**BECKHOFF** New Automation Technology

Drive Technology – Rethought.
XTS. eXtended Transport System.
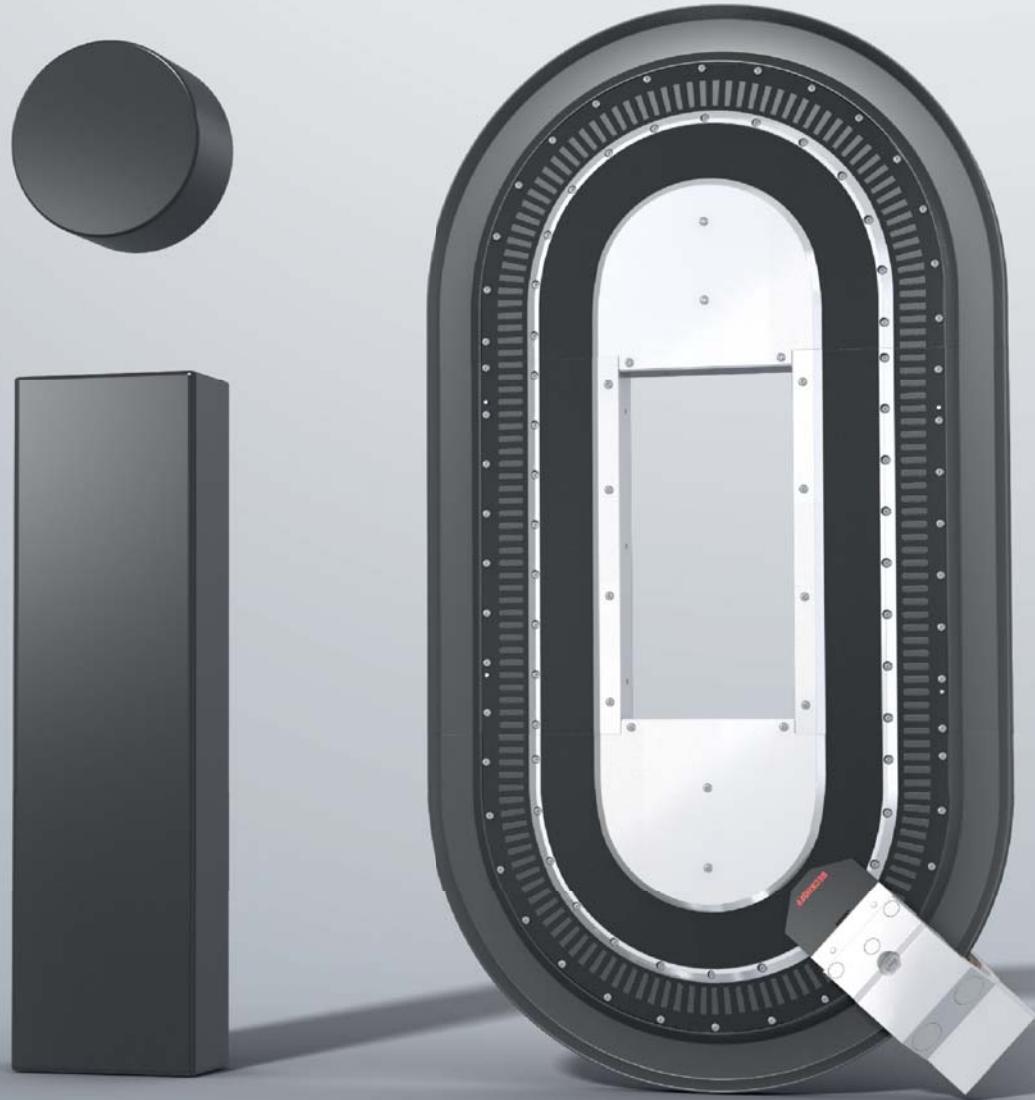
IPC

I/O

Motion

Automation

XTS: New freedoms for mechanical engineering

The Linear Transport System from Beckhoff.

Two proven drive principles – combined into a new one. With the XTS (eXtended Transport System) Linear Transport System, Beckhoff presents a Drive Technology that has not previously existed in this form – because it combines the advantages of two well-known drive principles in a single system. Where the possibilities to use rotary motors had previously ended, XTS adds the advantages of a linear system. And where the range of use of purely linear systems has been limited so far, XTS supplements the benefits of a rotary solution.

The result: a transport system with an almost arbitrary and highly flexible path configuration, in almost any desired length, wireless and controlled by a single PC via magnetic fields. From a technological point of view it is thus only an evolution of previous drive systems. Under aspects of use, however, it is a genuine revolution – and once again an exemplary piece of "New Automation Technology" from the pioneer of PC-based Control.

Only motor part, mover, software and IPC.
PC-based Control from Beckhoff follows a principle that is equally simple and efficient: the maximum application of information technology for the simplification of mechanical processes. With the XTS, Beckhoff has transferred this principle directly to the field of drive systems – and in this way has opened up new efficiency potentials in mechanical engineering, because the XTS makes do with four simple components.

- Firstly: an arbitrary number of motor parts, which serve as path modules.
- Secondly: an arbitrary number of movers, which act individually or in groups.
- Thirdly: control software.
- And fourthly: an Industrial PC.

Elaborate cabling? Nothing of the sort. Drag chain? Not necessary. Install a position measuring system? Already integrated.

Flexible usage. Arbitrary functional options.
There are virtually no limits to the possibilities of use of XTS: The movers can accelerate, brake, position and synchronise themselves. They can take up absolute positions and positions relative to each other; they can group themselves and accumulate; they can create clamping forces in motion, drive through curves and along straights, recover energy through regenerative braking and use both the return paths and the outward paths for transport purposes. And all of that with precise position control without oscillations, without backlash, without material fatigue, virtually without wear – and without cost-intensive maintenance.

▶ **www.beckhoff.com/XTS**

Rotatory drive

Linear technology

XTS
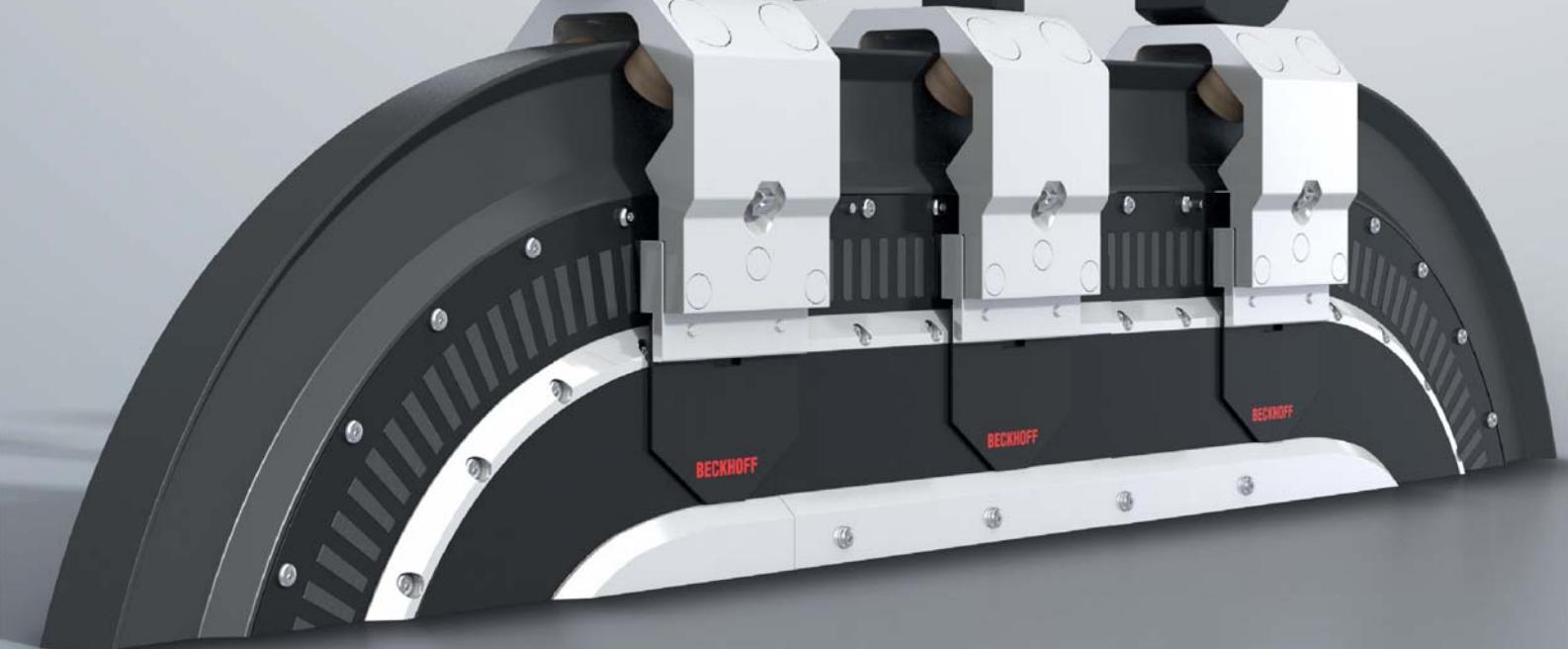
XTS, the linear motor that drives in a circle.

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XTS: Modular and flexible

XTS is a mechatronic system containing all functions necessary for operation. A modular, fully integrated linear motor with power electronics and displacement measurement in one device. A mover as the moved part. A mechanical guide rail. The most diverse applications can be realised with these few coordinated components. The desired geometries, lengths and radii are formed by the number and choice of the components.

EtherCAT

48 V, 24 V

Industrial PC

TwinCAT NC PTP
TwinCAT XTS

Mover

Straight
motor module
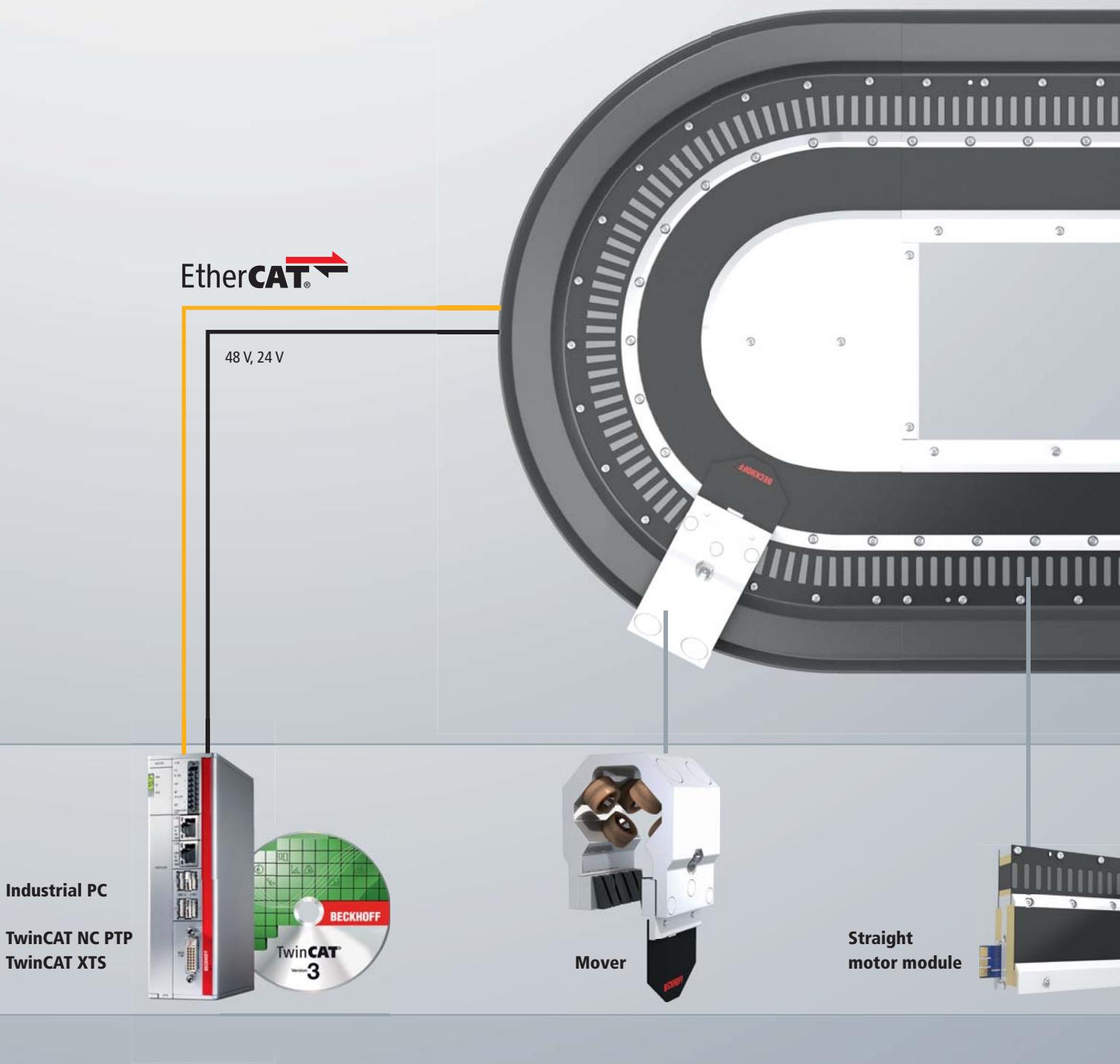
The XTS components:

- 2 curve sections
- 2 or more straight sections
- 1 or more movers
- Beckhoff IPC
- TwinCAT NC PTP
- TwinCAT XTS extension
- Power supply unit

➤ almost no control cabinet and no wiring necessarily

Guide rail

Curve motor module

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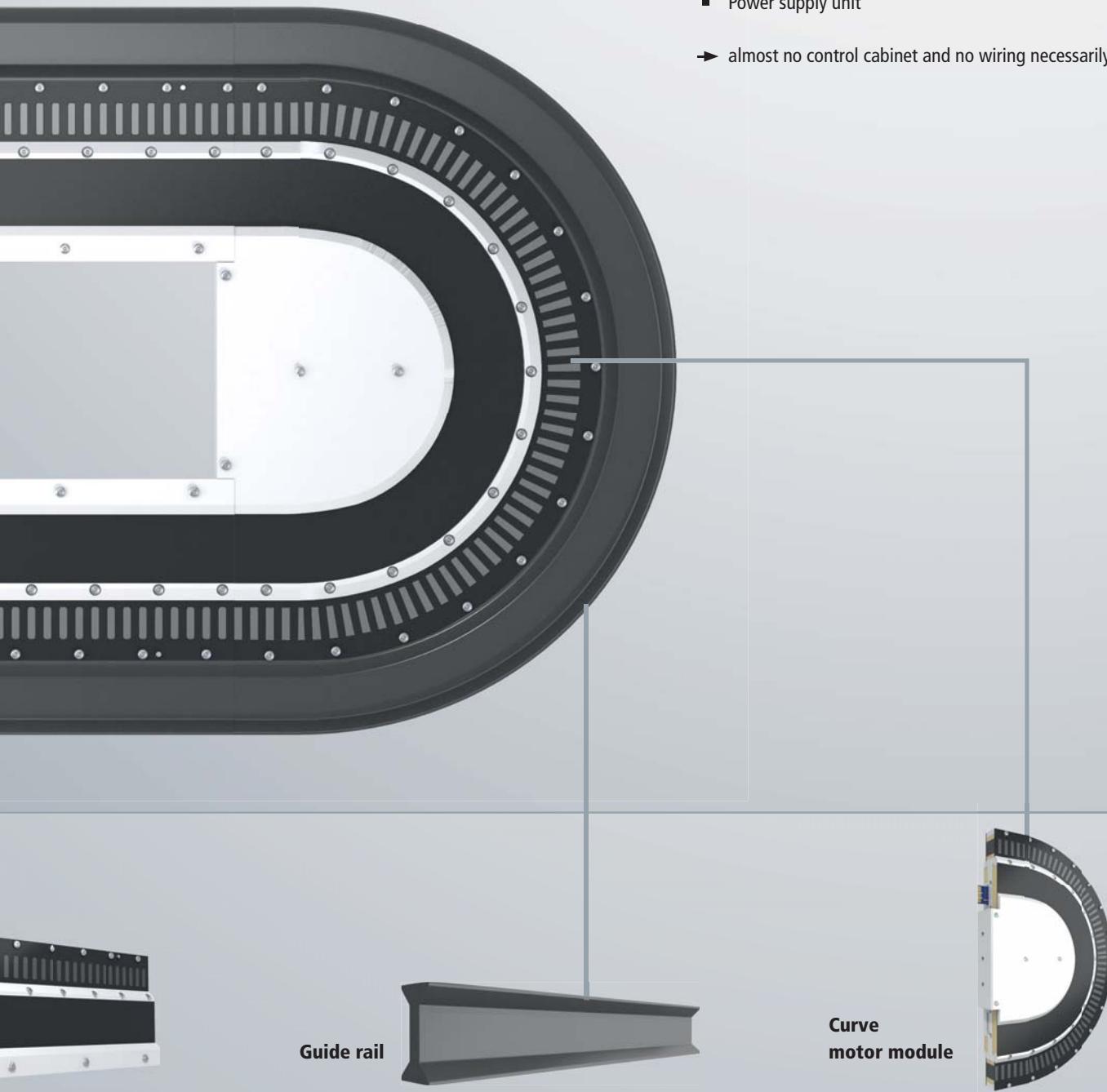
XTS: A transport principle that gives you an immediate advantage. Several times over.

1. Absolutely precise configuration.

XTS adapts itself precisely to your requirements: the arbitrary number of movers, the modular path guidance, the individual controllability of each individual mover and the simple integrability into existing machines and plants ensure a precisely matching solution with which you can further optimise the production efficiency of your machine.

2. Increased production speed.

Up to 4 m/s can be achieved with XTS – without jerking and with maximum positioning accuracy. Synchronisation, stopping and starting can be accomplished at any of the stations on the entire path. Added to this is a sensitive response; jerk-free acceleration profiles even allow the transport of open liquids. Even if stopping and restarting are necessary at workstations, the flow of product is retained.

3. Reduced installation volume.

A rethink in mechanical engineering: with XTS you can use the machine volume to the maximum, since the outward and return path as well as the curves can be used for the active material transport. In this way you save not only hardware, but also expensive production space. Power electronics, displacement measurement, primary motor part and the mounting surfaces are integrated in a single component, which makes compact and inexpensive machines possible.

4. Less wear, less maintenance.

The use of XTS leads to less mechanical wear, since only the mover needs mechanical bearings. Gears, belts, guide rollers and clamps are no longer necessary. Due to the high positioning accuracy, the compensation of inaccuracies as required in common transport solutions is unnecessary: there is no stretching of chains due to load and wear, re-tensioning of toothed belts or mechanical backlash during load changes. Apart from the payload, only the small mass of the mover is moved.

## 5. Fast, flexible format adaptation.

This advantage is of particular importance especially in the packaging industry: a change of format when changing products or, for example, when the filling quantity changes can be carried out without stopping production: modifications can be realised by changing the software parameters. Empirical values can be stored as a parameter set and can be retrieved at any time. The parameters can be exchanged between applications of the same type. In many cases mechanical adjustment can be omitted when commissioning.

6. High-power dynamics, but no unrestrained force.

The fast signal processing and the large bandwidth of EtherCAT, the fast real-time Ethernet bus, enable the best dynamic characteristics. Together with large peak forces, high acceleration is available to the application. Position lag monitoring avoids damage to the product in case of mechanical malfunctions. In addition, force limitation and jerk reduction allow the optimal handling of the product at all times at different points in the production. For example, the parameters can be adapted according to the fill level while moving.

7. Reduced volume, higher safety aspect.

Small masses lead to a low hazard potential. Unlike XTS, a conveyor chain is kept in motion by a central drive unit. Therefore the total force is as large as all the necessary individual forces along the entire length. This also means that the total force acts at any one particular place, if an error or mechanical malfunction occurs, or if somebody manually intervenes in the process. With XTS this risk can be significantly minimised and safety can be increased, since in most cases only the parameterised force of a mover acts. Hence, even in the case of a collision with an obstacle, only the mass of a mover with its payload acts.

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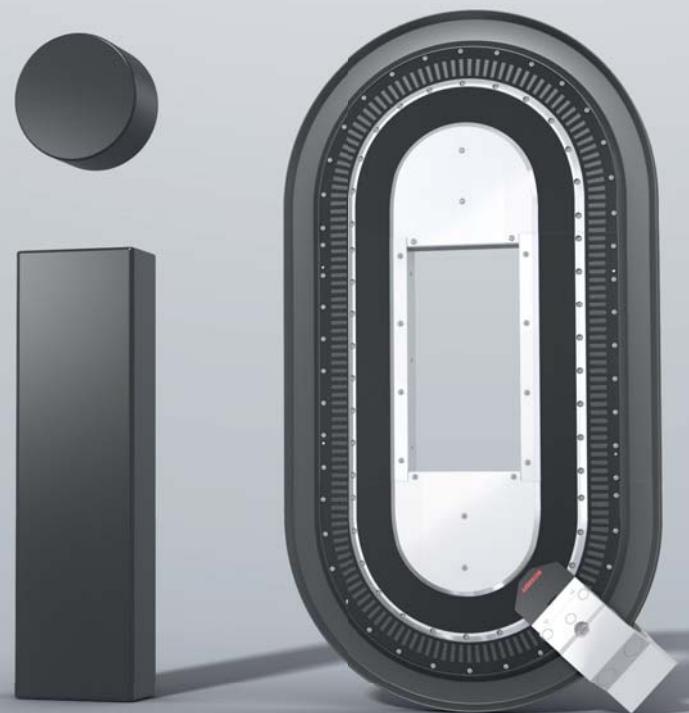
XTS: System components

Characteristics of the motor part:

The motor module contains the electromagnetic coils and all other active functions necessary for the operation of the system. Only a power supply and an EtherCAT connection are required. The motor module contains no moving parts and is not subject to any wear.

- fully integrated linear motor with power electronics and displacement measurement represent a mechatronic unit
- coil arrangement and mechanical structure make up a ready-to-use unit.
- Power electronics are optimised for the requirement and reduce assembly expenditure
- no parameterization expenditures
- displacement measurement is integrated, no additional installation, no calibration, tolerances are automatically compensated
- no control cabinet necessary
- double-action linear motor, hence low resulting forces on the mechanical bearing and compact total solution
- Connectable in series, straight segments and curves can be combined arbitrarily.

Straight motor module

Installation area guide rail

Motor, coil package

Power and EtherCAT are automatically through-connected

Installation area machine base

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We reserve the right to make technical changes.
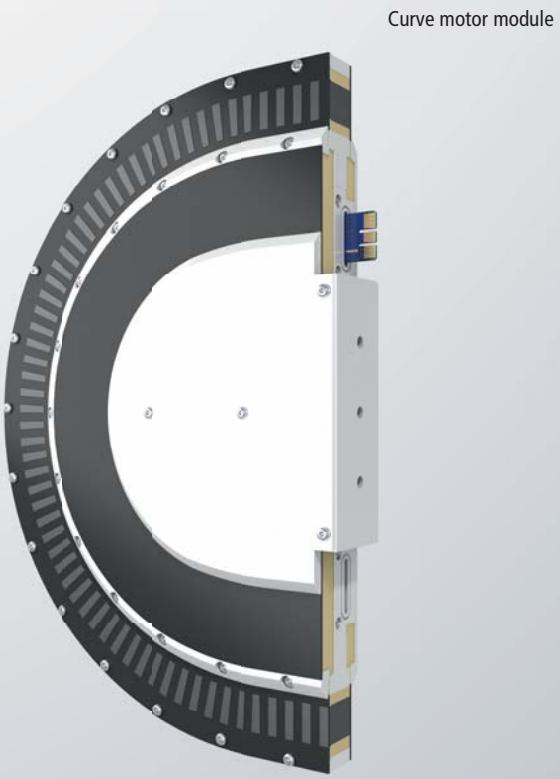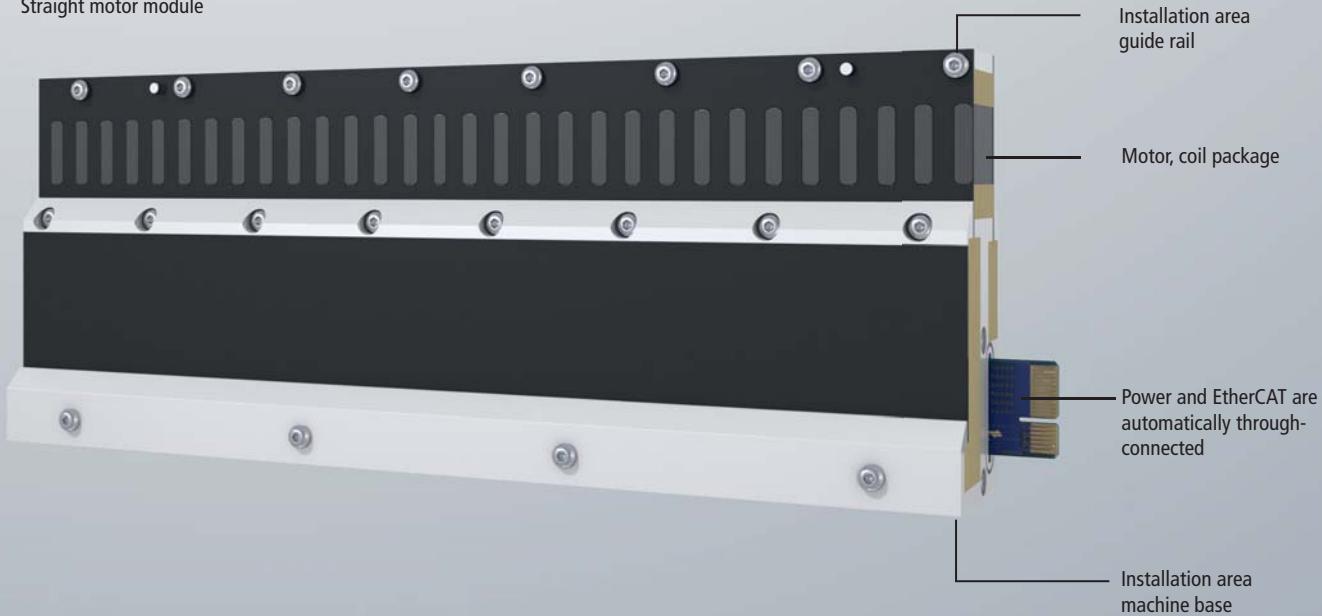
Guide rail system:

Movers and guide rail are optimally matched to each other. The geometry of the rail and the hard anodised aluminium of the surface in combination with the running surface of the mover rollers allow good running characteristics and low wear. Lubrication of the system is not necessary.

- optimised solution for immediate mounting on the motor module
- backlash-free due to low manufacturing tolerances and pre-tensioned rollers
- abrasion-resistant hard anodised aluminium
- free of abutting ends, lengths up to 6 m available
- high-precision mounting by means of fits
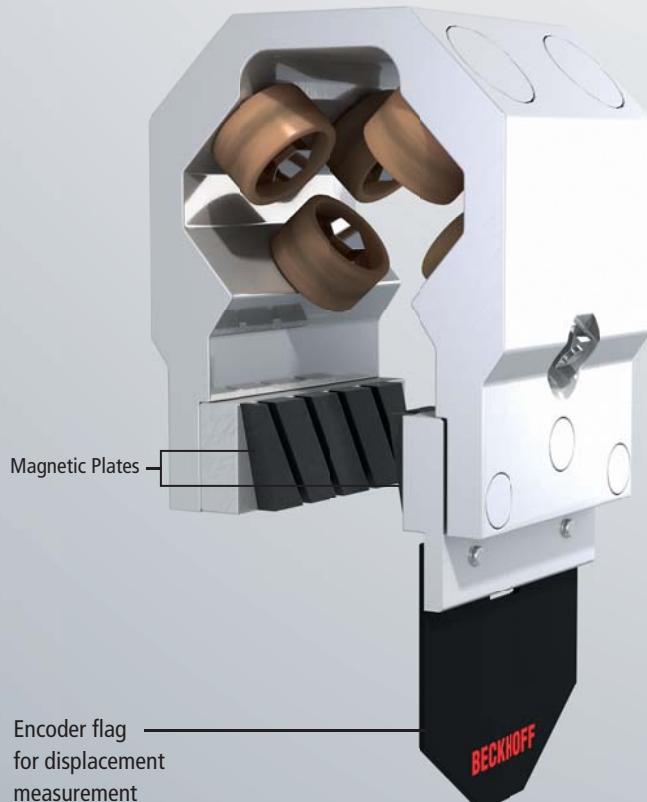
Characteristics of the mover:

The mover contains magnetic plates which, together with the coils in the motor modules, can generate propulsive forces. The mover absorbs the attractive forces of the magnets on both sides and compensates them as far as possible. This allows the rollers of the mover to run at high speed in the guide rail with low wear. The rollers are equipped with a particularly low-wear synthetic running surface. The tensioning of the rollers prevents backlash and is at the same time designed for low wear. Consequently, the lifetime of the rollers depends on the payload. A mechanically robust encoder flag conveys the mover position to the motor module.

- no sliding contacts or cables to the moved part, purely passive mover
- 2 magnetic plates generate the controlled propulsive force via the motor module.
- The attractive forces largely neutralise each other in relation to the guide mechanism.
- low friction losses
- light mover (< 350 g)
- A light encoder flag generates the position signal.
- short mover length allows product spacing of as little as 50 mm
- geometry allows driving through curves with full dynamics
- no development of heat on and in the mover

Magnetic Plates

Encoder flag
for displacement
measurement
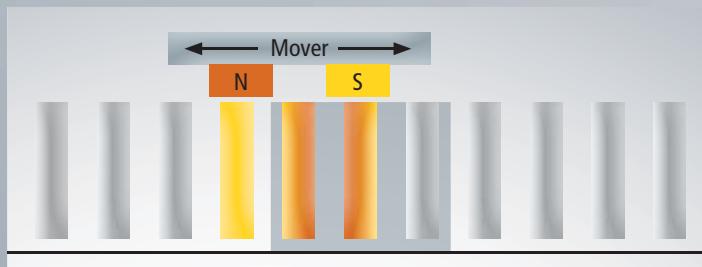
A travelling field is created by supplying the coils individually with current. This magnetic travelling field takes the permanent magnets of the movers along with it. The controlled current intensity through the coils adapts itself to the force requirement of the mover.

Mover

N   S

XTS: Basic functions

The XTS system enables a new class of functions that can be used at the same time in several places. Completely new, particularly flexible: transport and positioning tasks are economically solvable with little effort.

Free mobility of a mover
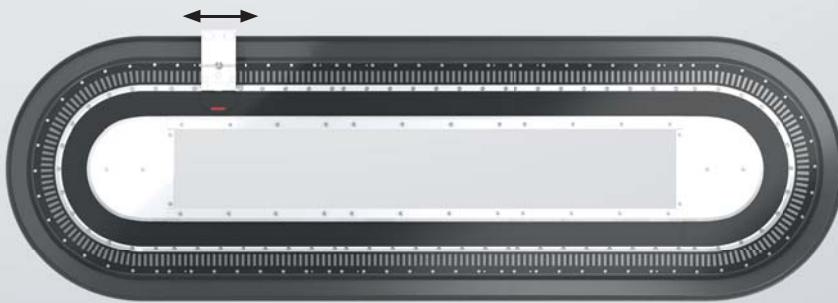
A mover can be moved freely over the entire path. It can brake, accelerate, position or exert a constant force at a standstill or also when in motion. Like every linear motor, the mover can synchronise itself to other movements, but without cables on the moving carriage, thus offering the maximum possible flexibility. When arranged in a circle the movers can drive endlessly and follow the flow of product. They do not have to be moved backwards against the flow.

Free mobility of several movers
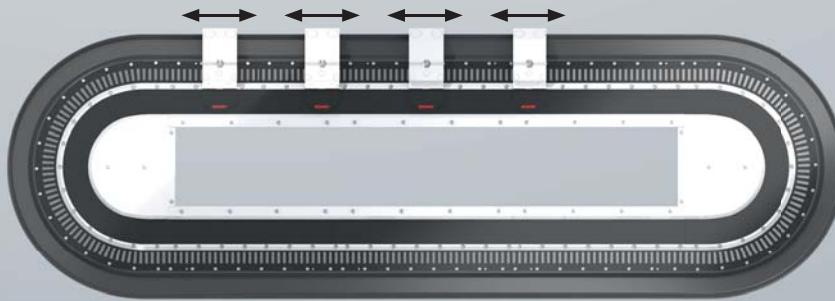


The movers can all be moved independently of one another. They can be positioned at absolute positions along the entire travel distance. In addition, they can be moved relatively to each other and always avoid a collision with their neighbour. They can automatically accumulate themselves, thus representing a moved buffer from which a moved destination can be driven to with very high dynamics.

Synchronous movement of a group
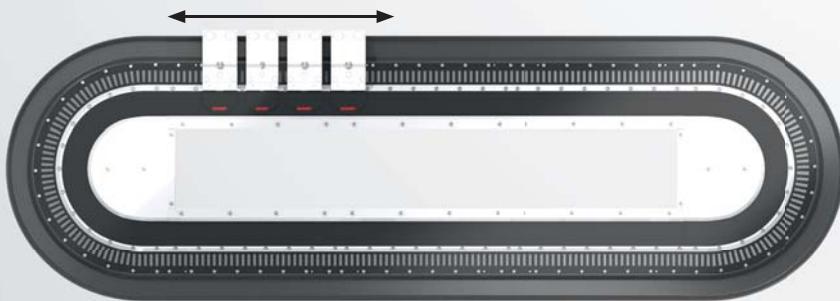
In the running movement groups can be formed that stop together or drive past processing stations with a specified speed profile. This formation is supported any desired number of times on the path. The size of the group (number and spacing) can be changed dynamically.

Constant force

F = constant
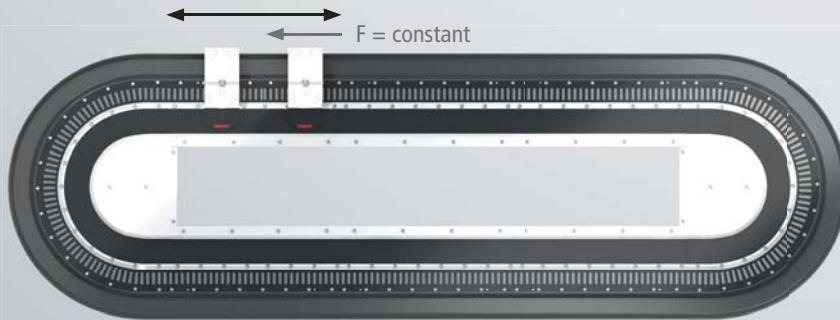
A mover follows another with a defined force. It can apply a "clamping force" while at the same time following a movement, for example in order to hold a product. For other applications the force can be limited so as not to place an unnecessary load on a product under any conditions. The acceleration and centrifugal forces can additionally be limited, for example for the transport of liquids in open containers.

Unrestricted curve function

F = constant
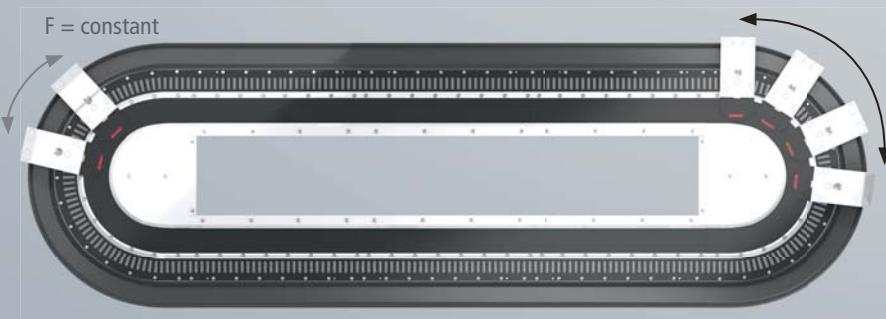
The total travel distance becomes the utilisable path. Outward and return path and also the curves are available for material transport and processing. This results in very compact application solutions that make completely new machine concepts possible.

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XTS: Basic functions

Arbitrary number of movers
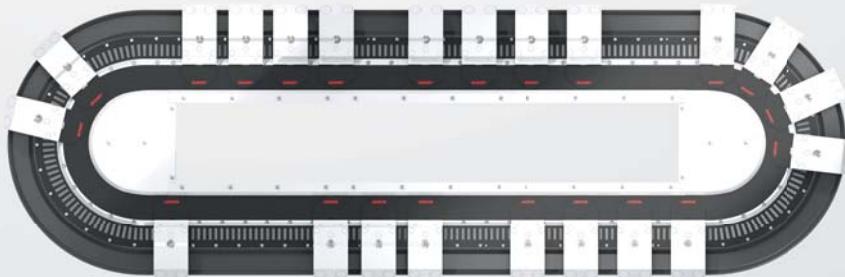
There are no system limits for the number of movers; consequently the number can be optimally adapted to the application. In practice the number is limited only by the available computing power of the PC.

Arbitrary system length

> 10 m
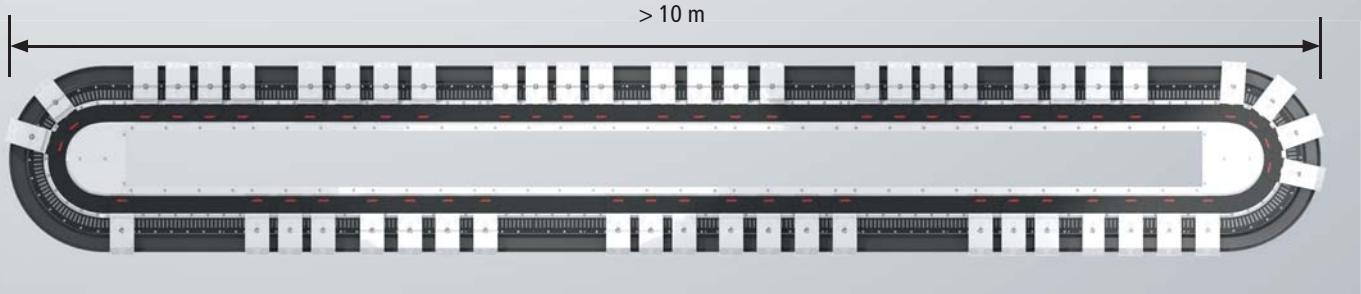
There are no length restrictions for the entire path.
10 m and more are technical possible.

XTS: Configuration

currently available

250 mm | 250 mm | 250 mm
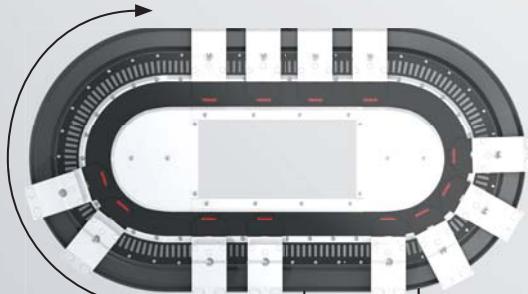
average length
approx. 500 mm
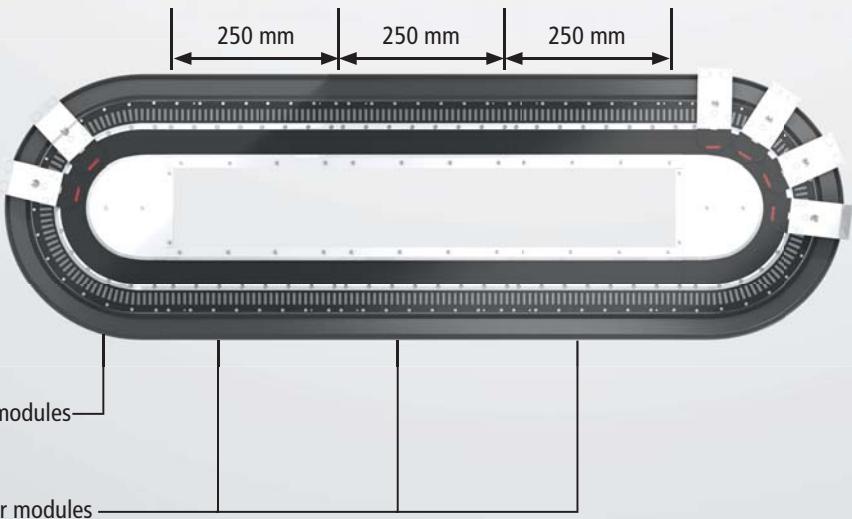
curve motor modules
180°

straight motor modules

In preparation.

Further curve motor modules:
average length approx. 250 mm

- 90°
- 45°
- 22,5°
- -90°
- -45°
- -22.5°
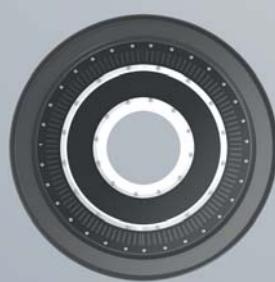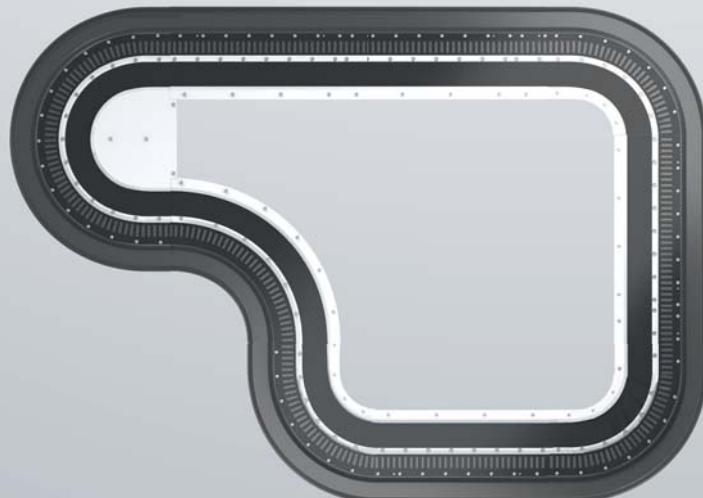
4 × 90° curves

All motor modules can be combined as desired.

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XTS: Areas of application

Flow of material in packaging and assembly technology:

High speed material transport:

- Controlled movement at all times and all places on the transport path. No jerks and no unnecessarily large forces; high positioning accuracy at up to 4 m/s. Even open liquids can be transported.
- Dynamic buffer. The transported material can be accumulated and grouped during the movement.
- Synchronisation, stopping and starting can be accomplished at any of the stations on the entire path.
- Maximum use of the machine volume. Outward and return path as well as the curves can actively transport material.
- The movers of the XTS system can always run with the flow of product. No return trip or return stroke is necessary. A change of format can be accomplished when changing product without stopping production, just by means of a software setting.

- Low mechanical wear since only the mover requires mechanical bearings. There is no need for: gears, belts, guide rollers and clamps.
- Reduced energy consumption due to lower friction and possible regenerative braking (the brake energy from one transported material can accelerate another)
- High positioning accuracy reduces the expenditure. The compensation of inaccuracies as required in common transport solutions is not necessary: stretching of chains due to load and wear, re-tensioning of toothed belts, mechanical backlash during a load change.

We reserve the right to make technical changes.
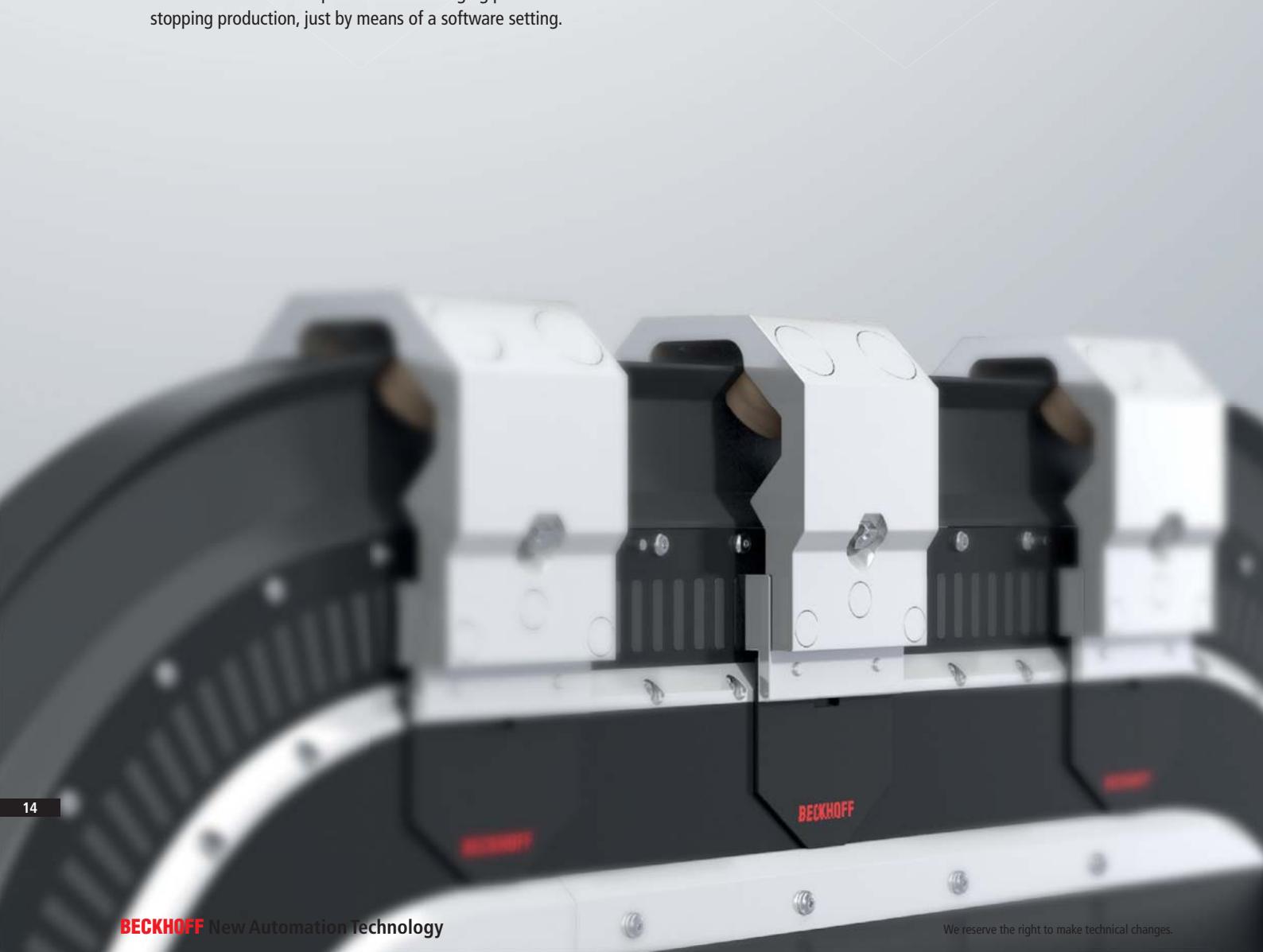
Further arrangement possibilities

The motor modules can be separated as desired, both electrically and in terms of control. This allows the travel distance to be interrupted and joined together during operation.

Example of a points function

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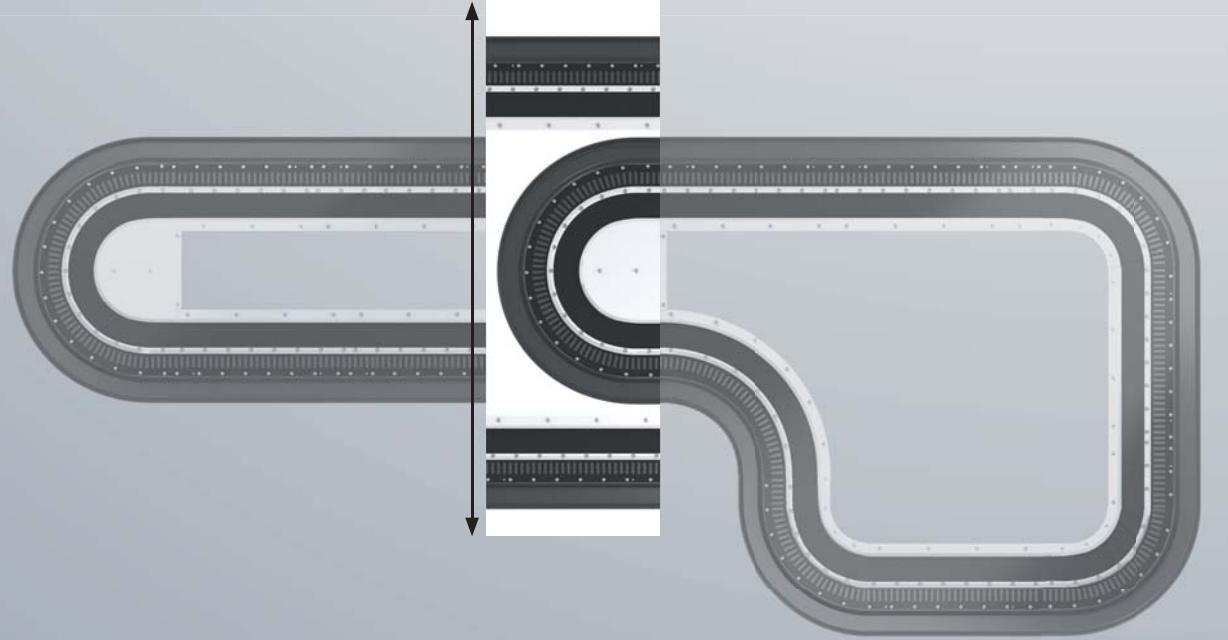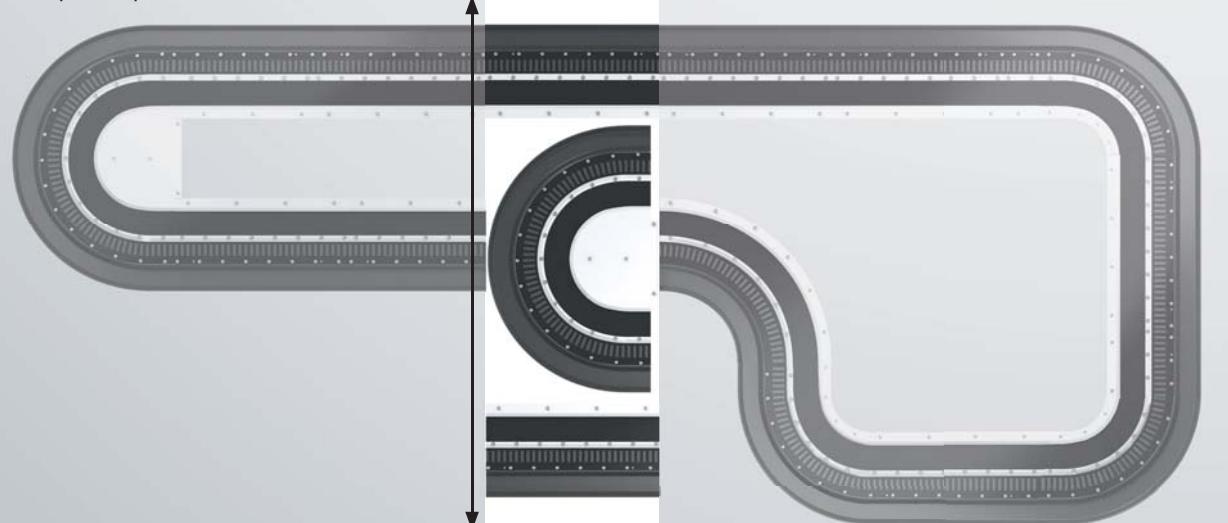
XTS: Areas of application

Push product, adapt product spacing, reduce or increase product speed

Clamp and move product
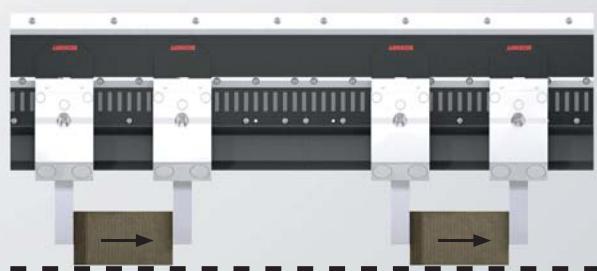
Actuator on the mover, electrical energy supply without cable

Feed module
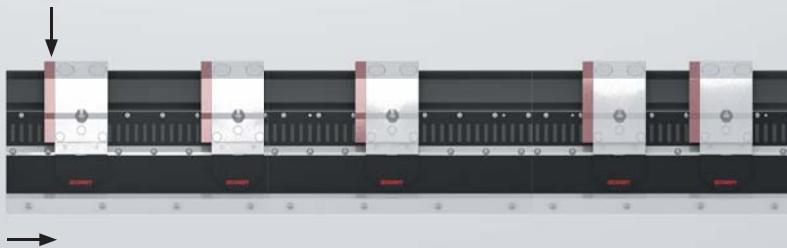
A feed module can be used to electromagnetically generate a supply voltage on the travelling mover. This energy can drive an attached actuator. Simple commands can be transmitted via the motor module. Extensive communication takes place by radio technology.

Transporting and discharging a product:
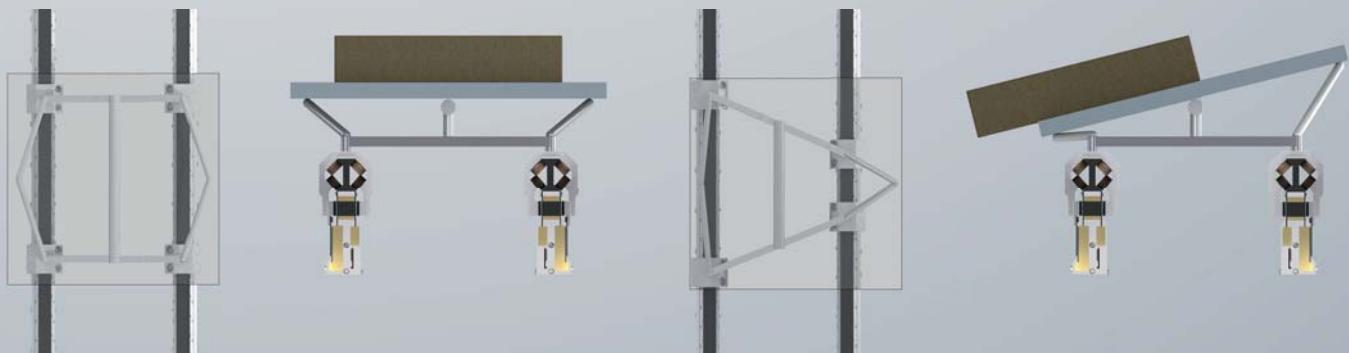
A package or a case is transported on a surface. The package is to be deposited at a station. The surface is tilted to the side and the package slips off. 4 movers on two paths move the tilting surface with the transported material. A change in the spacing of the movers with respect to each other generates a mechanical action that tilts the surface. The transported material can be prevented from slipping off when driving through curves by an inclined position and can be specifically deposited at another place while driving or after stopping.

Kinematics in the linear motion in order to manipulate a product: lifting, pressing…
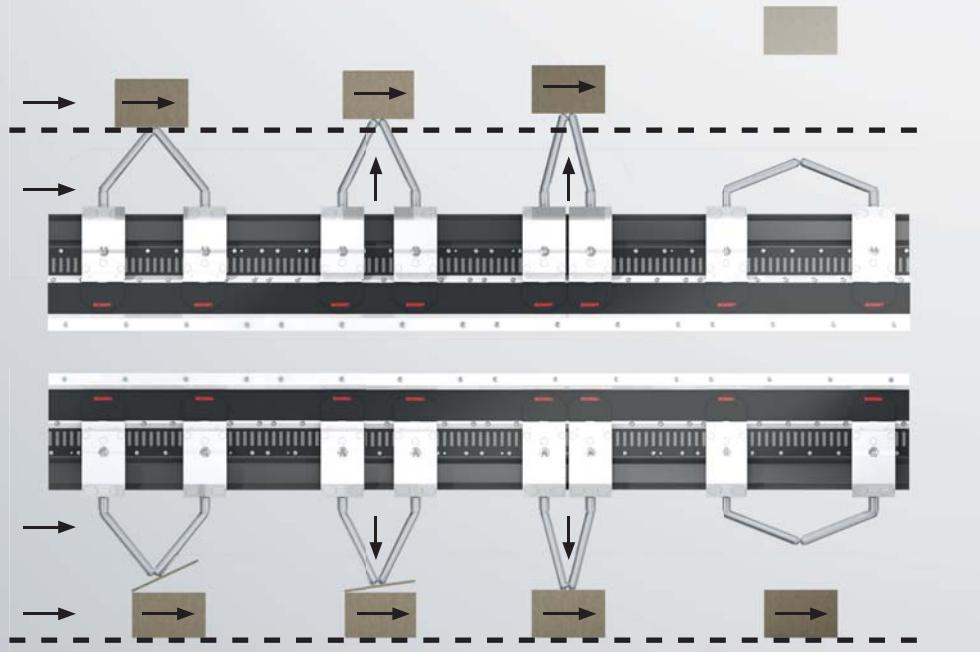
A mechanical action generated by the relative movement between two movers creates an additional movement that can manipulate a product. Transported materials can be pushed upwards or to the side. A product can be closed or processed in some other way while moving.

Kinematics in the linear motion in order to manipulate a product: turning, closing cap…

Gear rack
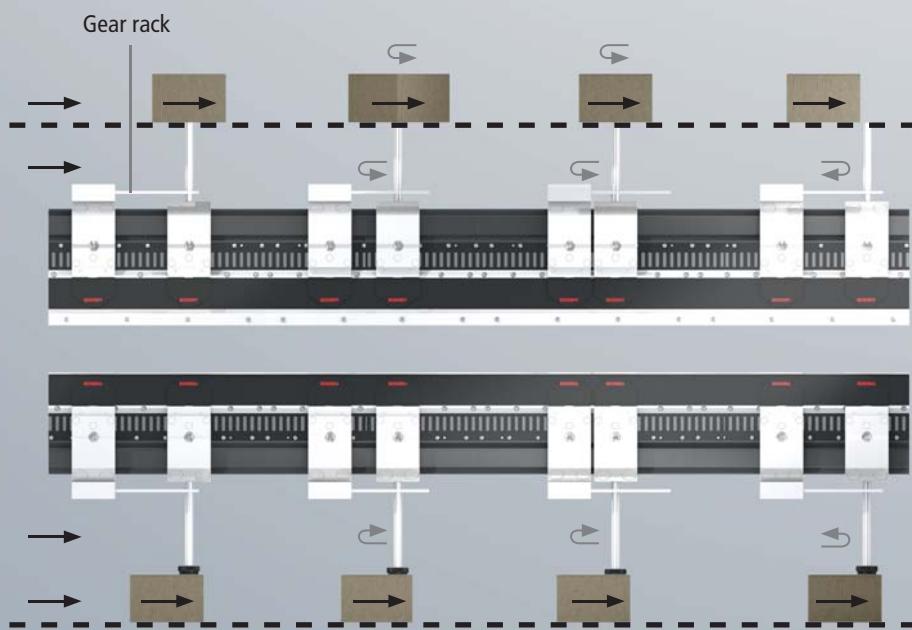
A rotary movement can be generated between two movers by a suitable mechanical action. This can screw a closure on, for example.

XTS: Technical details

System properties	
Max. force	100 N @ 3 m/s
Continuous force	30 N (at ~25 °C temperature increase in the motor)
Velocity	4 m/s @ 48 V supply
Acceleration	> 100 m/s² (without payload)
Positioning accuracy	< ±0.025 mm @ 1.5 m/s
Standstill repeatability	< 10 µm
Mover length in direction of movement	50 mm
Mover weight	approx. 350 g (complete mover without attachments)
Maximum system length	>> 10 m (dependent on computing power, no system limit)
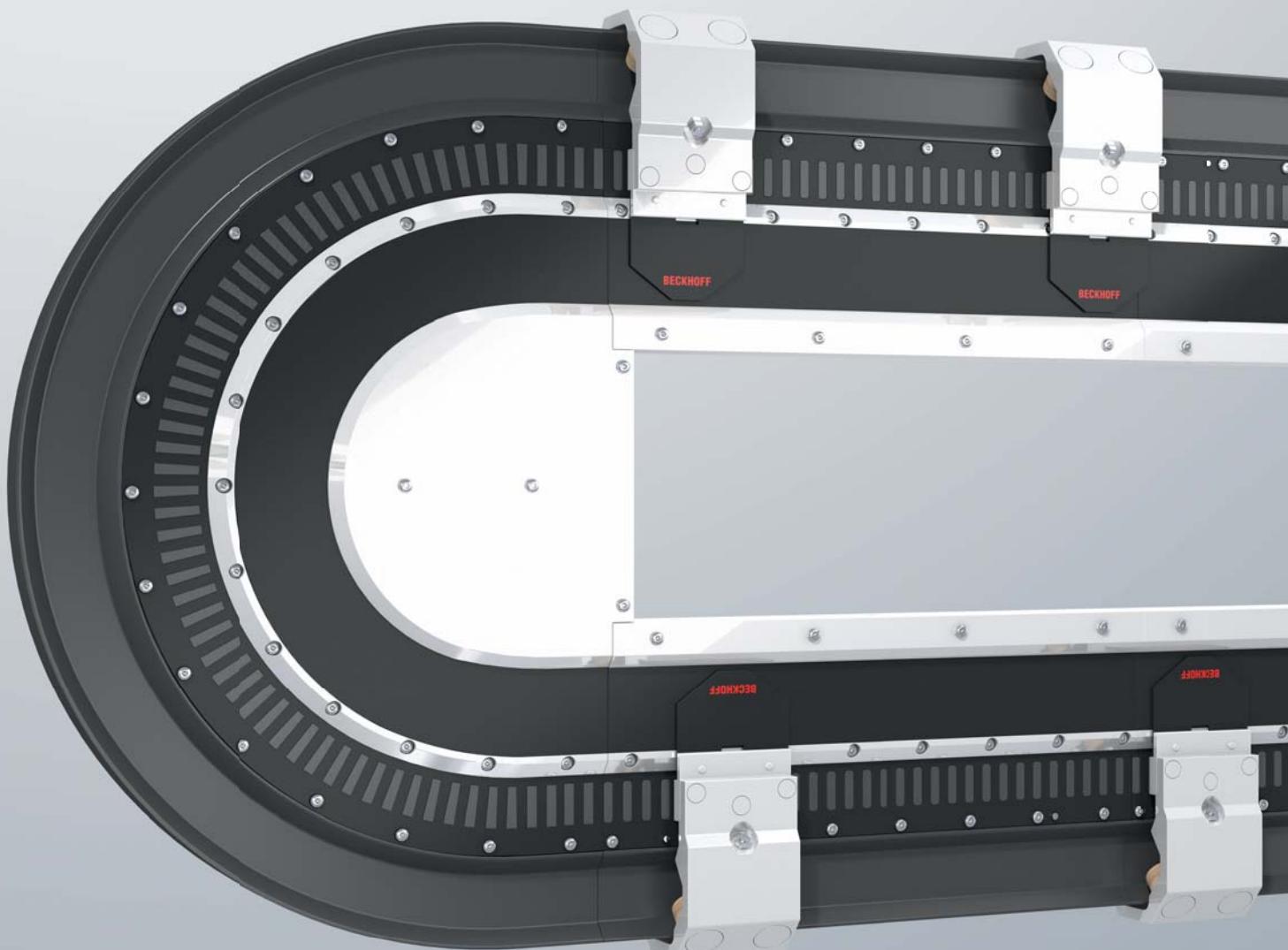
Electrical data	
Supply voltage	control voltage 24 V DC, power supply 50 V DC
Power consumption of motor modules	19 W/m (communication, electronics, position determination)
Length per feed	3 m (voltage supply, EtherCAT)
Power consumption per mover	approx. 12 W @ 4 m/s without payload
Electrical/mechanical efficiency at 30 N	η = 66 % to 90 % @ 1 m/s to 4 m/s

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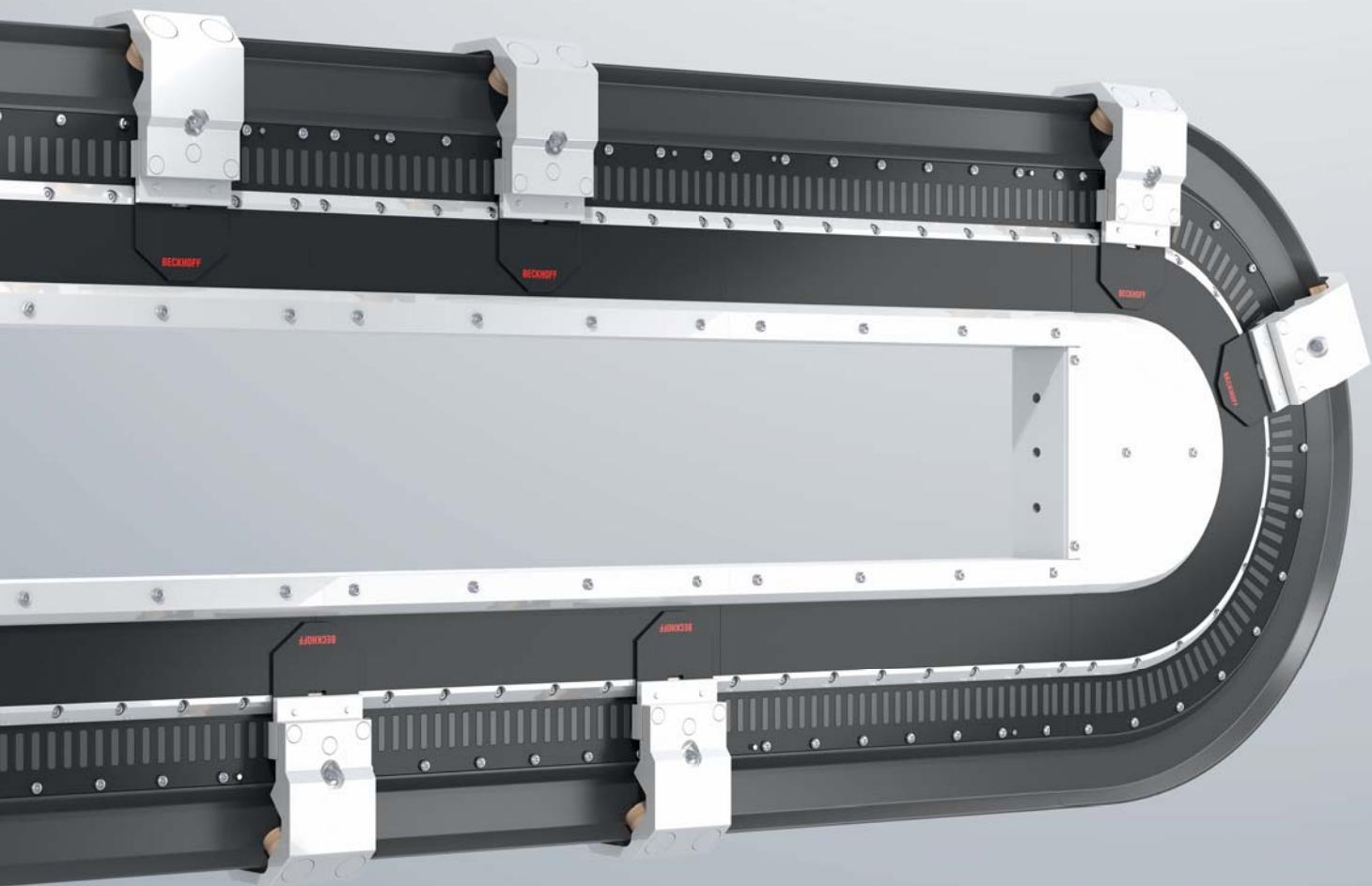
XTS motor module

Structure of the motor module

Curve motor module

In order to manufacture a path, the sections with IP 67 protection are bolted in front of one another on the machine frame.

250 mm

96 mm

38 mm

Supply – internal connection beyond modules is possible
- 24 V control voltage
- 50 V power supply
- EtherCAT

Mounting surface:
This surface enables mounting on the machine bed.
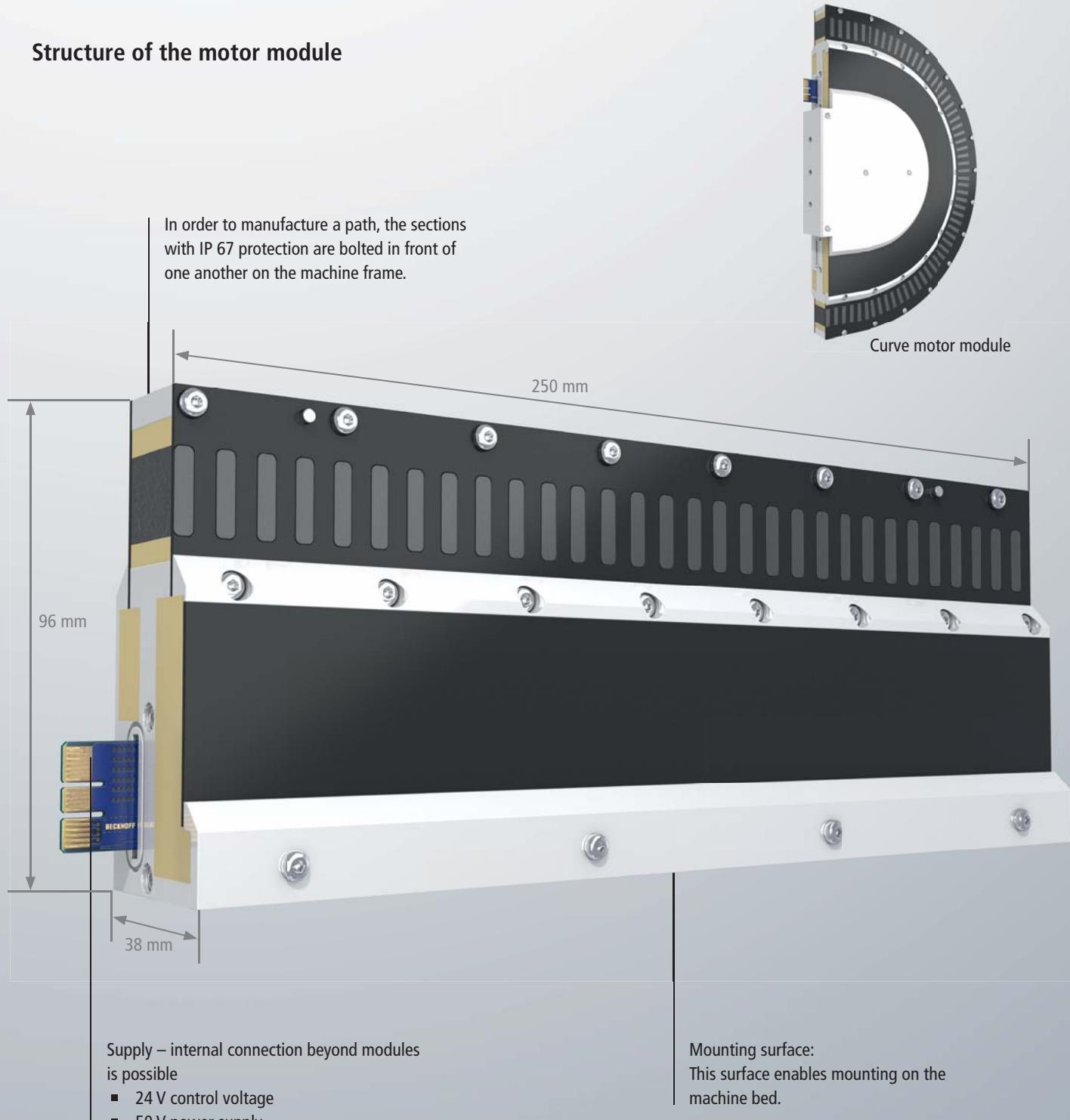
- The motor module, the power electronics and the displacement measurement are built into the profile
- There is an upper mechanical interface to the guide rail and a lower one to the support structure
- Double-air-gap motor:
  - attractive forces neutralise each other
  - lower force effect (wear) on the guide
  - friction losses are greatly reduced.

Output stages and coil package integrated

- No cables between coil and output stage
  - no wiring expenditure, exclusion of errors
  - minimum mounting space
  - output stage and coil are optimally matched to each other
- Supply voltage: 50 V DC, (low voltage, low safety expenditure)
- Current controller: 32.5 kHz (fast reaction time, good control behaviour)
- Independent supply of each individual coil with current is possible
  - arbitrary number of travelling fields/movers possible
  - adaptation to different mover sizes by software
- Temperature monitoring of the output stage
- Temperature model of the coils for optimum peak load use (PT model)
- low temperature rise due to good thermal coupling to the machine bed

XTS | Mechatronic motor components

| Ordering information	XTS motor modules
AT2000-0250	motor module, straight, 50 V/24 V, 250 mm x 38 mm x 96 mm (L x W x H), 2 kg
AT2001-0250	motor module with feed, straight, 50 V/24 V, 250 mm x 38 mm x 96 mm (L x W x H), 2 kg
AT2050-0500	motor module, 180° (clothoid, radius not constant), 50 V/24 V, 307 mm x 41 mm x 195 mm (L x W x H), 4 kg

Technical drawings see Internet:
▶ www.beckhoff.com/XTS

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XTS guide rail

Guide rail structure

The guide rail with the matching movers makes the XTS system a ready-to-use solution. However, the motor modules can also be used together with the magnetic plate sets as a custom solution without the XTS guide rail.

Aluminium profile rail with special hard anodised aluminium.

Mover with guide rollers
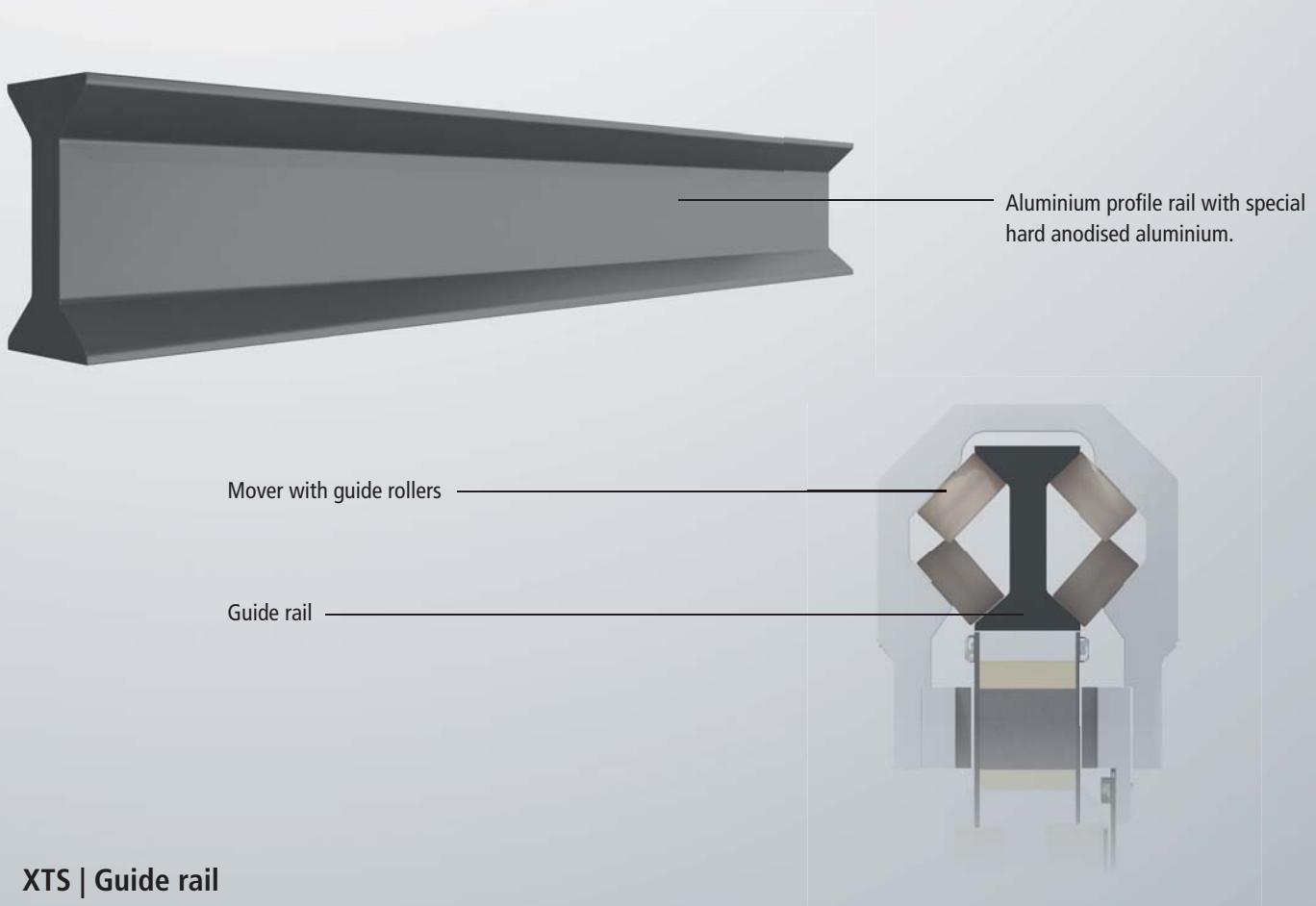
Guide rail

XTS | Guide rail

Ordering information	XTS guide rails available to suit the motor modules
AT9000-0250	guide rail, straight, 250 mm, suitable for 1 x AT2000-0250
AT9000-0500	guide rail, straight, 500 mm, suitable for 2 x AT2000-0250
AT9000-0750	guide rail, straight, 750 mm, suitable for 3 x AT2000-0250
AT9000-1000	guide rail, straight, 1000 mm, suitable for 4 x AT2000-0250
AT9000-1250	guide rail, straight, 1250 mm, suitable for 5 x AT2000-0250
AT9000-1500	guide rail, straight, 1500 mm, suitable for 6 x AT2000-0250
AT9000-xxxx	guide rail, straight, in steps of 250 mm in length, overall length up to 6 m
AT9050-0500	guide rail, 180° (clothoid), 390 mm x 22 mm x 233 mm (L x W x H), suitable for 1 x AT2050-0500

Technical drawings see Internet:
▶ **www.beckhoff.com/XTS**

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XTS mover

Mover structure

Retainer for
magnetic plate and
guide rollers

Magnetic plates

Encoder flag
for displacement
measurement
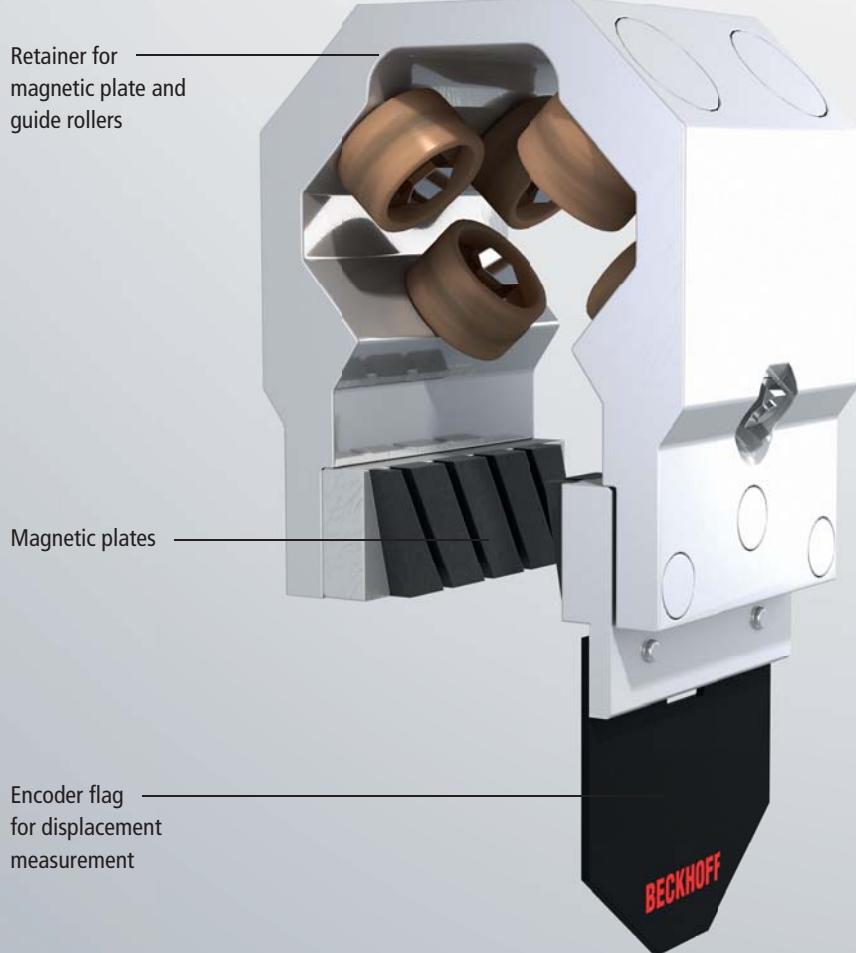
The mover is made of a light and solid aluminium alloy. Thanks to their arrangement the rollers allow backlash-free travel on the straights and in the curves. The coating of the rollers causes very little running noise and is particularly low-wear without lubrication of the guide rail. The attractive forces of the magnetic plates are largely balanced by the opposed arrangement, so that the rollers and the rail do not have to absorb the comparatively high attractive forces of the magnets.

The centre of the encoder flag supplies a position signal to the motor module. Movers can be distinguished from each other by the encoder flags. The encoder flag is made from a sturdy, lightweight glass-fibre reinforced material

XTS | Mover

Ordering information	XTS mover suitable for the guide rail system AT9000/AT9050
AT9011-0050-0550	mover, 6 rollers, length 50 mm with magnetic plate set AT9001-0550, 350 g, rollers: 6 x 19 mm, plastic coated; magnetic plates: 2 x 5-pin, neodymium
AT9011-0050-0350	mover, 6 rollers, length 50 mm with magnetic plate set AT9001-0350, 350 g, rollers: 6 x 19 mm, plastic coated; magnetic plates: 2 x 3-pin, neodymium

Technical drawings see Internet:
▶ www.beckhoff.com/XTS

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XTS displacement measurement

Displacement measurement integrated in the motor module

- non-contact measurement of the absolute mover position
- Positions are available immediately after switching on, no homing necessary.
- conversion time: 20 µs (fast reaction time, good control behaviour)
- multi-position measurement
  - the absolute positions of all movers that physically fit on a motor module are measured.
  - no position restrictions even at the module limits
- individual mover recognition
- repeatability 10 µm

We reserve the right to make technical changes.
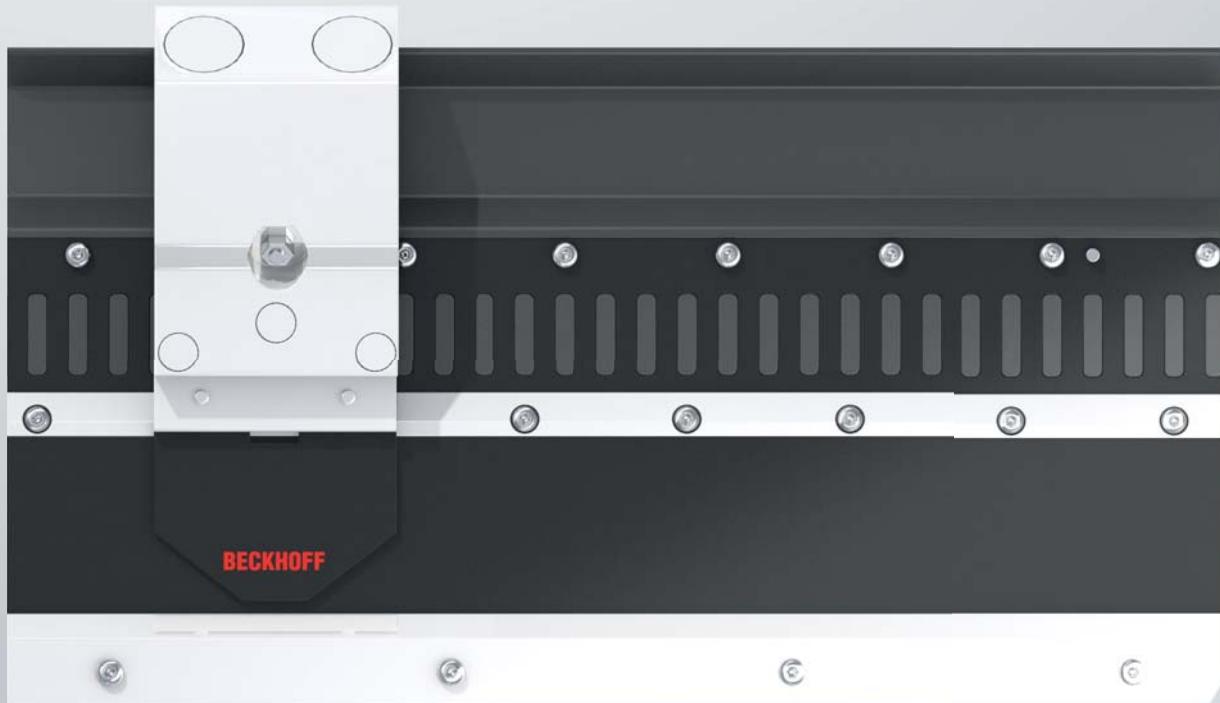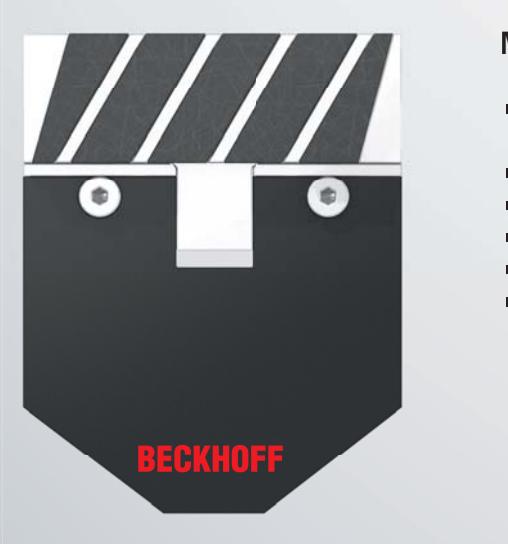
Mover component: encoder flag

- High positional accuracy, encoder flag and magnet bearer form a unit (absolute position formed from motor module to centre of encoder flag).
- Low installation volume due to composite linear motor and position detection
- No minimum distance with 50 mm mover length
- XTS recognises different encoder flags, which can be distinguished at any time on the path
- The module transitions provide a continuous position signal.
- The encoder flag can be recognised at any point on the path, even if it has not continuously followed the path. (if a mover was removed and inserted again by a lock or points)
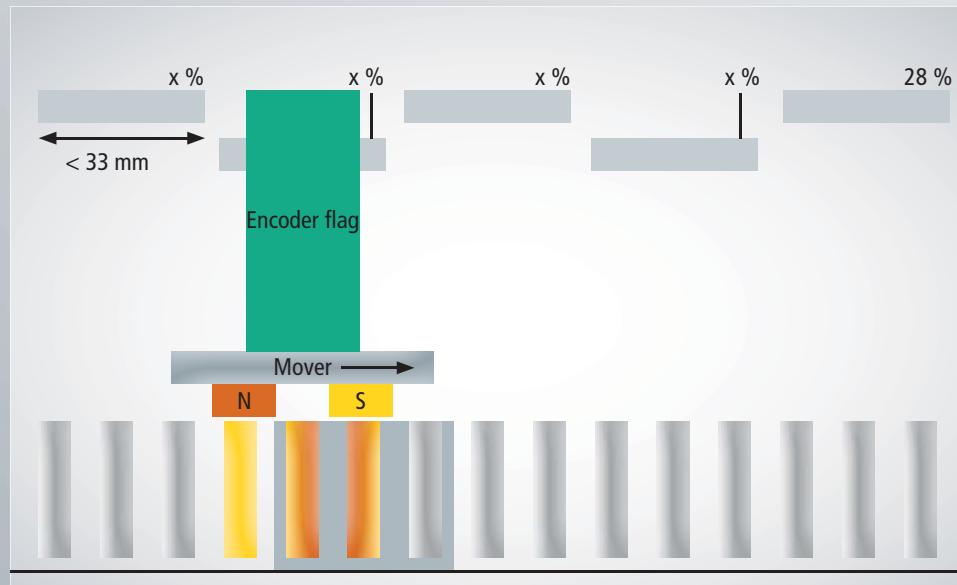
The absolute position of a metal plate/foil (encoder flag) can be detected without contact every 50 mm along the path.

Electronical potentiometer (without contact)

The magnetic plates can also be procured separately in order to be able to fit them to a self-developed mover. Technical boundary conditions and support on enquiry.

Ordering information	
AT9001-0550	magnetic plate set, 5-pin, 50 mm, encoder flag (individually orderable, components of mover AT9011-0050-0550)
AT9001-0350	magnetic plate set, 3-pin, 50 mm, encoder flag (individually orderable, components of mover AT9011-0050-0350)

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XTS: Software and programming

- Simple handling of the desired movements by mapping the mover as a "normal" servo axis in TwinCAT. All Motion Control functions such as flying saw, electrical gears and cam plate are usable.
- Function extensions in TwinCAT take care of typical XTS requirements: automatic accumulation, collision avoidance, jerk avoidance, centrifugal force limitation, etc.
- The integration of the XTS system into a production plant is easily possible thanks to support for different fieldbuses.
- Through realisation on a TwinCAT basis, the application-specific programming can be done in IEC 61131.
- All TwinCAT interfaces and functions simplify development and maintenance: remote access over Ethernet, setting of breakpoints, visualisation of arbitrary variables, etc.

We reserve the right to make technical changes.

System components: XTS software

PC platform

PLC ← TwinCAT Motion Control, PTP

1st axis | 2nd axis | mth axis

SoftDrive | SoftDrive | SoftDrive

Dynamic data distribution

EtherCAT master | Virtual connection

EtherCAT, XFC

Power output stages

Mover 1 | Mover 2 | Mover m
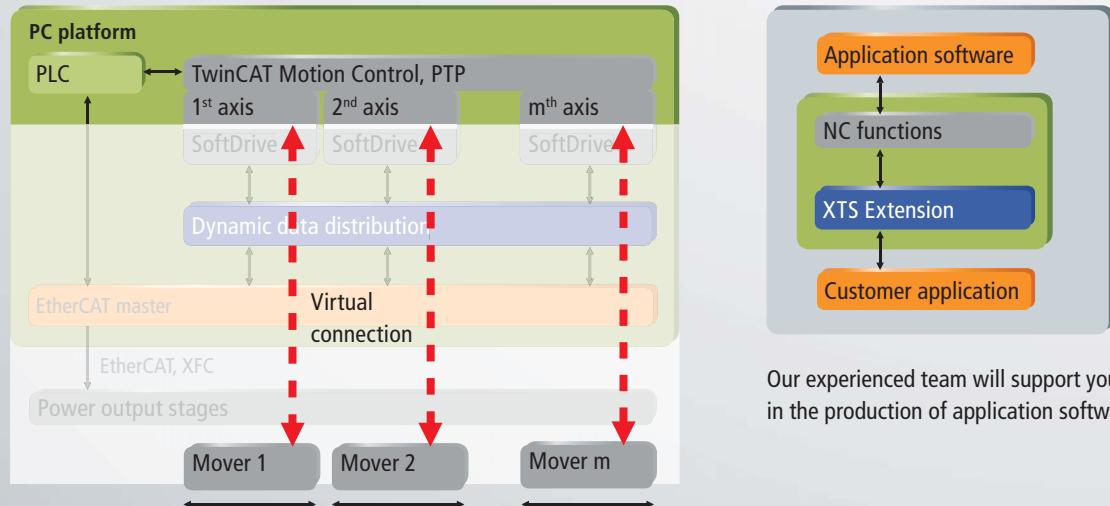
From the point of view of application programming, a mover looks like a "normal" servo axis.

Application software

NC functions

XTS Extension

Customer application

Our experienced team will support you in the production of application software.

Practise-proven TwinCAT automation software controls NC axes

By means of the XTS extension, servo algorithms are decoupled from the hardware and centrally calculated. Each output stage/coil is supplied with a current setpoint via EtherCAT.
- Each mover becomes a "servo axis".
- synchronisation (with external)
- accumulation
- drive on in jam

Ordering information	
TF5000-00pp	TwinCAT 3: TC NC PTP 10 Axes
TC5850-00xx	TwinCAT 3: TC3 XTS Extension

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XTS: Starter Kit

Components of XTS starter kit, small:

- 2-off straight modules
- 2-off 180° curve modules
- 5-off movers (with rollers, magnetic plates and encoder flag)
- guide rail, assembled
- stand and holder for all mechanical parts
- Industrial PC with all necessary interfaces and sufficient system performance
- TwinCAT NC PTP and XTS function package
- power supply units 24 V and 48 V/20 A
- 1 day instruction and programming support

Components of XTS starter kit, large:

- 4-off straight modules
- 2-off 180° curve modules
- 10-off movers (with rollers, magnetic plates and encoder flag)
- guide rail, assembled
- stand and holder for all mechanical parts
- Industrial PC with all necessary interfaces and sufficient system performance
- TwinCAT NC PTP and XTS function package
- power supply units 24 V and 48 V/20 A
- 1 day instruction and programming support

Operation requires: 230 V AC mains connection, DVI monitor and USB mouse and keyboard. Knowledge of TwinCAT and experience of programming with IEC 61131 are necessary for your own applications.
A one-day instruction course by an experienced application engineer shows by example how the system can be adapted to your own applications.

Ordering information	
AT2000-0500	starter kit, 500 mm, straight length, 5 movers
AT2000-1000	starter kit, 1000 mm, straight length, 10 movers

TwinCAT NC PTP +
XTS Extension

IPC

EtherCAT

24 V

Power supply

48 V, 24 V

Beckhoff worldwide

Million €

Turnover development

Chart values (right axis peak): **465**
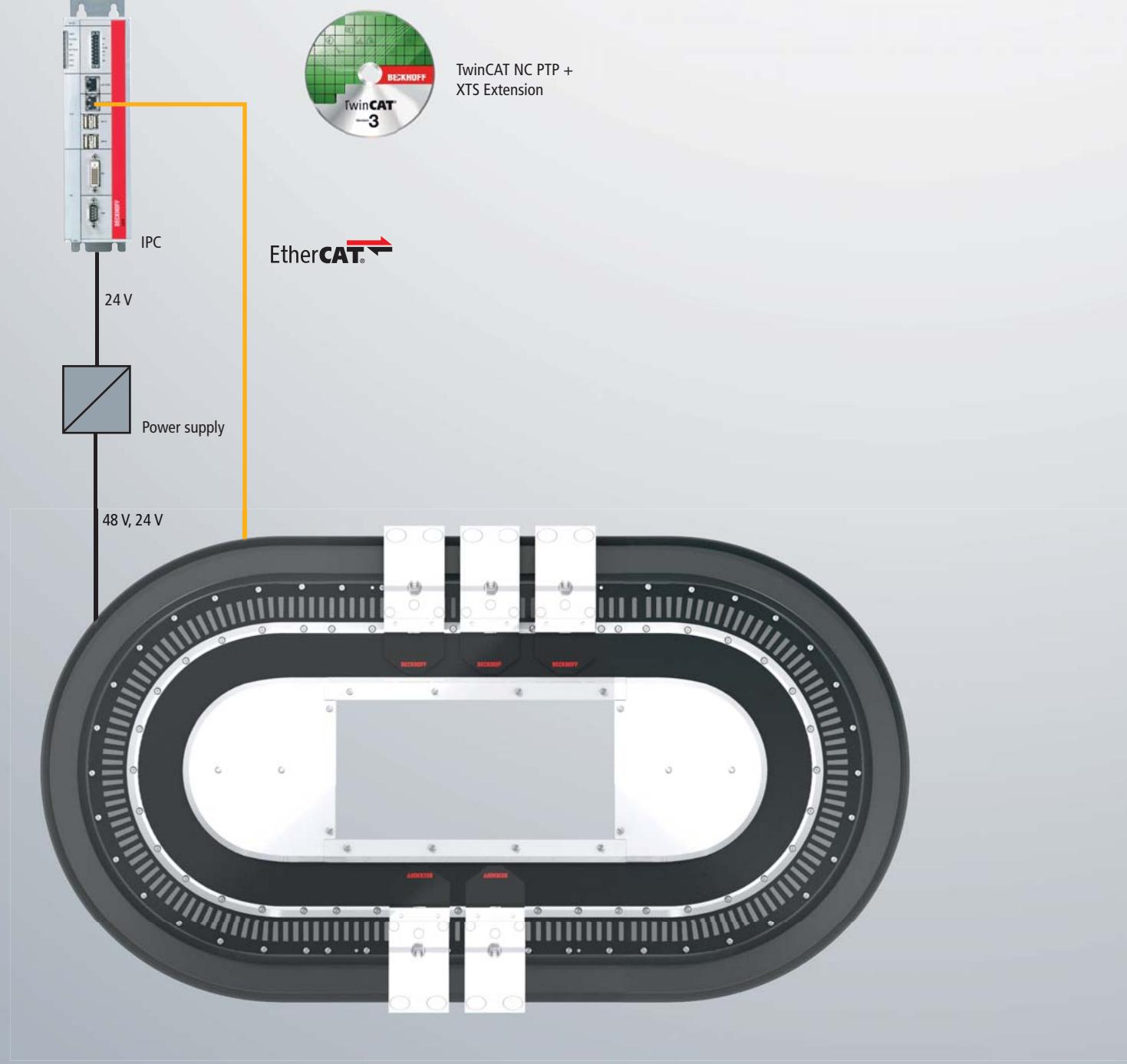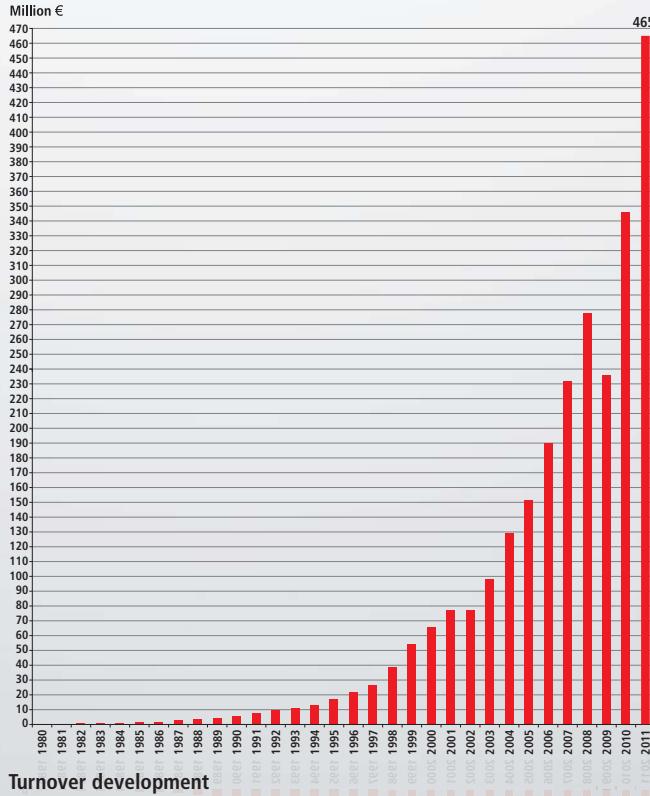
Beckhoff Automation

- Headquarters Verl, Germany
- Sales 2011: 465 million €
- Staff worldwide: over 2,100
- Branch Offices Germany: 11
- Subsidiaries/Branch Offices worldwide: 30
- Distributors worldwide:
  in more than 60 countries

North America map labels:

Seattle, Minneapolis, North Fond du Lac, London, Toronto, Chicago, Detroit, Denver, Indianapolis, Hanover, San Francisco, **NORTH AMERICA**, Coplay, Los Angeles, San Diego, Rogers, Raleigh, Charlotte, Atlanta, Austin, Dallas, San Luis Potosí, Bogotá

Beckhoff – New Automation Technology

Beckhoff implements open automation systems based on PC Control technology. The product range covers Industrial PCs, I/O and Fieldbus Components, Drive Technology and automation software. Products that can be used as separate components or integrated into a complete and seamless control system are available for all industries. The Beckhoff "New Automation Technology" philosophy represents universal and open control and automation solutions that are used worldwide in a wide variety of different applications, ranging from CNC-controlled machine tools to intelligent building automation.

▶ **www.beckhoff.com**

Map labels (Europe inset):
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Map labels (World):
Saint-Petersburg, Moscow, Ekaterinburg, Samara, Krasnodar, Shenyang, Beijing, Qingdao, Seoul, Yokohama, ASIA, Tehran, Beirut, Lod, Hefei, Shanghai, Ningbo, Chengdu, Wuhan, Hangzhou, Dubai, Ahmedabad, Guangzhou, Taipei, Pune, Bangkok, AFRICA, Kuala Lumpur, Singapore, Jakarta, AUSTRALIA, SOUTH AMERICA, La Paz, Campinas, São Paulo, Joinville, Buenos Aires, Montevideo, Johannesburg, Durban, Cape Town, North Ryde, Melbourne, Auckland

Worldwide presence on all continents

The central divisions of Beckhoff, such as development, production, administration, distribution, marketing, support and service are located at the Beckhoff Automation GmbH headquarters in Verl, Germany. Rapidly growing presence in the international market is taking place through 30 subsidiaries. Through worldwide co-operation with partners, Beckhoff is represented in more than 60 countries.

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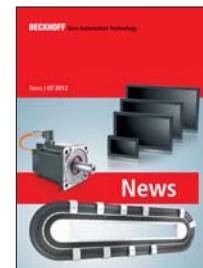
Main catalog   **News catalog**   **PC Control magazine**

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