Saia Motors Important notes

General

All specifications for torque, force and power are representative only and maybe subject to variation due to manufacturing tolerances.

Saia motors, except UR types, fulfil basis insulation requirements of EN 60335-1: 2004.

Application advice
The requirements for protection class I, II or III according to EN 60355-1: 2004 have to be fulfilled by customer application.

Stepper motors

Specified data for torque values is valid for

- a duty cycle of 100%, in Performance Charts additionally for 30% (cycle time: 5 min, type URG only 1 min.)
- an ambient temperature of 23 ± 5°C
- a defined driver circuitry, with constant voltage supply
- at rated voltage

Depending from operational conditions, max. load torque must be lower than specified torque in catalogue. Please send us an enquiry.

If duty cycle or actual maximum ambient temperature is lower, the motor can be designed for higher performance (torque and power) by using a different winding.

Chopper driver circuits can be applied alternatively to a driver with constant voltage supply. They are more expensive, but bring higher performance. Additionally, they reduce the effects of temperature and supply voltage change.
Performance charts available on request.

Step angle tolerance is about ±5%
(not cumulative)

Synchronous motors

Specified data for torque/power values are valid for

- a duty cycle of 100%
- an ambient temperature of 23 ±5°C
- at rated voltage
- synchronous torque (not starting torque)

Torque is specified with maximum values, overloading is not permissible.

Depending from operational conditions, max.load torque must be lower than specified torque in catalogue. Please send us an enquiry.

If duty cycle or actual maximum ambient temperature is lower, the motor can be designed with higher performance by using a different winding.

The basic design is the same as for our stepper motors, but the motors are operated by a sinus waveform voltage.
A capacitor, connected to one of the motor coils, is necessary for rotation in the appropriate direction.

Motor type UDS is a special design: It has only one coil, but is fitted with an internal backstop. This backstop forces the motor to rotate only in one direction.
Motor can be designed to rotate in CW or in CCW direction. A capacitor is not necessary.

Mechanical and electrical connections

On request we can deliver other options, e. g.

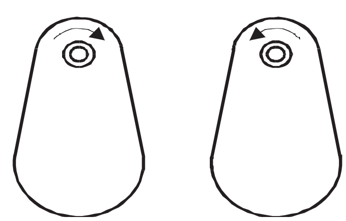
- special motor shafts
- pinions on shaft
- special cable lengths
- connectors

Gearboxes

Saia gearboxes are available in a variety of sizes to meet a wide range of torque requirements. Ratios from 4 1/6 to 6.048.000 are available. The basic design is a spur gearbox with gear wheels in metal, plastics and combinations of the two materials. A particular feature is the availability of freewheels and slipping clutches.
The gearboxes are turned by the motor, energy flow is from input to output shaft. That means, they are not allowed to be driven by the output shaft (for instance turning manually). This can lead to damage of some internal components!

Direction of rotation

As a function of the number of stages, the direction of rotation can be either clockwise or counter clockwise. The direction of rotation of motor gearbox units is generally specified by the gearbox output shaft (drive-side, see DIN EN60034-7, IEC 60050-411).



clockwise counter clockwise

Ratio

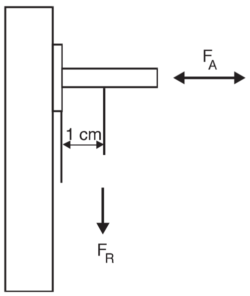
Gear ratio i is the ratio of input speed n_e and output speed n_a.

$$i = \frac{n_e}{n_a}$$

Permissible force FA and FR at the output shaft

Permissible force loads at the output shaft are:

- Axial load (or thrust) FA, pulling or pushing in axial direction of the shaft
- Radial load FR acting laterally on the shaft. The catalogue value is referred to a distance of 1 cm to the bearing



Permissible Torque

The lifetime of a gearbox is determined by the load on the gear teeth and the number of revolutions of the gear wheels.

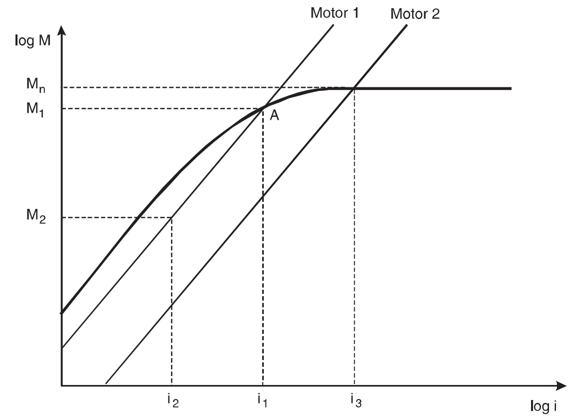
The maximum permissible torque Mn is defined by the load on the final stage of the gearbox and the stability of the housing.

Some gearboxes have lifetime graphs. It shows the relationship between ratio i and the associated torque for a fixed period of time, e.g. 1000 or 10000 hours. A conditional parameter is the input speed (equivalent to motor speed) corresponding to the total number of revolutions of all gear wheels. In the catalogue we show two curves – for a motor having 250/300 rpm and 500/600 rpm.

For example: Max.output torque Mx1 is permissible at a ratio of ix1. With smaller ratios the max. permissible torque has to be reduced, because otherwise the first stages of the gearbox would be overloaded.

Additionally to the lifetime curve the motor torque Mm, multiplied by gear ratio and reduced by the gear efficiency, is shown (resulting in output torque Mi).

$$M_i = M_m \times i \times eta$$



Example1: The application of Motor 1 combined with a gearbox of ratio i1 leads to an output torque M1 at point A. The gearbox can transmit this torque, meeting its lifetime.

If a ratio of i >i1 is selected, actual torque would be M > M1. However lifetime cannot be guaranteed, as the operating point lies above of the lifetime curve now.

Example 2: Motor 1 with a ratio of i2. Torque generated is M2. This is below of the lifetime curve. Lifetime of gearbox is higher.

Example 3: Motor 2 and a ratio of i3 generate a torque of Mn. When using a ratio of i > ix3 - the gearbox cannot be loaded more than Mn.

Efficiency

The efficiency is determined by the number of gearbox stages.

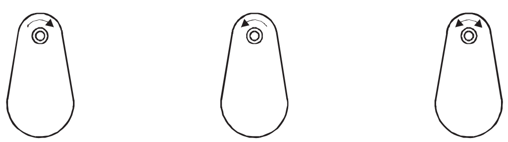
Efficiency of UGO/UGP and UGR is specified in catalogue

Efficiency of all other gearboxes on request.

Clutches

Gearbox types UGB and UGD can be fitted with freewheels or slipping clutches. Freewheels transmit the max. torque M in the locked direction, <1 cNm in the opposite direction. One way slipping clutches behave similarly except that the slip torque has a higher value. Two way slipping clutches can only transmit a limited torque value in either direction lower than the slip torque.

Slipping clutches are used to: Protect the gearbox against torque overloads, or to adjust the load by turning from the load side (remember: turning the output shaft directly can otherwise damage the gearbox).



Slipping clutch	One way	One way	Two way
Freewheel	yes	yes	no
Torque, clockwise	full torque	< slipping torque	< slipping torque
Torque Anti clockwise	< slipping torque	full torque	< slipping torque
Output shaft turning, clockwise	slipping possible	blocking	slipping possible
Output shaft turning, anti clockwise	blocking	slipping possible	slipping possible

Explanation of specifications

Power consumption P_{in}

The power consumtion (in W) was determined in no-load operation

Load

The total sum of all static and dynamic torques (e.g. friction torque, mass inertia, acting on the rotor).

Speed n

rmp revolution per minute

Torque

The running torque in cNm (also synchronous, braking or dynamic torque) defines the load at which the synchronous motor falls out of synchronism and stops.

Power output

The power output (in W) is determined according to the following formula

$$P_{out} = \frac{M \times 2 \pi \times n}{60} = [W]$$

M in Nm (1 cNm = 0,01 Nm), n in rpm

Pole pair number

The number of rotor pole pairs North/South.

Direction of rotation

This information always refers to the output shaft, either of the motor or of the gearbox.
Right = clockwise rotation (CW),
Left = counterclockwise rotation (CCW)

Gear torque

The maximum gear torque in cNm defines the maximum load for a required life of at least 1000 operating hours.

Running time

This value refers to the time (t) per revolution (U); it is calculated using the following formula

$$t/U = \frac{i}{n} \times 60 = [sec.]$$

i = gear ratio
n = motor speed in rpm

General technical terms relating to synchronous and torque limited synchronous motors

ED or Synchronous

The running of the rotor at the same speed as the stator field which is determined by the frequency of the supply.

Synchronous speed

Constant speed of rotation at constant frequency based upon the number of pole pairs of the motor

$$n = \frac{f \times 60}{p}$$

f = frequency (Hz), n = speed (rpm)
p = number of pole pairs

Synchronous torque

Load torque permissible without motor falling out of synchronism, once the synchronous speed has been reached.

Starting torque

Load torque the motor is capable to start.
It is influenced by the type and manner of coupling to the load, the load inertia, the gearbox design and the supply voltage. In the case of a very large reduction ratio a small external moment of inertia and nominal gearbox play the starting torque becomes equal to the synchronous torque.

Detent torque (static)

Defines the maximum torque which can be applied to a deenergised motor without causing the motor to rotate. Catalogue specifications refer to the static detent torque.

Detent torque (dynamic)

Defines the maximum torque at which the motor comes to an immediate standstill from synchronous running when the power supply is switched off.

Permissible load inertia

Is the maximum inertia load the motor can start without external help.

Stall-proof

Synchronous motors with permanent magnet rotors can be stalled without damage to the motor winding.

Torque limit (Torque limited motors)

The constant torque produced by the hysteresis-magnetic clutch within the torque limited synchronous motor in the stalled condition.

Design characteristics

The basic design is the same as for our stepper motors, but the motors are operated by a sinus
waveform voltage.

General technical terms relating to stepper motors

Duty Cycle (ED)

Duty cycle of operation, based on a cycle time of 5 minutes (1 minute for URG) and a frequency f=0Hz; e.g. ED=30% means that the motor can be continuously powered 1.5 minutes (30% of 5 minutes) without overheating

Step angle

Rotary angle through which the motor shaft turns per controlled pulse.

Stepping frequency

Number of steps of the stepping motor in 1 sec.

Driver

Electronics which convert step and direction input signals to high power currents and voltages to drive a step motor.

Unipolar driver

Unipolar means that every coil end has one polarity only. A unipolar coil consists in fact of 2 coils. Alternating the current flows through each of these coils always in the same direction. Compared to a bipolar motor only half of the copper is used at time.

The motor phase winding must be center tapped. On the SAMOTRONIC101 this is already fixed on the board.

Often an additional Z-diode is used to ensure a fast current decay in the switched-off coil. This will give an increased motor torque especially at higher frequencies.

Torque graphs in this catalogue are measured with a 10 V diode.

Bipolar Driver

Bipolar indicates that every coil end is bipolar, during driving it will be „+" as well as „-".Since every coil is fully used the motor has a higher torque compared to a unipolar one.

Very often a bipolar driver has a constant current drive capability (also called chopper). That will give an increased torque output at higher frequencies and a lower influence of temperature and supply voltage variations. Typical applications use the SAMOTRONIC102.

Rotational speed

Revolutions of the motor per minute calculated from:

$$n = f \times \frac{\alpha \times 60}{360°}$$

f = stepping frequency, α = step angle.

Detent torque (static)

Defines the maximum torque which can be applied to a deenergised motor without causing the motor to rotate. Catalogue specifications refer to the static detent torque.

Holding torque

Defines the maximum torque with which an energized motor can be loaded without giving rise to a continuous rotary movement.

Pull-in torque

Operation torque when switching on full step frequency at once, without a ramp.

Pull-out torque

Operation torque when applying an acceleration / deceleration ramp.

Load inertia moment

The sum of all the mass inertia moments occurring on the shaft of the stepping motor.

Steps/rev

The number of steps per 360° rotation.

Maximum operating torque

The maximum torque which a stepper motor without external mass inertia can generate without stepping losses.