to phase	L	mH	30,8	13,7	4,3	50,4	22,4
Cooling water flow	dV/dt	l/min	5	5	5	7,8	7,8
Cooling water temperature difference	$\Delta\vartheta$	K	5	5	5	5	5
Motor temperature switch-off threshold	ϑ_{PTC}	°C	110	110	110	110	110
DC link voltage	U_{DCL}	V	600	600	600	600	600

Schaeffler

Pressure loss vs. Volume flow (l/min), bar. Curves: RIB11-3P-384×25, RIB11-3P-384×75, RIB11-3P-384×50, RIB11-3P-384×100, RIB11-3P-384×125, RIB11-3P-384×150, RIB11-3P-384×175. Cooling water temperature: +20 °C. 001A8B8C
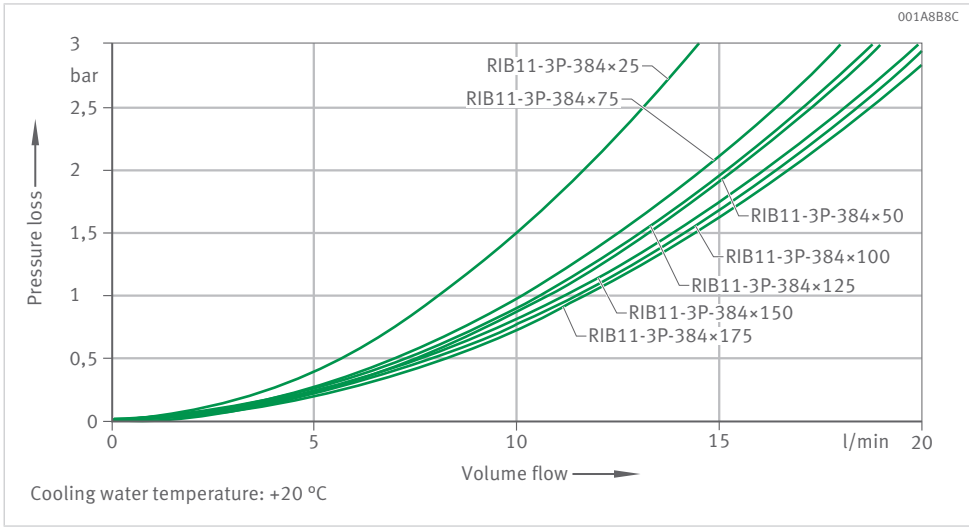
384×50	384×75	384×75	384×75	384×100	384×100	384×125	384×125	384×150	384×150	384×175	384×175
Z3.7	Z1.7	Z2.5	Z3.7	Z2.5	Z3.7	Z2.5	Z3.7	Z2.5	Z4.0	Z2.5	Z4.0
0,26	0,39	0,39	0,39	0,52	0,52	0,65	0,65	0,78	0,78	0,91	0,91
0,67	0,67	0,67	0,67	0,67	0,67	0,67	0,67	0,67	0,67	0,67	0,67
3,6	5,3	5,3	5,3	7,1	7,1	8,8	8,8	10,6	10,6	12,4	12,4
33	33	33	33	33	33	33	33	33	33	33	33
1182	1828	1828	1828	2462	2462	3077	3077	3692	3692	4308	4308
1057	1634	1634	1634	2201	2201	2751	2751	3301	3301	3852	3852
645	1022	1022	1006	1372	1351	1738	1711	2106	2106	2473	2473
229	384	384	378	536	527	685	674	835	835	985	985
490	776	776	764	1042	1026	1320	1300	1599	1599	1879	1879
3,07	4,61	4,61	4,61	6,14	6,14	7,68	7,68	9,21	9,21	10,75	10,75
313	69	111	207	81	154	63	122	51	114	42	96
227	69	111	207	81	154	63	122	51	114	42	96
230	45	78	154	55	114	41	89	31	84	24	70
108,4	40,7	61,1	108,4	61,1	108,4	61,1	108,4	61,1	122,2	61,1	122,2
86,7	32,6	48,9	86,7	48,9	86,7	48,9	86,7	48,9	97,8	48,9	97,8
44,2	17	25,5	44,6	25,5	44,5	25,8	45,1	26	52,1	26,2	52,4
14,3	5,8	8,7	15,2	9	15,8	9,3	16,2	9,4	18,8	9,5	19
31,8	12,3	18,4	32,1	18,3	32	18,6	32,4	18,7	37,5	18,9	37,8
7840	10034	10034	10353	12469	12865	14905	15378	17340	17340	19776	19776
2735	3671	3671	3671	4539	4539	5570	5570	6602	6602	7633	7633
213	320	320	320	427	427	534	534	640	640	747	747
15,71	21,47	21,47	21,14	25,93	25,53	29,65	29,19	32,99	32,99	36,04	36,04
16	66	44	24,8	59,2	33,4	74	41,7	88,8	44,4	103,7	51,8
13,1	53,9	35,9	20,2	48,4	27,3	60,5	34,1	72,5	36,3	84,6	42,3
0,7	6,3	2,8	0,9	3,5	1,1	4,2	1,4	4,8	1,2	5,5	1,4
7,1	70,1	31,2	9,9	39,9	12,7	48,7	15,5	57,4	14,3	66,1	16,5
7,8	10,5	10,5	10,5	13	13	16	16	18,9	18,9	14,6	14,6
5	5	5	5	5	5	5	5	5	5	7,5	7,5
110	110	110	110	110	110	110	110	110	110	110	110
600	600	600	600	600	600	600	600	600	600	600	600

2.2.14   RIB19-3P-460xH
Geometric data

Size			460×25
Rotor mass	m_S	kg	4,9
Stator mass	m_P	kg	37,6
Rotor height	H_S	mm	26
Stator height	H_P	mm	90
Rotor thread	$TS_S{\times}TD_S$	–	M8×16
Rotor thread, number×pitch	$n_S{\times}TP_S$	°	12×30
Stator thread, cable side	$TS_{PC}{\times}TD_{PC}$	–	M8×16
Stator thread, cable side, number×pitch	$n_{PC}{\times}TP_{PC}$	°	11×30
Stator thread	$TS_P{\times}TD_P$	–	M8×16
Stator thread, number×pitch	$n_P{\times}TP_P$	°	12×30

001A58DD

70

50

$TS_S \times TD_S$
$n_S \times TP_S$

$TS_{PC} \times TD_{PC}$
$n_{PC} \times TP_{PC}$

435

548

001A58DF

$TS_P \times TD_P$
$n_P \times TP_P$

~ 40

10

565 f8 | 548 | 531 | 460 | 435 | 420 H8

29

H_S

$TS_S \times TD_S$
$n_S \times TP_S$

5

H_P

460×50	460×75	460×100	460×125	460×150	460×175
9,8	14,6	19,5	24,4	29,3	34,2
50,4	63,4	79,1	93,5	107,8	122,1
51	76	101	126	151	176
110	130	160	185	210	235
M8×16	M8×16	M8×16	M8×16	M8×16	M8×16
12×30	24×15	24×15	24×15	48×7,5	48×7,5
M8×16	M8×16	M8×16	M8×16	M8×16	M8×16
11×30	23×15	23×15	23×15	45×7,5	45×7,5
M8×16	M8×16	M8×16	M8×16	M8×16	M8×16
12×30	24×15	24×15	24×15	48×7,5	48×7,5

2.2.15   RIB19-3P-460xH
Performance data

Size			460×25	460×25	460×25	460×50	460×50
Winding variant			**Z1.7**	**Z2.5**	**Z3.8**	**Z1.7**	**Z2.5**
Mass moment of inertia, rotor	J	kg · m^2	0,24	0,24	0,24	0,47	0,47
Axial attraction	F_a	kN	0,74	0,74	0,74	0,74	0,74
Radial attraction	F_r	kN/mm	1,9	1,9	1,9	3,8	3,8
Number of pole pairs	P		38	38	38	38	38
Ultimate torque	T_u	Nm	888	888	888	1813	1813
Peak torque	T_p	Nm	755	755	755	1541	1541
Rated torque, cooled	T_{cw}	Nm	447	436	434	977	953
Rated torque, not cooled	T_c	Nm	137	134	134	335	327
Stall torque, cooled	T_{sw}	Nm	334	326	325	731	713
Cogging torque	T_{cog}	Nm	1,97	1,97	1,97	3,95	3,95
Knee speed	n_{lw}	min^{-1}	143	226	419	70	112
Rated speed (S1), cooled	n_{lwS1}	min^{-1}	143	197	197	70	112
Limiting speed at $I_{p\,eff}$ and U_{DCL}	n_{lp}	min^{-1}	94	150	283	47	78
Effective ultimate current	$I_{u\,eff}$	A	41,2	62,3	112,4	41,2	62,3
Effective peak current	$I_{p\,eff}$	A	30,4	46	83	30,4	46
Effective rated current, cooled	$I_{cw\,eff}$	A	15,7	23,2	41,8	16,9	24,9
Effective rated current, not cooled	$I_{c\,eff}$	A	4,6	6,9	12,3	5,5	8,2
Effective stall current, cooled	$I_{sw\,eff}$	A	11,4	16,9	30,3	12,2	18,1
Power loss at T_p	P_{lp}	W	5349	5623	5658	7508	7892
Power loss at T_{cw}	P_{lw}	W	1927	1927	1927	3103	3103
Power loss at T_c	P_{lc}	W	125	125	125	250	250
Motor constant	k_m	Nm/√W	12,28	11,98	11,94	21,17	20,65
Moment constant	k_T	Nm/A(eff)	29,6	19,5	10,8	60,3	39,9
Back EMF constant, phase to phase	k_u	V/(rad/s)	24,1	15,9	8,8	49,3	32,6
Electrical resistance, phase to phase	R_{25}	Ohm	3,9	1,8	0,5	5,4	2,5
Inductance, phase to phase	L	mH	39,5	17,3	5,3	68,9	30,1
Cooling water flow	dV/dt	l/min	5,5	5,5	5,5	8,9	8,9
Cooling water temperature difference	$\Delta\vartheta$	K	5	5	5	5	5
Motor temperature switch-off threshold	ϑ_{PTC}	°C	110	110	110	110	110
DC link voltage	U_{DCL}	V	600	600	600	600	600

001A8BCC

Pressure loss (bar) vs Volume flow (l/min)

- RIB19-3P-460×25
- RIB19-3P-460×50
- RIB19-3P-460×75
- RIB19-3P-460×100
- RIB19-3P-460×125
- RIB19-3P-460×150
- RIB19-3P-460×175

Cooling water temperature: +20 °C
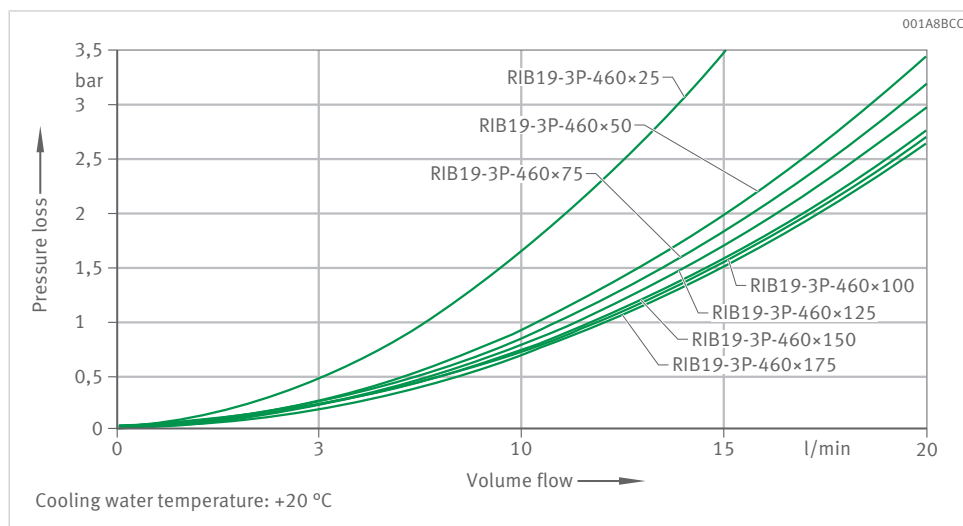
460×50	460×75	460×75	460×100	460×100	460×125	460×125	460×125	460×150	460×150	460×175	460×175
Z3.8	Z2.5	Z3.8	Z2.5	Z3.8	Z2.5	Z3.8	Z4.9	Z3.8	Z4.9	Z3.8	Z4.9
0,47	0,71	0,71	0,94	0,94	1,18	1,18	1,18	1,41	1,41	1,65	1,65
0,74	0,74	0,74	0,74	0,74	0,74	0,74	0,74	0,74	0,74	0,74	0,74
3,8	5,7	5,7	7,5	7,5	9,4	9,4	9,4	11,3	11,3	13,2	13,2
38	38	38	38	38	38	38	38	38	38	38	38
1813	2775	2775	3751	3751	4689	4689	4689	5739	5739	6695	6695
1541	2330	2330	3144	3144	3930	3930	3930	4811	4811	5612	5612
950	1417	1413	1961	1955	2494	2486	2557	3081	3169	3628	3731
326	522	520	726	723	931	929	955	1158	1191	1369	1408
711	1061	1057	1467	1462	1866	1860	1913	2305	2371	2714	2791
3,95	5,92	5,92	7,89	7,89	9,87	9,87	9,87	11,84	11,84	13,82	13,82
211	75	144	54	106	41	83	125	67	103	56	86
197	75	144	54	106	41	83	125	67	103	56	86
152	51	103	36	77	26	59	94	48	78	40	65
112,4	62,3	112,4	62,3	112,4	62,3	112,4	164,6	112,4	164,6	112,4	164,6
83	46	83	46	83	46	83	121,6	83	121,6	83	121,6
44,8	24,4	44	25,1	45,2	25,5	46	69,2	46,5	70,1	47	70,7
14,7	8,6	15,4	8,9	16	9,2	16,5	24,8	16,8	25,3	17	25,6
32,5	17,7	31,9	18,2	32,8	18,5	33,3	50,2	33,8	50,8	34,1	51,3
7941	10851	10919	13318	13401	15784	15882	15016	18364	17362	20846	19708
3103	4112	4112	5322	5322	6531	6531	6531	7740	7740	8950	8950
250	375	375	500	500	626	626	626	751	751	876	876
20,58	26,95	26,87	32,44	32,33	37,24	37,13	38,18	42,26	43,46	46,28	47,59
22,1	61	33,8	81,4	45,1	101,7	56,3	38,5	69	47,1	80,5	55
18	49,8	27,6	66,4	36,8	83	46	31,4	56,3	38,5	65,7	44,9
0,8	3,4	1,1	4,2	1,3	5	1,5	0,7	1,8	0,8	2	0,9
9,2	41,4	12,7	52,3	16,1	65,4	20,1	9,4	23,1	10,8	27	12,6
8,9	11,8	11,8	15,2	15,2	18,7	18,7	18,7	14,8	14,8	17,1	17,1
5	5	5	5	5	5	5	5	7,5	7,5	7,5	7,5
110	110	110	110	110	110	110	110	110	110	110	110
600	600	600	600	600	600	600	600	600	600	600	600

2.2.16   RIB13-3P-690xH
Geometric data

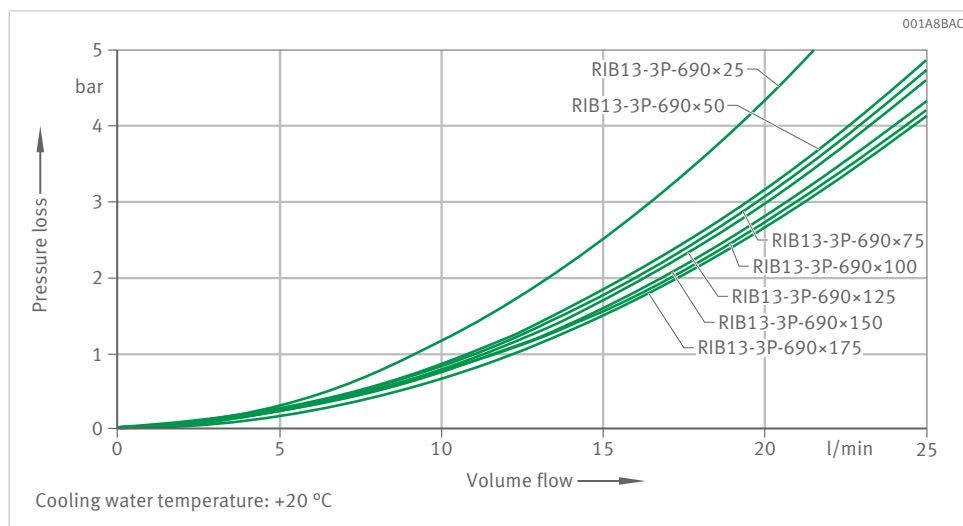| Size			690×25
Rotor mass	m_S	kg	7,6
Stator mass	m_P	kg	62,9
Rotor height	H_S	mm	26
Stator height	H_P	mm	110
Rotor thread	$TS_S \times TD_S$	–	M8×16
Rotor thread, number×pitch	$n_S \times TP_S$	°	16×22,5
Stator thread, cable side	$TS_{PC} \times TD_{PC}$	–	M8×16
Stator thread, cable side, number×pitch	$n_{PC} \times TP_{PC}$	°	15×22,5
Stator thread	$TS_P \times TD_P$	–	M8×16
Stator thread, number×pitch	$n_P \times TP_P$	°	16×22,5

001A590D

001A590F
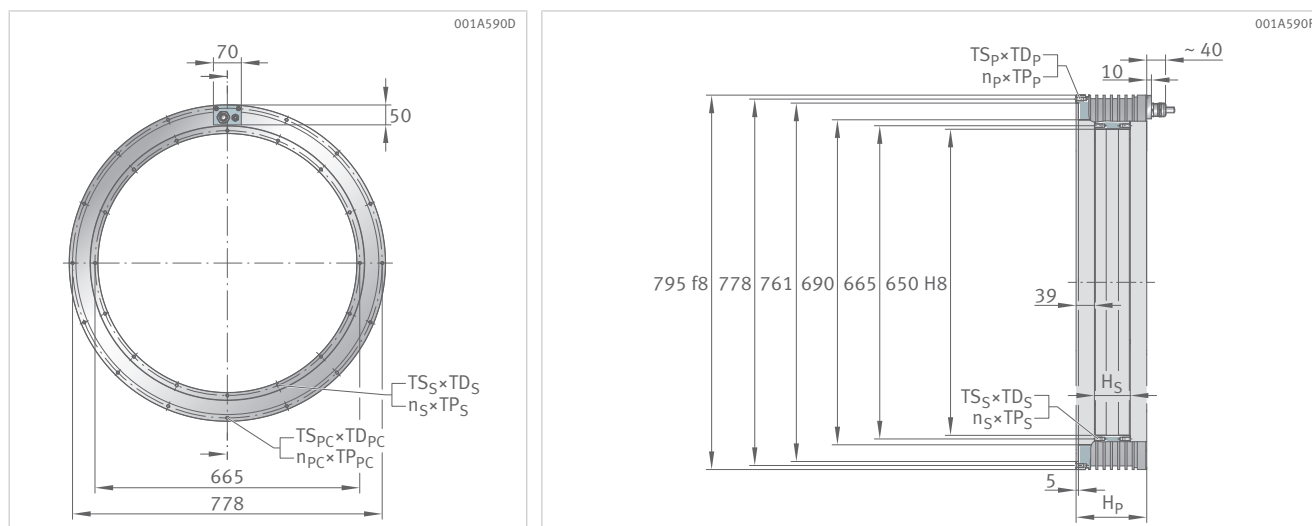
690×50	690×75	690×100	690×125	690×150	690×175
15,2	22,8	30,4	38	45,6	53,2
81,6	99,8	122,9	143,2	163,7	184,1
51	76	101	126	151	176
130	150	180	205	230	255
M8×16	M8×16	M8×16	M8×16	M8×16	M8×16
16×22,5	32×11,25	32×11,25	64×5,625	64×5,625	64×5,625
M8×16	M8×16	M8×16	M8×16	M8×16	M8×16
15×22,5	31×11,25	31×11,25	61×5,625	61×5,625	61×5,625
M8×16	M8×16	M8×16	M8×16	M8×16	M8×16
16×22,5	32×11,25	32×11,25	64×5,625	64×5,625	64×5,625

2.2.17   RIB13-3P-690xH
Performance data

Size			690×25	690×25	690×25	690×50	690×50	690×75
Winding variant			**Z2.2**	**Z3.3**	**Z4.2**	**Z3.3**	**Z4.2**	**Z3.3**
Mass moment of inertia, rotor	J	kg · m^2	0,85	0,85	0,85	1,7	1,7	2,55
Axial attraction	F_a	kN	1,11	1,11	1,11	1,11	1,11	1,11
Radial attraction	F_r	kN/mm	3,3	3,3	3,3	6,6	6,6	9,9
Number of pole pairs	P		65	65	65	65	65	65
Ultimate torque	T_u	Nm	1978	1978	1978	4059	4059	6244
Peak torque	T_p	Nm	1768	1768	1768	3627	3627	5579
Rated torque, cooled	T_{cw}	Nm	989	956	989	2094	2166	3288
Rated torque, not cooled	T_c	Nm	356	344	356	829	857	1363
Stall torque, cooled	T_{sw}	Nm	769	743	769	1628	1684	2557
Cogging torque	T_{cog}	Nm	1,47	1,47	1,47	2,94	2,94	4,41
Knee speed	n_{lw}	min^{-1}	70	123	184	66	101	44
Rated speed (S1), cooled	n_{lwS1}	min^{-1}	70	115	115	66	101	44
Limiting speed at $I_{p\,eff}$ and U_{DCL}	n_{lp}	min^{-1}	42	74	115	42	68	28
Effective ultimate current	$I_{u\,eff}$	A	49,1	81,5	122,7	81,5	122,7	81,5
Effective peak current	$I_{p\,eff}$	A	39,3	65,2	98,2	65,2	98,2	65,2
Effective rated current, cooled	$I_{cw\,eff}$	A	19,3	30,9	48,2	33	51,5	33,7
Effective rated current, not cooled	$I_{c\,eff}$	A	6,8	10,9	17	12,8	20	13,7
Effective stall current, cooled	$I_{sw\,eff}$	A	14,7	23,6	36,7	25,2	39,2	25,7
Power loss at T_p	P_{lp}	W	7758	8303	7758	12076	11284	15850
Power loss at T_{cw}	P_{lw}	W	2510	2510	2510	4160	4160	5690
Power loss at T_c	P_{lc}	W	233	233	233	466	466	699
Motor constant	k_m	Nm/√W	23,34	22,56	23,34	38,38	39,7	51,53
Moment constant	k_T	Nm/A(eff)	52,3	31,5	20,9	64,7	42,9	99,5
Back EMF constant, phase to phase	k_u	V/(rad/s)	42,7	25,7	17,1	52,8	35,1	81,3
Electrical resistance, phase to phase	R_{25}	Ohm	3,4	1,3	0,5	1,9	0,8	2,5
Inductance, phase to phase	L	mH	41,4	15	6,6	23,1	10,2	31
Cooling water flow	dV/dt	l/min	7,4	7,4	7,4	12,3	12,3	16,9
Cooling water temperature difference	$\Delta\vartheta$	K	5	5	5	5	5	5
Motor temperature switch-off threshold	ϑ_{PTC}	°C	110	110	110	110	110	110
DC link voltage	U_{DCL}	V	600	600	600	600	600	600

001A8BAC

Pressure loss (bar) vs Volume flow (l/min)

RIB13-3P-690×25
RIB13-3P-690×50
RIB13-3P-690×75
RIB13-3P-690×100
RIB13-3P-690×125
RIB13-3P-690×150
RIB13-3P-690×175

Cooling water temperature: +20 °C

| 690×75 | 690×100 | 690×100 | 690×100 | 690×125 | 690×125 | 690×125 | 690×150 | 690×150 | 690×150 | 690×175 | 690×175 |
Z4.2	Z3.3	Z4.2	Z5.9	Z3.3	Z4.2	Z5.9	Z3.3	Z4.2	Z5.9	Z4.2	Z5.9
2,55	3,4	3,4	3,4	4,25	4,25	4,25	5,1	5,1	5,1	5,95	5,95
1,11	1,11	1,11	1,11	1,11	1,11	1,11	1,11	1,11	1,11	1,11	1,11
9,9	13,1	13,1	13,1	16,4	16,4	16,4	19,7	19,7	19,7	23	23
65	65	65	65	65	65	65	65	65	65	65	65
6244	8366	8366	8366	10457	10457	10457	12549	12549	12549	14640	14640
5579	7475	7475	7475	9343	9343	9343	11212	11212	11212	13081	13081
3401	4504	4659	4504	5712	5909	5712	6924	7163	6924	8421	8140
1410	1895	1960	1895	2425	2508	2425	2958	3060	2958	3613	3493
2645	3502	3623	3502	4441	4595	4441	5384	5570	5384	6548	6329
4,41	2,94	2,94	2,94	7,35	7,35	7,35	4,41	4,41	4,41	10,3	10,3
68	32	51	90	25	40	71	19	32	58	27	47
68	32	51	90	25	40	71	19	32	58	27	47
47	21	36	65	15	28	51	11	22	41	18	32
122,7	81,5	122,7	203,7	81,5	122,7	203,7	81,5	122,7	203,7	122,7	203,7
98,2	65,2	98,2	163	65,2	98,2	163	65,2	98,2	163	98,2	163
52,5	34,5	53,7	86,2	35	54,5	87,4	35,3	55,1	88,3	55,5	89
21,3	14,2	22,1	35,5	14,5	22,7	36,4	14,8	23	37	23,3	37,4
40	26,3	40,9	65,7	26,6	41,5	66,6	26,9	42	67,3	42,3	67,8
14811	19624	18337	19624	23398	21864	23398	27172	25390	27172	28916	30946
5690	7364	7364	7364	9037	9037	9037	10711	10711	10711	12384	12384
699	932	932	932	1165	1165	1165	1399	1399	1399	1632	1632
53,3	62,05	64,19	62,05	71,03	73,48	71,03	79,09	81,82	79,09	89,45	86,47
66,1	133,3	88,5	53,3	166,7	110,6	66,7	200	132,8	80	154,9	93,3
53,9	108,9	72,3	43,5	136,1	90,3	54,4	163,3	108,4	65,3	126,5	76,2
1	3,1	1,3	0,5	3,7	1,5	0,6	4,3	1,8	0,7	2	0,8
13,7	37,6	16,6	6	46,1	20,3	7,4	55,3	24,4	8,8	28,4	11,5
16,9	14,6	14,6	14,6	17,9	17,9	17,9	15,9	15,9	15,9	18,4	18,4
5	7,5	7,5	7,5	7,5	7,5	7,5	10	10	10	10	10
110	110	110	110	110	110	110	110	110	110	110	110
600	600	600	600	600	600	600	600	600	600	600	600

2.3 Checklist for your enquiry

Torque motors

Please fill out the following checklist so that we can answer your enquiry as quickly and precisely as possible. Please do not hesitate to contact the Schaeffler sales team if you have any questions.

Company

Contact name

Sector · Project name

Phone

E-mail

Application

Predominant operating mode	☐ Continuous operation (S1, e.g. in NC axes)	☐ Intermittent operation (S6, e.g. in cycled applications)

Operating several motors in parallel	☐ Yes
	    ☐ Tandem arrangement
	    ☐ Janus arrangement
		☐ No

Motor type (if known)

Any required mounting compatibility to

Manufacturer _____ Type _____

Installation space

Min. inside diameter / max. outside diameter / max. height [mm]

_____ / _____ / _____

Required operating points

Operating point 1
Torque _____   Speed _____
☐ Continuous operation (S1)   ☐ Intermittent operation (S6)
☐ Stationary

Operating point 2
Torque _____   Speed _____
☐ Continuous operation (S1)   ☐ Intermittent operation (S6)
☐ Stationary

Frequency converter

Manufacturer _____   Type _____
DC link voltage [V_{DC}] _____   Continuous operation current _____ (S1)
Peak current _____

Cooling	☐ Water (standard)	☐ Natural convection/not cooled
	☐ Other	
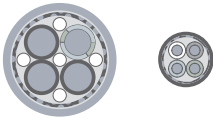
Cable outlet   ☐ Axial (standard)

☐ Tangential

☐ Radial

Cable type · cable length	☐ Separate motor and sensor cables	☐ 1 m standard, open ends

Other types and lengths available by agreement.

O-rings

Seals required for water-cooled motors
☐ Yes   ☐ No

Temperature monitoring   ☐ PTC and Pt1000

Technical documentation   ☐ Paper   ☐ CD   ☐ PDF
Language _____

Requirement · quantities   ☐ One-time requirement

☐ Prototype

☐ Series

Contact

Schaeffler Industrial Drives AG & Co. KG
Phone +49 3681 7574-0 · sales-sid@schaeffler.com

Glossary

dV/dt, cooling water flow

Flow rate required to achieve the specified cooling water difference $\Delta\vartheta$ with power loss P_{lc}.

F_a, axial attraction

Axial force that draws the rotor into the stator.

$f_p(n)$, pole change frequency

The pole change frequency is calculated from the speed and number of pole pairs of the motor: $f_p(n)$ [Hz] = n [min^{-1}] / 60 · P.

F_r, radial attraction

Magnetic radial force between rotor and stator, which changes depending on the eccentricity of the rotor relative to the stator.

$I_{c\ eff}$, rated current, not cooled

Effective current at which the associated power loss leads to relatively low heating of the motor without forced cooling, depending on the size of the mounting base.

$I_{cw\ eff}$, rated current, cooled

Effective rated current, which is permissible during continuous operation with water cooling above a pole change frequency of 0,1 Hz.

$I_{p\ eff}$, peak current

Effective peak current in the iron saturation range, which should be used as the dimensioning variable, see also T_p. When the rotor is only moderately warm (magnet temperature max. +60 °C) and pulsed mode is used (max. 1 s to 3 s), $I_{p\ eff}$ can be increased to the limit value $I_{u\ eff}$.

$I_{pl\ eff}$, peak current, linear range

Effective peak current up to which an approximately proportional torque curve occurs.

$I_{sw\ eff}$, stall current, cooled

Effective continuous stall current when the motor is stationary and with pole change frequencies up to approx. 0,1 Hz. Owing to the varying power distribution in the motor phases, the motor current must be reduced to this value in order to prevent local overheating. This is based on the most unfavourable rotor position from a thermal perspective.

$I_{u\,eff}$, ultimate current

Effective ultimate current at which the magnetic circuit has high saturation. It is determined either by the maximum current density in the winding or by the incipient risk of demagnetisation at a magnet temperature of +80 °C.

k_m, motor constant

Motor constant which expresses the relationship between torque and power loss, i.e. efficiency.

The motor constant depends on the temperature and is only completely accurate during static operation as well as in the linear dynamic range of the motor, e.g. in positioning procedures at low speeds and torques.

If the winding temperature is +130 °C, the motor constant reduces to 0,85 times its normal value.

k_T, torque constant

Torque constant which, when multiplied by the current in the linear dynamic range, represents the motor torque that is being produced: $T = I \cdot k_T$.

k_u, back EMF constant

Voltage constant which, in generator operation, when multiplied by the speed, produces the armature counter voltage (peak value) resulting at the motor terminals: $U_{EMF} = k_u \cdot n$.

L, inductance, phase to phase

Inductance between two motor phases, applies to the linear range between torque and current.

n_{lc}, limiting speed

Winding-dependent speed limit without taking the dynamic heat losses into account when operating at $I_{c\,eff}$ and without field weakening. The motor torque drops significantly after this point.

n_{lp}, limiting speed

Winding-dependent speed limit without taking the dynamic heat losses into account when operating at $I_{p\,eff}$ and without field weakening. The motor torque drops significantly after this point.

n_{lw}, knee speed

Winding-dependent speed limit without taking the dynamic heat losses into account when operating at $I_{cw\,eff}$ and without field weakening. The motor torque drops significantly after this point.

n_{lwS1}, rated speed (S1), cooled

Speed limit up to which the motor can be continuously operated at $I_{cw\,eff}$.

P, number of pole pairs

Number of magnetic pole pairs on the rotor.

P_l, power loss

The thermal output occurring in the motor winding, which leads to a time-dependent temperature increase subject to the operating mode (current) and the environmental conditions (cooling).

In the upper dynamic range (at T_p), P_l is particularly high due to the squared dependence on current, whereas the warming in the rated current range is relatively low.

P_l is calculated in a simplified manner with the aid of the motor constant k_m for a movement section with the required torque T: $P_l = (T/k_m)^2$.

P_{lc}, power loss

Power loss at $I_{c\ eff}$.

P_{lp}, power loss

Peak power loss at $I_{p\ eff}$.

P_{lw}, power loss

Power loss at $I_{cw\ eff}$.

R_{25}, electrical resistance

Winding resistance between two motor phases at +25 °C. At +130 °C, the winding resistance increases to approx. 1,4 times its normal value.

T_c, rated torque, not cooled

Motor torque at rated current I_n, at which the motor can be operated in a thermally stable manner, without cooling, but is subject to a temperature increase in the process.

T_{cog}, cogging torque

Torque, also known as cogging, which acts in a pulsating manner depending on the rotor position. The specified value is the peak value in the de-energised state.

T_{cw}, rated torque, cooled

Motor torque at rated current $I_{cw\ eff}$, which is available as a continuous torque in nominal operation with water cooling and a maximum temperature gradient of approx. 100 K between the winding and cooling fluid.

T_p, peak torque

Short duration (1 s to 3 s) torque at $I_{p\ eff}$, which is reliably attained in the saturation range and at all operating temperatures. With magnet temperatures up to +60 °C and in pulsed mode, T_p can be increased up to the value of T_u.

T_{pl}, peak torque, linear range

Briefly (a few seconds) producible motor torque, which is attained at the end of the linear dynamic range $I_{pl\,eff} \cdot k_T$.

T_{sw}, stall torque, cooled

Stall torque that can be produced when the motor is stationary and with pole change frequencies up to approx. 0,1 Hz.

T_u, ultimate torque

Torque at high saturation in the magnetic circuit resulting from the ultimate current. May be approached briefly (‹1 s) only if the stator is cold (approx. +60 °C) and magnet temperatures are below +60 °C. At higher temperatures, there is a risk of demagnetisation of the rotor and thermal destruction of the stator within a very short period of time. The ultimate torque should not be used as a dimensioning variable, but must be observed in the case of short-circuit braking.

U_{DCL}, DC link voltage

DC link voltage or supply voltage of the power actuators. The higher the speed and the counter voltage that rises with it and the greater the losses that depend on the frequency, the higher the voltage has to be.

ϑ_{PTC}, motor temperature switch-off threshold

With continuous operation at $I_{cw\,eff}$ (water-cooled), the motor settles just under the temperature switching limit. If this temperature is exceeded, as measured by the PTC sensor, a tripping device must switch off the servo controller in order to protect the motor thermally.

$\Delta\vartheta$, cooling water temperature difference

Maximum temperature difference between coolant inlet and outlet.