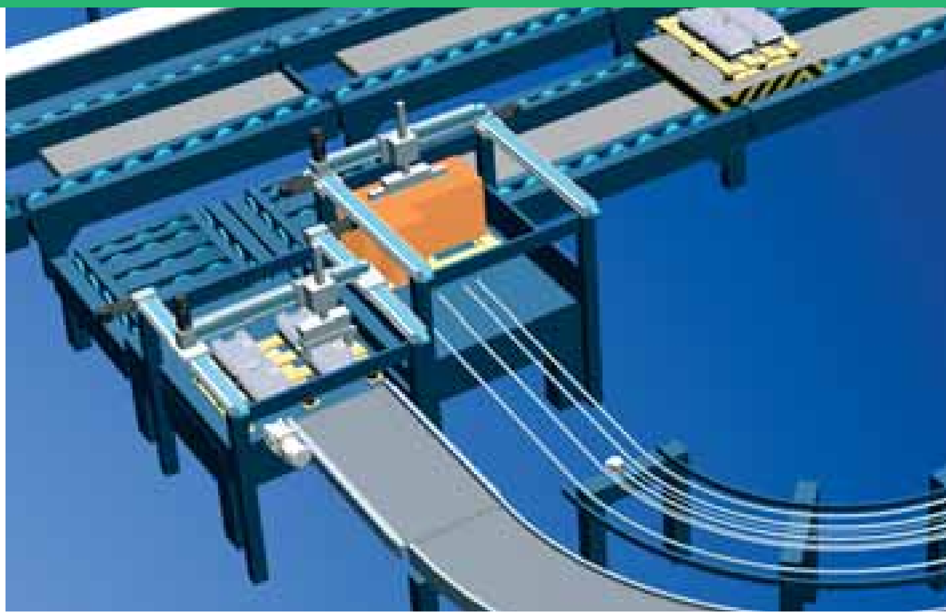
Drive solutions

for mechanical and system engineering



Lenze

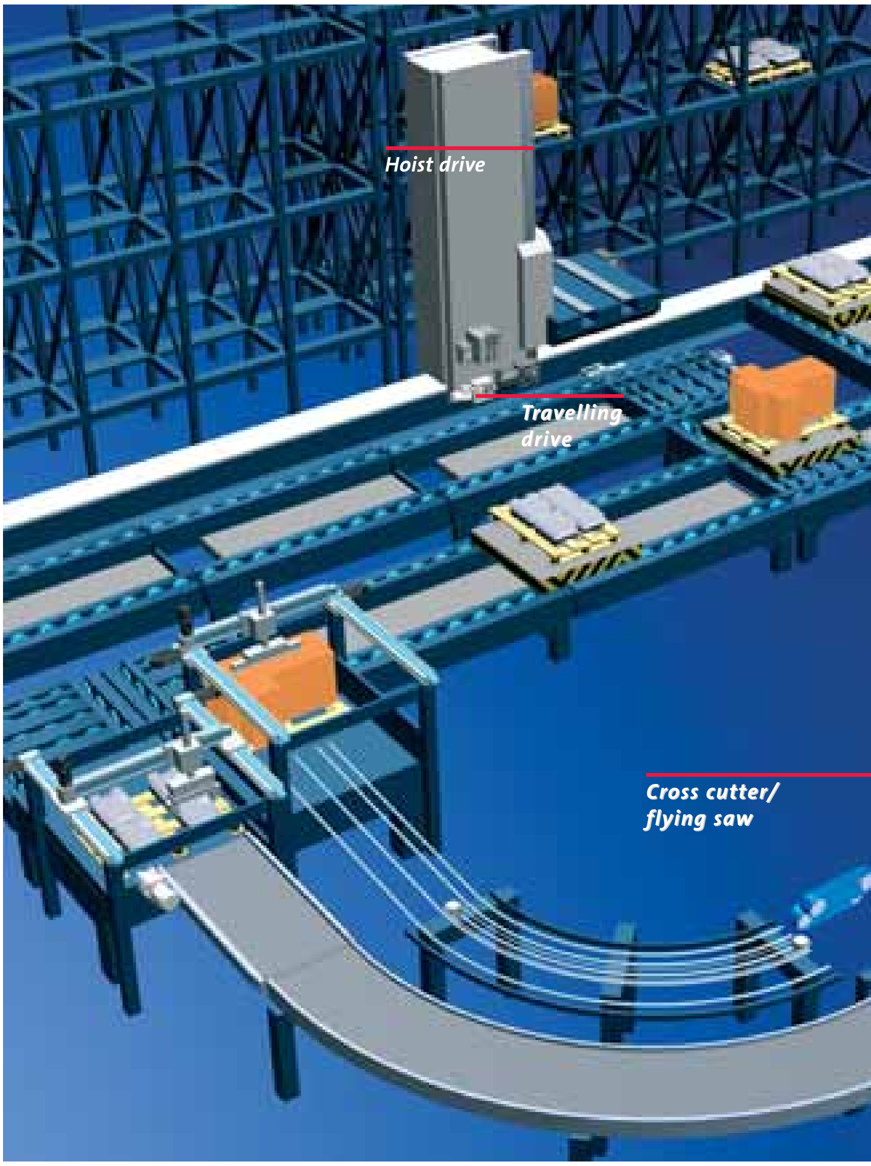
Your partner | for drive and automation tasks

If you need to implement modern machine and system concepts simply and effectively or to optimise and modernise existing concepts, you need look no further than Lenze's comprehensive range of products and services, which offers everything you need.

Rather than dealing with individual drives, Lenze prefers to focus on drive solutions which have been specifically designed for handling and materials handling technology, for all types of automotive engineering process, for robotics, for a wide range of packaging machines and for many other applications. These solutions are the key to implementing innovative machine and system concepts quickly and successfully in the interests of increased productivity.

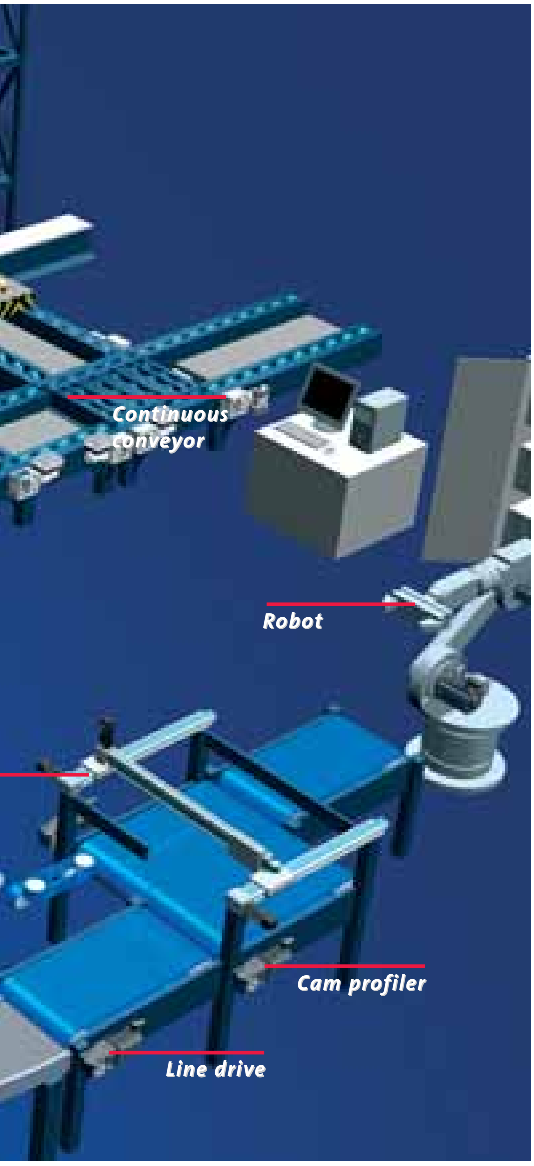
Lenze's powerful and highly reliable products are based on established standards and are very user-friendly. They enable us to create the ideal conditions to enable you to adapt your machines and systems in line with market requirements flexibly and easily.

Our made-to-measure solutions and services will provide you with the winning formula as you race towards your goals. You will also benefit from our extensive technology and application expertise.



Mechanical engineering calls for a variety of drive functions

- Machines and systems are now required to perform considerably more tasks than in the past, with the result that drive tasks have to be implemented flexibly and must be tailored to requirements.
- Generally speaking, our customers, who come from all sectors of industry, expect to be provided with standardised solutions that are easy to use, but which can also be adapted to their individual needs.



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The following pages illustrate how Lenze technology can solve the drive tasks associated with a variety of machines.

Applications | conveying and sorting

Automatic conveyors are used to transport and sort materials. They are sometimes installed as part of a storage or logistics system or may be used between the machining stations of factory plant and equipment. In the case of unit loads, the speeds of individual conveyor sections must be aligned with the flow of material. By contrast, bulk materials are conveyed continuously.

Typical applications include
- ▶ Roller conveyors
- ▶ Chain conveyors
- ▶ Belt conveyors
- ▶ Screw conveyors

As their name suggests, continuous conveyors support constant movement. Their speed depends on the materials being transported and the process conditions. Defined acceleration and braking ramps prevent materials tumbling or slipping during stopping and starting. Frequency-controlled operation has become the norm whenever variable speeds are required.

On conveyor drives, as well as on the basis of friction, torque is determined on the deformation work and churning work of the belt conveyor. The proportion of potential energy is also taken into account from a need to overcome height differences. Acceleration is not a primary concern, as the drives change speed gradually.

In the case of conveyor sections used to transport unit loads (from which individual units are discharged and sorted), the speed of the material must be varied in accordance with specific requirements. That is why dynamic torque loads also need to be taken into account within this context. As a result, servo drives are often used in such situations.

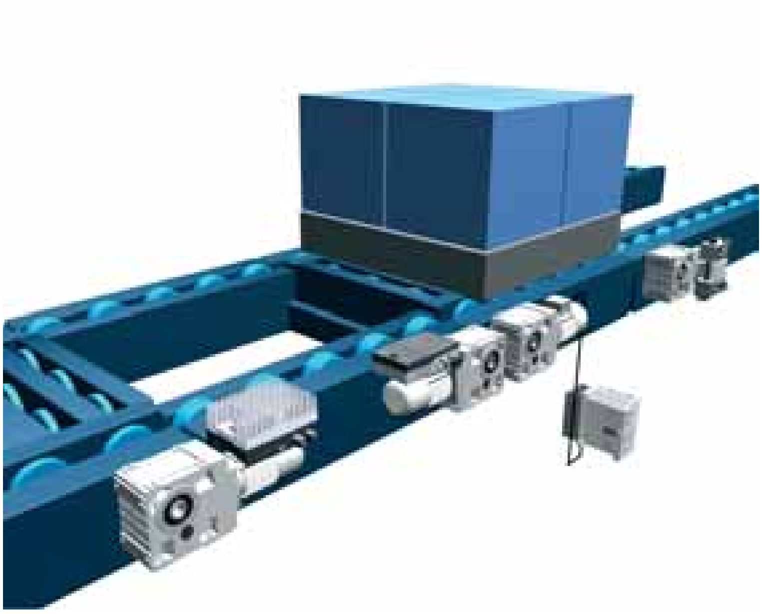
The sensor signals (from photoelectric barriers or limit switches) that are necessary for the purpose of monitoring and controlling the volume flow are processed by higher-level controls or directly by the inverter.

Drive solutions for conveyor drives
The driving force behind a conveyor is the geared motor. Fixed speed motors are either controlled via a contactor or a distributed motor starter. To facilitate soft starting, Lenze's electronic motor starter, starttec, can be used to raise motor voltage gradually by means of a ramp.

If variable speeds are required, there will be a need for precise acceleration, braking and positional accuracy when stopping. In this case, a frequency inverter is the ideal solution. Lenze's 8200 vector and 8200 motec frequency inverters can be connected to fieldbuses. This minimises wiring and cabling to the controller.

The decentralised 8200 motec frequency inverter should be installed outside the control cabinet and directly on the machine frame or on the motor in place of the terminal box. This means that conveyor sections can be tested easily prior to delivery, thereby reducing installation and commissioning times. This results in cost savings, especially when you consider the layout concept, which allows loop-through wiring of the power and control cables.

Lenze servo drives are designed for high dynamic performance applications. The servo motors can be combined with the complete Lenze range of gearboxes and this means that they can be adapted perfectly to the requirements of any conveyor section.



Matching Lenze products for

- Applications with straightforward requirements
  - G-motion geared motors with or without brake
  - starttec distributed, electronic motor starter
- Applications with some complex requirements
  - G-motion geared motors with or without brake
  - smd, 8200 vector, 8200 motec frequency inverters
- Applications with complex requirements
  - G-motion geared servo motors
  - 9300 servo inverter

Application examples with typical parameters

Application	Sector	Speed [m/min]	Mass	Items/h	Power [kW]
Unit loads	Materials handling technology, logistics, transport	20 ... 60	1 ... 2000 kg/item	50 ... 500	up to 5.5 kW
Bulk materials	Materials handling technology, basic materials	20 ... 60	1 ... 50 t/h		up to 45 kW

Applications | travelling drives

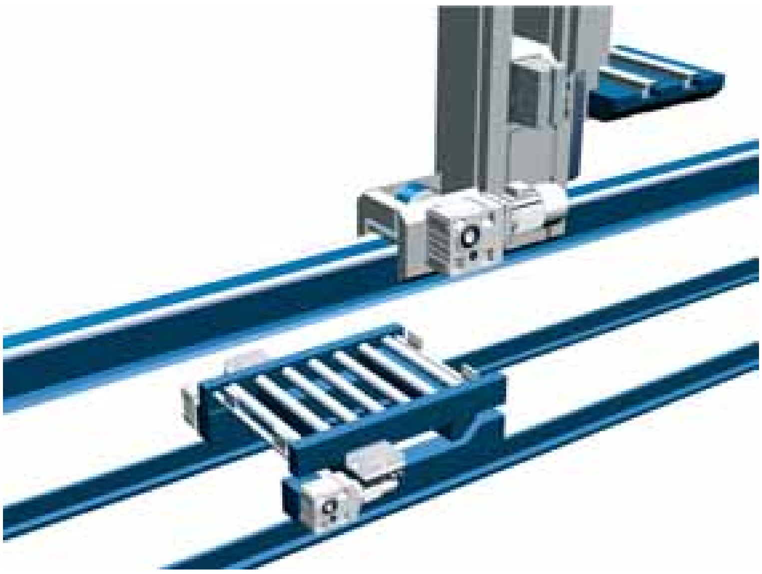
Travelling drives are used to move vehicles that transport payloads horizontally or along slopes. The vehicles are guided by means of wheels, which may be attached to rails or may be free to move across a surface.

Typical applications include

- Rail vehicles or rail carriages
- Crane trolleys
- Monorail overhead conveyors
- Storage and retrieval units
- Industrial trucks

In the case of travelling drives, the drive moves with the vehicle. This calls for flexible energy transmission, which is achieved by means of a trailing cable or cable drum where movement is limited, or if longer distances are involved by means of sliding contacts or contactless, inductive energy transmission. Industrial trucks are generally supplied with power via battery-operated supplies.

Power transmission is achieved using wheels, chains, toothed belts or toothed racks. Rail-bound vehicles may be equipped with two motors that are either switched in parallel by a controller or are controlled by means of two controllers on the basis of an electronic differential.



The necessary torque is primarily calculated on the basis of the required acceleration and the vehicle's mass. The torque is effective during the acceleration and braking phases, but when the vehicle is travelling at constant speed, only the friction needs to be overcome and energy requirements will be lower. Gradients also lead to an increase in steady-state torque.

Drive solutions for travelling drives

Geared motors and geared servo motors are used. To cater for the requirements associated with monorail overhead conveyors and other rail-guided vehicles, Lenze is able to offer the special GKK gearbox series. These gearboxes feature an integrated disconnect clutch and there is an integrated brake to enable stopping and standstill.

Typically, travelling drives are powered by a frequency inverter (Lenze smd, 8200 vector, 8200 motec product ranges)

in conjunction with a three-phase AC motor. Photoelectric barriers or proximity switches are used to detect limit positions. The position is approached using the frequency inverter braking curve. This enables sufficiently precise positioning accuracy to be achieved in the majority of cases.
Applications with complex requirements in respect of dynamic performance and positioning accuracy, e.g. storage and retrieval units and carriages for machines with a high number of cycles, call for the use of servo drives (L-force 9400 Servo Drives, ECS, 9300 Servo product ranges).

The profile of S-shaped ramps protects the mechanics and the products to be transported. Lenze servo controllers support integration of positioning and logic functions as well as autonomous travel programs. If several motors with an electronic differential need to be used, then the necessary control function will also be implemented in the servo inverter.

Often, travelling drives must be equipped with safety functions so that they do not pose a danger to personnel. The 8200 vector, 9300 vector, 9300 Servo, ECS and L-force 9400 Servo Drives product ranges come ready-equipped with appropriate safety functions in the form of “Drive-based Safety". As there is no need for any external components, you can save space and money and can also reduce the amount of wiring required.

Matching Lenze products for

- Applications with relatively straightforward requirements
  - G-motion geared motors with brake
  - smd, 8200 vector or 8200 motec frequency inverters
- Applications with complex requirements
  - G-motion geared servo motor range with brake and encoder or resolver
  - Servo inverter (9300 Servo, ECS, L-force 9400 Servo Drives) with integrated positioning control

Application examples with typical parameters

Application	Sector	Speed [m/min]	Mass [t]	Power [kW]
Storage and retrieval unit	Logistics	240	5 ... 15	55
Monorail overhead conveyor (EHB)	Materials handling technology, logistics, transport, automotive industry	130	5	5
Gantry crane	Materials handling technology	200	200	500 *
Rail vehicles Logistics	Materials handling technology	100	100	15
Industrial trucks	Materials handling technology, automotive industry, assembly	40	4	10

* Several parallel drives

Applications | hoist drives

Hoist drives are used for lifting and lowering loads and have to be able to hold these loads secure in defined positions.

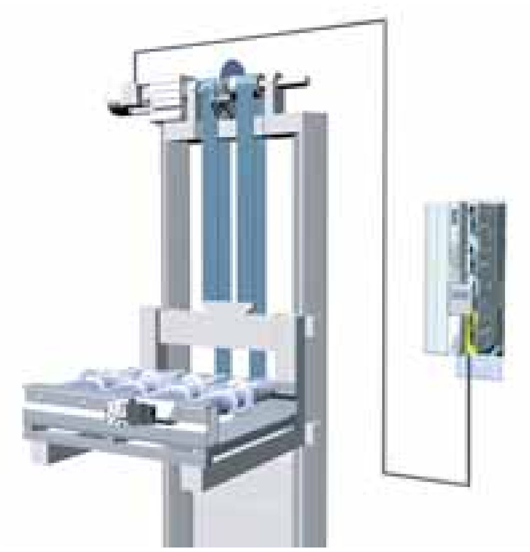
Typical applications include

- Goods lifts, crane systems and winches
- Hoist drives in storage and retrieval units within the context of storage technology
- Hoisting stations and scissor-type lift tables, e.g. within the automotive industry
- Passenger lifts, escalators, stage machinery
- Roller shutters

In contrast to scenarios involving horizontal movements, hoist drives have to be able to achieve permanently high torques when lifting or lowering. During lowering, energy is fed back. Counterweights (which are commonplace in the case of passenger lifts and certain types of goods lift, for example) reduce steady-state load torques but increase dynamic torque requirements. Cables, toothed belts, chains, spindles and toothed racks are used to transmit power from the drive to the hoist.

Drive solutions for lifting applications
Geared motors and geared servo motors are used in lifting applications. To some extent direct drives (torque motors) are also used. For the purpose of stopping the load, the motor features an integrated brake which, for safety reasons, exceeds normal requirements. To ensure jerk-free transition when applying and releasing the brake, Lenze servo inverters are equipped with integrated brake logic.

The energy that is fed back into the drive during lowering is generally converted into thermal energy by brake resistors. In the case of some inverters (such as the 8200 vector, 8200 motec, L-force Servo 9400 Drives series), the brake transistor is already integrated. An extensive range of external braking units is available from Lenze for use in conjunction with the other product ranges. If a high degree of regenerative power is required or in the case of applications that need to be particularly energy-efficient (and therefore need to rule out heat losses), the braking energy can be fed back into the mains via regenerative modules, e.g. Lenze 9340.



For many lifting applications, the drive behaviour of a frequency inverter will be perfectly adequate. It is only when you start talking about applications that require high dynamic performance and positioning accuracy or about high drive powers that you will need to consider using servo drives. This is the case, for example, if you are using storage and retrieval units. S-shaped acceleration ramps gently increase payload, result in good travel characteristics and protect the mechanics. An integrated positioning control function (e.g. as provided by the 9300 Servo controller series) takes care of the entire lifting operation on the basis of defined positions, autonomously and without the need for a master control. In this case, the PLC will merely use commands to specify the position to be approached by the drive.

Matching Lenze products for

- Applications with relatively straightforward requirements
  - G-motion geared motors with brake
  - 8200 vector or 8200 motec frequency inverters
  - Brake resistor
- Applications with complex requirements
  - G-motion geared servo motor with brake and encoder or resolver
  - Servo inverter (9300 Servo, L-force 9400 Servo Drives) with integrated positioning control
  - Brake resistor or 9340 regenerative module

Application examples with typical parameters

Application	Sector	Speed [m/min]	Mass [t]	Power [kW]
Storage and retrieval unit	Logistics	120	5	150
Crane systems, winches	Materials handling technology	200	150	100
Stage machinery	Materials handling technology	120	1.5	22
Lift tables	Materials handling technology, logistics, transport	10	10	7.5
Lifts	Materials handling technology, logistics, transport	120	5	45

Applications | handling and robotics

Handling systems and robots are used to move goods, workpieces or tools along defined paths or in three dimensions. They are a key part of factory automation and enable motion sequences to be performed that would otherwise call for a great deal of effort on the part of humans.

Typical applications include

- Body construction in the automotive industry, within the context of welding, gluing, painting and sealing
- Automatic drive assembly
- Loading and unloading of machines, e.g. machine tools
- Palletising and depalletising

Some examples of typical robot and handling system designs:

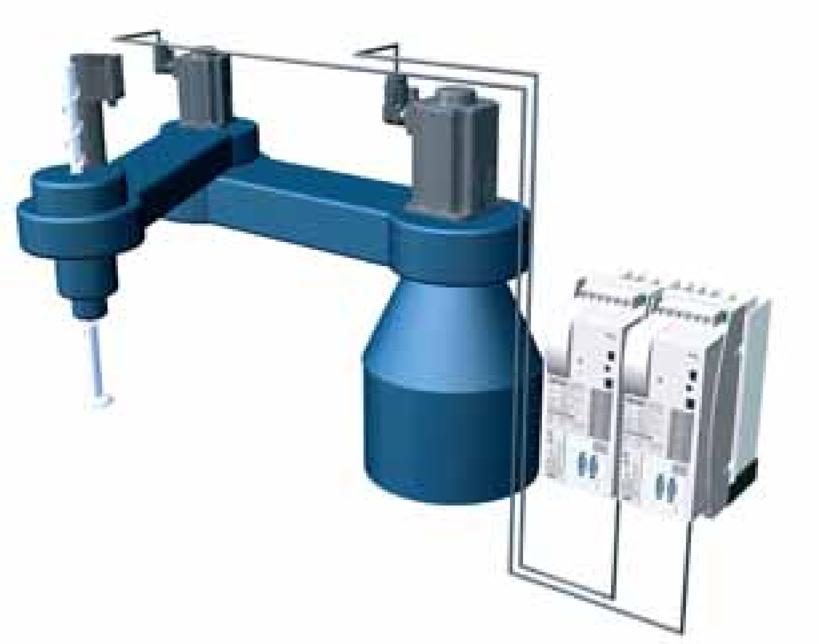
- Six-axis articulated robots
- SCARA robots
- Gantry systems
- Linear X-Y-Z axis systems
- Parallel kinematics, e.g. hexapods

Drive dimensioning is dependent on the mass that needs to be moved, the system's load capacity and the dynamic response required. Connecting members between the drive and the mechanism typically consist of shafts, spindles and toothed belts. Gearboxes are sometimes also connected directly to the arms of the mechanism.

Drive solutions for handling/robotics
Within this context, synchronous and asynchronous servo motors are used (e.g. the Lenze MCS and MCA product ranges) in conjunction with encoders or resolvers and an integrated brake. They can be combined with low backlash planetary gearboxes (such as the Lenze GPA product range) or special robotic gearboxes. As several drives are always used within one mechanism, the ideal solution is to use a number of inverters with a shared power supply unit, e.g. the Lenze ECS servo system. In this case, the only additional items required will be a single mains

supply (with mains filter) and an integrated brake transistor (with brake resistor) inside the power supply unit.

Motion tasks are frequently managed by a motion control system (such as the Lenze ETC product range) or by a special industrial PC. The motion control system acts as a central "master station" and calculates the speed/torque setpoints for the individual axes on the basis of the multi-dimensional motion sequence. The servo inverters for the axes are connected to the control via a realtime-capable communication system, e.g. via CAN or Ethernet Powerlink.



Matching Lenze products for

- Applications with relatively straightforward requirements
  - MCS, SDSGS, MCA, MDFQA, SDSGA synchronous and asynchronous servo motors with GPA low backlash planetary gearbox, with belt, resolver and brake
  - ECS servo inverter, L-force Servo Drives 930 fluxxtorque, 9300 Servo, L-force 94 Servo Drives, L-force 9400 Servo Drives
- Applications with complex requirements
  - MCS, MCA synchronous and asynchronous servo motors with special robotic gearbox, high-resolution encoder and brake
  - ECS servo inverters, 9300 Servo, L-force 9400 Servo Drives

Application examples with typical parameters

Application	Sector	Accuracy [mm]	Cycles [rpm]	Required power [kW]
Automotive engineering	Robotics	0.1	<60	1.0 ... 15
Picking of small goods	Handling	0.1	<30	1.0 ... 10
Sorting systems	Handling	0.1	<120	<5
Material assembly	Packaging	0.1	<120	<5
Workpiece removal	Plastics	0.1	<60	<5

Applications | positioning drives

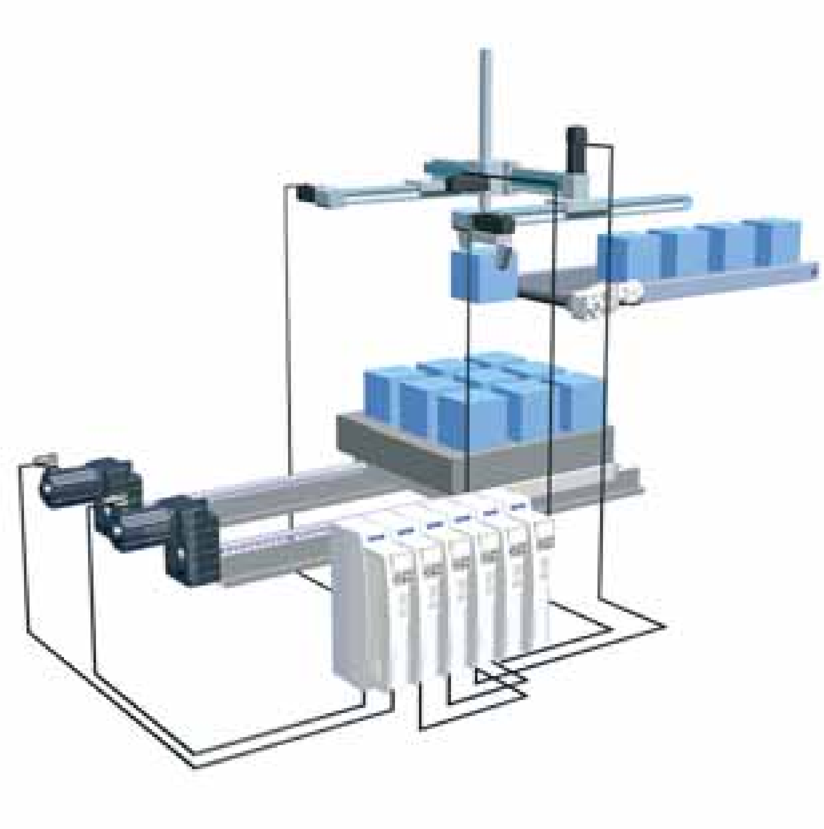
Positioning drives are used to move material, workpieces or tools in a rotary or linear way to exactly defined target positions.

Typical applications include

- Turning and lifting equipment
- Equipment for cutting material into lengths
- Limit stop adjustment
- Infeed drives on machining centres
- Dosing and filling plant

Frequently, positioning is effected in cycles. Examples for this are rotary indexing tables and revolving transfer tables. Linear motions can also be realised with rotary drives using belts, spindles, toothed racks, cables, roller mechanisms. Furthermore, linear motors are used. The different drive mechanisms have different features.

- Toothed belt: low cost, high degree of efficiency, low inertia, high speeds and accelerations, medium accuracy
- Spindle: high degree of precision, high drive speeds (may be possible to dispense with gearbox), relatively small traversing range and low efficiency
- Toothed rack: any traversing range, simple mechanism, medium accuracy, high backlash
- Direct drive in the form of a linear or torque motor: high acceleration, speed and accuracy



Drive functions for positioning drives
Drive system design can be optimised by selecting the appropriate physical parameters (leadscrew pitch, diameter, belt pulley/gear characteristics). The design is determined on the basis of the masses to be accelerated, moments of inertia and motion profiles used.

If a high degree of positioning accuracy and reproducibility is required of the drive system, low backlash gearboxes, such as Lenze's GPA range of servo planetary gearboxes, or direct drives are used.

Selecting the right encoder system for position detection is crucial. Encoders or resolvers are used in combination with servo drives (e.g. from the Lenze 9300 Servo, L-force 9400 Servo Drives ranges) and Lenze MCS and MCA servo motors. If multiturn absolute value encoders are used, there is no need for referencing. An integrated positioning control function takes care of the entire positioning operation on the basis of defined positions, autonomously and without the need for a master control. In this case, the PLC will merely use logic commands to specify the position to be approached by the drive.

Matching Lenze products for

- Applications with relatively straightforward requirements
  - G-motion geared motors with encoder and brake
  - 8200 vector frequency inverter with Lenze Drive PLC control
- Applications with complex requirements
  - MCS/MCA servo motors with brake and encoders or resolvers
  - Servo inverter (9300 Servo, L-force 940 Servo Drives, L-force 9400 Servo Drives, ECS) with integrated positioning control
  - Brake resistor or 9340 regenerative module

Application examples with typical parameters

Application	Sector	Accuracy [mm]	Mass [kg]	Speed [m/s]	Acceleration [m/s²]	Power [kW]
Pick and place	Handling	0.5 ... 1	5 ... 100	10 ... 20	20 ... 30	0.55 ... 10
Limit stop adjustment (spindle)	e.g. wood working	0.01	5 ... 50	0.05	0.5	0.25 ... 3
Linear axis (toothed belt)	Handling	0.1	1 ... 50	10	10 ... 50	0.55 ... 15

Applications | line drives and printing units

Line drives are used for manufacturing, transporting and processing or finishing continuous material. The types of material include, for example, paper, film, yarns and textile webs, sheet metal and wire.

Typical applications include

- Plant for rolling, drawing, stretching and coating metal
- Transporting and straightening continuous material (metal webs from a coil)
- Calender for rubber, textiles, paper
- Printing units with single drives

Line drives are quasi-stationary drives where precision in respect of speed, torque or angular guidance is crucial. The speed changes during machine start and stop as well as during material exchange. A high concentricity factor ensures precise production sequences and is therefore vital to the quality of the product being processed.

Printing units with single drives are a special type of line drive. These function as adjustable electronic gears where precision in respect of angular synchronism is crucial to ensure perfect register precision as far as the various colours of the printing units are concerned.

In the case of line drives, the ratio between the speed or angle of several drives is fixed (electronic gearbox). If individual processes within a plant need to be separated out, dancer controls or tension controls are used for this purpose.

The physical dimensioning of the drive depends on the process parameters tensile force, speed, moment of inertia and on the acceleration required in the event of an emergency-stop operation.

Drive functions for process line drives and printing units

Within this context, geared motors or three-phase AC motors are used and to a certain extent so are direct drives. There are a small number of simple applications for which vector control-based operation without speed/angle measurement will suffice. However, generally speaking a phase angle sensor/tacho generator will be used in conjunction with precise speed control. The Lenze 9300 Servo series of controllers are capable of performing many of the tasks involved:

- Electronic gearbox
- Register mark detection and control
- Dancer and tension control
- Torque precontrol
- Mains failure control, which ramps down the entire process line in a synchronised manner in the event of a mains interruption

For the purpose of enabling energy exchange between the drives on the line, a DC-bus connection is established. In some cases, the braking energy of the drive system is fed back into the mains via

a regenerative module (Lenze 9340 product range). The advantages of using the DC-bus connection are lower input power, lower energy consumption and fewer components inside the control cabinet. The necessary safety engineering for the line drives can be implemented in the drives. Advantage: lower costs as a result of fewer components coupled with faster installation.

Matching Lenze products for

- Applications with relatively straightforward requirements
  - Three-phase AC motors and geared motors
  - 8200 vector or 9300 vector frequency inverters
- Applications with complex requirements
  - Three-phase AC motors and geared servo motors with encoder or resolver
  - ECS servo inverters, L-force 9400 Servo Drives, 9300 Servo with integrated drive solutions for electronic gearbox

Application examples with typical parameters

Application	Sector	Speed [m/min]	Power [kW]
Manufacturing, processing and finishing paper or plastic sheeting	Paper Plastics	1 ... 2000	0.37 ... 100
Manufacturing and finishing textile webs	Textiles	5 ... 150	0.37 ... 55
Rolling, annealing and finishing sheet metal	Metal	5 ... 300	0.37 ... 200
Wire drawing machines	Wire industry	10 ... 2000	0.75 ... 250
Printing on paper and plastic sheeting as well as textiles	Printing	5 ... 1000	0.75 ... 110

Applications | winding drives

In general, continuous material is stored on a reel, transported for processing and then wound back onto a reel at the end of the process. The line drives are located between the unwinder and rewinder.

Typical applications include

- Manufacturing textiles, films, paper, sheet metal and metal foils
- Packaging machines
- Continuous processing and finishing operations

The winding material is wound or unwound at a constant circumferential speed, which is set in accordance with the material speed of the upstream or downstream processes. The tensile force to which the material is subjected is kept constant or varied in accordance with diameter. Dancer or tension controls are used to ensure this. As the radius is constantly changing during winding and unwinding, the drive needs a wide speed and torque setting range. During unwinding, the drive always operates as a generator. It decelerates the material and feeds back energy during this process.

In many applications, reels are changed automatically by means of turret winders using an appropriate sequence control and additional drives for the reel change process.

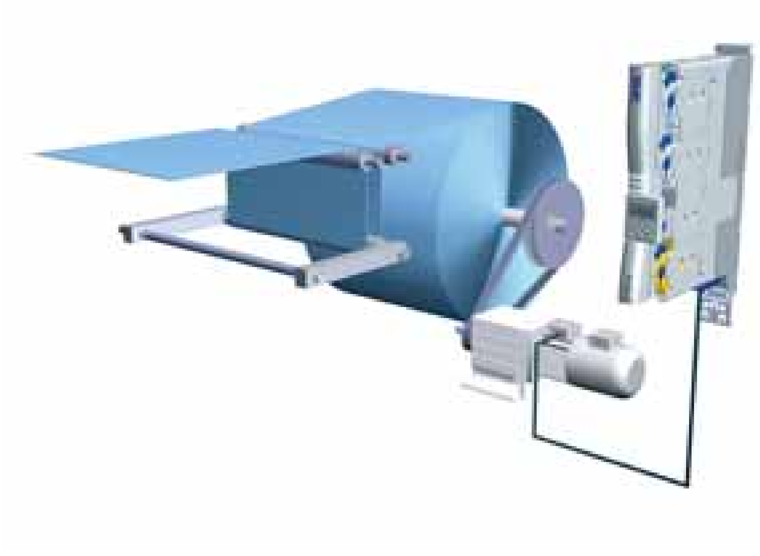
Drive functions for winding drives

In this context, geared motors or three-phase AC motors are installed. Often, field weakening is used for the purpose of drive dimensioning, as although speed increases as diameter decreases, this is accompanied by a reduction in the required torque. This characteristic corresponds to the field weakening curve for three-phase AC motors. As a result, controllers with considerably smaller ratings can be selected.

In the case of applications with low requirements, frequency inverters such as those from the Lenze 8200 vector or 8200 motec series should prove perfectly adequate. The winding process is controlled by a dancer control. In the case of applications with higher requirements, it will be necessary to use servo inverters (e.g. from the Lenze 9300 Servo or L-force 9400 Servo Drives product ranges) in conjunction with geared motors and encoders or resolvers.

The 9300 Servo PLC product range and Winder technology package are the key to achieving complete winding, including control of the winding calculator with precise pilot control of the torque and speed according to how full the reel is. Also the traverse control is supported by the drive's software.

The power fed back during the unwinding process can be utilised by means of a DC-bus connection to the line drives. Alternatively, brake transistors and resistors or regenerative modules are available.



Matching Lenze products for

- Applications with straightforward requirements
  - G-motion geared motors
  - 8200 vector or 8200 motec frequency inverters
- Applications with relatively straightforward requirements
  - G-motion geared motors/geared servo motors or motors with encoders or resolvers
  - 9300 Servo servo inverters, L-force 9400 Servo Drives, ECS
- Applications with straightforward requirements
  - G-motion geared motors/geared servo motors or motors with encoders or resolvers
  - 9300 Servo PLC servo inverter with Winder technology package

Application examples with typical parameters

Application	Material	Speed [m/min]	Power [kW]
Winding paper and plastic webs	Paper, Film	30 ... 2000	0.37 ... 400
Winding textile webs	Textile fabric	5 ... 150	0.37 ... 55
Winding sheet metal or metal foil	Metal	5 ... 300	0.37 ... 200
Winding cables	Cable	5 ... 250	0.37 ... 75
Winding wire	Wire	5 ... 2000	0.75 ... 200

Applications | cross cutter and flying saw

Cross cutter and flying saw are machine functions used for processing continuous material at various points along and (in particular) at the end of production lines, either in batches or individually.

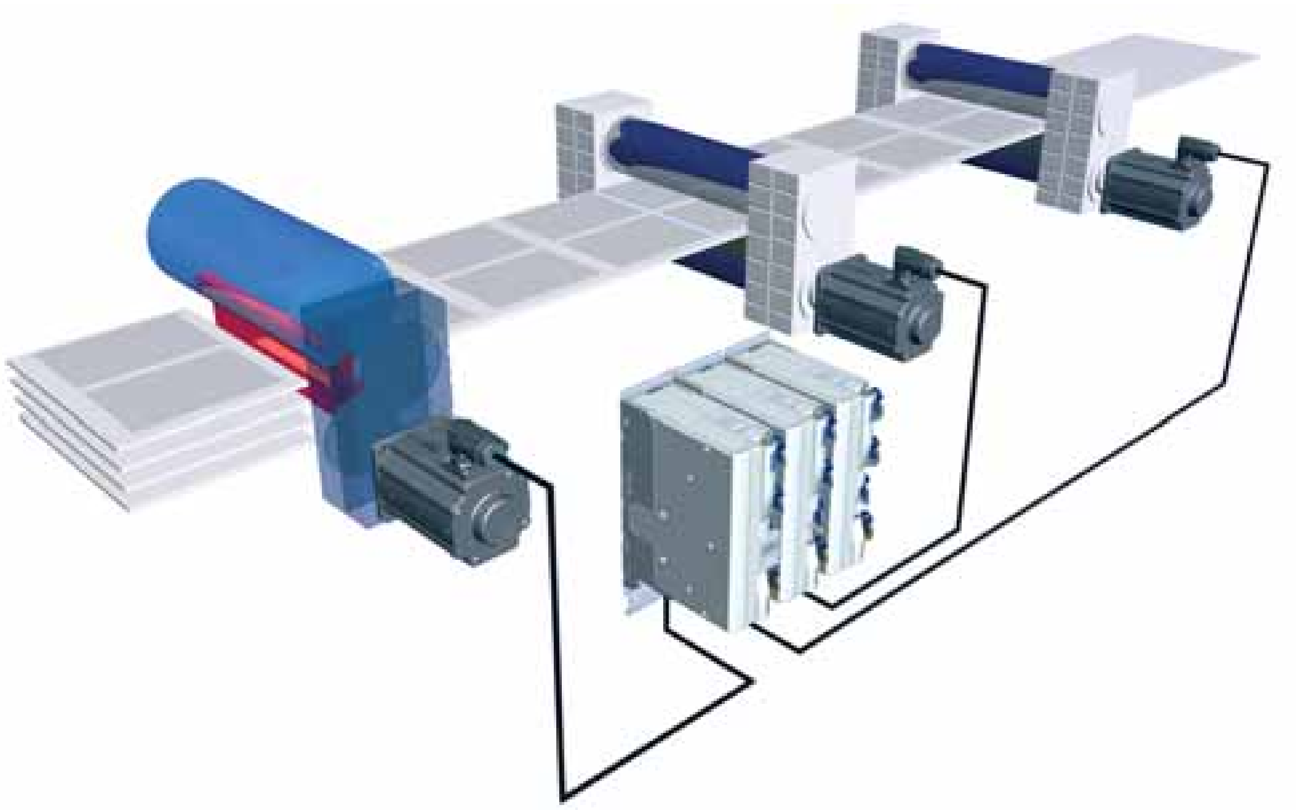
Typical applications include

- Cutting
- Sawing
- Embossing
- Welding
- Stamping
- Perforating

What all these tasks have in common is the fact that movement has to be synchronised with material speed during processing. Sometimes this must be synchronised with a registration mark. At the same time, the position of the next processing step must be approached. Thus, this movement is dependent on the format length to be produced.

Cross cutter and similar machine functions (e.g. welding bars, coining dies) are rotary. With each machining process, the drive rotates by one interval at the output end. The machining distance is determined by the average speed between machining processes. This necessitates highly-dynamic acceleration and braking. As a result, cross cutters impose complex requirements on the drive in respect of dynamic performance and precision.

By contrast, saws and related functions are based on translatory motion. During the machining process, they move in synchronism with the material speed. At the end of the process, they have to move back to the next machining position. High dynamic performance is often also required during the return movement.

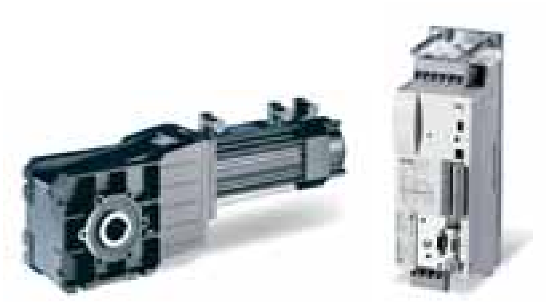


Drive functions for cross cutters and flying saws
In cases where exact positioning control and high dynamic performance are required, servo drives have to be used. For this purpose, Lenze offers the MCS, MCA and MDFQA servo motors, which can be flexibly combined with Lenze's range of geared motors.

Ideal servo inverters are available in the form of Lenze's ECS, 9300 Cam, 9300 Servo PLC and L-force 9400 Servo Drives product ranges. With these products, the motion sequence can either be defined by the controller itself or by an external control.

The angular position of the master drive, which is required for synchronisation, is transmitted via a real time communication system such as CAN or Ethernet Powerlink. In addition, register detection is sometimes also necessary to ensure that the machining position can be determined exactly. For this reason, Lenze servo inverters are equipped with rapid touch probe inputs.

Matching Lenze products for
- Applications with relatively straightforward requirements
  - MCS, MCA or MDFQA servo motors, possibly combined with gearboxes
  - ECS, 9300 Cam or L-force 9400 Servo Drives servo inverters
- Applications with complex requirements
  - MCS, MCA or MDFQA servo motors, possibly combined with gearboxes or taking the form of direct drives
  - 9300 Servo PLC or L-force 9400 Servo Drives



Application examples with typical parameters

Application Cross cutter	Sector	Speed [m/min]	Accuracy [mm]	Cycles [rpm]
Cutting, embossing card, sheets, films	Paper, plastics	100 ... 200	0.1	300 ... 600
Assembling packaging material	Packaging	100 ... 200	0.1	300 ... 600
Producing and assembling corrugated board	Paper	100 ... 400	0.1 ... 0.5	60 ... 300
Producing and assembling steel wire	Metal	40 ... 80	0.2 ... 0.3	60 ... 300

Applications | cam drives

Electronic cam drives transform linear position information relating to a master axis into curved motion profiles via a path-controlled profile generator. These profiles result in gentle, low-jerk sequences that protect both the products and the machine's mechanical components. They are the key to achieving high speeds and therefore result in higher cycle rates. Examples for this are cutting, embossing, gluing, coating, welding, bending and forming processes.

Typical applications include

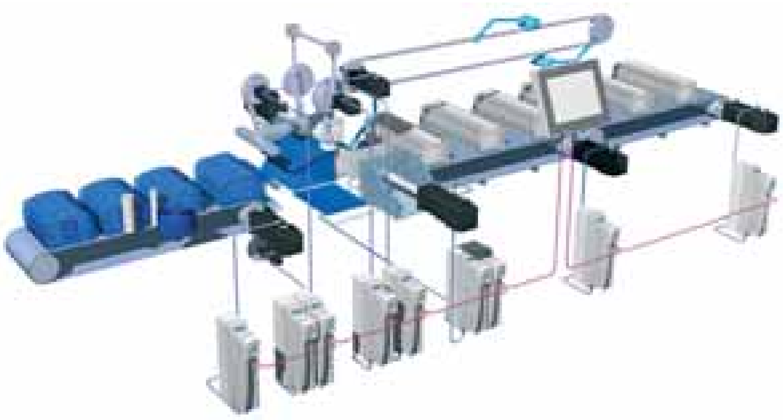
- ▶ Packaging machines
- ▶ Automatic assembly machines
- ▶ Adhesive binders
- ▶ Filling stations

Cam drives are used when the position of one or more axes (slave axis/axes) depends on the position of a master axis. In this case the motion sequences are position-coordinated. In the past, generally mechanical cams were used on synchronised machinery. Within this context, a vertical shaft was the mechanical component responsible for ensuring that the system ran in synchronism.

Electronic cam drives imitate cam mechanisms. As a result, you can have as many cams and cam characteristics as you want. These provide the optimum motion profile and can be changed in next to no time. The advantages of this are increased flexibility and productivity with modern production and processing machines. The electronic solution reduces the masses to be driven. The advantages of this are increased dynamic performance due to smaller moments of inertia, less wear, smaller drives.

Drive functions for cam applications
When it comes to dimensioning drive components within the context of cam technology, it makes sense to utilise motion profiles that have already been optimised in order to increase the power and performance of the drive axes. Cam applications impose complex requirements in terms of dynamic performance and accuracy, which means that they are used in conjunction with servo controllers, gearboxes with synchronous servo motors (e.g. Lenze MCS series), and encoders or resolvers. In terms of gearboxes, the motors are often combined with low backlash planetary gearboxes such as those from the Lenze GPA series. In view of the large data volume created within the context of cam characteristic calculation, it makes sense to implement this task in the servo controller. The Lenze 9300 Servo and L-force 9400 Servo Drives servo controllers are prime examples of this Depending on the capabilities of the communication system used (e.g. CAN or Ethernet Powerlink) curve profiles can

also be calculated by an industrial PC or motion control system such as Lenze's ETC control. In this case, the controllers are provided with the motion sequence in the form of a speed setpoint via the bus. If confronted with multidimensional motion sequences that involve several drives, it is best to use inverters with a common power supply unit and central mains filter, e.g. Lenze ECS servo drives.



Matching Lenze products for

- Applications with relatively straightforward requirements and involving a single axis
  - Synchronous MCS servo motor with gearbox
  - 9300 Cam/PLC, ECS, L-force 9400 Servo Drives servo inverters with integrated cam control
- Applications with complex requirements in a multi-axis grouping with control
  - Synchronous MCS servo motor or asynchronous MCA, MDFQA servo motor with gearbox
  - Multi-axis servo system, e.g. ECS, L-force 9400 Servo Drives
  - ETC motion control system

Application examples with typical parameters

Application	Sector	Accuracy [mm]	Cycles [rpm]	Power [kW]
Adhesive binders	Paper	0.1 ... 0.4	<100	1.0 ... 55
Bag forming, filling and sealing machine	Packaging	0.1 ... 0.5	<600	1.0 ... 55
Assembling packaging material	Packaging	>0.1	30 ... 500	0.75 ... 5.5
Labelling	Paper plastics	0.1	<200	0.75 ... 5.5
Sealing machines	Packaging	0.1 ... 0.5	75	0.75 ... 3
Wood working machines	Wood working	1 ... 2	<85	0.75 ... 5.5
Textile machines	Textiles	0.1	800	1.7 ... 15

Applications | shaper drives

Shaper drives are used to create workpieces from raw materials or for providing workpieces with a definitive shape. There is a huge range of starting materials. Consequently, the various shaping processes and potential applications are also extremely diverse. These can take the form of continuous or cyclic processes.

Typical applications include

- Extruder within the plastics industry
- Shakers used for compression within the cast stone industry
- Swaging resin moulds
- Edge machining of metal workpieces
- Compressing composites

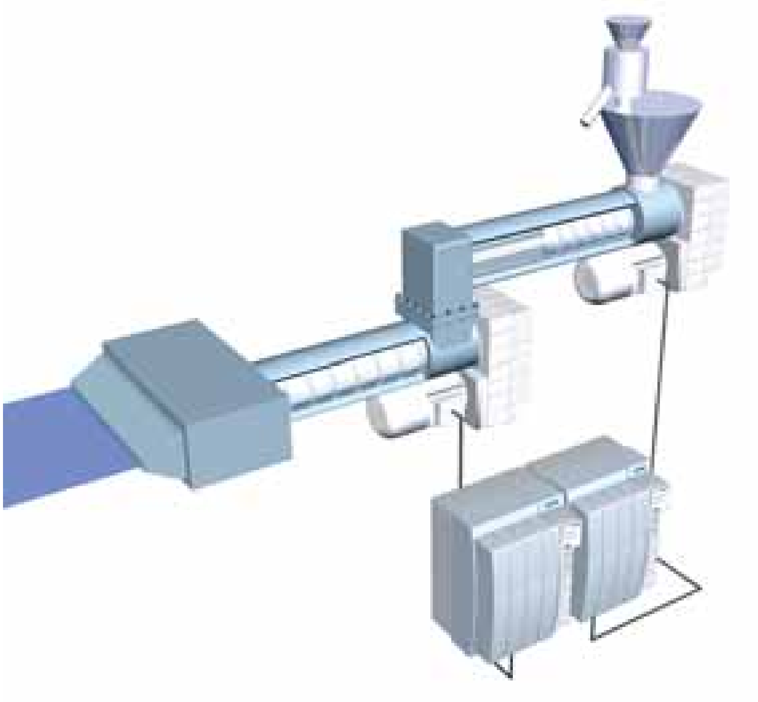
Bulk materials assume the required shape as part of a continuous process, e.g. the extrusion of plastic profiles. Load impulses cannot be allowed to result in speed variation, otherwise the strength of the material will be affected. Uniform levels of force are required when a plant is starting up or alternatively production must be slowed.

Cyclic shaper drives are used if a workpiece's basic shape has already been achieved, but it needs to be finished. As this type of material shaping is linked to an external process cycle, the requirements in terms of accuracy and dynamic performance are much more complex than with continuous forming processes.

Drive functions for shaper drives

Standard three-phase AC motors are primarily used within this context (e.g. Lenze MDXMA series) and are combined with various gearboxes depending on the mounting requirements. In the case of continuous production, frequency inverters generally provide the driving force. To ensure consistent production quality on the basis of good levels of speed stability even during slow forming processes or at the beginning and end of the production run, the drives are equipped with their own vector control (Lenze 8200 vector or 9300 vector product ranges) and there may or may not be a feedback device on the motor.

Cyclic shaper drives impose complex requirements in respect of dynamic performance, overload capacity and accuracy. Consequently, the obvious choice is generally to use servo inverters (Lenze 9300 Servo, L-force 9400 Servo Drives series) and geared servo motors (MCA, MDFQA and MCS servo motors combined with gearboxes) in conjunction with speed and position feedback.



Matching Lenze products for

- Continuous applications with relatively straightforward requirements
  - G-motion three-phase AC motors or geared motors
  - 8200 vector or 9300 vector frequency inverters
- Cyclic applications with complex requirements
  - MCA, MCS and MDFQA geared servo motors with speed and position feedback
  - 9300 Servo or L-force 9400 Servo Drives servo inverters

Application examples with typical parameters

Application	Sector	Accuracy [mm]	Cycles [rpm]	Required power [kW]
Extrusion	Plastics processing		Continuous	1 ... 400
Swaging plastic parts	Plastics processing	0.1	<60	1 ... 75
Deep drawing sheet metal components	Automotive industry	0.1	<20	5 ... 75
Presses	Automotive-industry	0.1	<20	30 ... 400
Shaking	Cast stone industry		Continuous	5 ... 30

Applications | single and machining drives

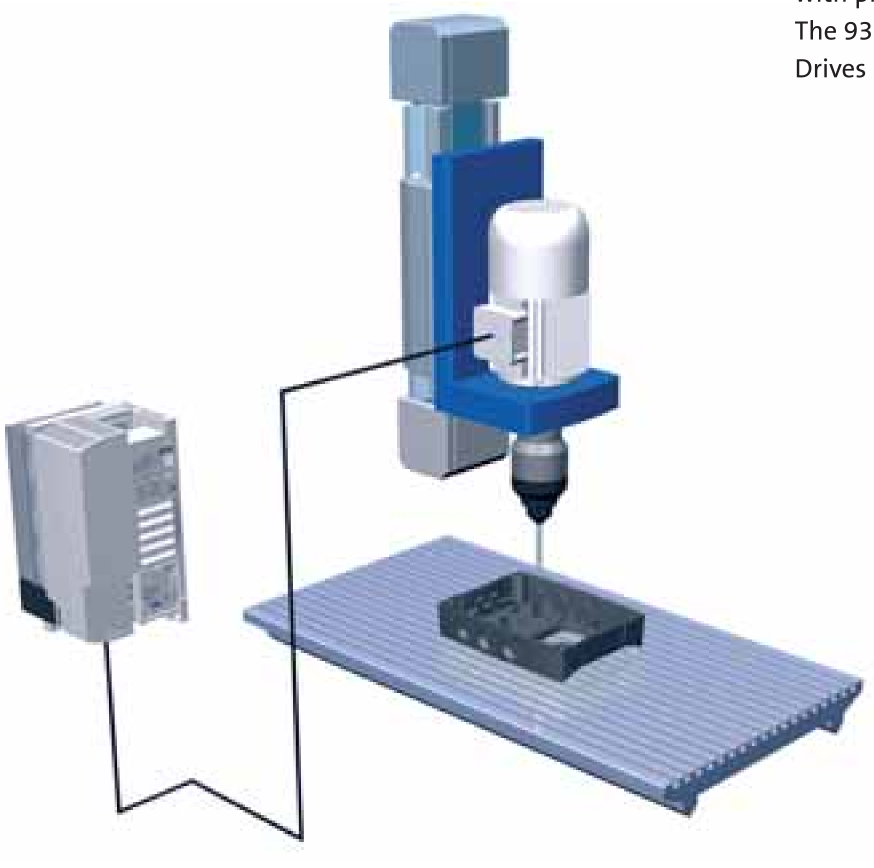
In the case of many machining processes, electric drives are responsible for driving tools.

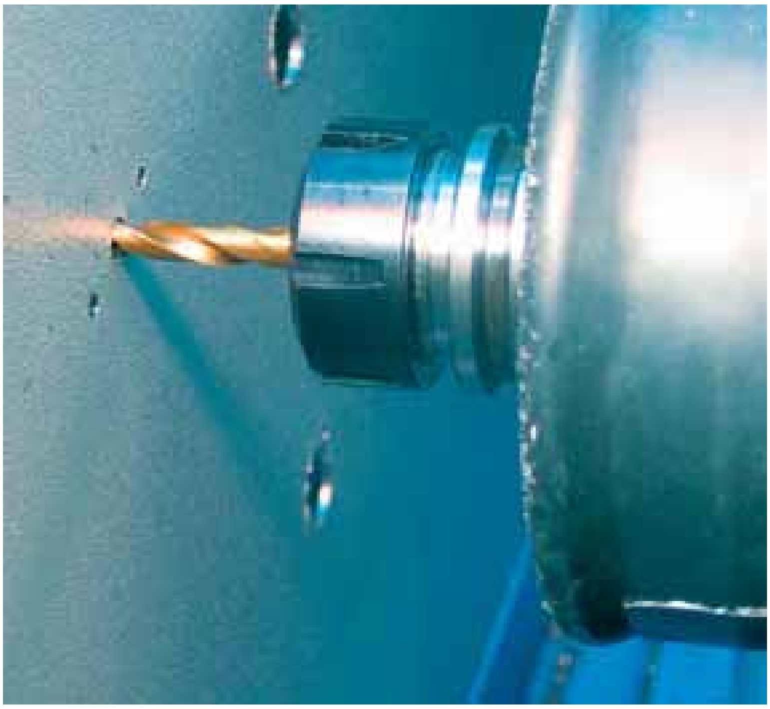
Typical applications include
- Drills on drilling machines
- Saw blades
- Milling cutters
- Grinding tools

The drive speed is dependent on the tool and the workpiece material and must be kept constant throughout the entire machining process. By contrast, the level of required torque will vary (especially at the beginning and end of a process).

Many tools operate at very high speeds in conjunction with specially adapted motors. The high frequencies required by these motors are provided by inverters. Mid-frequency drives such as these are sometimes also responsible for driving multiple tools, e.g. on wood working machines. In this case, the individual motors are switched in and out separately.

Drive functions for individual and machining drives
Three-phase AC motors and special spindle motors are used in cases where very high rated speeds are required. The control function is handled by frequency inverters with vector control such as those from the 8200 vector and 9300 vector product ranges. This results in a good level of speed stability. If a higher degree of accuracy is required, then servo inverters with precise speed control can be used. The 9300 Servo and L-force 9400 Servo Drives series are prime examples.





Matching Lenze products for

- Applications with relatively straightforward requirements
  - MDXMA standard three-phase AC motors
  - 8200 vector or 9300 vector frequency inverters
- Applications with complex requirements
  - MDXMA standard three-phase AC motors or MCS, MCA servo motors with encoders or resolvers
  - 9300 Servo, L-force 9400 Servo Drives servo inverters

Application examples with typical parameters

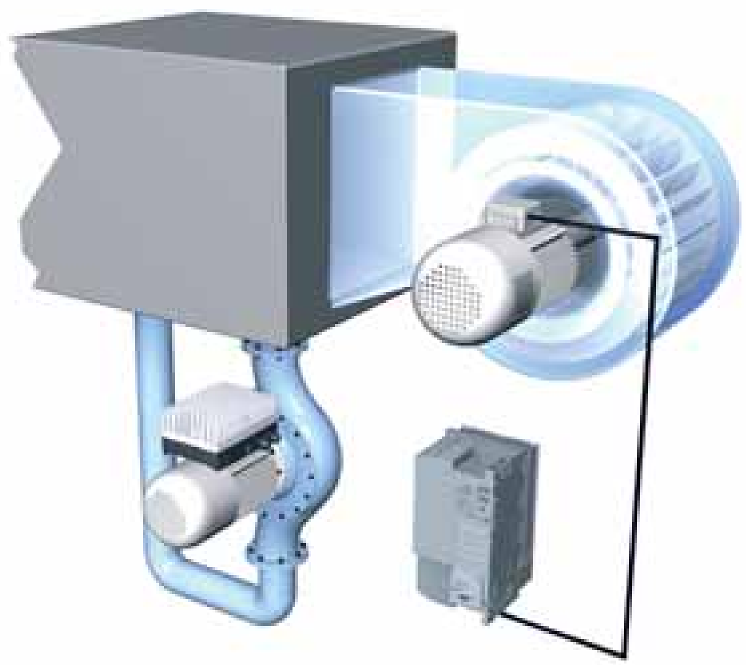
Application	Sector	Speed [rpm]	Required power [kW]
Drilling, milling, grinding, Polishing	Metal working, wood working, stone working, glass and plastics processing	12,000 ... 18,000	0.5 ... 5.5
Sawing, cutting	Metal working, wood working, stone working, glass and plastics processing	1000 ... 5000	0.5 ... 400

Applications | pumps, fans and compressors

Pumps, fans and compressors transport and/or compress gases and liquids. A distinction is made between two working principles: reciprocating and gear pumps and axial-flow fans use displacement, radial-flow fans and centrifugal pumps in contrast use centrifugal force.

Typical applications include

- Building services technology (HVAC)
- Chemical and foodstuff industry (conveying, dosing, filling)
- Water supply
- Compressed air generation
- Fans for industrial processing operations (dryers, air cushion ovens)
- Extraction plant within the wood, paper and printing industries
- Sewage technology and sewage plant technology
- Refrigerators
- Environmental technology
- Vacuum pumps



Many of these applications run at constant speed and therefore do not require speed adjustment, whereby the flow or pressure can be controlled via throttle or bypass control. Nevertheless, higher degrees of process automation (pressure monitoring, sequential circuits and remote control) and more complex energy-saving requirements (sequential shutdown, partial load operation) mean that frequency inverters are increasingly being used for the purpose of motor control. The advantage is that pumps and fans can be designed with maximum power requirements in mind, e.g. summer and winter operation of air conditioning systems. However, these requirements are only applicable on a few days of every year. Instead of operating the motors continuously at full load and using bypass or throttle valves to cancel out the excess power, a large amount of energy can be saved by using an appropriate means of speed control.

Drive solutions

Frequency inverters assist the control technology in the operation of pumps, fans and compressors. For example, they are capable of handling all pressure control tasks independently on the basis of an integrated PID controller, which works in conjunction with a pressure sensor. The Lenze 8200 vector frequency inverter is a prime example of this.

As pumps, fans and compressors frequently take the form of individual units, distributed drive components (such as Lenze's 8200 motec frequency inverter or starttec motor starter) are becoming increasingly common. These components can be mounted directly on the motor in place of the terminal box and away from the control cabinet.

If there is already a control cabinet then the construction volume of the components will often be the decisive factor. That is why the 8200 vector and smd frequency inverters are of such a compact design.

Matching Lenze products for

- Applications with straightforward requirements
  - MDXMA standard three-phase AC motors
  - smd, 8200 vector, 8200 motec frequency inverters
- Applications with complex requirements
  - MDXMA standard three-phase AC motors
  - 8200 vector, 8200 motec, 9300 vector frequency inverters

Application examples with typical parameters

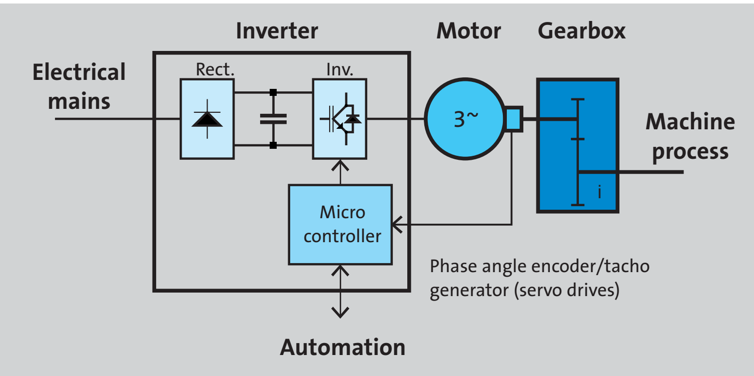
Application	Sector	Pressure [bar]	Power [kW]
Feed pumps and sewage pumps	Municipal water supply management	1 ... 10	400
Blower	Air conditioning technology, building services engineering,	0.5 ... 1	2 ... 350
Process technology Chemical and pharmaceutical industries	Chemical, pharmaceutical, medical technology	1 ... 10	400
Air compressors and compressors for technical gases	Various industries	0.8 ... 10	55 ... 450
Water supply	Air conditioning technology, building services engineering	2 ... 10	90

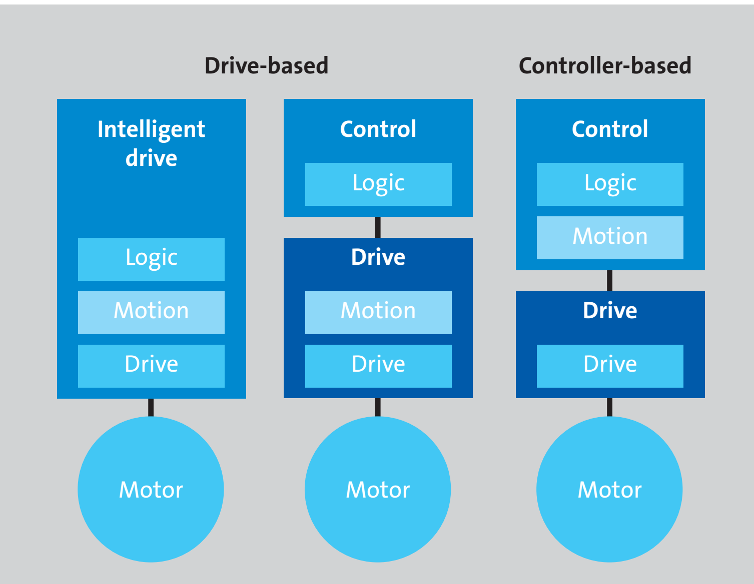
Structure of drive systems

Drive systems consist of the following components:

- ▶ The inverter, which transfers the electrical power from the mains in a controlled manner
- ▶ The electric motor, which converts electrical power into mechanical power
- ▶ The gearbox, which adapts the mechanical power of the motor in line with the operating point of the machine (by reducing the speed and increasing the torque)

Fixed speed applications do not require the use of an inverter. In such cases, electronic motor starters or conventional motor contactors are used.





If the motor's high output speed can be used directly, there is no need for a gearbox. Pumps are a good example of this.

Open and closed-loop drive control

The inverter is responsible for drive control. There are two basic configurations:

- ▶ Open-loop speed control without an encoder (frequency inverter)
- ▶ Closed-loop speed control with an encoder (servo inverter)

Open and closed-loop control

In an automation system, open and closed-loop drive control consists of the following three function levels:

- ▶ Logic – sequence control, PLC functions
- ▶ Motion – motion control, e.g. for positioning
- ▶ Drive – drive control, e.g. speed, torque, angle of rotation

Controller-based and drive-based

Motions can be managed by a controller (PLC, CNC, industrial PC) or directly by the drive. The former is referred to as a controller-based approach and the latter as a drive-based approach.

Whereas a controller-based concept will be required for performing three-dimensional movements (for example, in the case of robots), a drive-based concept will be implemented in the case of the following drive tasks, in particular:

- ▶ Positioning
- ▶ Line processes
- ▶ Winding
- ▶ Cross cutter/flying saw
- ▶ Cams

For the purpose of motion control, intelligent drives also process drive-based logic functions.

Frequency inverters
Frequency inverters are used in conjunction with three-phase AC motors or geared motors for the purpose of varying their speed. The electrical power is converted as follows:

- Rectifier
- DC bus with capacitor for storing energy
- Insulated gate bipolar transistor, switching frequency of e.g. 8 kHz

Pulse width modulation is controlled by a microprocessor. The processor's software is responsible for controlling the electric drive. There are two motor control methods available for frequency inverters:

- V/f characteristic control
- Vector controls

Vector control makes better use of the torque, features faster torque build-up and provides higher speed accuracy. Some frequency inverters will also evaluate signals from an encoder for the purpose of speed control. In this respect they resemble servo drives.

Braking energy
Fundamentally a frequency inverter can only transfer motor power from the mains to the motor. By contrast, regenerative power occurs within the context of the following applications:

- General braking of a motor
- Lowering with a hoist drive
- Unwinding drives

This braking energy can be dissipated as follows:

- Converted into heat using a brake transistor and resistor
- Transferred to the motor by means of DC-injection braking
- Converted into motor energy for other drives by connecting the DC buses of several inverters in the case of multi-axis applications
- Transferred to the electrical mains via a regenerative feedback inverter

	Frequency inverter	Servo drive
Motor	**Three-phase AC motor**	**Servo motor**
Encoder	No	Yes
Speed adjustment range	1:50 ... 100	>1:10,000
Speed accuracy	3 ... 5% (V/f) 0.5% (Vector)	<0.01%
Dynamic response (minimum acceleration time at rated speed)	100 ms ... 1 s	10 ... 100 ms

Servo drives
Servo drives consist of a servo inverter and a servo motor. The servo motor features an encoder or resolver, which is evaluated by the inverter. This results in precise and dynamic control of the drive's speed and position:

- Servo control
  This solution offers far more in terms of the speed setting range and the level of dynamic performance that can be achieved than is possible with a frequency inverter in combination with a three-phase AC motor.

Motor starter
The purpose of a motor starter is to switch a fixed speed drive on and off and to ensure that the drive starts up smoothly. Motor starters are particularly found within the context of distributed conveyor applications where the power and control signal wiring (e.g. fieldbus systems) is linear for several drives.

Product information | frequency and servo inverter

starttec motor starter

- ▶ Motor starter
- ▶ Power range 0.25 to 4.0 kW
- ▶ Integrated brake control
- ▶ Integrated motor protection
- ▶ Wall or motor mounting
- ▶ 2-motor operation

8200 motec frequency inverter

- ▶ Power range 0.25 to 7.5 kW
- ▶ Sensorless vector control
- ▶ Wall or motor mounting
- ▶ High degree of operational reliability thanks to thermally independent system
- ▶ Handling of process signals

L-force Servo Drives 930 fluxxtorque

- ▶ Power range 0.14 to 0.5 kW
- ▶ Reduced wiring requirements
- ▶ Naturally ventilated, no fan
- ▶ Compact design
- ▶ Integrated positioning control
- ▶ Control via digital inputs/outputs and/or fieldbus
- ▶ Can be installed without a control cabinet, IP55

smd/tmd frequency inverters

- ▶ Compact frequency inverter for straightforward applications
- ▶ Power range 0.25 to 22 kW
- ▶ Operating modes V/f linear, sensorless vector control
- ▶ Pluggable memory module (EPM)

8200 vector frequency inverter

- ▶ Modular frequency inverter
- ▶ Power range 0.25 to 90 kW
- ▶ Sensorless vector control
- ▶ Overload capacity of up to 180%
- ▶ Switching frequencies 1, 2, 4, 8, 16 kHz
- ▶ Fieldbus communication

9300 vector frequency inverter

- ▶ For demanding applications
- ▶ Power range 0.37 to 500 kW
- ▶ Freely configurable function block structure
- ▶ Vector control with and without encoder feedback
- ▶ Control via digital inputs/outputs and/or fieldbus

L-force 930 Servo Drives

- Multi-axis and single-axis operation, high degree of functionality even if space is limited
- Power range 600 W
- Integrated positioning control
- Resolver or absolute value encoder feedback
- Control via digital inputs/outputs and/or fieldbus

ECS servo system

- Compact multi-axis system with central supply featuring high dynamic drive performance
- Power range 1.1 to 13.8 kW
- Overload capacity of up to 300%
- Safe torque off
- Choice between built-in units, push-through technique or cold plate units
- Control via digital inputs/outputs and/or fieldbus
- Two integrated CAN interfaces

9300 servo inverter

- Intelligent servo inverter
- Power range 0.37 to 75 kW
- Single axis and multi-axis applications
- Control via digital inputs/outputs and/or fieldbus
- Freely configurable function block structure or programmable in accordance with IEC 61131-3
- CAN interface as standard
- Comprehensive encoder interfaces

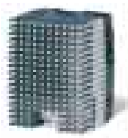
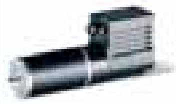
L-force 9400 servo system

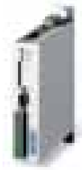
- intelligent servo drive system
- Power range 0.37 to 30 kW
- Single axis and multi-axis applications
- Freely configurable function block structure
- Comprehensive encoder interfaces
- Control via digital inputs/outputs and/or fieldbus
- Comprehensive communication interfaces
- Modular safety engineering
- Innovative backplane system

L-force 94 and 940 Servo Drives

- Easy to use
- Power range 0.25 to 2.2 kW
- Overload capacity of up to 300%
- Pluggable memory module (EPM)
- Integrated operating unit
- Positioning control (940)

Product range | frequency and servo inverter

	Distributed drive technology					Frequency
	starttec	8200 motec	930 fluxxtorque	smd	tmd	
● = Standard ○ = Option □ = Variant						
Voltage and power range	3-ph. 100 ... 550 V: 0.25 ... 4.0 kW	1-ph. 180 ... 264 V: 0.25 ... 0.37 kW 3-ph. 320 ... 550 V: 0.55 ... 7.5 kW	1-ph. 230 V: 0.25 ... 0.5 kW DC 24 or 48 V: 0.14 ... 0.17 kW	1-ph. 180 ... 264 V: 0.25 ... 2.2 kW 3-ph. 320 ... 528 V: 0.37 ... 22 kW	1-ph. 180 ... 264 V: 0.25 ... 2.2 kW 3-ph. 320 ... 528 V: 0.37 ... 7.5 kW	
Approvals	CE, UL508C, cUL	CE, UL508C, cUL	CE	CE, UL508C, cUL	CE, UL508C, cUL	
Permissible supply forms	TT, TN	TN, TT		TN, TT	TN, TT	
Switching frequencies		2, 4, 8, 16 kHz	10 kHz	1 kHz to 16 kHz	1 kHz to 16 kHz	
Mechanical design						
Built-in unit				●	●	
Push-through technique						
Cold plate						
Installation backplane						
Motor mounting	●	●	●			
Wall mounting	●	●	●			
Degree of protection	IP65	IP65	IP54	IP20	IP20	
Operation in generator mode						
Integrated brake transistor		●	●			
External brake transistor						
Regenerative						
Motor control methods	Start-up ramp control					
V/f control		●		●	●	
Vector control (sensorless)		●			●	
Servo control			●			
Drive functionality						
Frequency control		●		●	●	
Torque control		●	●		●	
Speed control		●	●		●	
PID controller		●	●	●	●	
Motion control			●			
Programmability						
Parameter setting	●	●	●	●	●	
Function block programming						
IEC 61131-3						
I/O						
Analog input/output		1/1 or 2/2		1/1	2/1	
Digital input/output		5/1 or 7/3	1/1	4/1	4/2	
Relay output		1		1	1	
Speed feedback						
Encoder emulation output						
PTC and/or KTY	●	●	●			
IxT software, temp. model	●	●		●	●	
Fieldbuses						
CAN bus	○	○	○	□		
PROFIBUS	○	○	○			
INTERBUS	○	○				
Modbus				□	●	
LECOM	○	○		□	●	
AS Interface	□	○				
Device Net	○	○		□		
LON						
Ethernet TCP/IP						
ETHERNET Powerlink						
Safety functions						
Safe torque off						
Diagnostic support						
LEDs	●	●				
Integrated keypad				●	●	
External keypad	○	○		○	○	
PC interface	○	○	●		□	
Memory module				●	●	
PC tools	Global Drive Control	Global Drive Control	fluxx	Tech-Link	Tech-Link	

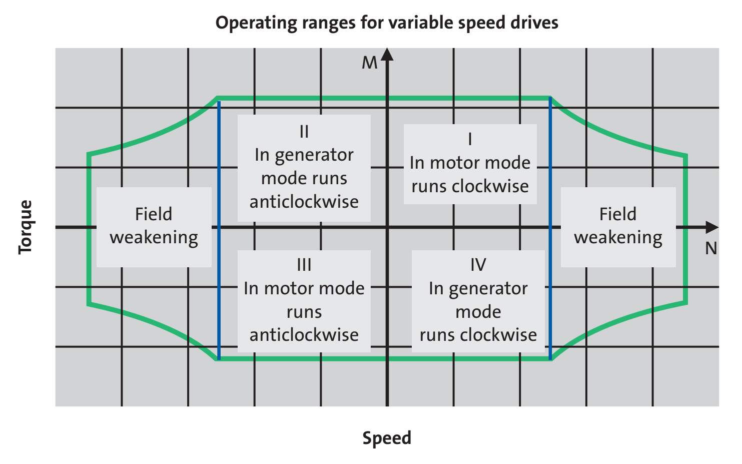
inverter			Servo inverter				
	8200 vector	9300 vector	930	ECS	9300 Servo	9400 Servo	94/940
							
	1-ph. 180 ... 264 V: 0.25 ... 2.2 kW 3-ph. 100 ... 264 V: 0.55 ... 7.5 kW 3-ph. 320 ... 550 V: 0.55 ... 90 kW	3-ph. 320 ... 528 V: 0.37 ... 90 kW 3-ph. 340 ... 456 V: 110 ... 400 kW 3-ph. 340 ... 577 V: 132 ... 500 kW	DC 24 ... 48 V: 0.6 kW	3-ph. 180 ... 528 V: 1.1 ... 13.8 kW	3-ph. 320 ... 528 V: 0.37 ... 75 kW 460 ... 740 V DC: 0.37 ... 75 kW	3-ph. 180 ... 550 V: 0.37 ... 30 kW 260 ... 775 V DC: 0.37 ... 30 kW	1-ph. 200 ... 240 V: 0.25 ... 2.2 kW 3-ph. 400 ... 480 V: 0.50 ... 2.2 kW
	CE, UL508C, cUL	CE, UL508C, cUL	CE	CE, UL508C, cUL	CE, UL508C, cUL	CE, UL508C, cUL	CE, UL508C, cUL
	TT, TN, (IT variant from 15 kW)	TT, TN, (IT variant up to 90 kW)		TT, TN, IT	TT, TN, IT	TT, TN, IT	TT, TN
	2, 4, 8, 16 kHz	1, 2, 4, 8, 16 kHz	10/20 kHz	4, 8 kHz	8, 16 kHz	1, 2, 4, 8, 16 kHz	8, 16 kHz
	● ● ● (up to 22 kW)	● ● (up to 90 kW) ● (up to 22 kW)	●	● ● ●	● ● ● (up to 22 kW)	● ●	●
	IP20	IP20	IP20	IP20	IP20	IP20	IP20
	● (up to 11 kW) ○ (from 15 kW)	 ○ ○	● ●	●	 ● ○	● ○	●
	● ●	● ● ●	 ●	 ●	 ●	● ● ●	 ●
	● ● ● ●	● ● ● ●	 ● ● ● ●	 ● ● ● ●	 ● ● ● ●	● ● ● ● ●	 ● ● ● (940)
	●	● ●	●	● ●	● ● ●	● ● ●	●
	1/1 or 2/2 5/1 or 7/3 1 (2 above 11 kW) ● ●	2/2 7/4 2 1 ●	2/2 6/2 2 1 ●	1/- 4/1 1 2 1 ● ●	2/2 6/4 3 1 ●	2/2 9/4 2 (3 ○) ○ ● ●	1/1 2/2 or 14/5 1 (2 ○) ● ●
	○ ○ ○ ○ ○ ○ ○	● ○ ○ ○ ○ ○	●	● (2) ○ ○ ○ ○ ○	● ○ ○ ○ ○ ○	● ○ ○ ○ ○	○ ○ (940)
	□ (from 3 kW)	□		●	□	○	
	● ○ ○ ○	● ○ ○ ●	● ●	● ○ ○ ●	● ○ ○ ●	● ○ ○ ● ●	 ● ● ●
	Global Drive Control	Global Drive Control	Small Drives Control	Global Drive Control, Drive PLC Developer Studio	Global Drive Control, Drive PLC Developer Studio	L-force Engineer	Motionview

Three-phase asynchronous motors
A three-phase asynchronous motor converts electrical energy into mechanical power and can also function as a generator at the same time. The rated speed of the motor is determined by the number of pole pairs. 4-pole motors are the most frequently used type (1500 rpm at 50 Hz), but 2 and 6-pole motors are also sometimes encountered.

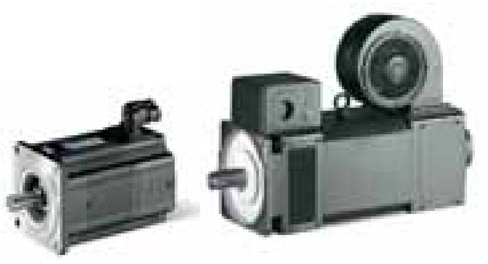
A magnetising current needs to start flowing when the motor is in the idle state so that a magnetic field can be generated. As soon as the motor goes on-load, the motor speed drops in relation to the no-load speed. A frequency inverter can be used to compensate for this phenomenon, which is termed slip, via its control function, e.g. vector control.

If the rated speed is exceeded, operation can continue but will be subject to reduced torque (field weakening range).

The basic dimensions of the motor, such as the shaft diameter, flange diameter and foot height, are standardised. Various built-on accessories (e.g. brake, encoder, blower) can be used to adapt the motor to suit the relevant drive task.



Servo motors
Servo motors differ from standard three-phase AC motors in that they offer optimum drive behaviour with high dynamic performance and accuracy. They are ideal for use in conjunction with servo inverters.



Two motor types are used:
- Synchronous servo motors with high-energy permanent magnets
- Asynchronous servo motors

Compared with asynchronous servo motors, synchronous servo motors achieve lower mass inertia at identical rated torque, are smaller in size and do not require magnetising current. This results in higher dynamic performance.

By contrast, asynchronous servo motors can be operated above rated speed with reduced torque in what is known as the field weakening range.

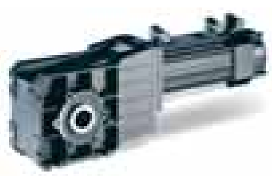
Overall, servo motors are characterised by their slimline design (with high power density), low inertia and high degree of efficiency. The shaft and flange diameters are fairly similar to those of standard asynchronous motors. Servo motors are generally equipped with an encoder or reolver (and frequently a brake, especially in the case of lifting applications.

Gearboxes and geared motors

Gearboxes function as speed and torque converters. The gearbox ration enables the motor speed and torque to be adapted in line with the operating point of the machine. When it comes to combining motors and gearboxes (geared motors), there are two basic designs:

- If mounting is based on the use of a coupling and bell housing, then IEC standard motors can be mounted. The coupling provides additional elasticity, which affects the drive characteristics.
- In the case of direct mounting, the motor and gearbox form an integrated unit. The motor is simultaneously an integral part of the first gearbox stage. This mounting option optimises the operating characteristics and construction volume.

The various gearbox ranges differ in terms of their design and output shaft configuration. This means that the right design will always be available for any application, regardless of whether you need an in-line or right-angle output shaft or even an offset hollow shaft in the case of a shaft-mounted helical gearbox. Planetary gearboxes offer the highest torque density.



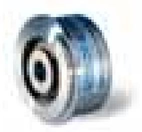
Enocders and resolvers

These ensure that the servo inverter control receives the actual values. The transmitters are installed inside the motors. The following types are used:

- Resolver
- Encoder
- Absolute value encoder

The type used will depend on the required level of accuracy and positioning range:

	Absolute positioning		
	No	**1 rev. (single-turn)**	**4096 rev. (multi-turn)**
Accuracy	**Asynchronous motor only**		
Medium 10 arcmin		Resolver	
High 2 arcmin	CDD50 IDT21 TTL signals	SRS50/60 sincos signals Hiperface	SRM50/60 sincos signals Hiperface
Very high 1 arcmin		ECN1313 sincos signals Endat	EQN1325 sincos signals Endat



Brakes

The brakes, which are an integral part of motors, keep the motor shaft fixed at standstill. If an inverter is used, the motor and inverter will take care of braking during operation in a wear-free manner. In this case, the brake will only perform an additional braking operation in emergency stop situations, e.g. when there is a mains failure. Two different designs are used:

- Spring-applied brakes generate braking torque by applying spring force to the armature plate and brake rotor.
- With backlash-free permanent magnetic brakes, braking torque is generated by the force of the permanent magnets on the armature plate.

Product information | motors and gearboxes

MDXMA and 13.750 asynchronous standard motors

- Optimised for use with inverters
- Large number of options allows applications to be solved flexibly and in optimum ways

SDSGA and 13.710 asynchronous motors with smooth housing

- Smooth surfaces
- Easy to clean
- Shines in the face of dirt

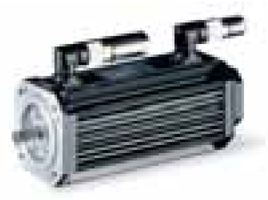
SDSGS synchronous servo motors

- Ideal for distributed applications
- Can optionally be combined with a servo controller to create an integrated drive
- Different variants for extra-low voltage 24 V/42 V DC applications
- Application-specific options

MCS synchronous servo motors

- High-energy magnets
- Innovative winding technology
- Superb dynamic performance and power density
- Robust structure
- Generously dimensioned bearings for long service life
- Encapsulated stator

MCA asynchronous servo motors



- Surface-ventilated
- Slimline design
- High power
- High power density and dynamic performance
- Extensive field weakening range

MDFQA asynchronous servo motors

- Through blown
- High power density and dynamic performance
- Power range up to 95 kW
- Extensive field weakening range

MDSLS servo spindle motor

- High axial force with compact dimensions
- High-energy magnets
- Integrated ball screw drive
- Strokes up to 170 mm

G-motion standard geared motors

- Helical gearbox GST
- Shaft-mounted helical gearbox GFL
- Helical-bevel gearbox GKS
- Helical-worm gearbox GSS
- Bevel gearbox GKR
- Wide torque range
- Various designs
- Finely stepped gear ratios
- Many of mounting options with different shaft and flange designs

GKK bevel gearbox

- The ideal companion in scenarios where a manual operation is required as an alternative to motor operation
- Disconnect clutch
- Typically: monorail overhead conveyors

GPA planetary gearbox

- Ideal for applications where a high degree of accuracy and dynamic performance is required
- compact design
- Minimal backlash
- High rigidity

Product range | Motors

			
	Asynchronous standard motor MDXMA 750	**Asynchronous motor with smooth housing SDSGA 710**	**Synchronous servo motor SDSGS**
	Asynchronous three-phase AC motor with options for inverter drives	Asynchronous three-phase AC motor with smooth housing, options for inverter drives	Synchronous servo motor, option available with built-on 931M servo drive
Degree of protection	IP54/IP55	IP54/IP55	IP54/IP55
Dynamic performance	Medium	Medium	High
Mass inertia	Medium	High	Low
Overload capacity	Medium	High	Very high
Power density	Medium	Medium	High
Field weakening	Medium	Extensive	Minimal
Detent torque (in relation to M_0)	n/a	n/a	
Torque ripple total at M_r (approx. guide values)	3.5% ... 4.5%		
No. of sizes	13	4	4
Power	30 W ... 45 kW	12 W ... 600 W	140 W ... 750 W
Speed	1400, 2500, 2800 rpm	1350, 2700 rpm	2000 ... 3000 rpm
Continuous torque	0.2 ... 290 Nm	0.09 ... 1.9 Nm	0.45 ... 2.2 Nm
Square dimension/diameter		Ø 65, 75, 85, 95 mm	Ø 65, 75, 85, 95 mm
Axis height	50, 56, 63, 71, 80, 90, 100, 112, 132, 160, 180, 200, 225 mm	33, 38, 43, 47 mm	33, 38, 43, 47 mm
Fan/brake	With axial blower (MDXMA only) or axial integral fan	No fan, spring-applied brake	No fan, spring-applied brake, permanent magnetic brake
Encoder	MDXMA series: Resolver, incremental encoder, SinCos encoder	SDSGA series: Resolver, incremental encoder	Resolver SinCos absolute encoder
Gearbox mounting	Direct mounting or standard mounting on **GST, GFL, GKS, GSS, GKR**, standard mounting on **SPL**, direct mounting on **SSN** (dependent on size)	Direct mounting or standard mounting on **GST, GKR**, standard mounting on **SPL**, direct mounting on **SSN** (dependent on size)	Direct mounting or standard mounting on **GST, GKR**, standard mounting on **SPL**, direct mounting on **SSN**
Motor-drive combination	**starttec, motec, smd, tmd, 8200, ECS, 9300, 9400**	**starttec, motec, smd, tmd, 8200, ECS, 9300, 9400**	**931M, 931E, 9300, 9400**

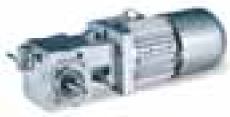
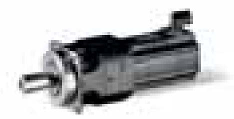



Synchronous servomotor MCS	**Asynchronous servo motor MCA**	**Asynchronous servo motor MDFQA**	**Servo spindle motor MDSLS**
Highly dynamic servo motor with high power density	Totally enclosed fan-cooled asynchronous servo motor	Through blown asynchronous servo motor, high power and high power density	Totally enclosed fan-cooled synchronous servo motor with integrated linear spindle
IP54/IP65	IP54/IP65	IP23	IP54
Very high	High	Very high	Very high
Very low	Low	Very low	Very low
Very high	Very high	Very high	Very high
Very high	High	Very high	High
Minimal	Extensive	Extensive	Minimal
<1%	n/a	n/a	<2%
2.5%	3.5% ... 4.5%	3.5% ... 4.5%	3.5% ... 4.5%
5	6	4	2
250 W ... 10 kW	1 kW ... 20 kW	10 kW ... 95 kW	Stroke 160/170 mm
1300 ... 6000 rpm	1600 ... 4100 rpm	500 ... 3000 rpm	Speed 250 mm/s
0.6 ... 65 Nm	2 ... 75 Nm	75 ... 480 Nm	Force 1.9 ... 15 kN
☐ 6, 9, 12, 14, 19 cm	☐ 10, 13, 14, 17, 19, 21 cm	☐ 20, 22, 26, 32 cm	☐ 10, 13 cm
31, 45, 58, 71, 96 mm	56, 71, 80, 90, 100, 112 mm	100, 112, 132, 160 mm	56, 71 mm
No fan, permanent magnet brake	No fan, with axial blower, permanent magnetic brake	Radial blower, spring-applied brake	No fan, spring-applied brake
Resolver, SinCos encoder, SinCos absolute encoder	Resolver, incremental encoder, SinCos encoder, SinCos absolute encoder,	Resolver, incremental encoder, SinCos encoder, SinCos absolute encoder	Resolver
Direct mounting or standard mounting on **GST, GFL, GKS, GSS, GKR**, standard mounting on **GPA**	Direct mounting or standard mounting on **GST, GFL, GKS, GSS, GKR**, standard mounting on **GPA**	Standard mounting on **GST, GFL, GKS, GSS**	Not applicable
ECS, 9300, 9400, 94/940	**ECS, 9300, 9400**	**ECS, 9300, 9400**	**ECS, 9300, 9400**

Product range | gearboxes

	Helical gearbox **GST**	**Shaft-mounted helical gearbox** **GFL**	**Helical-bevel gearbox** **GKS**	**Helical-worm gearbox** **GSS**
	Single-stage or two-stage helical gearbox (three-stage with pre-stage), coaxial design	Two-stage helical gearbox (three-stage with pre-stage), flat design	Three-stage right-angle gearbox with helical and bevel stage (four-stage, with pre-stage)	Two-stage right-angle gearbox with helical and worm stage (three-stage, with pre-stage),
Torque density	Medium	Medium	Medium	Medium
Efficiency	High	High	High	Medium
Backlash	Low	Low	Low	Medium
No. of sizes	8	7	7	4
Power	0.06 ... 45 kW	0.12 ... 45 kW	0.12 ... 45 kW	0.12 ... 9.2 kW
Rated torque	45 ... 5.920 Nm	190 ... 11.600 Nm	190 ... 11.790 Nm	180 ... 1.250 Nm
Ratio	1.6 ... 435	3.5 ... 856	5 ... 1.510	5.6 ... 1.847
Shaft	Solid shaft	Solid/hollow shaft	Solid/hollow shaft	Solid/hollow shaft
Design	Foot/flange	Foot/flange	Foot/flange	Foot/flange
Motor mounting	Direct mounting or standard mounting on **MDXMA, MCS, MCA, SDSGA, SDSGS,** standard mounting on **MDFQA, 710, 750**	Direct mounting or standard mounting on **MDXMA, MCS, MCA,** standard mounting on **MDFQA**	Direct mounting or standard mounting on **MDXMA, MCS, MCA,** standard mounting on **MDFQA**	Direct mounting or standard mounting on **MDXMA, MCS, MCA,** standard mounting on **MDFQA**

				
Bevel gearbox GKR	**Bevel gearbox GKK**	**Planetary gearbox GPA**	**Planetary gearbox SPL**	**Worm gearbox SSN**
Two-stage right-angle gearbox with helical and bevel stage	Bevel gearbox with integrated disconnect clutch	Planetary gearbox with coaxial input and output shaft	Planetary gearbox with coaxial input and output shaft	Right-angle gearbox with worm stage
Medium	Medium	Very high	High	High
High	High	High	Medium	Low
Low	Low	Very low	Low	Medium
4	4	6	5	3
0.06 ... 7.5 kW	0.12 ... 5.5 kW	0.25 ... 9.5 kW	0.025 ... 0.750 kW	0.025 ... 0.240 kW
45 ... 450 Nm	70 ... 900 Nm	19 ... 1000 Nm	3 ... 120 Nm	7 ... 36 Nm
3.4 ... 76	7.7 ... 86.8	3 ... 100	3.7 ... 168	5 ... 80
Solid/hollow shaft	Solid shaft	Solid shaft	Solid shaft	Solid/hollow shaft
Foot/flange	Foot/flange	Flange	Flange	Foot/flange
Direct mounting or standard mounting on **MDXMA, MCS, MCA, SDSGA, SDSGS**, standard mounting on **MDFQA, 710, 750**	Direct mounting on **MDXMA**	Standard mounting on **MCS, MCA**	Standard mounting on **SDSGA, SDSGS, 13.710, 13.750**	Direct mounting on **SDSGA, SDSGS, 13.710, 13.750**

Selection help | overall technical/commercial evaluation

Applications	Frequency and servo inverters										
	Frequency inverter			Servo inverter							
	startec motor starter	8200 vector motec	smd tmd	9300 vector	9400	9300		ECS	930 3)		94/940
						Servo Posi CAM	plc		Servo	Fluxx-torque	
Conveying and sorting	◑	●	●	●●	●●	●●	◑◑	●●	●●	●●	
Travelling drives	○	●	◑	●●	●●	●●	●●	●●	◑◑	◑◑	
Hoist drives		◑ 1)	○	●●	●●	●●	●●	●●	○○	○○	
Handling and robotics		○	○	◑	●●	●●	●●	●●	●●	●●	●●
Positioning drives		○	○		●●	●●	●●	●●	●●	●●	●●
Line drives and printing units		○	○	◑	●●	●●	●●	●●			
Winding drives		◑ 2)		◑	●●	◑◑	●●	◑	◑	◑	
Cross cutter and flying saw				○	●●	●●	●●	●●	●● 4)	○○	
Cam drives					●●	●●	●●	●●	●● 4)		
Shaper drives (extruders, presses)		●		●●	●●	●●	●●	○○			
Individual and machining drives	○	●	◑	●●	●●	●●	●●	○○	◑◑	◑◑	
Pumps, fans and compressors	○	●●	●	●●	○○	○○	○○		○○	○○	

1) In V/f operation, only possible/advisable up to a max. of 7.5 kW

2) Only for dancer controls, not torque controls
3) Up to a max. permanent power of 600 W
4) With ETC master control

Applications	In-line gearbox/ratios				
	Helical	Shaft-mounted helical	Planetary	Belt	
	GST	GFL	GPA SPL	GSL	positive-fit 7)
Conveying and sorting	●	●	◑◑	◑◑	●
Travelling drives	●	●	◑◑	●●	●
Hoist drives	●	●	◑◑	○○	●
Handling and robotics	◑	◑	●●	○○	●
Positioning drives	◑	◑	●●	○○	●
Line drives and printing units	●	●	●●	○○	●
Winding drives	●	●	●●	○○	●
Cross cutter and flying saw	●	◑	●●	○○	●
Cam drives	◑	◑	●●	○○	●
Shaper drives (extruders, presses)	●	●	◑◑	◑◑	◑
Single and machining drives	●	●	◑◑	◑◑	●
Pumps, fans and compressors	○	○			●

Relatively complex requirements
○ Suitable to an extent
◑ Suitable
● Very suitable

Complex requirements
○○ Suitable to an extent
◑◑ Suitable
●● Very suitable

7) e.g. toothed belt, chain
8) e.g. V-belt, flat belt

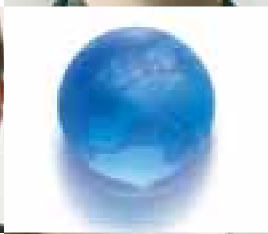
Applications	Motors							
	Asynchronous motors				Synchronous motors			
	Standard motor	Asynchronous servo			Synchronous servo			
	MDXMA	MCA	MDFQA	SDSGA 5)	MDSLS	MCS	MDXKS	SDSGS 5)
Conveying and sorting	●	◑◑	◑◑	◑◑		●●	◑◑	◑◑
Travelling drives	●	◑◑	●●	○○		○○	○○	○○
Hoist drives	●	●●	●●	○○		●●	◑◑	○○
Handling and robotics	○	●●	◑◑	●●	●●	●●	◑◑	●●
Positioning drives	●	●●	◑◑	●●	○○	●●	●●	●●
Line drives and printing units	●	●●	●●	○○		◑◑	◑◑	○○
Winding drives	●	●● 6)	●●	○○		◑◑	◑◑	○○
Cross cutter and flying saw	◑	●●	●●	○○		●●	●●	○○
Cam drives	◑	●●	●●	●●	○○	●●	●●	●●
Shaper drives (extruders, presses)	●	●●	●●	○○		◑◑	◑◑	○○
Single and machining drives	●	●●	●●	●●		◑◑	◑◑	●●
Pumps, fans and compressors	●	○○	○○	○○				○○

5) Up to a max.permanent power of 600 W
6) For torque controls with high setting ranges, we recommend using MCA

Gearbox							
			Right-angle gearbox				
			Helical-bevel	Helical-worm	Worm	Bevel	Bevel and clutch
non-positive-fit 8)	Chain	Direct drive	GKS	GSS	SSN	GKR	GKK
●	●	◑	●	●	●	●	◑
●	○	◑	●	◑	◑	●	◑
○	◑	●	●	●	◑	●	
		●	◑	○		◑	
		●	◑	○		◑	
○		◑	●	○		●	
			◑	○		●	
		●	●			●	
		●	◑	○		◑	
●			●	◑		●	
●	○	◑	●	●	◑	●	
●		◑	○		○	○	

It’s good to know | why we are there for you

“Our customers come first. Customer satisfaction is what motivates us. By thinking in terms of how we can add value for our customers we can increase productivity through reliability.”



“The world is our marketplace. We develop and manufacture internationally. Wherever you are in the world, we are nearby.”

“We will provide you with exactly what you need – perfectly co-ordinated products and solutions with the right functions for your machines and installations. That is what we mean by ‘quality’.”

“Take advantage of our wealth of expertise. For more than 50 years we have been gathering experience in various fields and implementing it consistently and rigorously in our products, motion functions and preprepared solutions for industry.”

“We identify with your targets and strive towards a long-term partnership which benefits both sides. Our competent support and consultation process means that we can provide you with tailor-made solutions. We are there for you and can offer assistance in all of the key processes.”

You can rely on our service. Expert advice is available 24 hours a day, 365 days a year, in more than 30 countries via our international helpline: 008000 24 Hours (008000 2446877).

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