



The Linear Transport System XTS enables individual product transport with continuous material flow. Due to the low construction volume the efficiency can be increased and the size of a machine can be significantly reduced.

XTS – eXtended Transport System: Drive Technology – rethought

The dynamic linear motor that drives in a circle

The new XTS drive system (eXtended Transport System) from Beckhoff offers completely new degrees of freedom for mechanical engineering. It combines the benefits of tried and tested rotational and linear drive systems and represents a drive system that extends the conventional linear motor principle: XTS is a linear motor that moves in a circle. The motor is completely integrated together with power electronics and displacement measurement into one assembly. One or more wireless movers can be moved highly dynamically at up to 4 m/s on an almost arbitrary and flexible path. The compact XTS revolutionizes drive technology and enables completely new, space-saving machine concepts.

XTS is a mechatronic system with only a few different components containing all functions necessary for operation:

- a modular, fully integrated linear motor with power electronics and displacement measurement in one device
- one or more movers as moveable parts
- a mechanical guide rail system
- an Industrial PC with the TwinCAT control software

The desired geometries, lengths and radii of the drive system are formed by the number and choice of the components. Complex cabling and drag chains are no longer required. In addition, the position measurement system is already integrated.

XTS enables maximum utilization of the machine footprint, since the circular movement utilizes travel in both directions as well as along curves for active material transport. In this way you save not only hardware, but also expensive production space. Maximum positioning accuracy is achieved at speeds of up to 4 m/s.

All XTS components are developed and produced by Beckhoff in Germany. In combination with TwinCAT automation software and PC-based Control technology, Beckhoff offers a complete drive solution.

The new linear motor principle

There are virtually no limits to the possibilities of use of XTS: the movers can accelerate, brake, position and synchronize; they can take up absolute positions relative to each other; they can group themselves and accumulate; they can create clamping forces in motion; they can travel through curves as fast as along straights; they can recover energy through regenerative braking and utilize both travel directions 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.

This new linear motor principle gives rise to completely new possibilities in drive technology:

- linear motor characteristics on an endless path
- any desired number of movers on a common path
- modular structure, simple adaptation to the application
- low spatial and power requirements
- simple implementation of demanding transport tasks
- low project engineering and assembly expenditure

The XTS system components

The XTS system is simple and modularly configurable: The motor modules form a unit with the movers and guide rails. They contain the electromagnetic coils and all other active functions necessary for the operation of the system.

The XTS motor module

The fully integrated linear motor with power electronics and displacement measurement represent a mechatronic unit. It 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. A control cabinet is no longer required. The motor module contains no moving parts and is therefore not subject to any wear. The coil arrangement and the mechanical configuration are ready for use. The power electronics are optimized for the XTS requirements. Integration of displacement measurement eliminates the need for additional installation and the calibration. Tolerances are compensated automatically. XTS uses a double air gap linear motor. Magnets are positioned above a coil package on opposite sides. The high attraction forces of the magnets cancel each other, which means that only low resultant forces act on the mechanical bearings.

The XTS guide rail

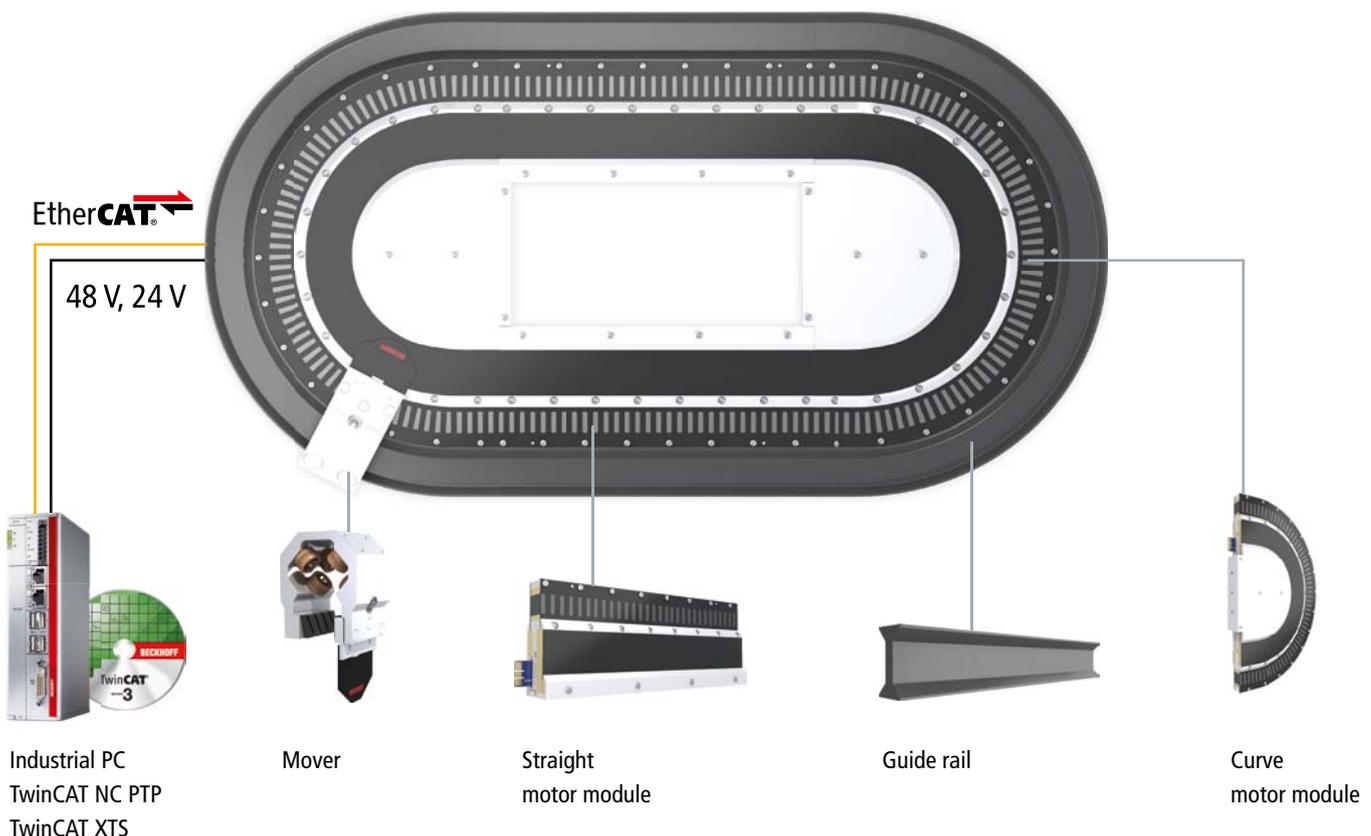
The rail system can be extended with straight and curved sections as required. The desired geometries, lengths and radii are formed by the number and choice of the components. In combination with the contact surface of the mover rollers, the system results in good running characteristics and low wear. Lubrication of the system is not necessary. The guide rail system is optimized

for instant installation on the motor module. Minimum manufacturing tolerance and pre-stressed rollers ensure zero backlash. The guide rails have no joints and are available in lengths of up to 6 m. Fittings ensure high-precision mounting.

The XTS mover

The mover contains magnetic plates which, together with the coils of the motor module, generate a controlled driving force. The mover absorbs the attraction forces of the magnets on both sides and largely compensates them vis-à-vis the guide mechanism. This enables the rollers of the mover to run at high-speed in the guide rail with low wear. The rollers are equipped with a particularly robust plastic contact surface, resulting in low friction losses. The tensioning of the rollers prevents backlash and is at the same time designed for low wear. The service life of the rollers depends on the payload. A mechanically robust encoder flag transfers the position signal to the motor module.

The mover is entirely passive. There are no sliding contacts or cables to the moving part. With a weight of less than 350 g, the mover is exceptionally light. Its short length enables a product distance of up to 50 mm. The geometry of the guide rails allows driving through curves with full dynamics. There is no heat generation at or in the mover.





Multiple benefits and advantages through XTS

Absolutely precise configuration

XTS precisely adapts to the respective requirements: the arbitrary number of movers, the modular path guidance, the individual controllability of each mover and the ease of integration in existing machines and systems ensure tailored solutions for optimizing the production efficiency of the machine.

Increased production speed

Speeds of up to 4 m/s can be achieved with XTS – without jerking and with maximum positioning accuracy. Synchronization, 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 containers holding liquids. Even if stopping and restarting are necessary at workstations, the flow of product is retained.

Reduced installation volume

XTS enables the machine volume to be fully utilized, 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. Therefore, all the prerequisites for compact and cost-effective machine construction are met.

Low wear, less required 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 (< 350 g) is moved.

Fast, flexible format adaptation

Versatile format adaptation is a significant benefit, particularly in the packaging industry: during a product changeover or change in filling quantity, for example, the format can be changed without production stop. Modifications are realized by changing the software parameters. Empirical values can be stored as parameter sets and 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.

Peak forces and high acceleration

The fast signal processing and the high bandwidth of EtherCAT, the fast real-time Ethernet fieldbus, 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 and at different points in the production. For example, the parameters can be adapted according to the filling level while moving.

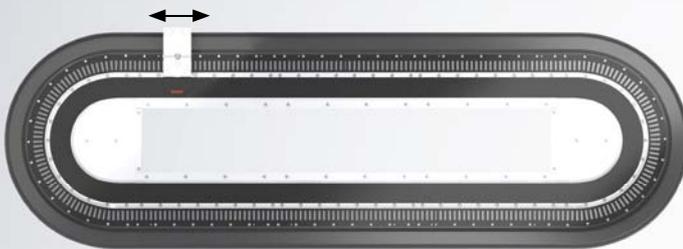
Lower mass, increased safety

Small masses lead to a low hazard potential. In contrast to the XTS system, a conveyor chain has to be kept moving by a central drive. Therefore, the total force is as large as all the necessary individual forces along the entire length. It follows that the total force can take effect at a single point in the event of

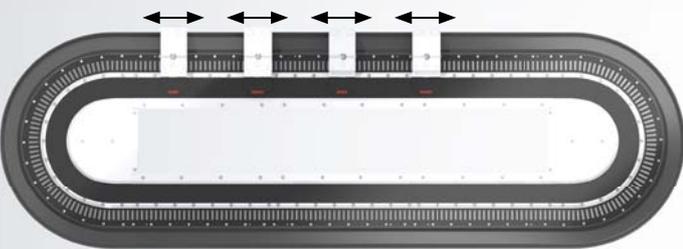
an error, a mechanical fault or manual intervention in the process. With XTS this risk can be significantly minimized and safety can be increased, since in most cases only the parameterized force of a mover acts. As a result, even in the case of a collision with an obstacle, only the mass of a mover with its payload acts.

The basic XTS functions

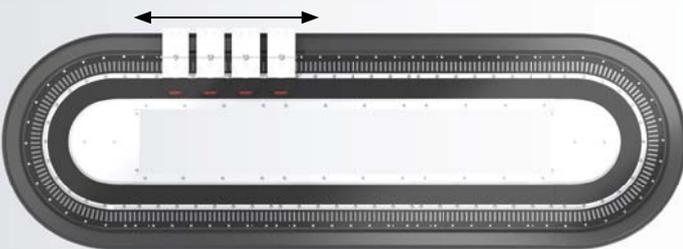
The XTS system offers a new class of functions which enable the realization of new, particularly versatile transport and positioning tasks in a cost-effective manner.



Free movement of one or several movers



Synchronous movement of a group



Movements with constant force

Free mobility of the mover

The mover can move freely along the whole track, i.e. it can brake, accelerate, position and exert a constant force at standstill and in motion. Like every linear motor, the mover can synchronize 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 product flow. They do not have to be moved backwards against the flow.

Free mobility of several movers

All movers can be moved independently and positioned at absolute positions along the whole track. In addition, they can be moved relative to each other and always avoid a collision with their "neighbor." The movers can automatically accumulate themselves, thus representing a moved buffer from which a moved destination can be approached 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

A mover follows another with a defined force. It can apply a "clamping force" while at the same time following a movement, in order to hold a product, for example. For other applications the force can be limited, in order to avoid unnecessary load on a product under all conditions. Acceleration and centrifugal forces can also be limited, in order to enable the transport of liquids in open containers, for example.

Areas of application for XTS

XTS can be used in many different ways in the most diverse industries. It is ideal for high-speed material handling:

- push product, adapt product spacing, reduce or increase product speed
- clamp and move product
- transport and discharge product
- manipulate product: lift out, close, rotate, screw cap on

Unrestricted curve function

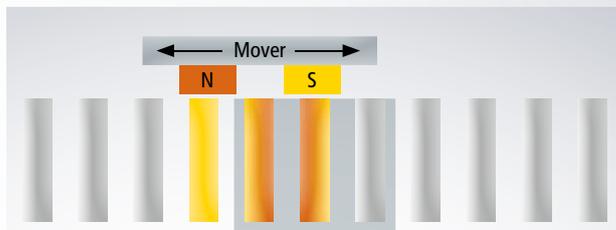
The total travel distance becomes the utilizable path. Outward path, return path and the curves are available for material transport and processing. This results in very compact application solutions that make completely new machine concepts possible.

Arbitrary number of movers

There are no system limits for the number of movers; 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

There are no length restrictions for the entire path. 10 m and much more are technically possible.



Individual energizing of coils generates a travelling magnetic field, which moves the permanent magnets of the mover along with it. The controlled current intensity through the coils adapts itself to the force requirement of the mover.

An irregular product flow is isolated and transferred at a constant interval and constant speed to the next workstation.

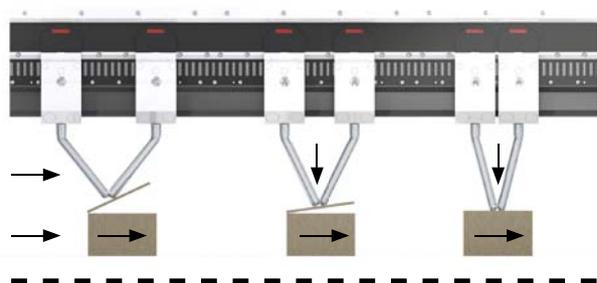
Products are picked up and transported from one workstation to the next. If the tracks between stations are free, the products are moved with high-speed. Otherwise, the products approach the target in a moving buffer. At slow processing stations the products can be processed in parallel groups. Fast stations process one product at a time. The return movement can always be used actively.



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



Clamp and move product



Kinematics in linear motion for handling a product: lifting, sealing.

Further Information:

www.beckhoff.com/XTS

Estimated market release:

4th quarter 2012



The new linear motor concept: Interview with Uwe Prüßmeier

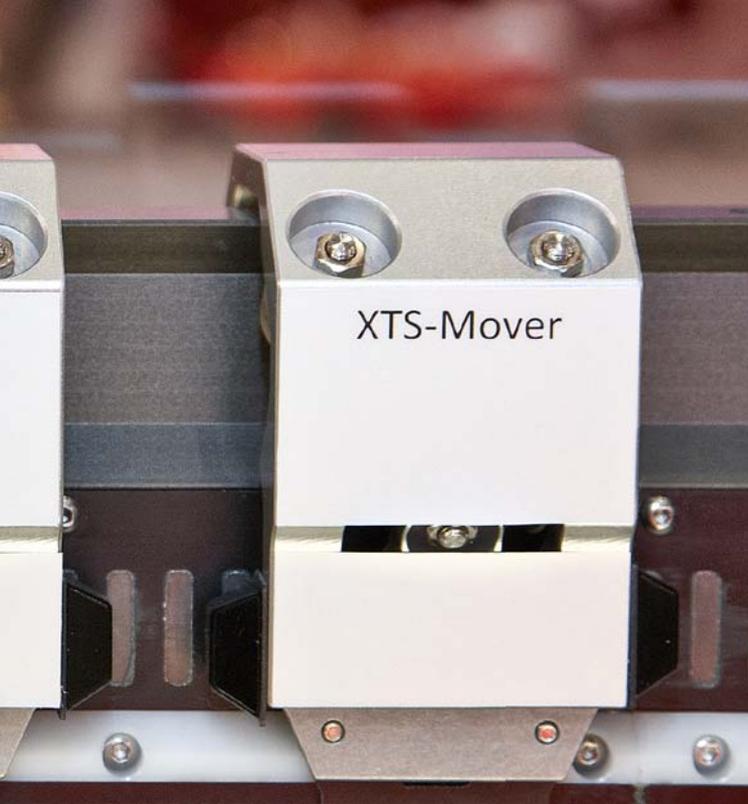


Uwe Prüßmeier, Product Manager
for Fieldbus and Drive Technology,
Beckhoff

The XTS system was developed in a very short amount of time. From the initial idea to the presentation at the Hannover Messe 2012 it took less than one year. In a short interview Uwe Prüßmeier, Product Manager for Fieldbus and Drive Technology, who played a key role in the development of XTS, explains the background and design details of the new linear motor concept.

XTS consistently follows the core Beckhoff technologies, PC-based Control and EtherCAT. What were the underlying ideas in the development of XTS?

Uwe Prüßmeier: The processing power of PCs keeps growing by more than a factor of 1000 every 10 years. The question therefore arises: What new technological breakthroughs does this enable us to achieve in the future? In addition, EtherCAT enables large data quantities to be transferred to PCs, in order to fully utilize their capacity. We moved away from conventional approaches and reflected on what features an optimum linear motor should offer from a user perspective. The main criteria seemed to be: any number of slides and continuous travel. It appeared technically feasible to control all motor coils centrally and to calculate all positions in the PC and control them from there. The computing power is affordable and the concept is manageable for the user. This led us to develop a mechatronic system. XTS is more than just an IT effort. Mechanical engineers and electronics developers were also closely involved in the process. It is a "total work of art" based on three disciplines.



What is the difference between XTS and a conventional linear motor?

Uwe Prüßmeier: In addition to the usual favorable positioning characteristics of linear motors, the XTS system enables continuous travel of the movers. This has a big advantage: the mover never has to return against the delivery direction. Moreover, a large number of movers can travel on the same track. For XTS we developed a double air gap motor. This means that there are two magnets opposite each other, which move on the coil package. The typical high attractive forces of the magnets are absorbed by a static, mechanical support. Compared with conventional linear motor XTS is not demanding in terms of the guiding system. The movers can travel almost without influence of static forces. With 350 g, the mover mass is very low, so that virtually the full motor forces are available for the application, without significant reduction through friction. In summary, in addition to the new features described above, XTS has other advantages over conventional linear motors such as better acceleration, an excellent energy balance and low wear.

The XTS system is modular. The basic elements, i.e. the motor module and the magnetic plates, are available separately. What factors do users have to take into account when designing their own guide rails and movers?

Uwe Prüßmeier: Users can order guide rails and movers from Beckhoff, or they can develop them themselves to suit their applications. The mover is designed such that it can travel along any radius greater than 150 mm. Different radii don't necessarily require "new" movers. We intend to offer different motor modules with suitable rails, based on market requirements. It is unlikely that our mover design will be suitable for each and every application. We therefore offer users the option to use their own guide rails and movers.

One application option for XTS is holding of an item between two movers. What forces is the holding function designed for?

Uwe Prüßmeier: We can achieve forces up to 100 N. The limiting factor for the continuous force is self-heating of the motor coils. Since we apply the linear motor principle in reverse – the coil is stationary while the magnetic plate is moved – it is possible for the mover to exert large forces during fast motion. Only at standstill, i.e. when the mover is positioned over a single coil, is the continuous force reduced to 30 N.

