BECKHOFF New Automation Technology
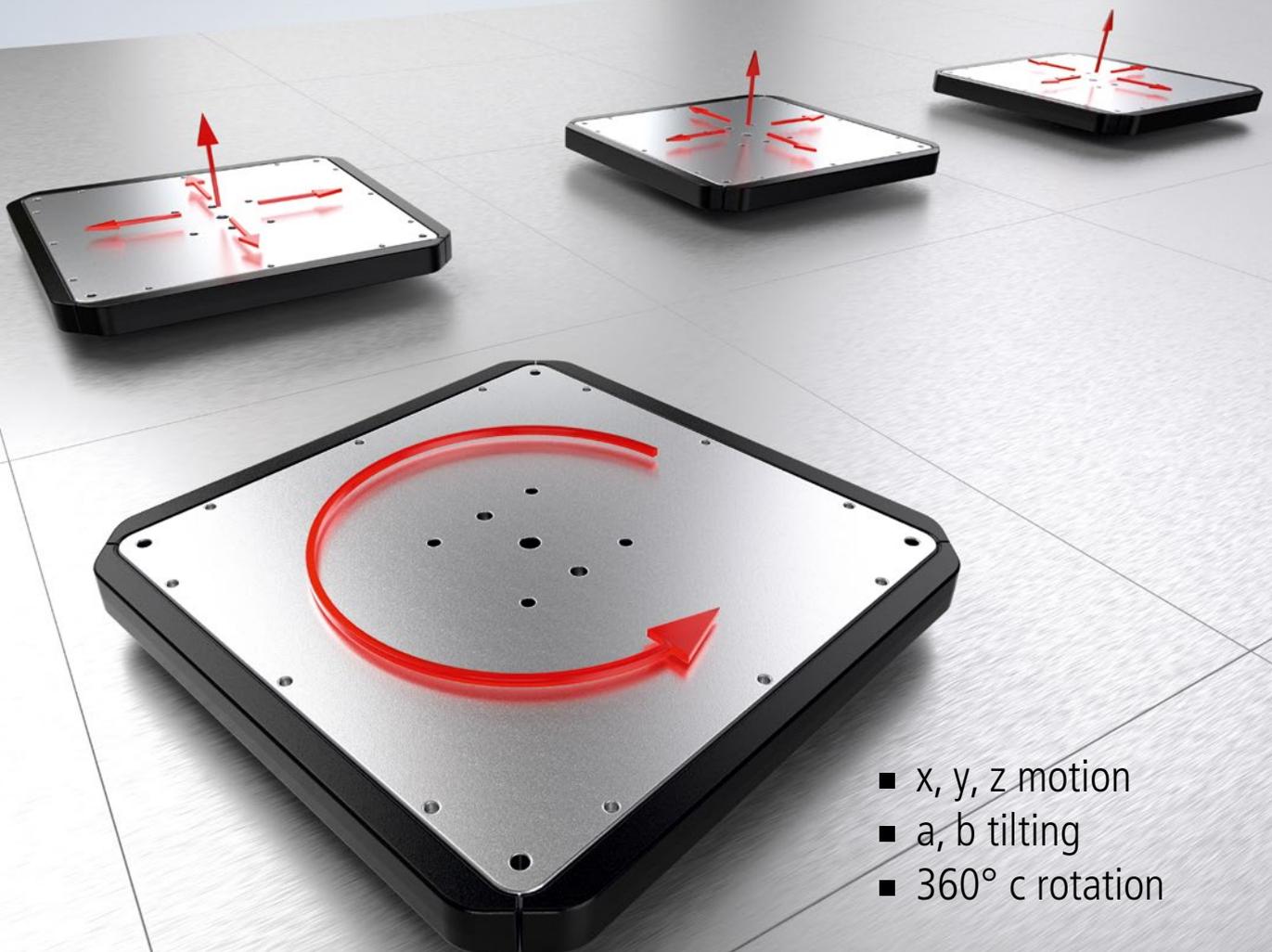
XPlanar®: Levitating, contactless, intelligent!

- x, y, z motion
- a, b tilting
- 360° c rotation

With its free 2D product movement with up to six degrees of freedom, the XPlanar planar motor system opens up a whole new world of product handling options. Levitating XPlanar movers travel on individually arranged XPlanar tiles along freely programmable tracks. 6D product processing and 2D transportation are dynamically combined in a single system while multi-mover control enables parallel and individual product handling. Mechanical wear and extensive cleaning procedures are a thing of the past with XPlanar. The system is completely integrated into standard TwinCAT software and controlled via a single central industrial PC. All proven advantages of PC-based control technology from Beckhoff are available, making XPlanar the ideal handling system for economical lot size 1 production in the machines of the future.

▶ **www.beckhoff.com/xplanar**
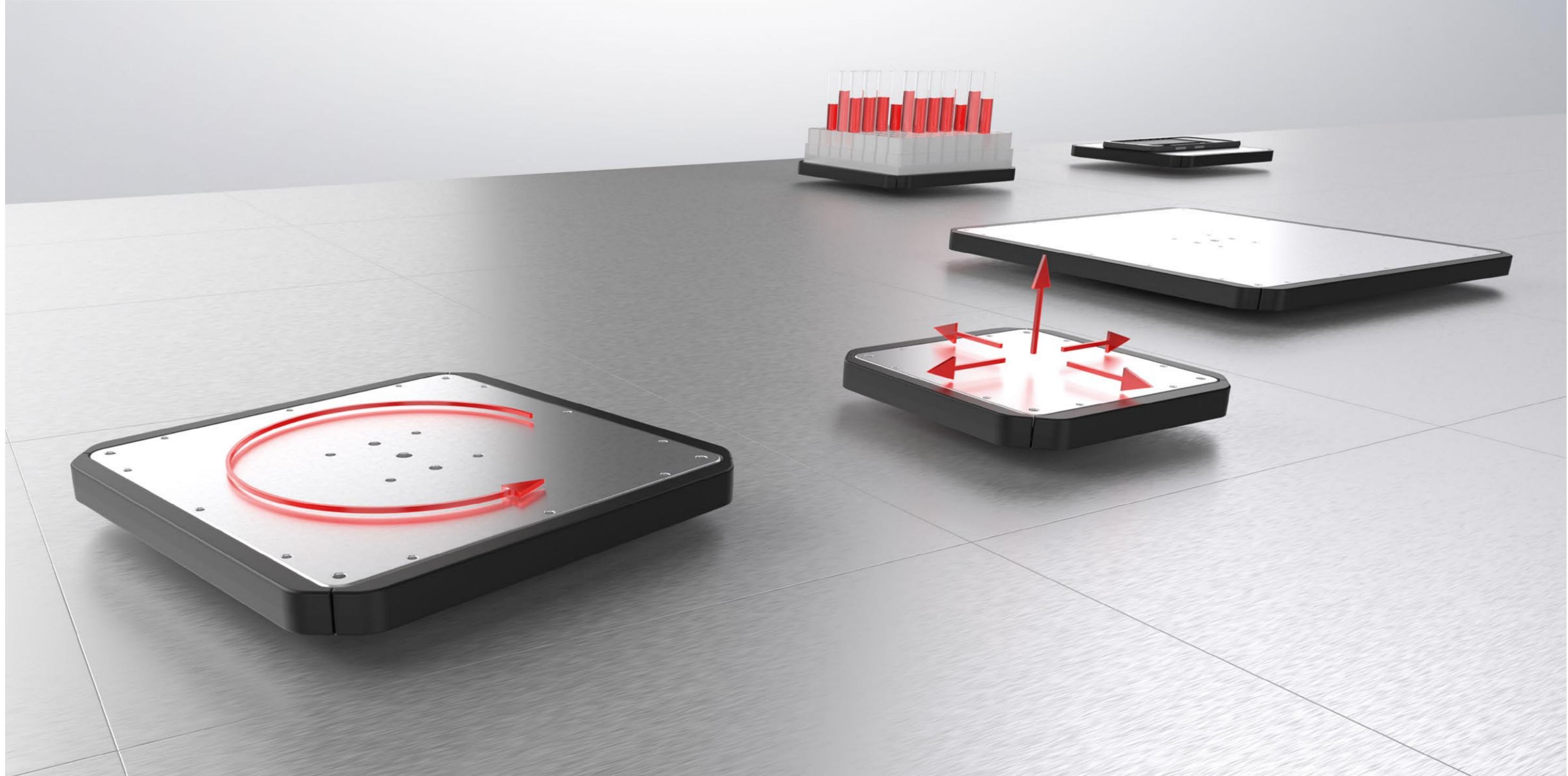
How XPlanar works: Levitating movers for contactless travel

The XPlanar system is a planar motor, which – like rotary motors – consists of multiple stationary energized coils (in the tiles) and mobile permanent magnets (in the movers). Contrary to rotary motors, both the coils and the permanent magnets are arranged in a horizontal plane. The XPlanar tiles are the electrically active part of the system and generate an electromagnetic field that causes the movers to levitate above the tiles. The movers are electrically passive and highly robust. The unique floating effect means any pollutants or contaminants from the goods being transported are not spread throughout the system, there are no emissions, and there is no wear caused by friction. The XPlanar system stands out as a revolutionary motion concept in general mechanical engineering, and in the food and pharmaceutical industries.

A planar mover equipped with permanent magnets levitates above planar tiles which generate a magnetic field and continuously detect the mover's position.

XPlanar advantage: One system for transport and processing

The XPlanar system combines highly dynamic 2D product transportation with precise 6D product processing in a single system. The XPlanar movers travel at speeds of up to 2 m/s and can be positioned with a repeat positioning accuracy of ≤ 10 μm. Since the movers travel completely independently, each product can take its own individual path through the system. Different products can be manufactured at the same time in a single machine, which is ideal for economical lot size 1 production. The 2D movement can be combined with superposed tilting, inclining and lifting for free 6D positioning. This generates innovative possibilities for streamlined processing stations. In many applications, XPlanar can replace XY gantries or robots to reduce the mechanical complexity of a machine considerably. Moreover, the unique 360-degree rotation functionality opens up further possibilities for the inspection, alignment or centrifugation of products.
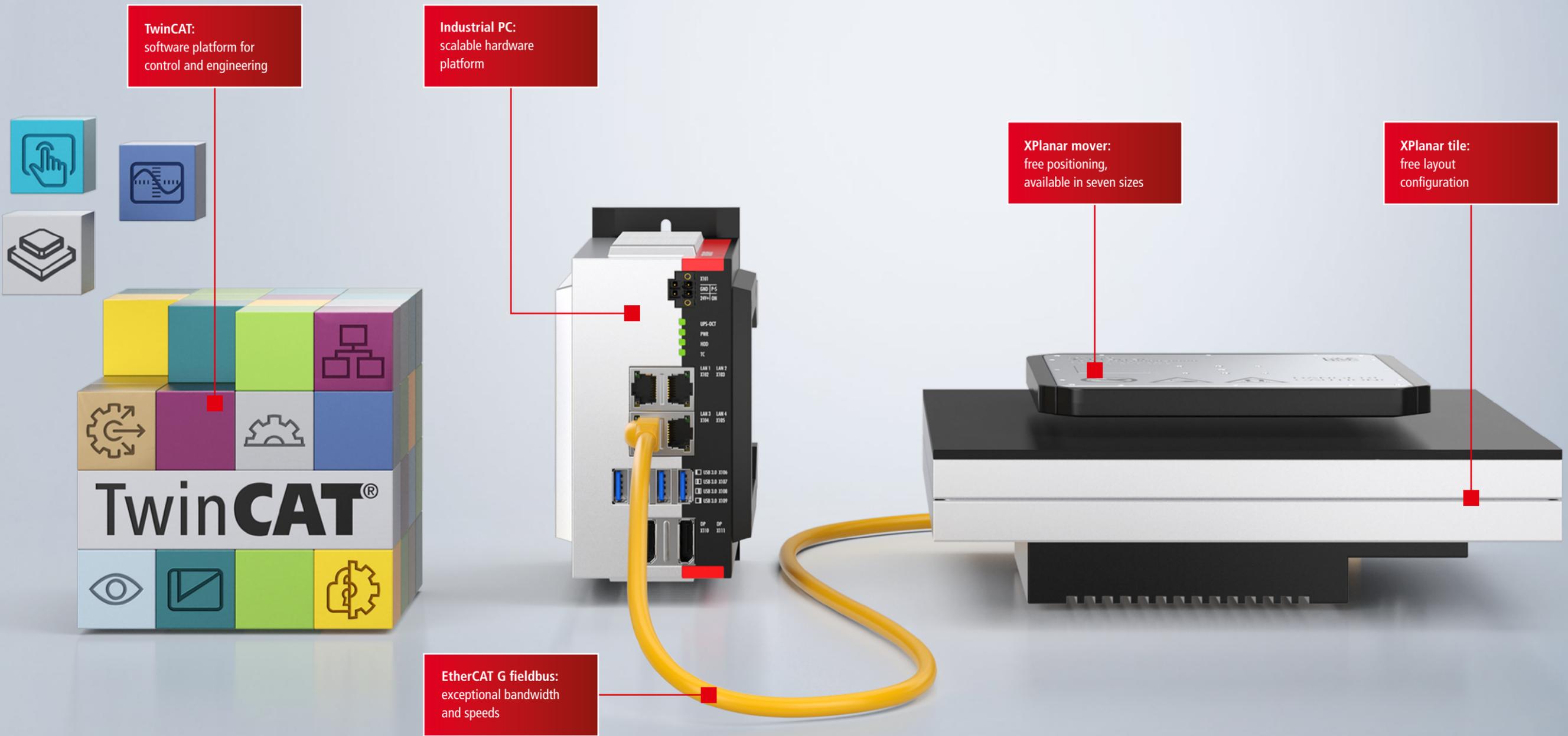
- Levitating planar movers
- Scalable payload
- 360-degree rotation
- Tilting by up to 5°
- Lifting by up to 5 mm
- Dynamic motion at up to 2 m/s
- 6D motion
- Any installation layout
- Individual product transport

Positioning accuracy	Technical data	Comments:
Position resolution	1 μm (x, y, z) 0.001° (a, b, c)	■ Accuracies within one tile ■ Average tile temperature: 40°C ■ Average ambient temperature: 24°C ■ Constant mover temperature
Typical repeat accuracy	≤ ±10 μm (x, y, z) ≤ ±0.03° (a, b, c)	

XPlanar system: Plug-and-play for tomorrow's machine concepts

The highlight of the XPlanar system is its compact system architecture. To operate it, only the tiles, movers, a Beckhoff Industrial PC with TwinCAT, and cables for the power supply and EtherCAT G are needed. The industrial PC is connected to the first XPlanar tile via EtherCAT G. The EtherCAT G communication is then daisy-chained from tile to tile. No cross-communication between individual XPlanar tiles is needed, and nor are infrastructure components such as port multipliers or external power supplies. In line with the Beckhoff PC-based control philosophy, the system is accessed via a central industrial PC. This enables perfect coordination of the XPlanar system with other machine components, along with easy process optimization and fast diagnostics. New system functionalities can easily be integrated into existing systems by updating the central control system's software on the industrial PC.

TwinCAT:
software platform for control and engineering

Industrial PC:
scalable hardware platform

XPlanar mover:
free positioning, available in seven sizes

XPlanar tile:
free layout configuration

EtherCAT G fieldbus:
exceptional bandwidth and speeds

XPlanar tile: Fully integrated for maximum space efficiency

The XPlanar tile is the fully integrated drive unit of the XPlanar system. It converts the supplied energy into precisely regulated electromagnetic fields. The fields levitate the XPlanar movers and guide them across the XPlanar tiles along freely programmable tracks. All components required to generate and regulate the magnetic fields are integrated in each XPlanar tile. This includes the coil groups and their associated power electronics along with the position detection, the power supply and EtherCAT G communication. This level of integration enables a highly compact and functional design that reduces the installation work and the total system footprint. XPlanar tiles can also be adapted to various environmental requirements. For example, they can be covered with plastic films, glass panes or non-magnetic stainless steel to protect them from liquids, cleaning agents or mechanical impact. Accordingly, the XPlanar system is well-suited for use in demanding hygienic environments.

APS4322-0000-0000
XPlanar tile, 110/230 V AC or 24 V DC
240 mm x 240 mm x 67 mm
Net weight: 5.6 kg

Free choice of surfaces: The choice of available surfaces includes hygienic stainless steel, plastic film, and easy-clean glass, making XPlanar tiles suitable for use in clean rooms and in the pharmaceutical and food industries.
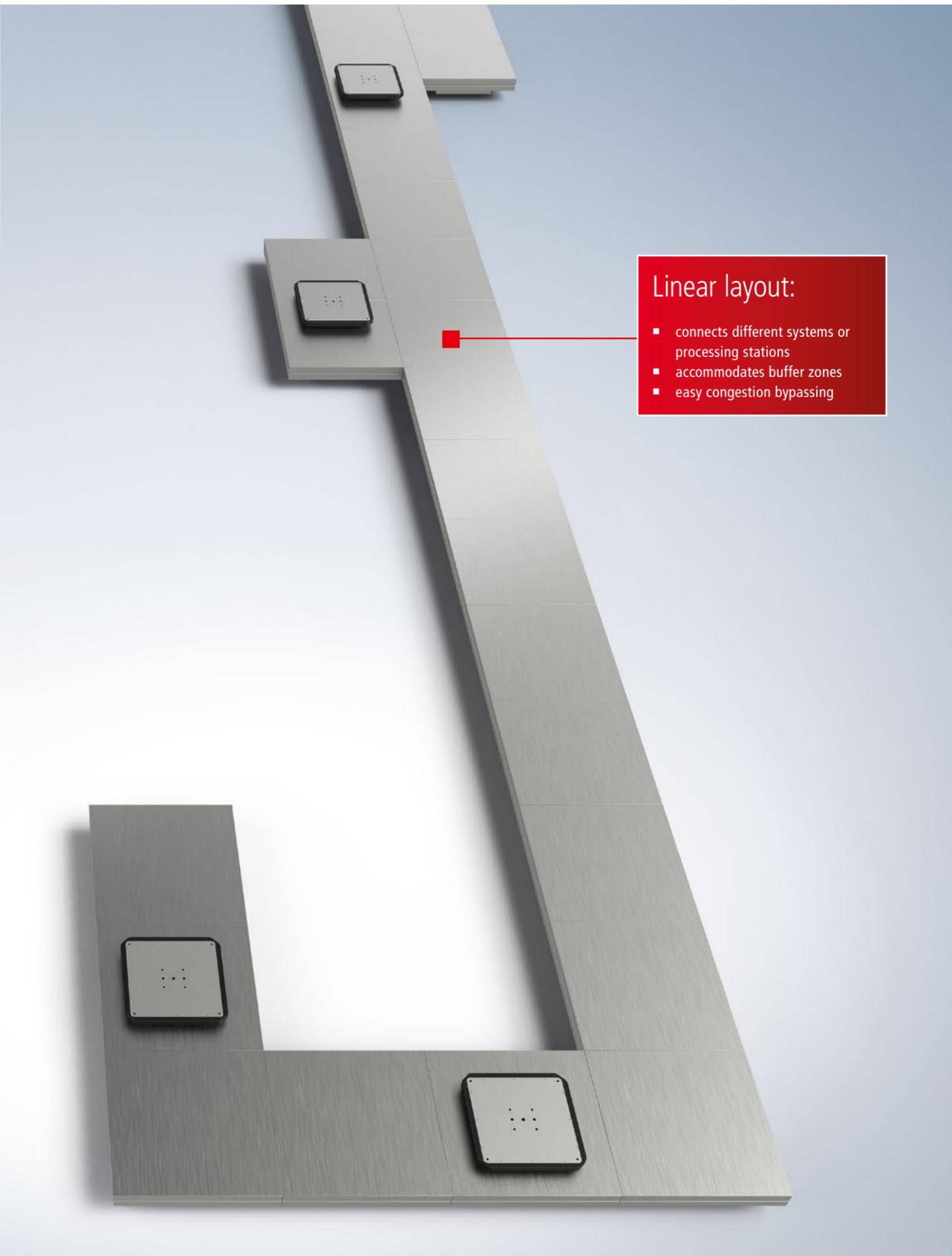
Power consumption	Average	Comments
Per APM4330 mover, 2 mm flight height, unloaded, at standstill	24 W	position-dependent
Per APM4330 mover, 2 mm flight height, 1000 g load, at standstill	54 W	position-dependent
Per APM4330 mover, 2 mm flight height, 1500 g load, at standstill	77 W	position-dependent

XPlanar system: Customizable and scalable layout

The XPlanar tile layout is freely definable to suit any application-specific requirements. Square, rectangular, L-shaped or circular systems can be created with ease. Bidirectional product transport is possible on linear systems that are one or two tiles wide. The width of the linear systems depends only on the size of the operated movers. Tiles and movers can be added to the system after the initial installation to adapt the machine to new requirements. Individual tiles can be mounted on additional actuators. This installation provides additional flexibility as tiles or entire tile segments can leave the original layout in horizontal or vertical directions while the movers are levitating.

The unique combination of layout customization and extension ensures an exceptional degree of future security for XPlanar based machines. At the same time, the system's footprint is minimized by optimizing the ratio of tiles and movers.

Linear layout:

- connects different systems or processing stations
- accommodates buffer zones
- easy congestion bypassing

Rectangular layout:

- compact arrangement
- short transport paths
- flexible use

XPlanar movers: Easy to clean, scalable payload

The XPlanar mover is the magnetically levitating, freely movable and wireless component of the XPlanar system. Due to an innovative arrangement of the integrated permanent magnets, the movers can carry their own weight and various payloads. XPlanar movers are passive without moving parts or connectors. Their smooth surface without sharp edges makes them easy to clean. Various square and rectangular movers which can carry payloads of up to 4.2 kg are available for different product sizes and weights. The movers can be mechanically linked or operated as a group to accommodate payloads above 4.2 kg. In this case, the payload capacity of the entire group is the total of the individual movers' payload capacities. Movers with an edge length of 115 mm are available for very high product packing density. Up to four of these movers can move simultaneously on a single XPlanar tile. The optional mover identification enables full product traceability through the entire installation and a machine start up without referencing. Each mover can be identified at any time, regardless of its position, through a unique identification number. Stainless steel movers with a high protection class are also available for hygienic applications.

0.4 kg payload

APM4220-
0000-0000
XPlanar mover,
aluminum housing
hard anodized,
115 x 115 x 12 mm

1.0 kg payload

APM4221-
0000-0000
XPlanar mover,
aluminum housing
hard anodized,
127 x 127 x 12 mm

0.8 kg payload

APM4230-
0000-0000
XPlanar mover,
aluminum housing
hard anodized,
115 x 155 x 12 mm

1.5 kg payload

APM4330-
0000-0000
XPlanar mover,
aluminum housing
hard anodized,
155 x 155 x 12 mm

3.0 kg payload

APM4350-
0000-0000
XPlanar mover,
aluminum housing
hard anodized,
155 x 235 x 12 mm

4.2 kg payload

APM4550-
0000-0000
XPlanar mover,
aluminum housing
hard anodized,
235 x 235 x 12 mm

1.0 kg payload

APM4330-
0001-0000
XPlanar mover,
stainless steel
housing,
155 x 155 x 12 mm
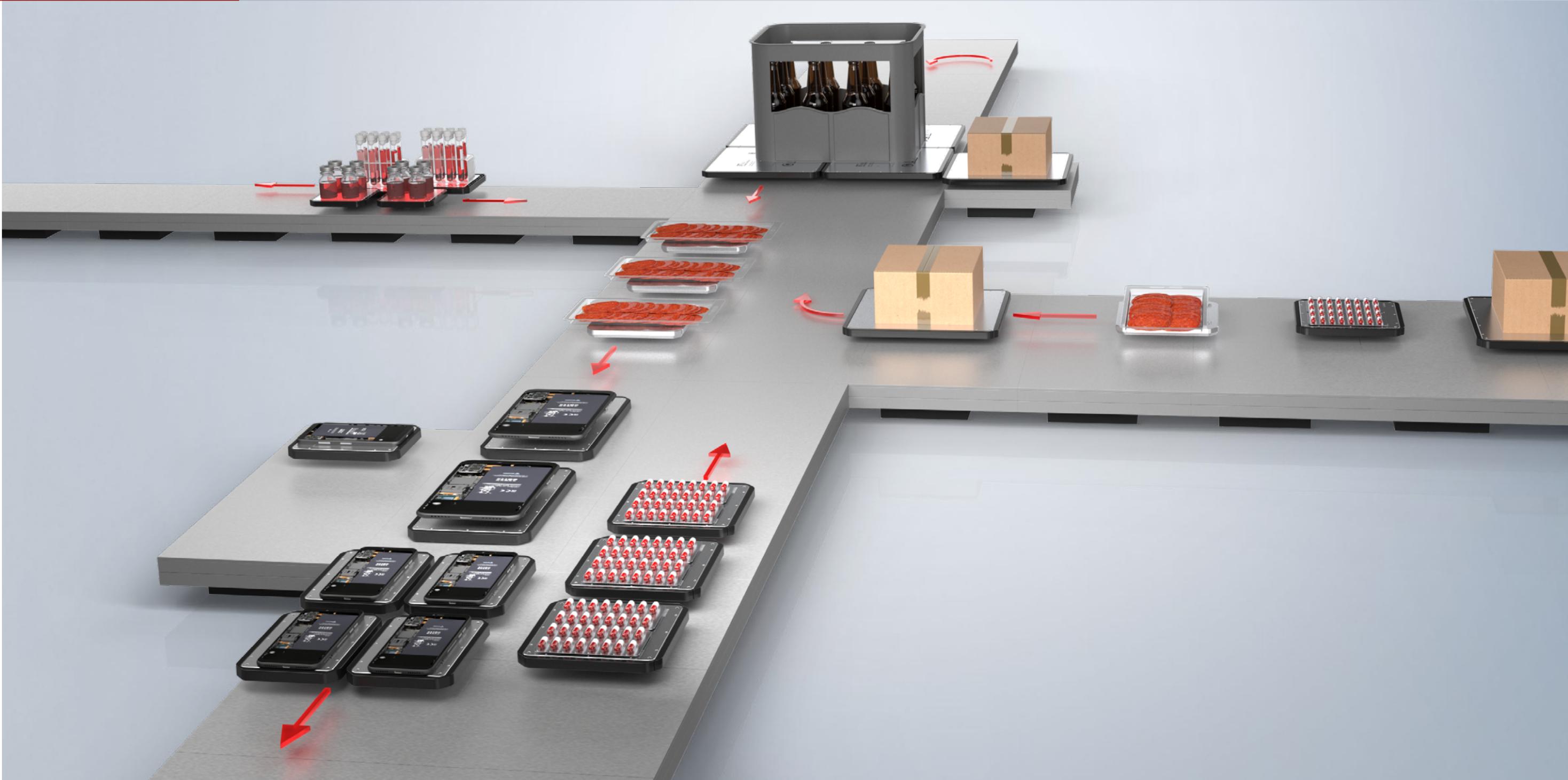
# XPlanar software: Centralized control of XPlanar applications

The TF5890 software is fully integrated into the standard TwinCAT environment and controls all functions of the XPlanar system from one central Beckhoff Industrial PC: graphic system configuration, real-time monitoring, intelligent track planning and precise position control merge seamlessly. The setpoint generation for the movers is handled by the track management: Users can define free 2D tracks. The movers follow these tracks intelligently and automatically avoid collisions. Complex and superposed 6D movements based on CNC with GCode or CAM and free 2D movements are possible. Due to the deep integration into TwinCAT, all familiar capabilities of the PC-based control technology from Beckhoff are available alongside the XPlanar control (TwinCAT, PLC in IEC 61131-3, motion, measurement, machine learning, vision, communication, HMI).

Track management:

- freely definable tracks
- automatic collision avoidance
- easy station connections
- can be combined with superposed 6D movements (CAM, CNC with GCode, etc.)

Track 1

Track 2

Track 3   Track 4   Track 5
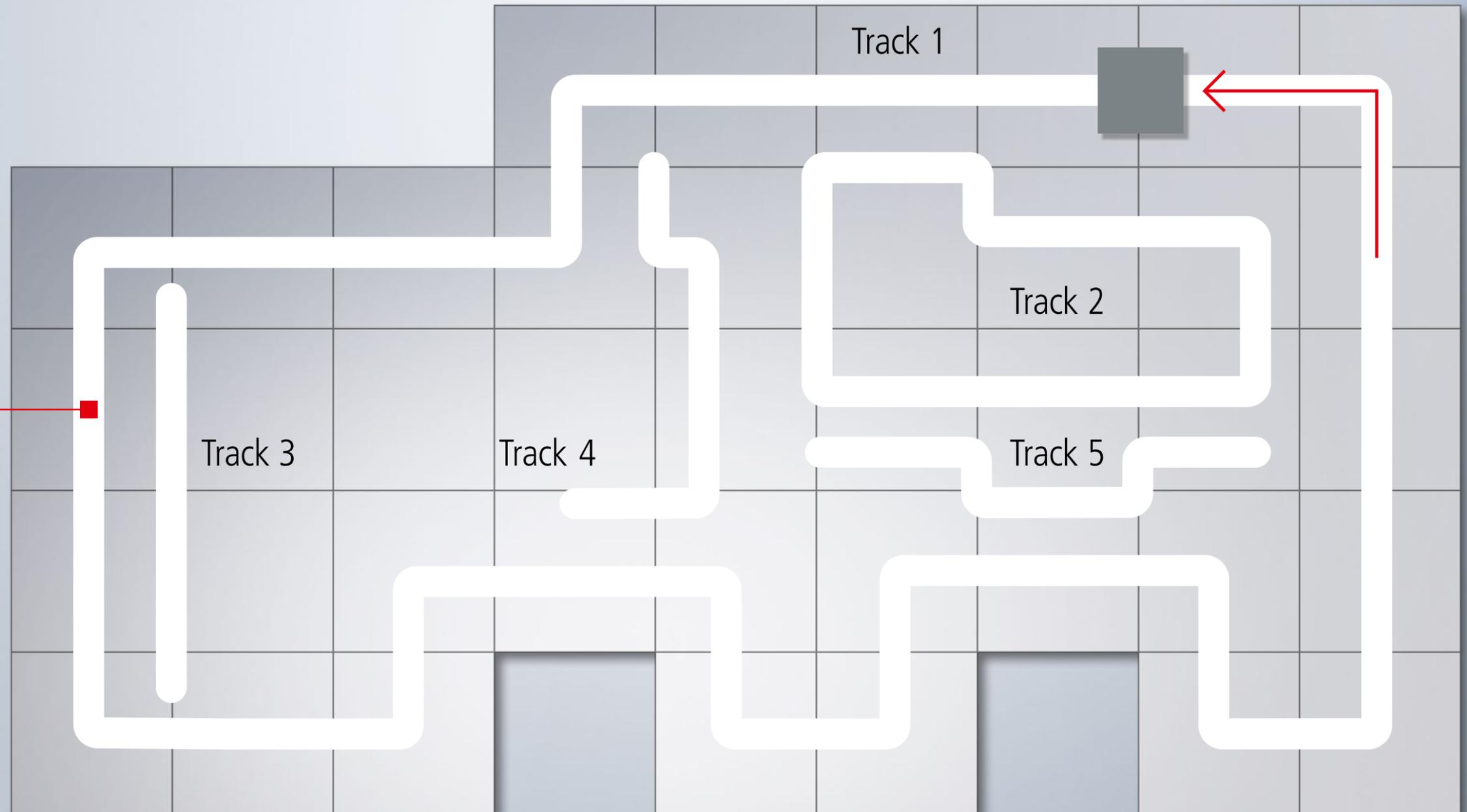
XPlanar for large and modular systems

XPlanar multi-computing enables larger and more modular XPlanar systems to be created. To this end, the entire system is split into individual subsystems. These are each controlled by a sub IPC. The dynamic handover of a mover between two subsystems is assured by the sub IPCs' communication with each other. The main IPC, which is superordinate to the sub IPCs, controls the operation of the entire system. Application programming and diagnostic options, as well as all the usual functionalities of the TF5890 XPlanar software, are made available centrally via the main IPC. The operator does not have to interact with the sub IPCs for the system to function.

XPlanar multi-computing thus makes it easy to increase the number of XPlanar movers and tiles within an overall system to a practically infinite amount. Beyond system enlargement, there are exciting possibilities for modularizing a machine. New subsystems can easily be mechanically coupled to the existing system if required. Simply integrate the subsystem into the overall plant process by adjusting the program in the main IPC.

Main IPC

Main IPC

- controls mover movement and system sequence in all subsystems
- central application programming, diagnosis and human-machine interaction

EtherCAT

Sub IPC 1

Sub IPC 2

Sub IPC 3

Sub IPCs

- control individual subsystems
- enable smooth mover handover between subsystems through cross-communication

Subsystem 1

Subsystem 2

Subsystem 3
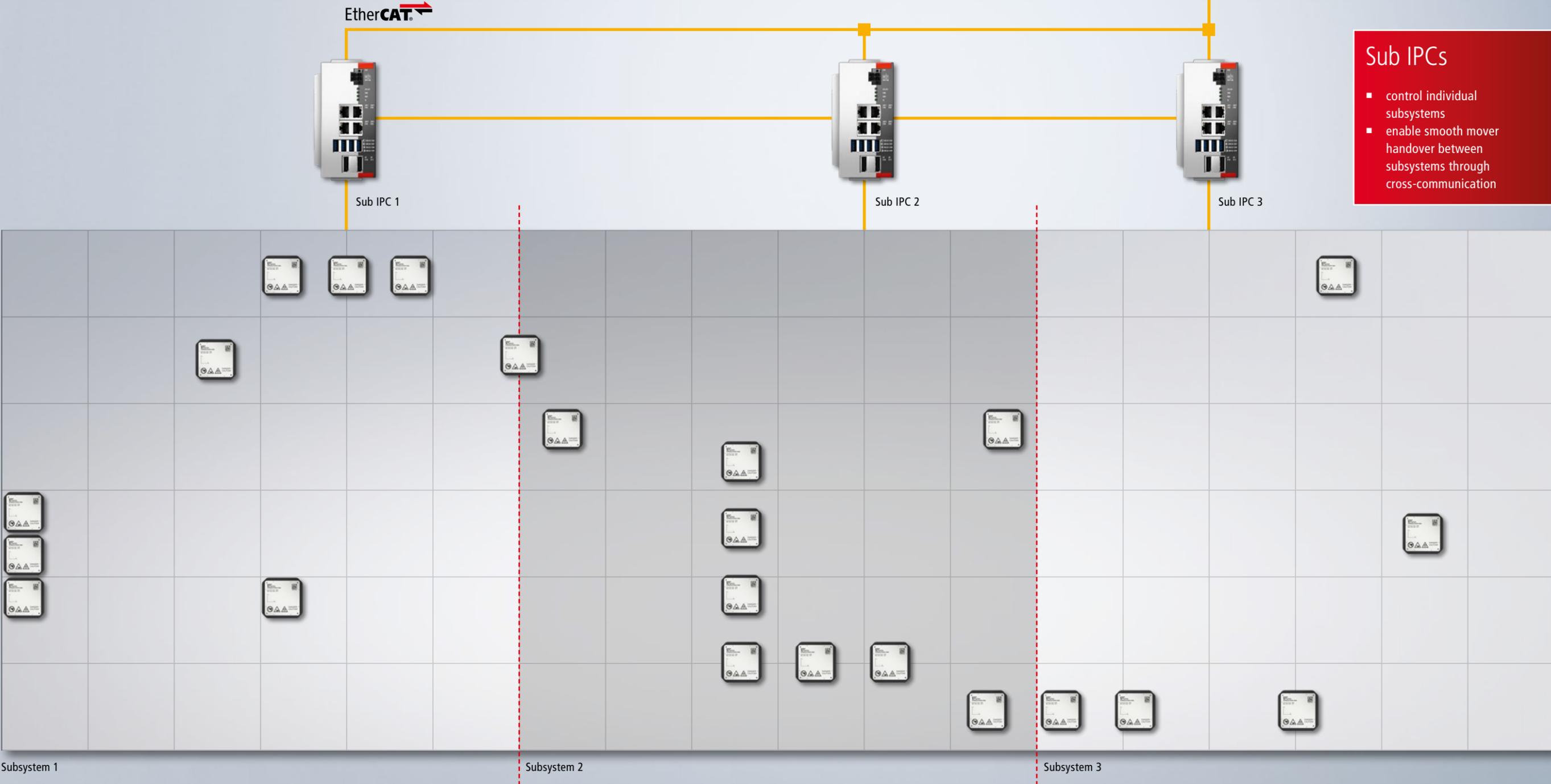
XPlanar applications: Revolutionary concepts across all industries

XPlanar enables innovative machine designs in a wide range of industries. Applications in the food industry benefit from the outstanding hygienic properties of the XPlanar tiles and movers. In electronics manufacturing, the free and highly accurate positioning capabilities of products in up to 6 dimensions can be used instead of external positioning systems. For example, adhesive dispensers or SMD placement systems can be mounted in a fixed position while the XPlanar movers carry out all positioning tasks to complete a process step. In pharmaceutical and lab environments, software-based shaking and vibration motion can be performed at defined amplitudes and frequencies in order to mix substrates. To save time, the shaking motion can be superposed on to the product transport from station to station. These and other system properties enable users to completely rethink existing processes. Based on the XPlanar system, engineers can design innovative machines that not only enhance cost-effective product manufacturing but also fundamentally reinvent what is possible with automation technology.

- jerk-free positioning
- high dynamics
- flexible use

- easy to clean
- chemically resistant surfaces
- hygienic product handling
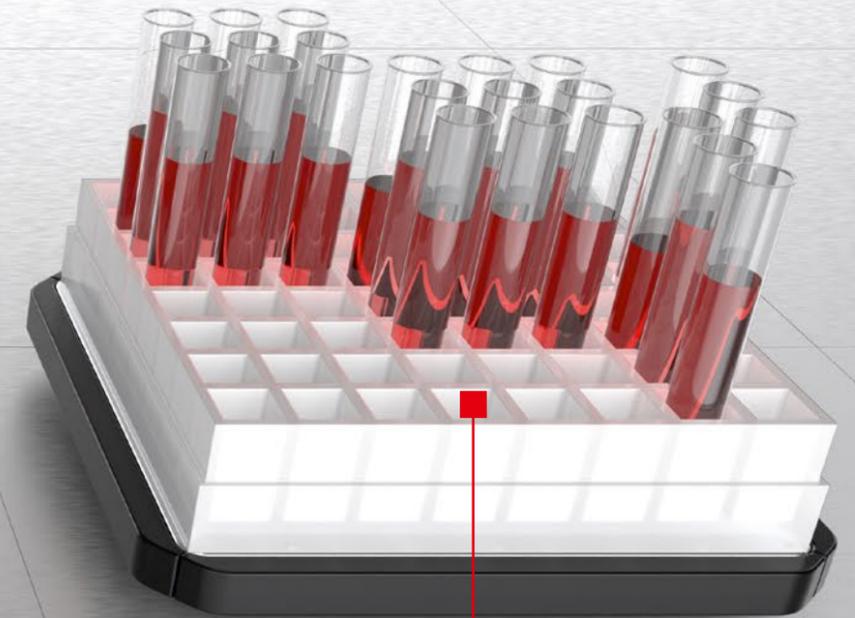
- no spilling of liquids
- no spreading of contaminants
- no abrasion/wear

XPlanar starter kits: Hitting the ground running with revolutionary technology

With the XPlanar starter kits, Beckhoff provides turnkey systems so that you can hit the ground running with XPlanar technology. The starter kits are delivered pretested and fully assembled. XPlanar tiles, a robust machine bed, the XPlanar movers, a high-performance industrial PC and a software example are included. Once they are out of the box, users can start to run their first tests immediately. The starter kits provide an overview of the technology's basic capabilities and an impression of the real-world application programming. They make it easy to take the first step toward your first XPlanar application.

APS9000
Starter kit for planar motor technology:
6 (2 x 3) APS4322 planar motor tiles,
2 APM4330 movers, CX2062 Embedded PC,
software, pre-installed, ready for operation

APS9001
Starter kit for planar motor technology:
12 (4 x 3) APS4322 planar motor tiles,
4 APM4330 movers, CX2062 Embedded PC,
software, pre-installed, ready for operation

DK3462-0623

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