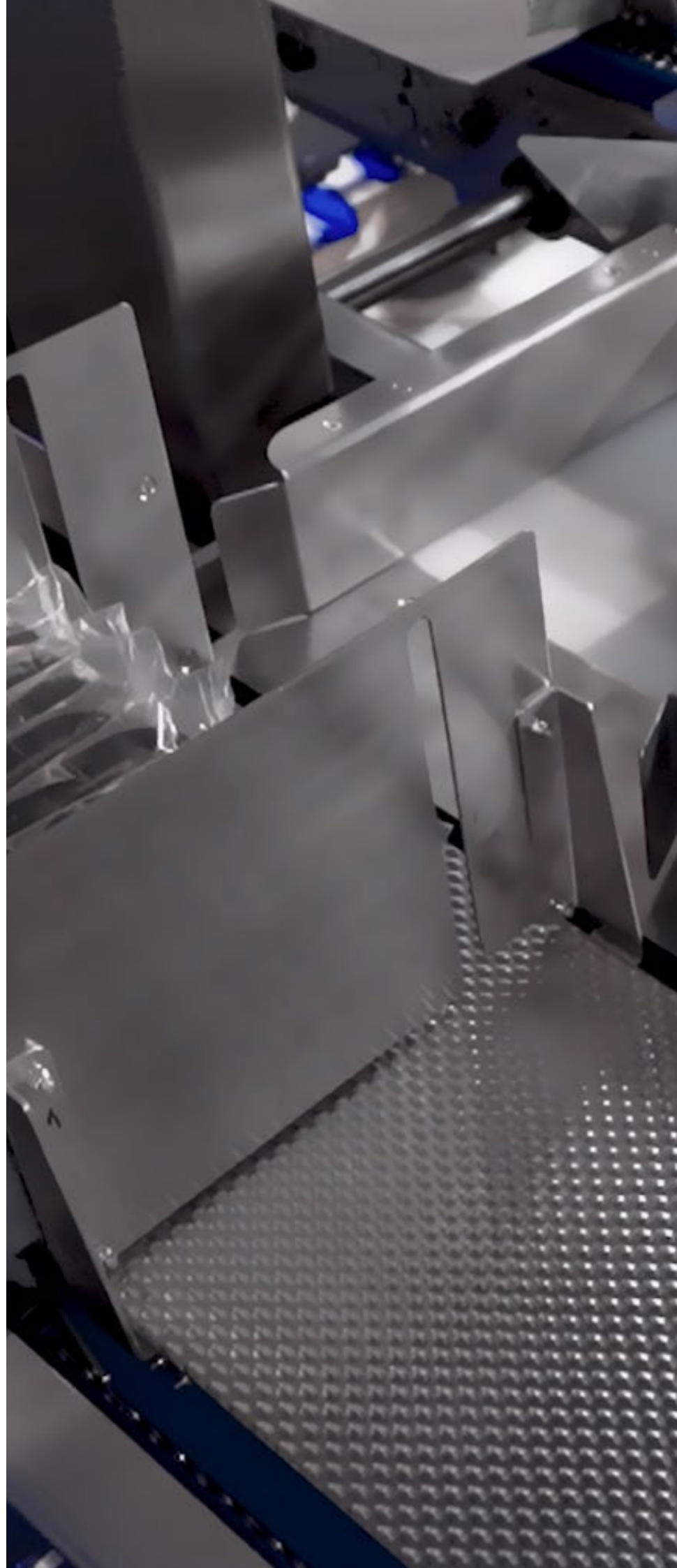


Conveyor Management: Prepared programming tools for continuous product infeed control

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**WHITE
paper**



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The operation of any packaging machine relies on the timely delivery of products through the control of a series of mechanical components. Software components that contribute to the harmonization of these processes form the basis of the logic for the subsequent steps in the installation and throughout the entire line.

Executive Summary

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This is where sustainability begins

In today's agenda, sustainability is closely associated with ecology, and the packaging world is keeping pace - regularly introducing new materials that are increasingly suitable for recycling in accordance with the 2030 European Strategy for Plastics in a Circular Economy. During the packaging process, numerous technological and consumer-oriented aspects must be taken into account, necessitating flexible and quickly adjustable production lines.

When crafting such production lines, numerous intricacies are paramount. One such critical aspect involves guaranteeing the prompt delivery of products with varying shapes to the processing and packaging area. Successfully tackling this challenge lays the groundwork for building a well-balanced ecosystem of mechanical and electrical components geared towards achieving high overall productivity, mitigating equipment downtime and curbing the generation of excess production waste.

Even during the production of standardized machines, a considerable amount of time is dedicated to tailoring them to meet specific customer demands, whether it involves modifications in engineering documentation or control software, or during the implementation phase. These procedures necessitate extra manpower and hours, potentially constituting up to 10% of the overall machine cost. Resource optimization becomes an unavoidable challenge for contemporary machinery manufacturers grappling with labor shortages in the job market.

This paper explores solutions for controlling the product feed in two customer-specific mechanical setups. The objective is to efficiently deliver these products to primary or secondary packaging machines, either individually or grouped together, at precisely the right moment, optimizing the transport of goods, boxes, and pallets, as well as managing half-products, waste, and unused consumables.



Why is product handling so important for the entire production chain

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Managing infeeding products on a system of conveyors is a critically complex and significant task in industrial operations. The efficiency and effectiveness of this process directly impact overall productivity, operational costs, and product quality.

Firstly, ensuring a smooth and continuous flow of products onto conveyors is essential for maintaining production consistency and meeting throughput targets. Any interruptions or bottlenecks in the infeeding process can result in downtime, leading to decreased productivity and increased costs.

Secondly, managing the infeeding process requires careful coordination to prevent product damage or loss. Products must be properly aligned, spaced, and

oriented to prevent jams, collisions, or spills, which can not only damage the products themselves but also disrupt the entire production line.

Additionally, in modern manufacturing environments, where customization and just-in-time production are increasingly common, the ability to quickly adjust and reconfigure conveyor systems to accommodate changing product requirements is paramount. Flexibility in managing infeeding processes allows for agile responses to market demands and customer preferences.

All we need is motion

Motion profiles offer significant benefits in terms of efficiency, precision, and safety in product handling,

“Managing infeeding products on a system of conveyors is a critically complex and significant task in industrial operations.”

their implementation is a complex endeavor that requires careful consideration of various technical and operational factors. Transfer of the product from the Feeding conveyor to the Receiver must be done synchronously to guarantee that neither slip nor friction have any effect on the products final position.

The SmartConveyor and RaceTrack library provide a ready-made solution for 2 types of the customer mechanics for handling of the multiple products from the feeding conveyor and deliver them to a primary or secondary packaging machine one-by-one or grouped in right time. This reduces developing and commissioning time, thus reducing total implementation costs.

Tool implementation

Both tools are deployed as a Sysmac Studio Functional Block library, compatible with NX and NJ controllers. So, the first step is to add desired library to a Sysmac Studio project.

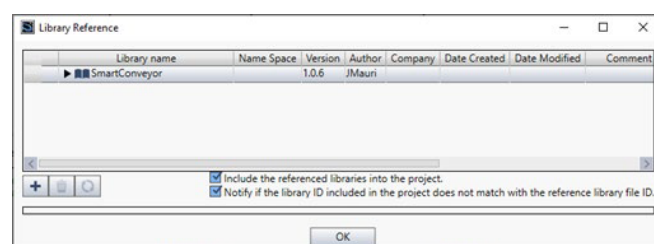
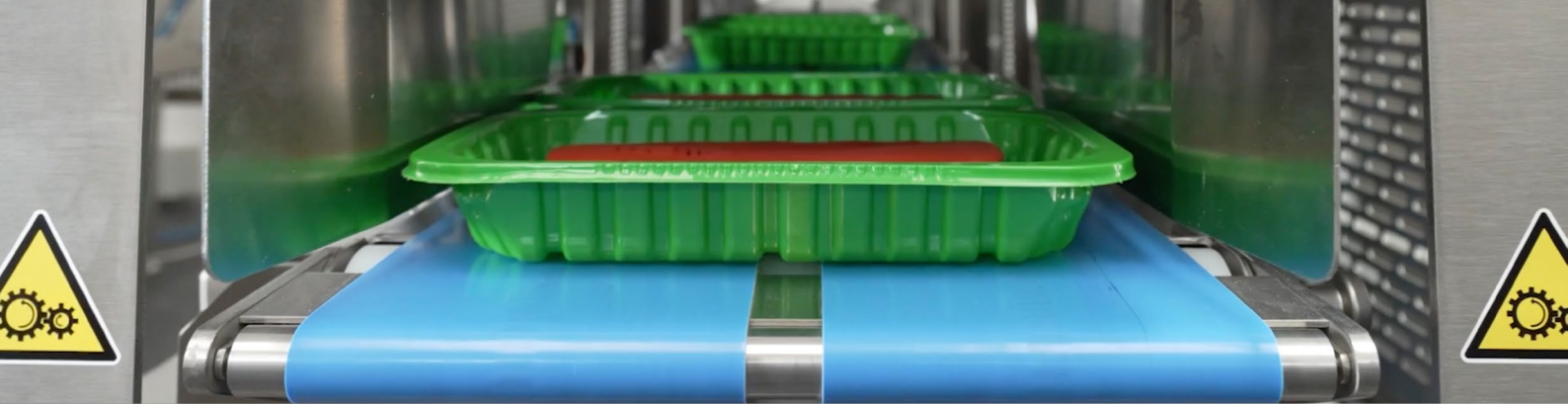


Figure 1. Adding FB library to a Sysmac Studio project



The SmartConveyor solution

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The main component of this library is the FB_SmartConveyor function block. It can control a sequence of two conveyor belts, one should be coupled with Omron Servo system (G5/1S/1SA-series) via EtherCat, the second one - with encoder device (or servo system too), plus we need to install a product detection sensor on the feeding side. Depends on are there pushers on the receiving belt or not, we can identify 2 working mode. Look at the picture 1.

The SmartConveyor operates as a slave axis, with its master determined by the current operating mode. In Receiver mode, the feeding conveyor acts as the master, while in Feeder mode, it's the receiving conveyor. The SmartConveyor calculates its motion profile based on product positions to ensure synchronous product transfer, eliminating the need for CAMs and profile correction calculations. Product position buffering is managed by FB_ProductsQueue from the same library.

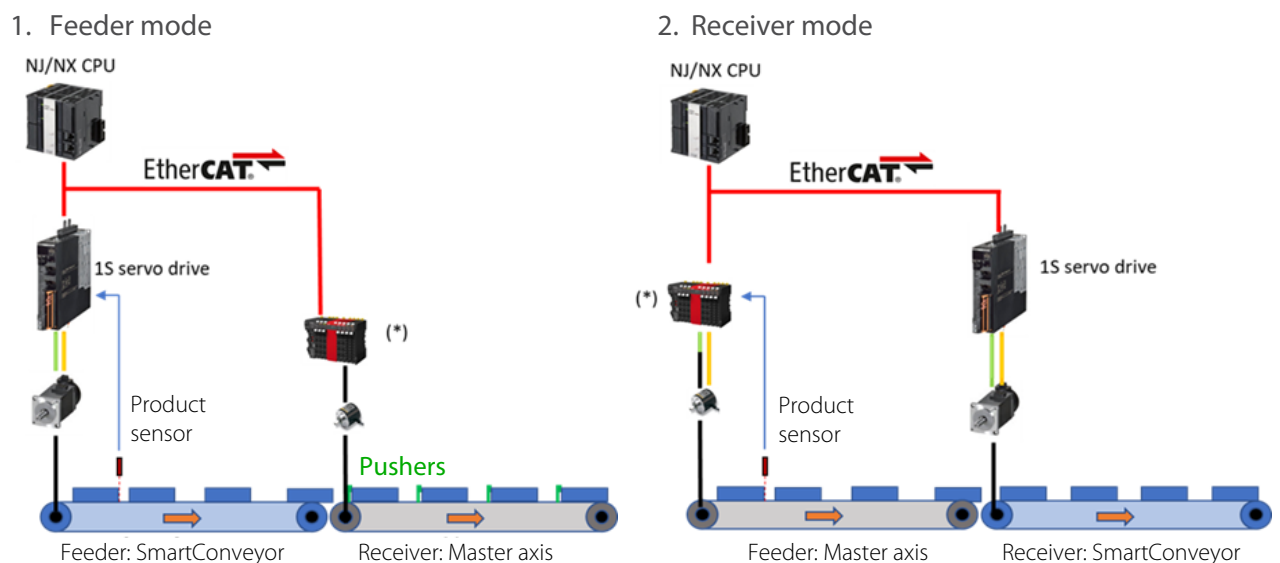


Figure 2. SmartConveyor: architecture of 2 modes

Quick parametrization

In programming part it is necessary to call the FB instance and operate with its input and output variable sets. Some of them are simple, for example, assign motion axes; some are quite complex, like data structures.

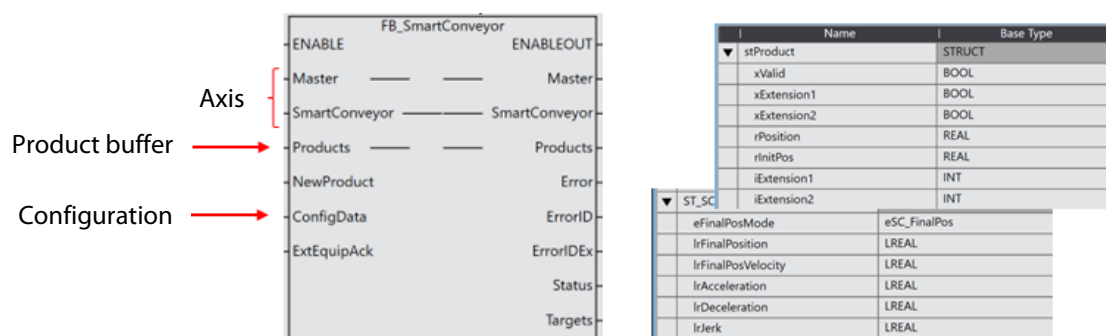


Figure 3. FB instance and input structure example

A synchronized “window” between conveyors ensures seamless product transfer with matching velocities to prevent slip or friction. This synchronization guarantees accurate product positioning on the receiving conveyor. The SmartConveyor adjusts its velocity outside the window to maintain the desired product distance. Product content monitoring is available for system behavior observation.

Extended functionality

Ensuring consistent spacing between products is crucial to maintain the uninterrupted operation of horizontal packaging machines (HFFS) or tray sealers. However, in Receiver mode, the Function Block offers additional functionality. It enables the grouping of products, allowing them to be handled simultaneously by external mechanisms, such as robots.

Moreover, the FB in Receiver mode includes a valuable feature for suppressing mechanical vibrations of products during movement and stopping. Anti-sloshing capability is particularly important as it helps prevent splashing of liquid products onto conveyor mechanisms, reducing the risk of contamination and minimizing product loss before sealing. For instance, this feature is especially beneficial when handling trays of ready-to-eat food, ensuring optimal product quality and efficiency in the packaging process.



Figure 4. Smart Conveyor

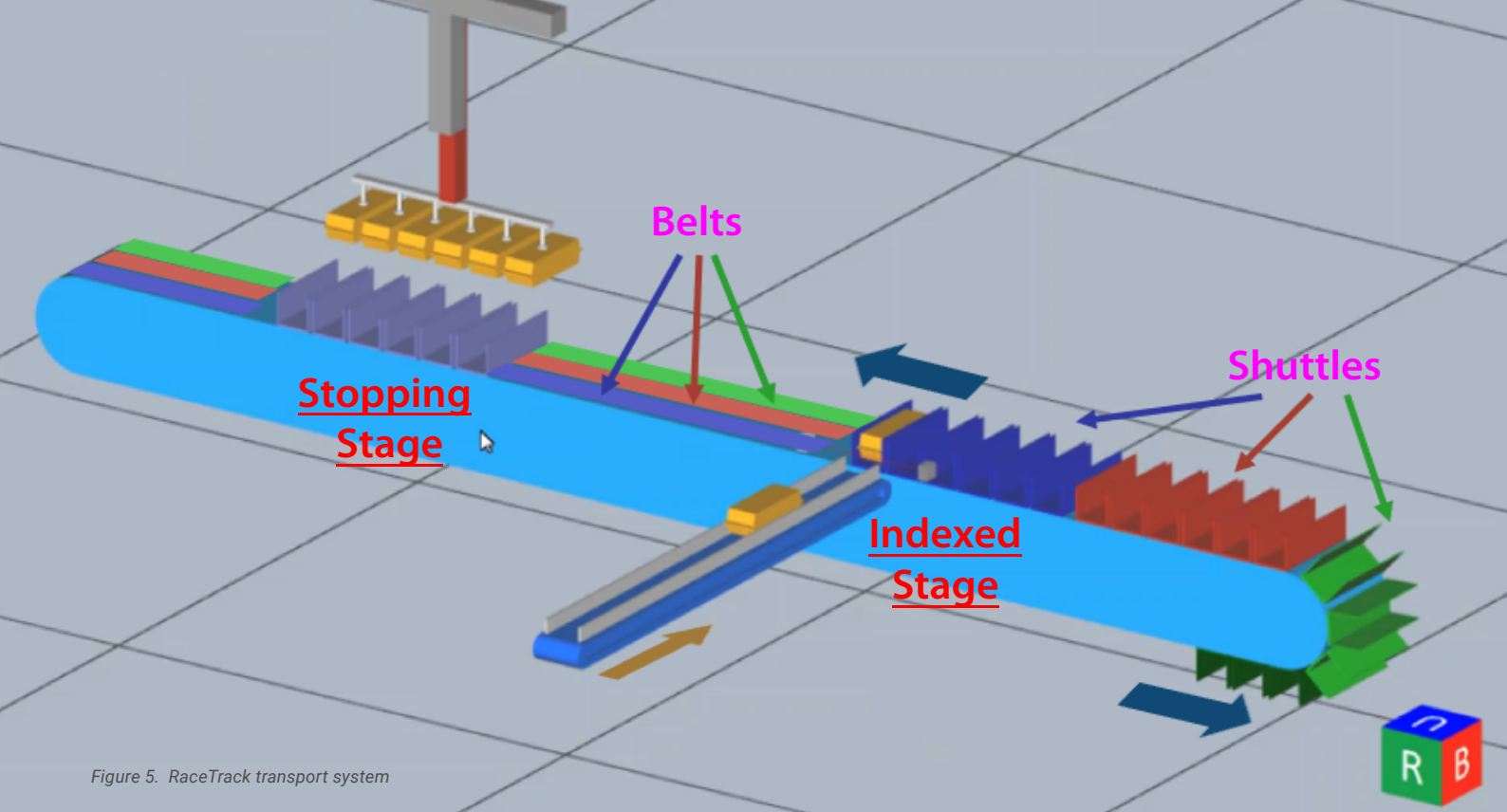


Figure 5. RaceTrack transport system

The RaceTrack Solution

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The RaceTrack transport system revolutionizes material handling with its high-speed capabilities and efficient design. Its unique closed-loop track layout ensures seamless product flow without the need for complex reversing maneuvers. By employing multiple parallel conveyor belts along the looped track, products are swiftly transported from one point to another, optimizing throughput rates while conserving floor space.

In various industries the RaceTrack system plays a pivotal role in streamlining operations. Products are efficiently changed orientation, grouped and transported along, ready for further processing or packaging. One common integration is with Top/Side Loader Case

Packers, where products are seamlessly loaded into cases for packaging and distribution. This integration maximizes efficiency, reduces labor costs, and minimizes the risk of errors in the packaging process. Moreover, the RaceTrack transport system offers flexibility in routing and sorting products, catering to diverse production needs. Its ability to handle high volumes of products with precision and care makes it an invaluable asset in modern manufacturing and distribution facilities. By combining speed, efficiency, and adaptability, the RaceTrack system contributes to enhanced productivity and streamlined operations across various industries.

Since the belt system (and Shuttles on them) utilize the same path (trajectory) while executing asynchronous movements, each of them is connected to its servo system, and the control system must prevent potential mechanical collisions between shuttles. Additionally, various scenarios of interaction with external devices and products within the limited trajectory segment (Stage) must be implemented. Basically, four options of stages can be distinguished:

- Indexed;
- Stopping;
- Continuous velocity;
- Waiting.

FB_RaceTrack library features

The library supports control of up to 4 belts and up to 6 stations with various purposes. Each belt can accommodate more than one shuttle, and the number, configuration, and sizes of slots inside the shuttle are not fixed rigidly and can be specified with different variability.

Supported stages:

- **Indexed stage:** when a shuttle is in this type of stage, it'll move a given distance each time a signal is received. Typically used to load products in the shuttle.
- **Stopping stage:** the shuttle remains stopped in the stage until a condition is fulfilled (signal or time).
- **Continuous velocity:** the shuttles just go through the stage at a defined velocity.
- **Waiting:** the shuttle goes to an initial position waiting a new task for the next stage.

In addition, the library includes functionality for returning all mechanisms to their Homing positions; Auto & Manual mode; Emergency stop and seamless recovery from it; Troubleshooting. Continuous monitoring is implemented to prevent mechanical collisions. Similar to the previous library, the parameterization of the transport system's operation is done by writing data to the input variables of the Function Block, the detailed structure of which is described in the documentation. In particular, values need to be inputted for: track length, number of belts, shuttles, stations, and their parameters, as well as slot configuration.

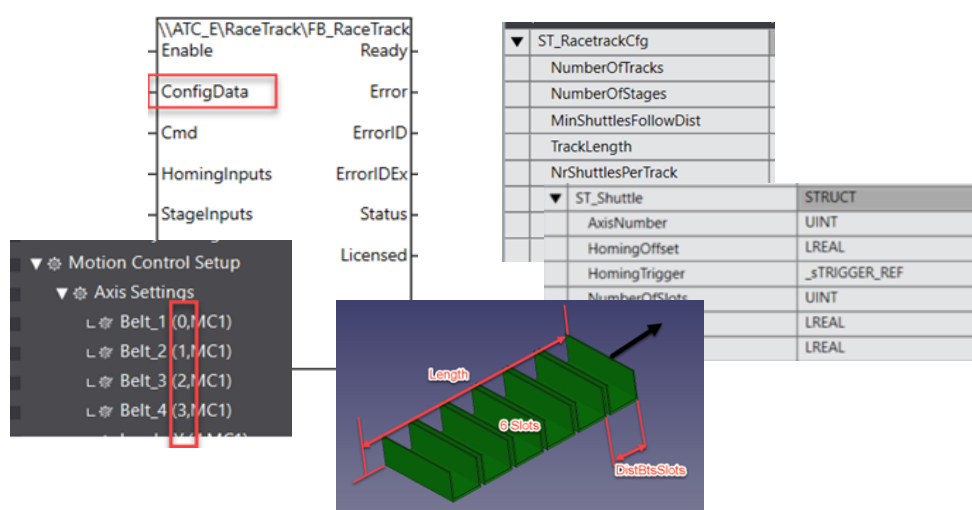
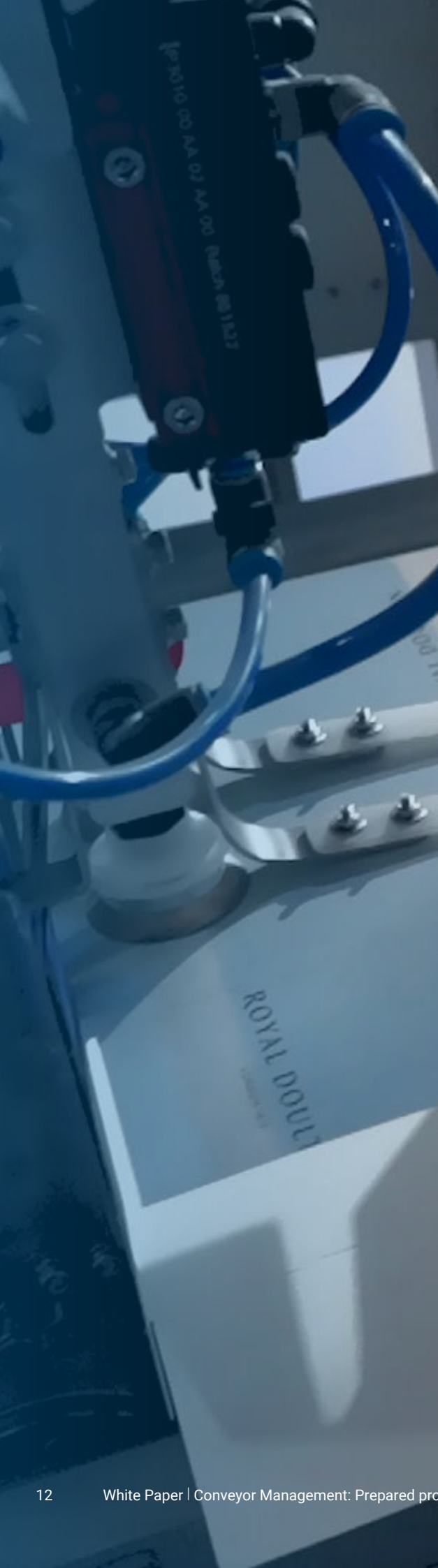


Figure 6. FB_RaceTrack and parametrization



Tool distribution

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Both Function Block libraries are distributed under a license agreement. The license is perpetual, requires prepayment, and is intended for managing a single declared mechanism. The key is strictly tied to the PLC's MAC address and is embedded in one of the input variables of the Function Block. To obtain installation files, documentation and activate the key, please contact your local OMRON representative. For testing purposes, the FB can be used for the first two hours without inputting a license key.

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Sysmac Studio

Stands out as an advanced software compliant with IEC 61131-3, offering a versatile programming environment with support for multiple languages and motion control instructions. Sysmac Studio supports wide portfolio of OMRON devices, from NX and NJ machine automation controllers to smart devices like servo systems, vision, safety devices and digital sensors. Its 3D Simulation feature simplifies development and debugging processes, enabling control and verification of robots and peripheral equipment in a single operation. Moreover, it incorporates advanced security features to protect investments and machines, including prevention of incorrect connections or operations.

Sysmac FB Libraries Repository

This online software repository lets licensed Sysmac Studio users download some free of charge rigorously tested Function/Function Blocks for multiple applications in different industries. The libraries are intended to be used with both the NX and NJ series machine automation controllers. In total, this will help reduce programming time and focus on increasing the efficiency of your overall developed system. For more information, please visit: <https://www.ia.omron.com/product/tool/sysmac-library/>

With extensive expertise in OMRON equipment, profound knowledge in motion control and process automation tasks, and rich experience in solutions for packaging machines, we bring a comprehensive skill set to the table. Our deep understanding of OMRON technology allows us to effectively implement and optimize solutions tailored to the unique needs of our clients. We excel in designing, integrating, and maintaining systems that leverage OMRON's capabilities to drive efficiency and productivity in packaging operations.

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