REV 1.3

ITS PLC®

INTERACTIVE TRAINING SYSTEM FOR PLC

# User Guide

## Professional Edition



Real Games

IMPROVING REALITY

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# CONTENTS

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# Welcome

## WHAT IS ITS PLC® PROFESSIONAL EDITION?

ITS PLC Professional Edition - Interactive Training System for PLC - is an education and training tool for PLC programming. Based on the latest PC technology, ITS PLC makes PLC training easy and fun. Virtual environments have never been so real, featuring cutting-edge 3D real-time graphics, physics, sound and total interactivity. The result is an immersive simulated environment that allows highly realistic training systems, without any risk of injury to man or damage to machine.

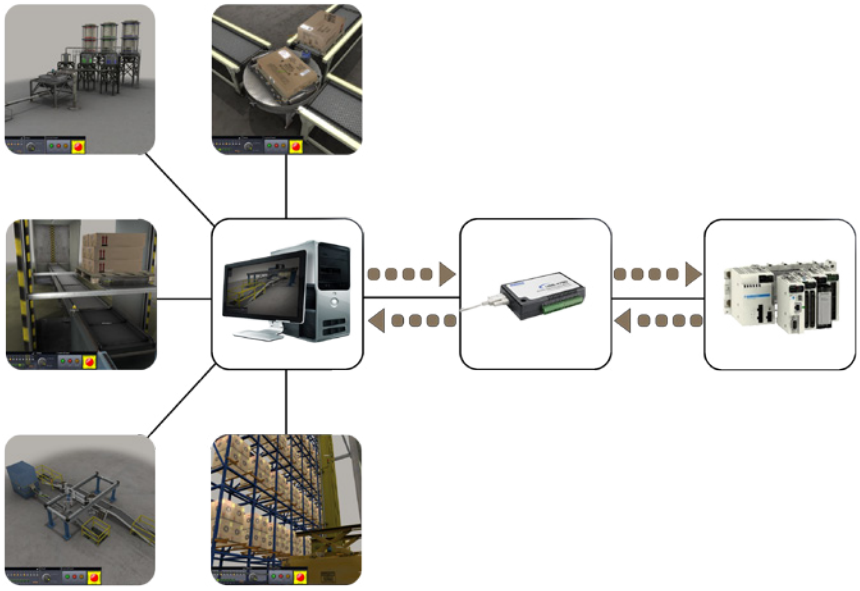
ITS PLC offers problems with increasing levels of difficulty so that users can progress to more advanced exercises as they improve their skills.

## HOW DOES IT WORK?

ITS PLC offers five virtual systems for education and training in PLC programming. Each system is a visual simulation of an industrial system including virtual sensors and actuators, so its state can be sensed by the PLC. The objective is to program the PLC to control each virtual system as if it was a real system.

The information is exchanged between the PLC and the virtual system by a data acquisition board (DAQ) with 32 I/O isolated channels and USB interface.

Information exchange between the systems, DAQ board and the PLC:



# Installation

## MINIMUM SYSTEM REQUIREMENTS

The minimum system requirements to run ITS PLC Professional Edition are:

| | |
|---|---|
| **Processor** | Pentium IV or AMD K8 at 1GHz |
| **Memory** | 256 MB of RAM |
| **Disk Space** | 200 MB of available disk space |
| **Operative System** | Windows XP (Service Pack 2) |
| **Graphics Card** | Compatible with DirectX 9.0, 64MB and support for vertex/pixel shader 1.1 |
| **USB** | One USB 1.1/2.0 port |
| **PLC** | PLC with 16 digital inputs and 10 digital outputs* |

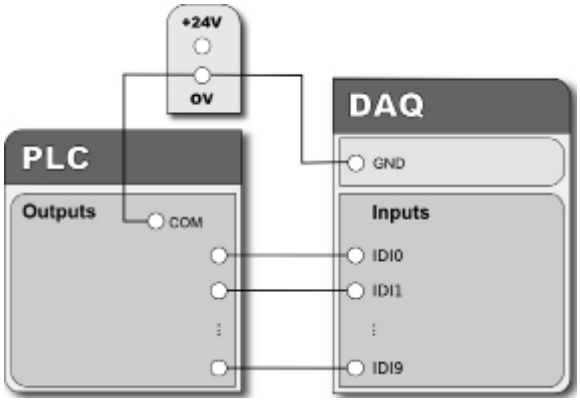
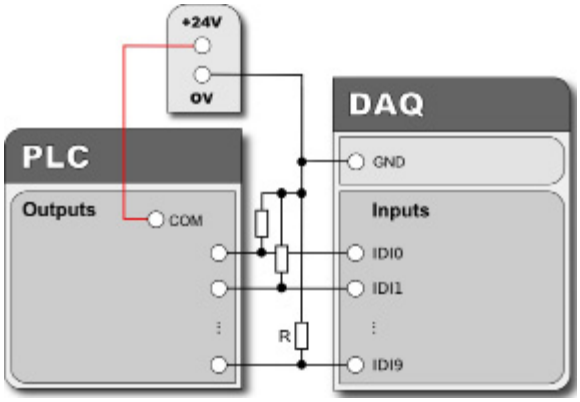
* It is possible to control the systems with a 12 inputs and 8 outputs PLC, if you are not using the Start, Stop, Reset, Emergency buttons and the LED indicators from the Start and Reset buttons.

## HARDWARE CONFIGURATION

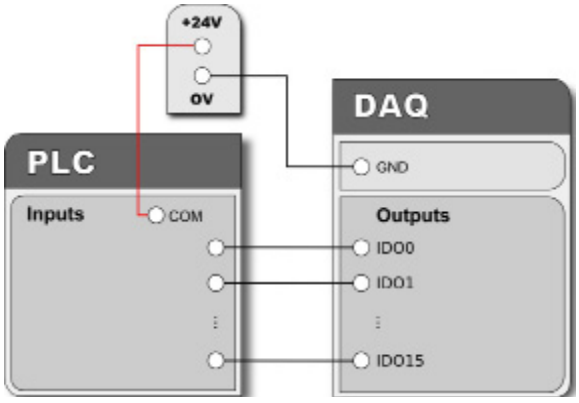
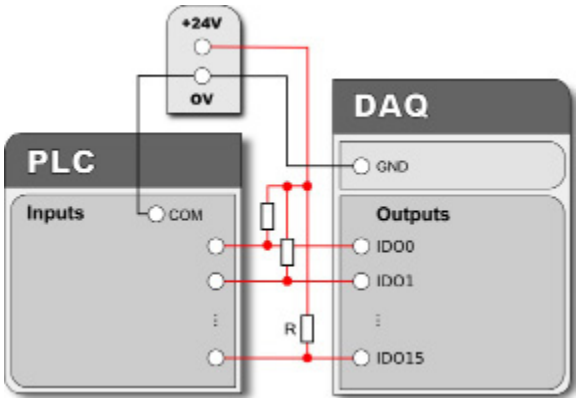
The information exchange between a PLC and ITS PLC Professional Edition is made with an USB DAQ board from Advantech, with 32 isolated I/O channels.

Advantech DAQ board (USB-4750).

To establish a connection between a PLC and the DAQ board, follow the schemes below:

| PLC OUTPUTS | |
|---|---|
| Type | How to Wire |
| RELAYS/SINK TYPE TRANSISTORS |  |
| SOURCE TYPE TRANSISTORS<br><br>When using a PLC with source type transistor outputs, the logic values are inverted. Invert the actuators values on the options menu |  |
| **Resistors R** | We suggest resistors with values between **1KΩ** and **4.7KΩ** with a power rating of **0.5W** |

## PLC INPUTS

| Type | How to Wire |
|---|---|
| SOURCE TYPE TRANSISTORS |  |
| SINK TYPE TRANSISTORS<br><br>When using a PLC with sink type transistor inputs, the logic values are inverted. Invert the sensors values on the options menu |  |
| **Resistors R** | We suggest resistors with values between **1KΩ** and **4.7KΩ** with a power rating of **0.5W** |



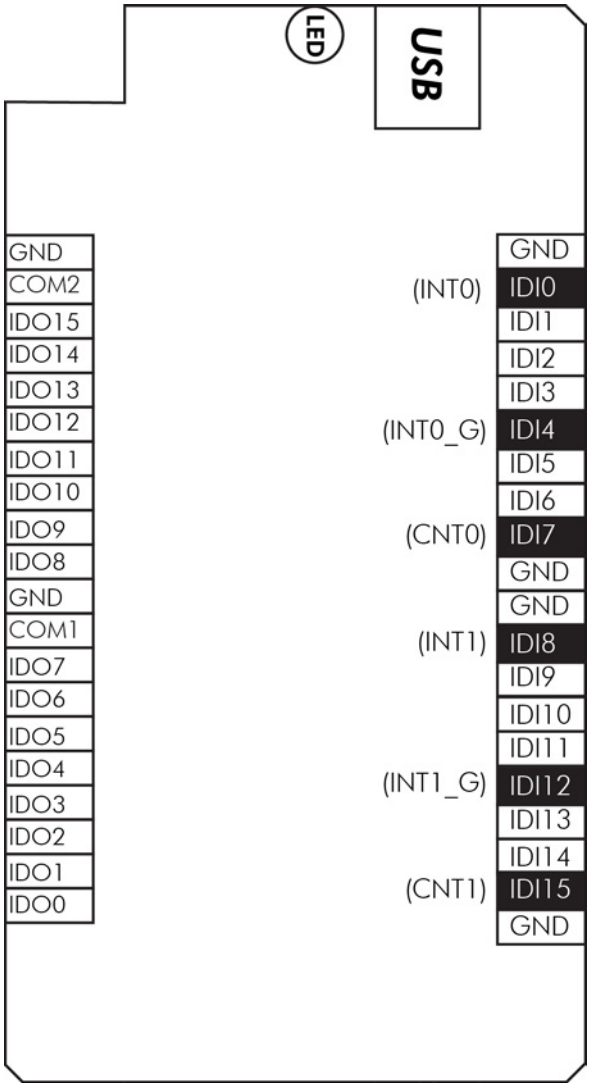


**Note:** The DAQ board supports input voltages from 5V to 50V, and output voltages from 5V to 40V. If you're not sure on how to properly wire the device, consult the Advantech manual.

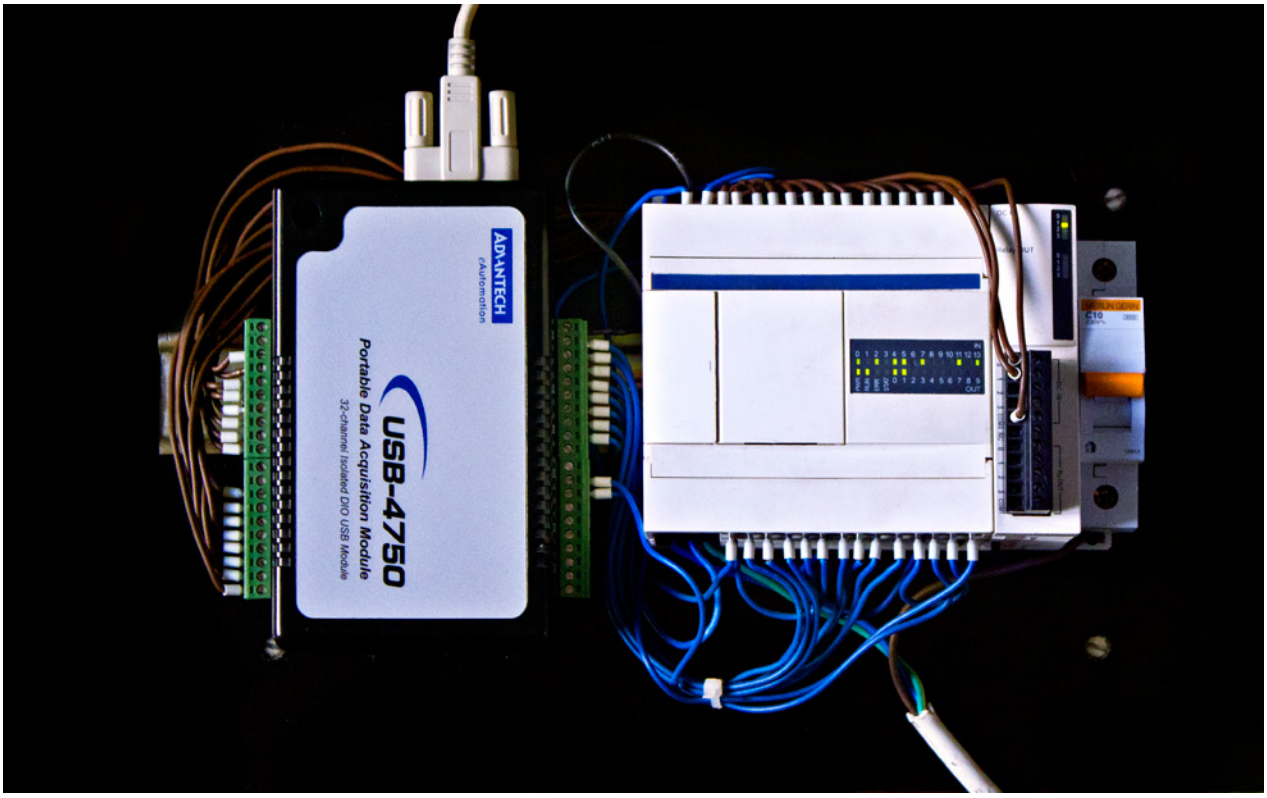
**Important:** The DAQ board must be configured with BoardID = 0 (default configuration).

The relation between ITS PLC inputs/outputs and the DAQ board:

| ITS PLC | DAQ Board |
|---|---|
| Sensor 0 | IDO0 |
| Sensor 1 | IDO1 |
| Sensor 2 | IDO2 |
| Sensor 3 | IDO3 |
| Sensor 4 | IDO4 |
| Sensor 5 | IDO5 |
| Sensor 6 | IDO6 |
| Sensor 7 | IDO7 |
| Sensor 8 | IDO8 |
| Sensor 9 | IDO9 |
| Sensor 10 | IDO10 |
| Manual/Auto Selector Switch | IDO11 |
| Start Button | IDO12 |
| Stop Button | IDO13 |
| Reset Button | IDO14 |
| Emergency Stop Button | IDO15 |
| | |
| Actuator 0 | IDI0 |
| Actuator 1 | IDI1 |
| Actuator 2 | IDI2 |
| Actuator 3 | IDI3 |
| Actuator 4 | IDI4 |
| Actuator 5 | IDI5 |
| Actuator 6 | IDI6 |
| Actuator 7 | IDI7 |
| Start Button Light | IDI8 |
| Reset Button Light | IDI9 |



Electrical wiring between DAQ board and PLC.

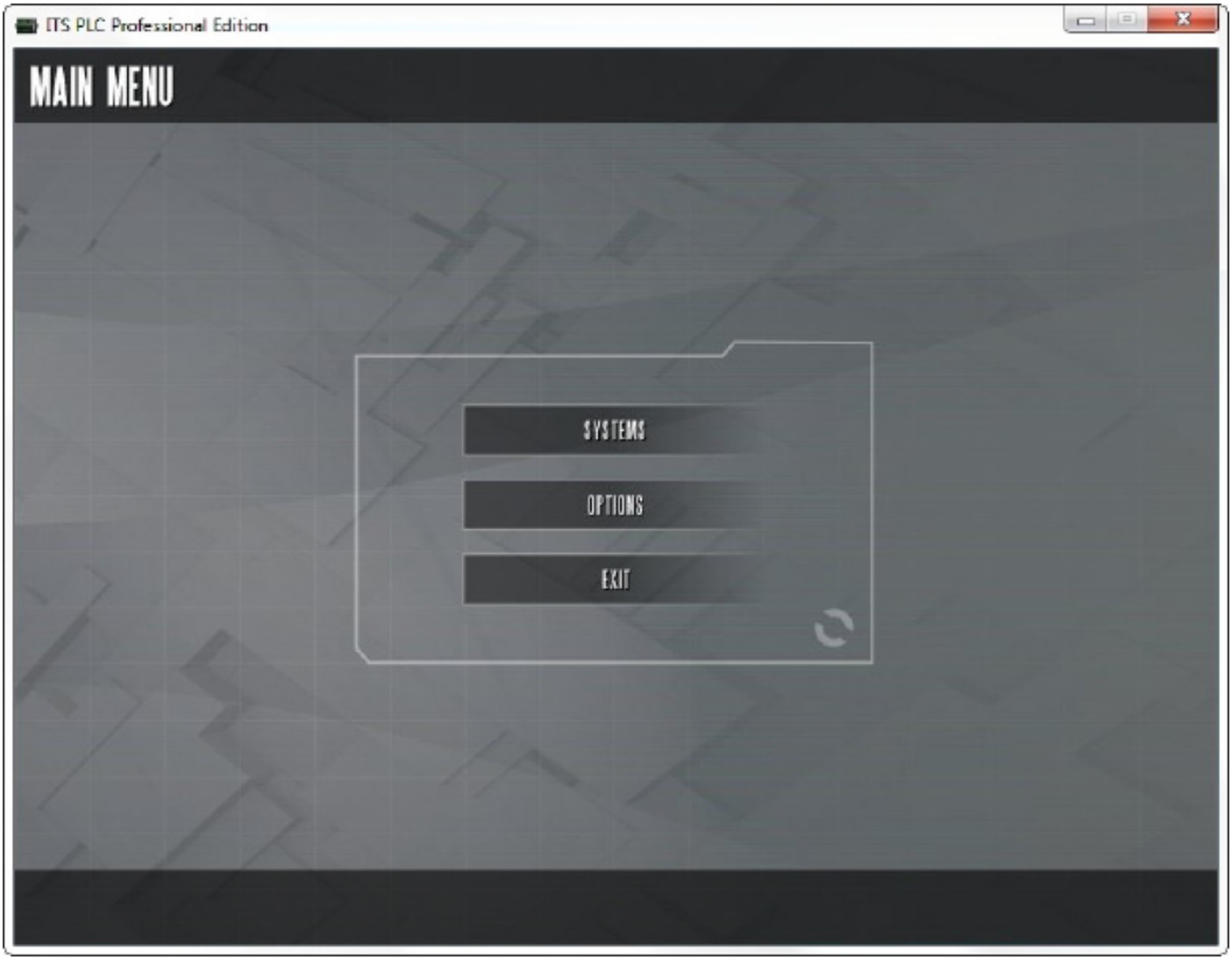



USB interface between PC and DAQ board.

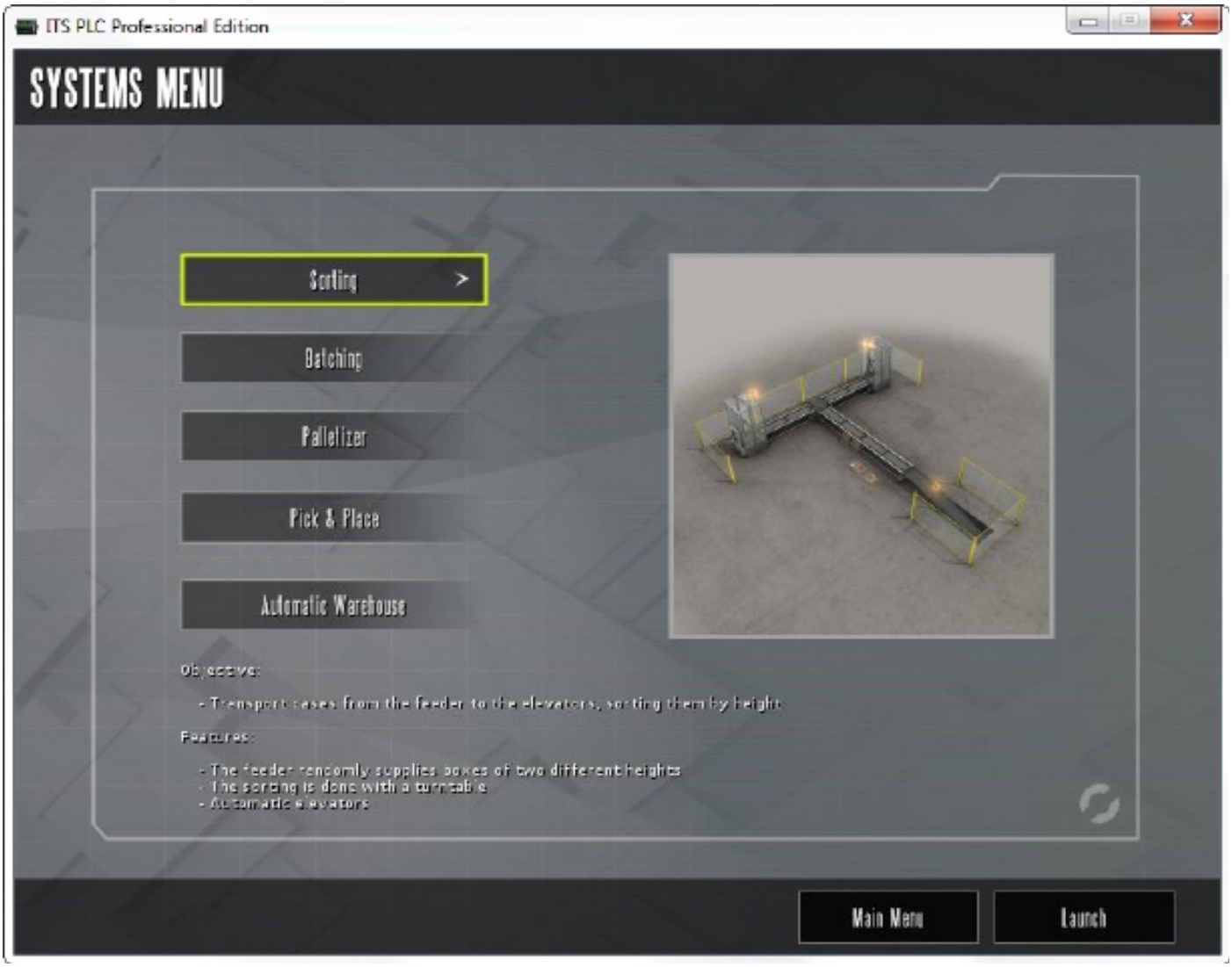
# User Interface

## MENUS

After ITS PLC Professional Edition is started, the main menu is displayed.
Click **Systems** to enter the systems menu or **Options** to enter the options menu. Click **Exit** to exit and close the application.

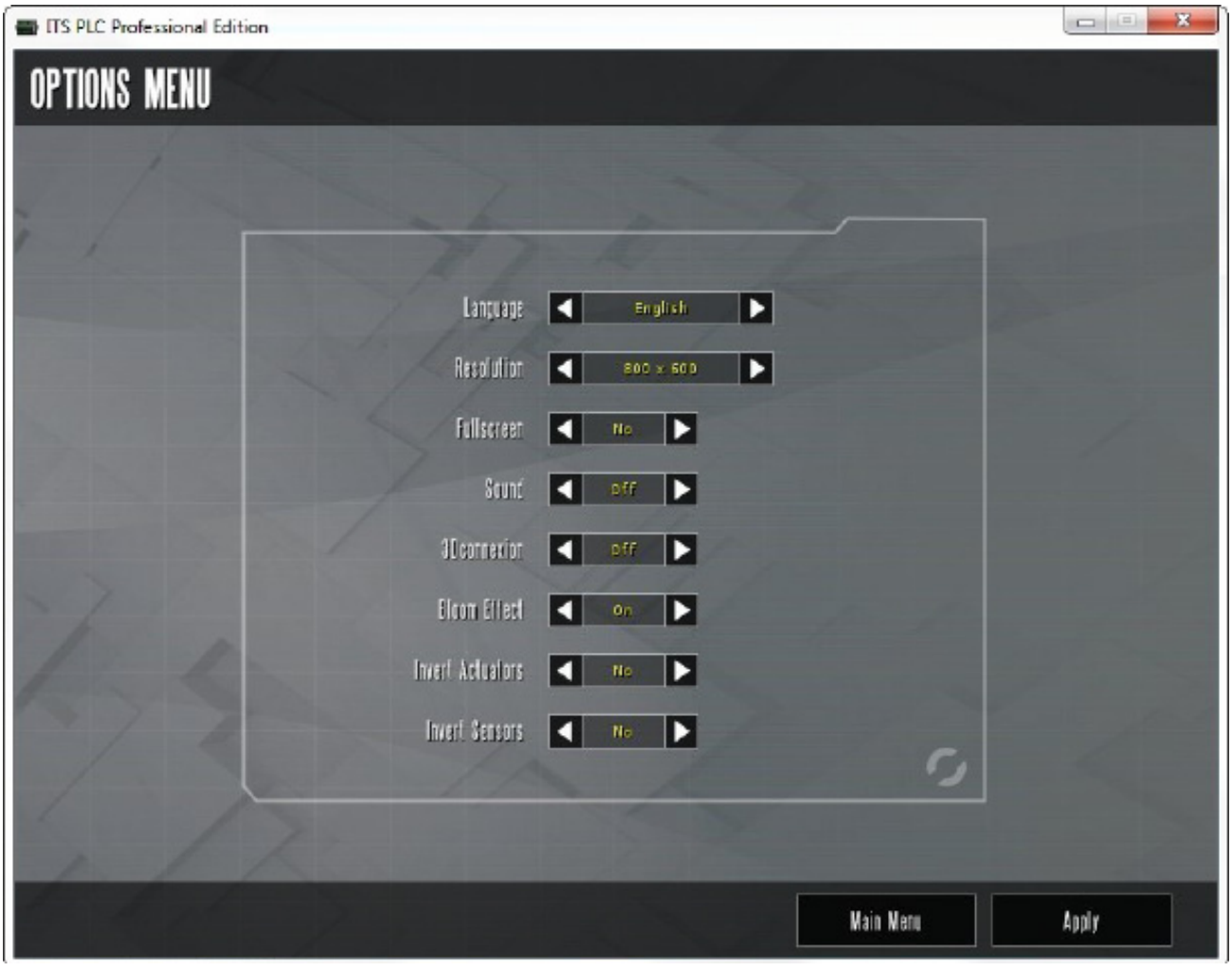


In the systems menu select the desired system and click **Launch**. If you wish to go back to the main menu click **Main Menu**.



In the options menu you can choose from several settings:

| | |
|---|---|
| **Language** | Select a language |
| **Resolution** | Select a supported screen resolution |
| **Fullscreen** | **Yes** - Fullscreen mode |
| | **No** - Window mode |
| **Sound** | Turn the systems sound **On** or **Off** |
| **3Dconnexion** | **On** - Use the 3Dconnexion SpaceNavigator™ for navigation |
| | **Off** - Use the keyboard + mouse for navigation |
| **Bloom Effect** | **On** - For a more realistic scene illumination |
| | **Note:** This effect requires a graphics card with DirectX9.0c support |
| **Invert Actuators** | **Yes** - For PLC with source type transistor outputs |
| | **No** - For PLC with relay or sink type transistor outputs |
| **Invert Sensors** | **Yes** - For PLC with sink type transistor inputs |
| | **No** - For PLC with source type transistor inputs |



## SYSTEM PANELS

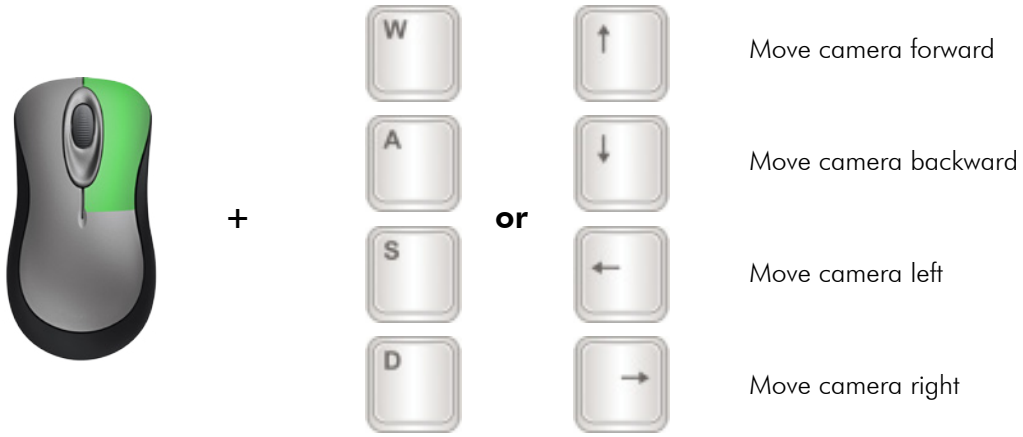

All the systems have a common user interface consisting of five panels, described below:

| | | |
|---|---|---|
| Utility Panel | 1 | • Choose one of the predefined cameras, with the **Camera selector**<br>• Click **Sensors** to display the sensors overhead tags<br>• Click **Actuators** to display the actuators overhead tags<br>• Click **Failures** to display the failures panel<br>• Click **Clear** to reset the system<br>• Click **Exit** to return to the main menu |
| Inputs/Outputs Panel | 2 | • Shows the state of the sensors and actuators<br>• Use this panel to manually control the system, when in manual mode<br>• Click the sensors LED to force its state to On<br>• Click the actuators buttons to force its state to On (in auto mode)<br>• If the DAQ board connection is established, the USB icon color changes to orange<br>• If a valid license key is found, an open lock is displayed in the top right corner of this panel. Otherwise a closed lock is shown |
| Mode Panel | 3 | Toggle the system mode with the mode selector. When in manual mode the system is controlled by the user. When in auto mode the system is controlled by the PLC |
| Control Panel | 4 | Control the system through this panel when in auto mode |
| Failures Panel | 5 | Simulate failures on sensors and actuators through this panel |

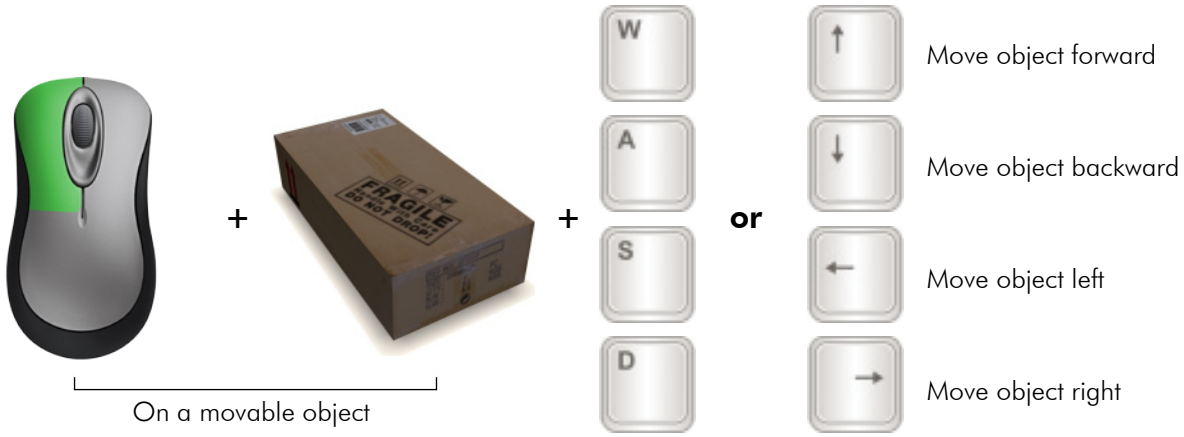
## SYSTEM NAVIGATION

### Mouse + Keyboard

Press the right mouse button and use the W, S, A, D or the cursor keys to move and rotate the camera. Use the scroll wheel to translate the camera vertically.



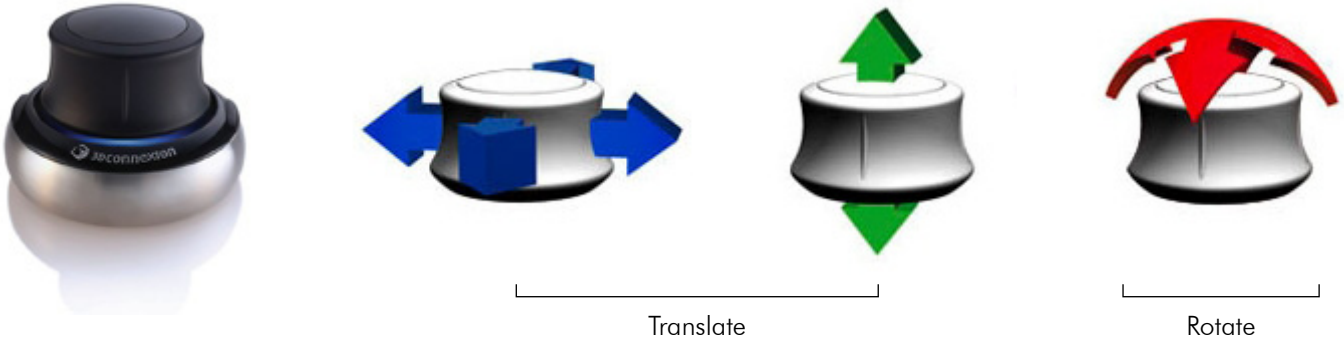

To pick up and drag any movable object (pallets, cases, etc.) press the left mouse button and drag the object.




**Note:** You can simultaneously move the object and rotate the camera by pressing both mouse buttons.

### Mouse + 3Dconnexion

To use this navigation mode, you need a SpaceNavigator™ from 3Dconnexion. The following image shows the different available movements.




To pick and drag any movable object (pallets, cases, etc.) press the left mouse button and drag. Notice that you can combine the movement of the camera with the movement of the picked object.

## SHORTCUT KEYS

For a quicker interaction with ITS PLC use the following shortcut keys:

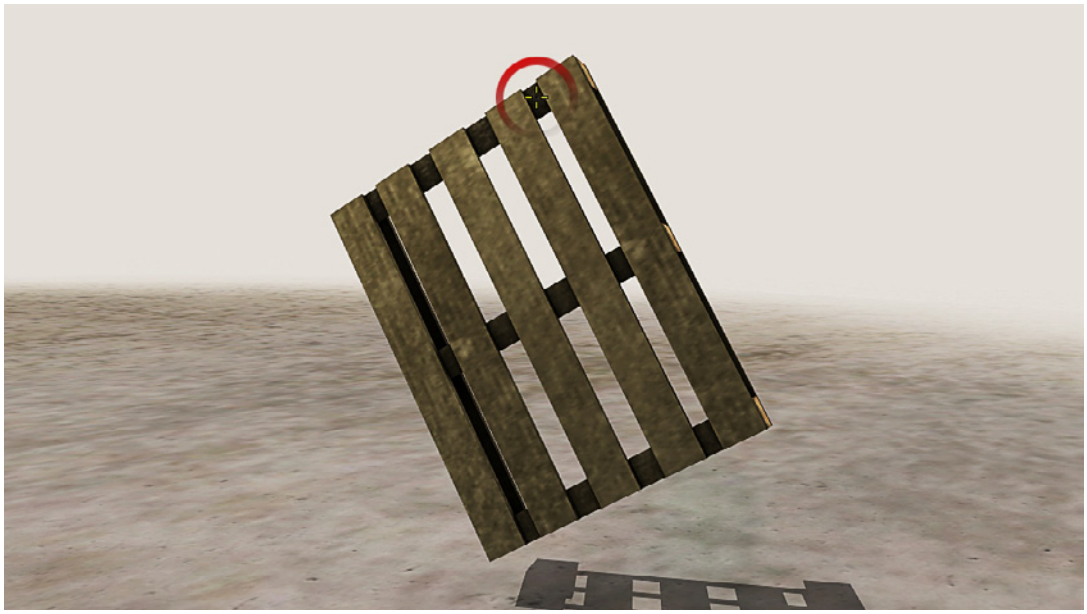
| | |
|---|---|
|   | Select the previous/next camera |
|   | Show/hide the sensors overhead tags |
|   | Show/hide the actuators overhead tags |
|   | Show/hide the failures panel |
|   | Clear the system |
|   | Switch the actuators On/Off |
|   | Select manual mode |
|   | Select auto mode |
|   | Zoom the camera |
|   | Exit the system |

## SYSTEMS INTERACTIVITY

One of the main features of ITS PLC Professional Edition is the ability to interact with movable objects in real time, at any moment during the simulation. The movable objects are identified by a target mouse icon. Simply click and drag the object to where you want to place it.

The target mouse icon indicates a movable object:

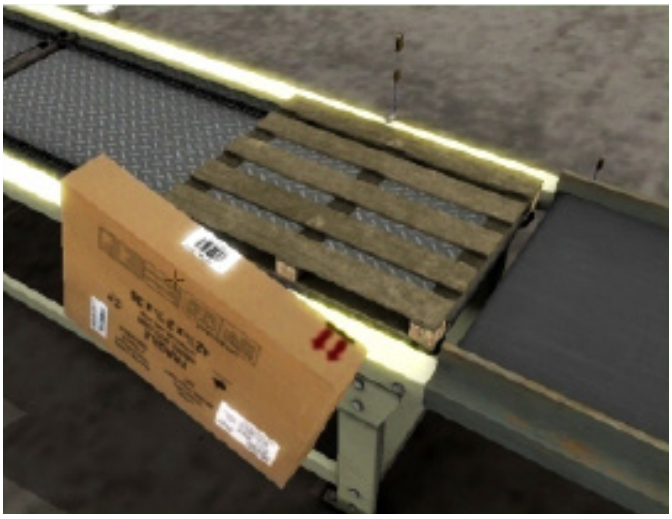
**PLAY VIDEO**

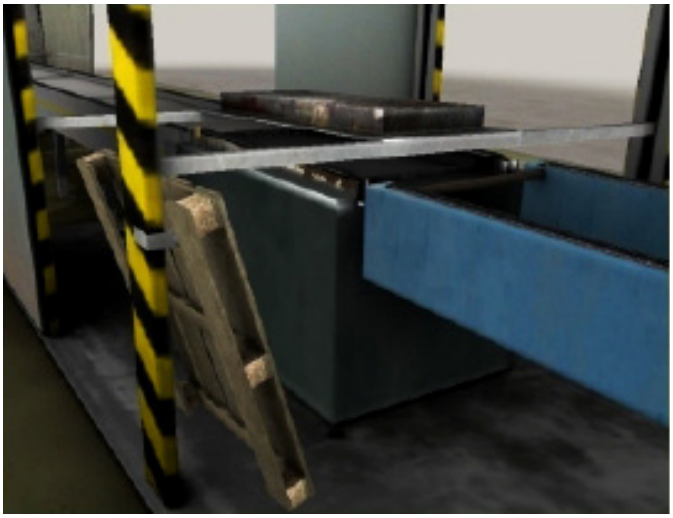


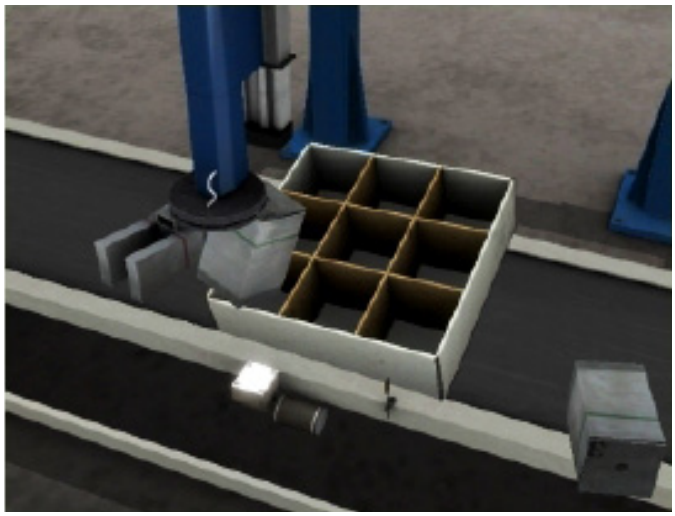
With this feature you can:

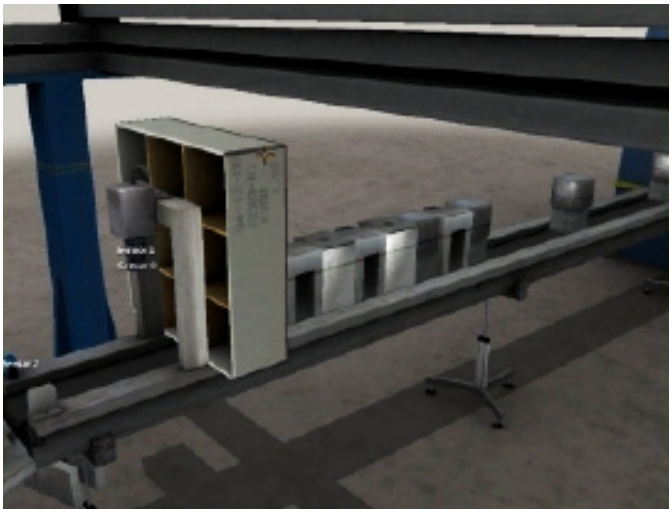
- Interact with the system as you would in a real system.
- Add and remove objects from the production circuit, at any time during the simulation.
- Cause error situations or system jams.
- Test individual parts of the system; for example: test a conveyor table.

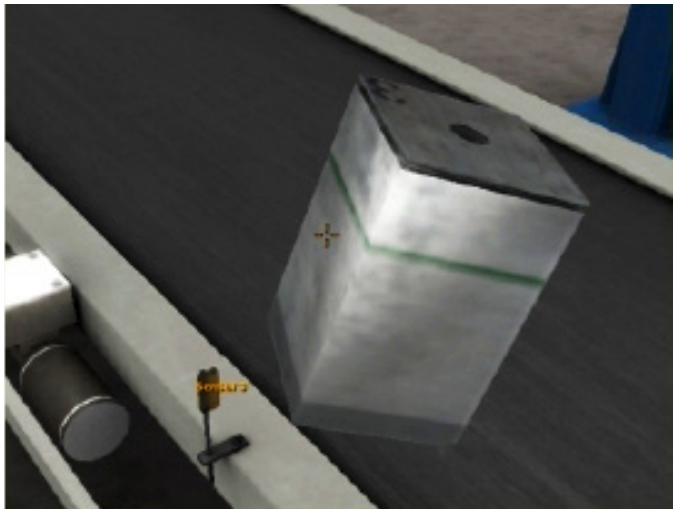
Some examples of systems interaction:











# Manual/Auto Mode

## MANUAL/AUTO MODE

All the systems can be controlled in manual mode by the user, or in auto mode by the PLC. In manual mode the user acts as the system controller, so that he can get familiar with the systems working process. When in auto mode the PLC is the system controller.

**In manual mode:**

- Turn actuators On and Off.
- Force sensors (indicated by a red LED).

By default all systems initiate in manual mode. At any time you can alternate between manual mode and auto mode.

Inputs/outputs panel in manual mode:


**In auto mode:**

- Force actuators (indicated by a blue button), i.e., the PLC output values are ignored.
- Force sensors (indicated by a red LED).

When changing to auto mode, the control panel becomes visible. Use it to control the PLC.

Inputs/outputs panel in auto mode:


| | |
|---|---|
| **Start** | Starts the system |
| **Stop** | Stops the system (normally closed contact) |
| **Reset** | Resets the system |
| **Emergency** | Emergency stop (normally closed contact) |

**Note:**

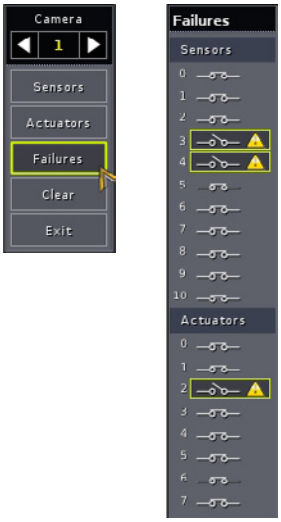
- Use the bit associated with the mode selector (bit 11) to set the PLC to RUN mode
- The sensors and actuators values are alternately refreshed every 16 ms (in low-end computers the update rate can be of 32 ms)

## FAILURES SIMULATION

ITS PLC Professional Edition allows you to simulate failures in sensors and actuators. These failures can be in open-circuit or short circuit. With this feature the user is able to induce malfunctions in the system, presenting new challenges and increasing the realism of the simulation.

Click **Failures** in the utility panel to access the failures panel.

Utility panel and failures panel:




In the failures panel you can cause open-circuit failures in sensors and actuators.

Click the sensor button in which you want to cause a failure. The sensor becomes indifferent to the system state, staying Off. Click the actuator button in which you want to cause a failure. The actuator becomes indifferent to the PLC state, staying Off.

Open-circuit failure in a sensor:

Create short circuit failures in sensors and actuators, through the inputs/outputs panel.

Click the LED that corresponds to the sensor that you want to fail. The sensor becomes indifferent to the system state, staying On (LED changes to red). Click the button that corresponds to the actuator that you want to fail. The actuator becomes indifferent to the PLC state, staying On (button changes to blue).

Examples of sensors and actuators with short circuit failures:


**Note:** Program the PLC in a way that it detects the system failures and reacts according to the situation.

You can hide the simulated failures from the trainees by entering the instructor password. Every time you wish to hide/unhide the simulated failures you must enter the password. To enter the password press the Ctrl + F keys to access the instructor panel then type the password and press Return. When the simulated failures are hidden you can see a blinking signal at the bottom right corner of the screen.

Instructor panel:


The default instructor password is 0000. To change the password you need to edit the Password.xml file located in the ITS PLC installation folder (typically **C:\Program Files\ITS PLC Professional Edition**). The password must only contain numbers and must be at most 10 characters long.

Follow the next steps to change the instructor password:

- Open the Password.xml file using a regular text editor like Microsoft® Notepad.
- Type the new password between the User tags (e.g. <User>1234</User>).
- Save the file.
- Start ITS PLC.

**Note:** To change the password you must have a Windows® administrator account. After the password is changed it is automatically encrypted.

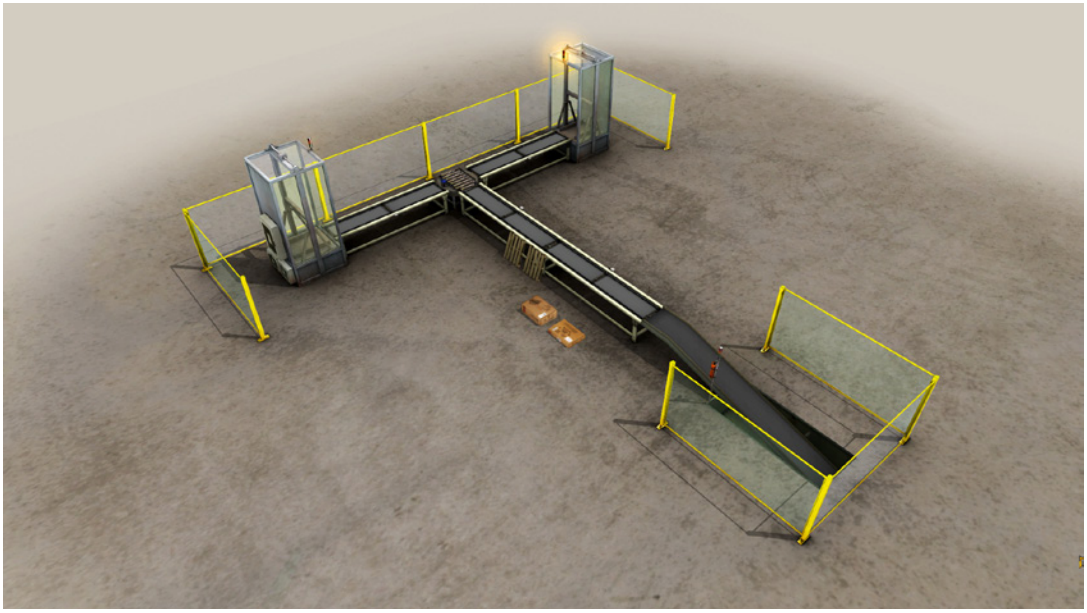
**Important:** You must restart ITS PLC for the password change to take effect.

# Systems

ITS PLC Professional Edition presents five training systems based on real world industrial scenarios. Each system offers standard problems found in PLC programming. The systems are presented in order of increasing level of difficulty, namely: Sorting, Batching, Palletizer, Pick & Place and Automatic Warehouse.

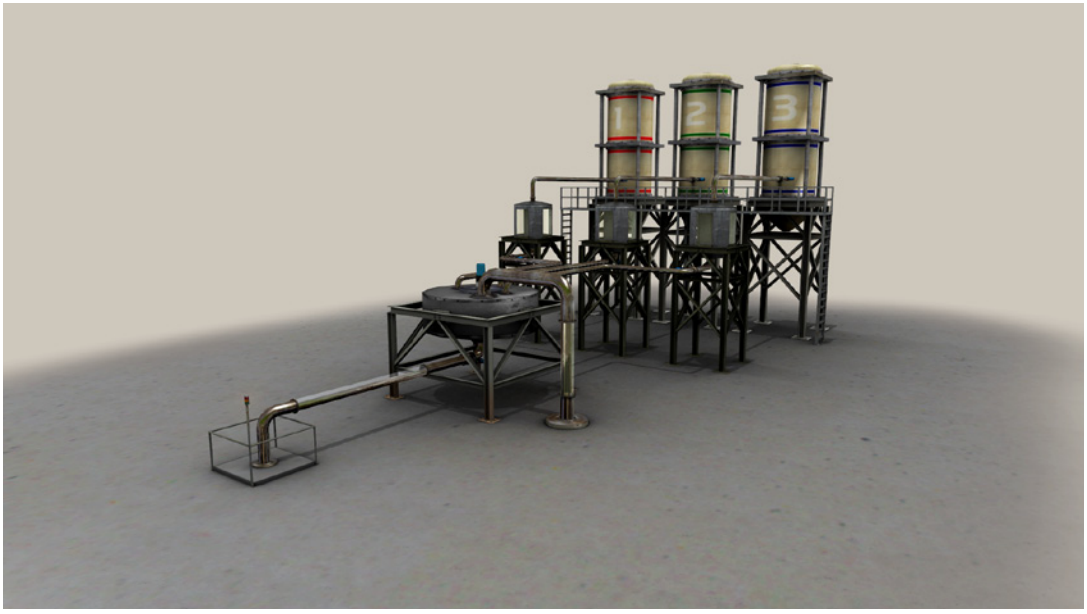
**Sorting** - Transport cases from the feeder to the elevators, sorting them by height.

**PLAY VIDEO**



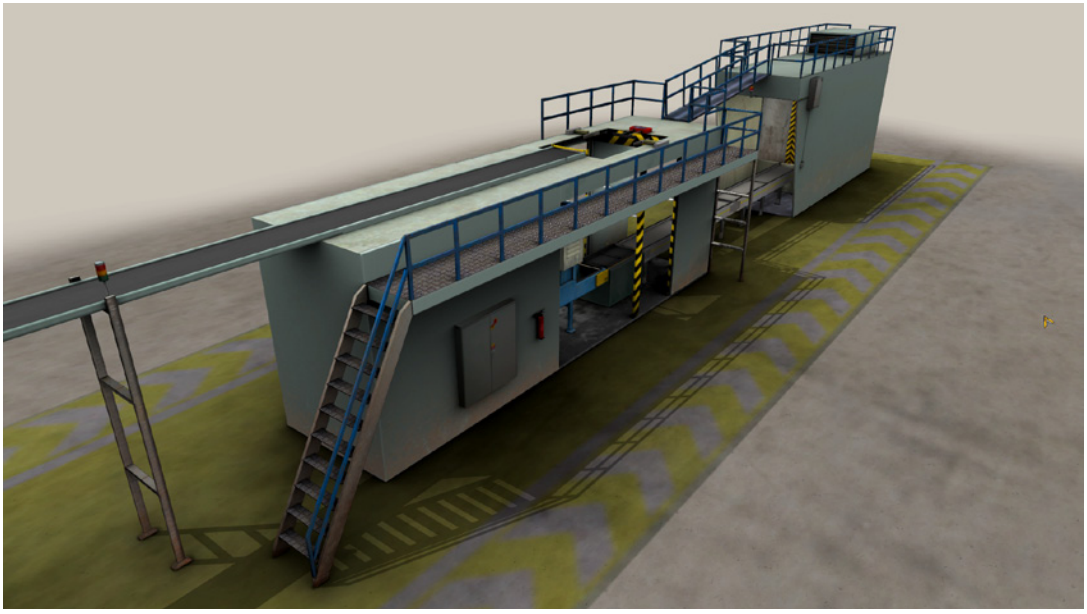
**Batching** - Mix three primary colors (red, green and blue) to obtain a desired color.

**PLAY VIDEO**



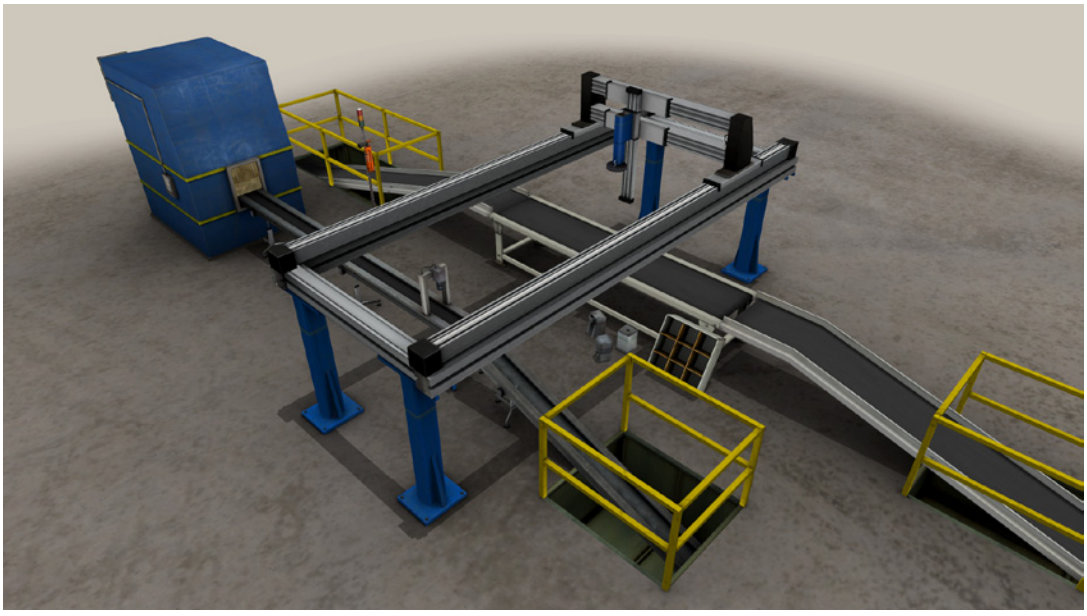
**Palletizer** - Palletize cases in several layers.

PLAY VIDEO



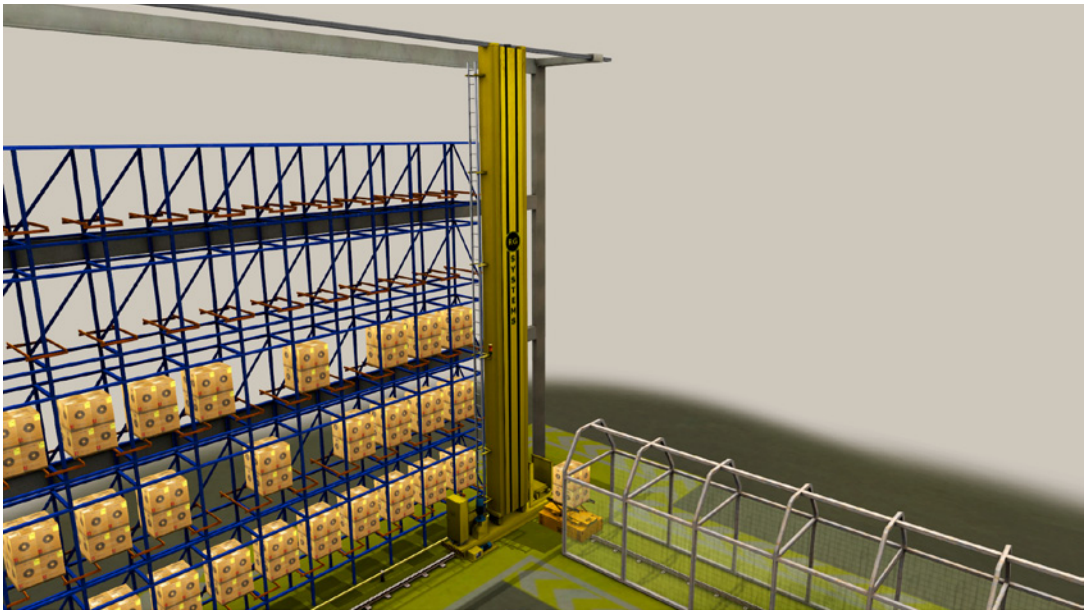
**Pick & Place** - Place parts inside boxes, using a three axis manipulator.

PLAY VIDEO



**Automatic Warehouse** - Transport, store and retrieve boxes from the racks.

**PLAY VIDEO**



The five systems have the following points in common:

• Entry and exit zones, where movable objects (like pallets, cases or parts) are automatically inserted and removed from the scene.
• Limited number of movable objects simultaneously in the system.
• Maximum of 16 sensors (PLC inputs) and 10 actuators (PLC outputs).

| Bit Number | Input Bits | Type of Contact |
|---|---|---|
| **0** | Sensor 0 | **NO** |
| **1** | Sensor 1 | **NO** |
| **2** | Sensor 2 | **NO** |
| **3** | Sensor 3 | **NO** |
| **4** | Sensor 4 | **NO** |
| **5** | Sensor 5 | **NO** |
| **6** | Sensor 6 | **NO** |
| **7** | Sensor 7 | **NO** |
| **8** | Sensor 8 | **NO** |
| **9** | Sensor 9 | **NO** |
| **10** | Sensor 10 | **NO** |
| **11** | Manual/Auto Selector Switch | **NO** |
| **12** | Start Button | **NO** |
| **13** | Stop Button | **NC** |
| **14** | Reset Button | **NO** |
| **15** | Emergency Stop Button | **NC** |

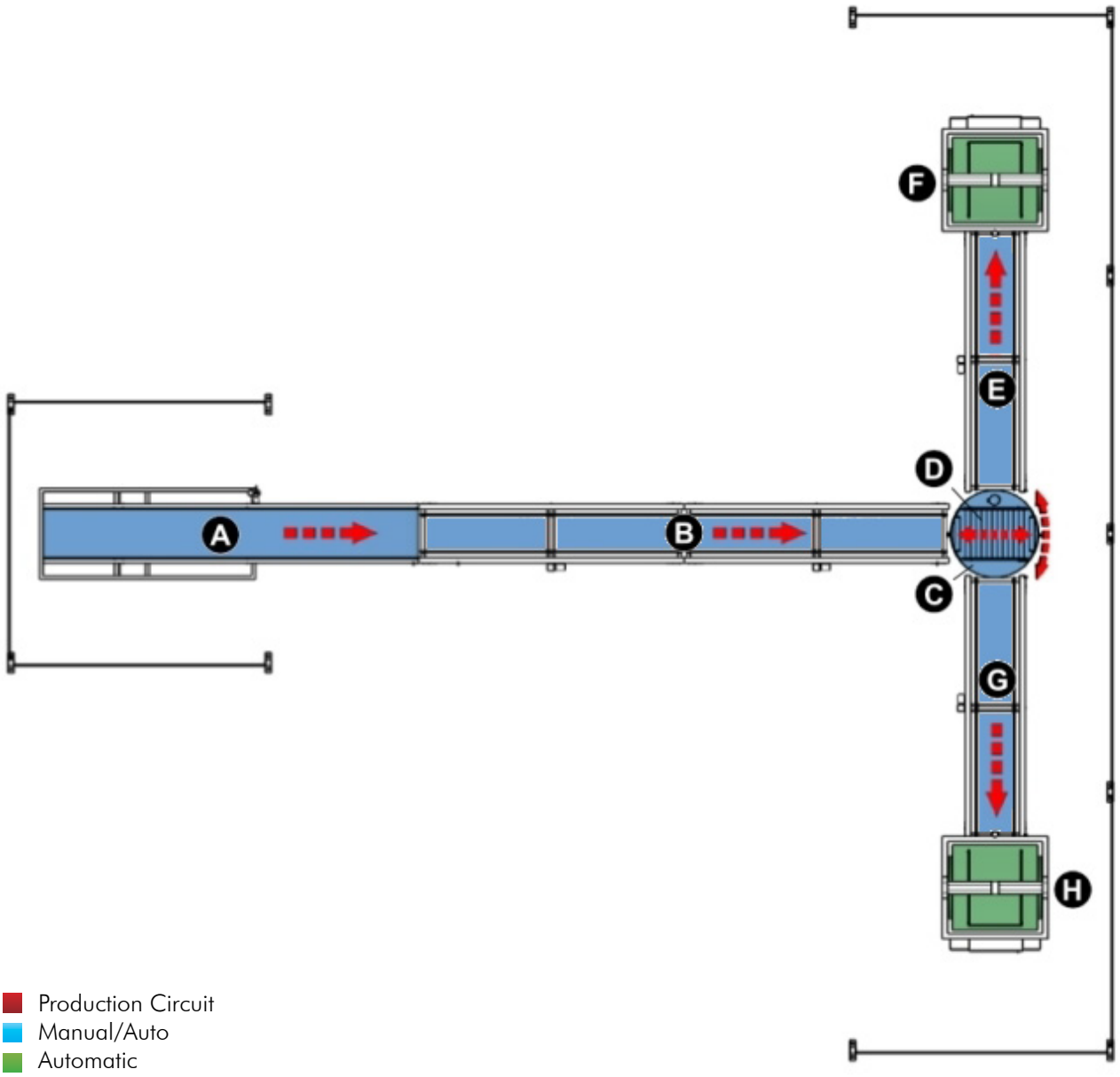
**NO:** Normally open contact.
**NC:** Normally closed contact.

| Bit Number | Output Bits |
|---|---|
| **0** | Actuator 0 |
| **1** | Actuator 1 |
| **2** | Actuator 2 |
| **3** | Actuator 3 |
| **4** | Actuator 4 |
| **5** | Actuator 5 |
| **6** | Actuator 6 |
| **7** | Actuator 7 |
| **8** | Start Button Light |
| **9** | Reset Button Light |

# SORTING

## SORTING - SYSTEM DESCRIPTION

This is a sorting system where the main goal is to transport cases from the entry bay to the elevators, sorting them by height.



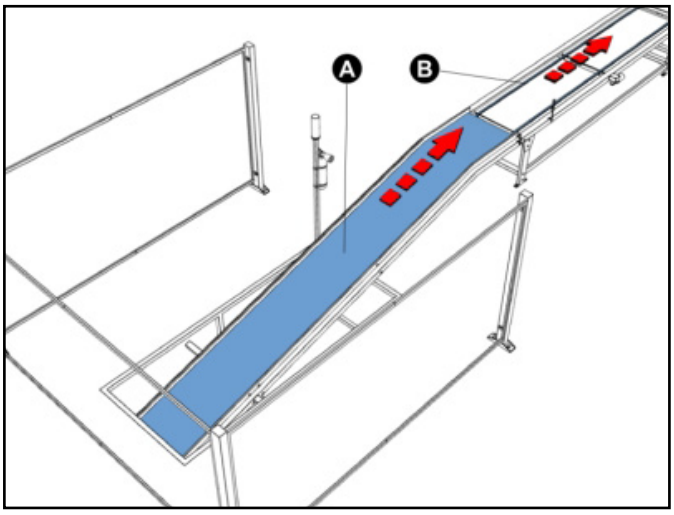

Production Circuit
Manual/Auto
Automatic

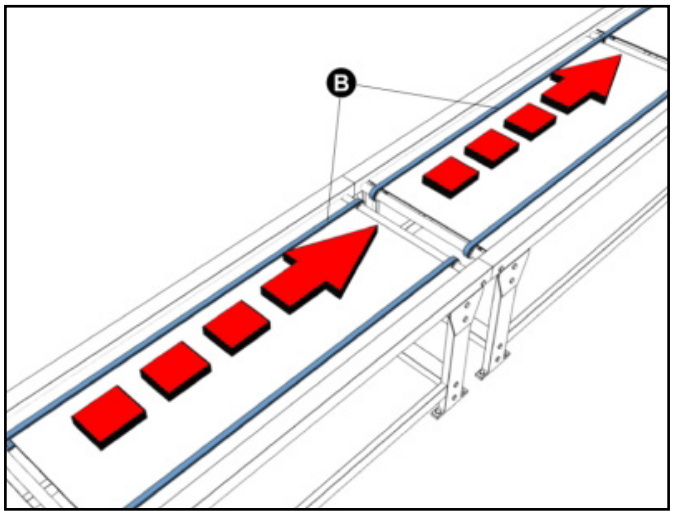
This sorting system is composed of an entry bay, transport tables and two exit bays.

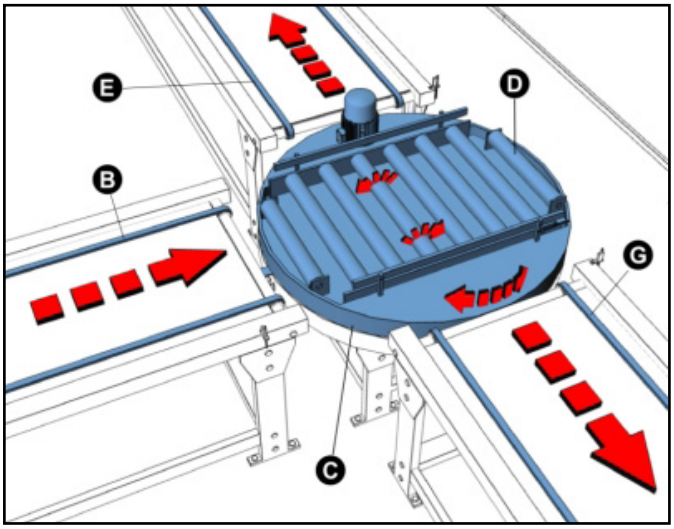
The feeder belt (A) randomly delivers high and low cases, loaded on pallets. The pallets are transported by the transport tables (B) to the turntable (C) and are loaded through the rollers (D). The pallets are rotated 90° by the turntable (C) according to the cases height, which is detected at the entrance of the transport tables (B). The pallets are then deployed through the rollers (D) to the transport tables (E or G). Finally, they are shipped to the automatic elevators (F or H).

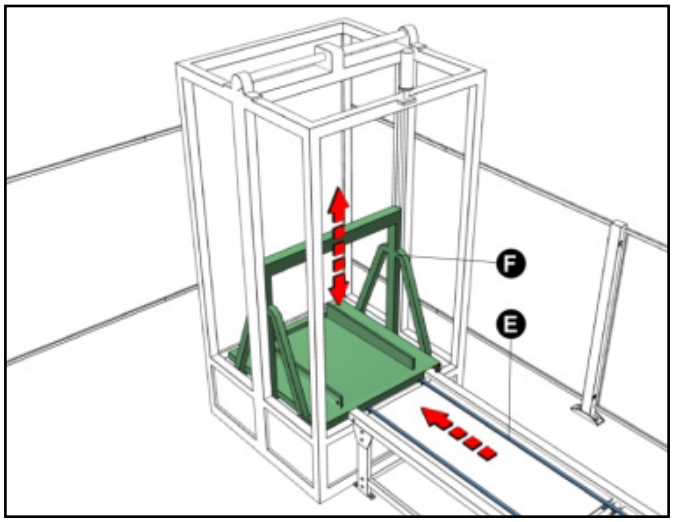
## LOW CASE

## HIGH CASE

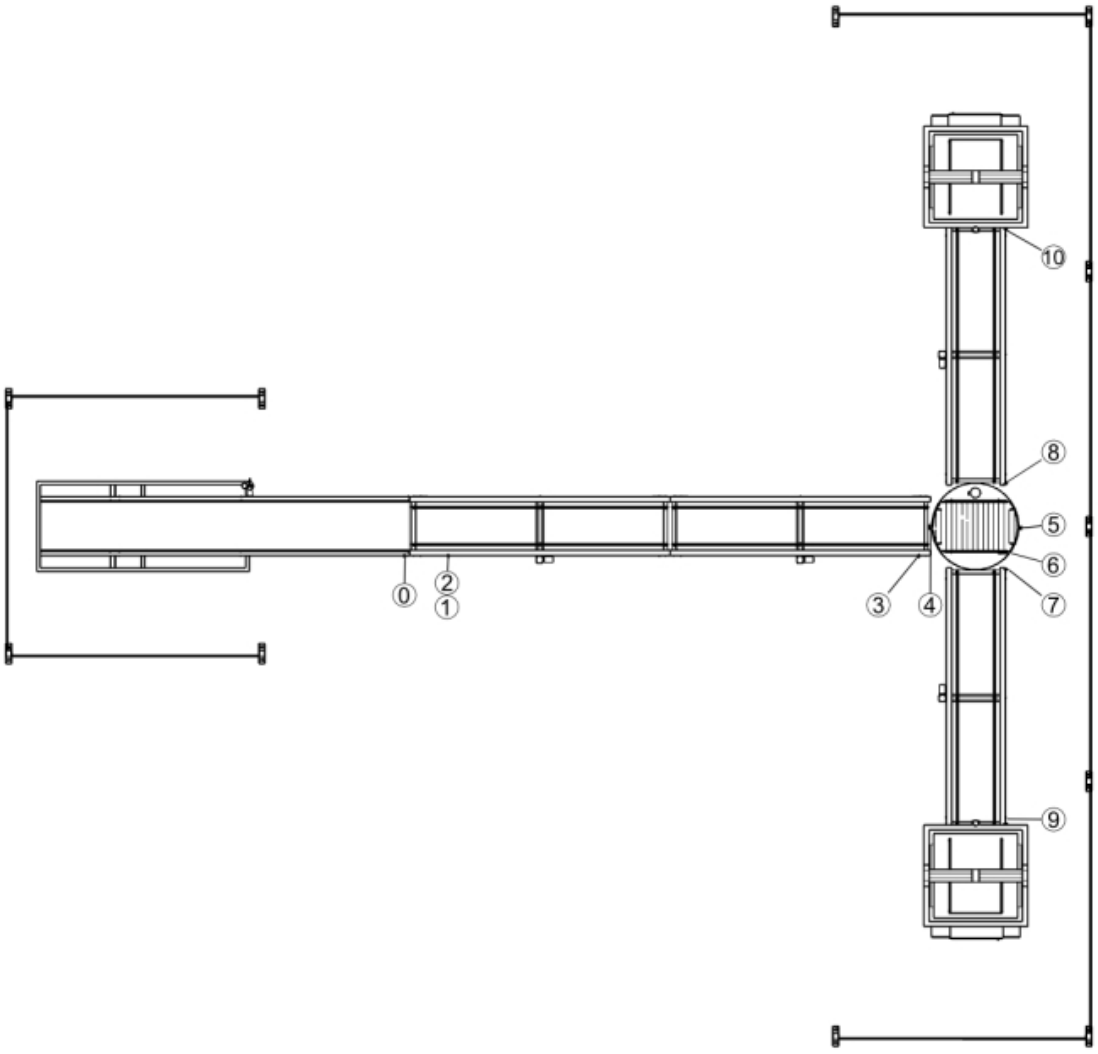



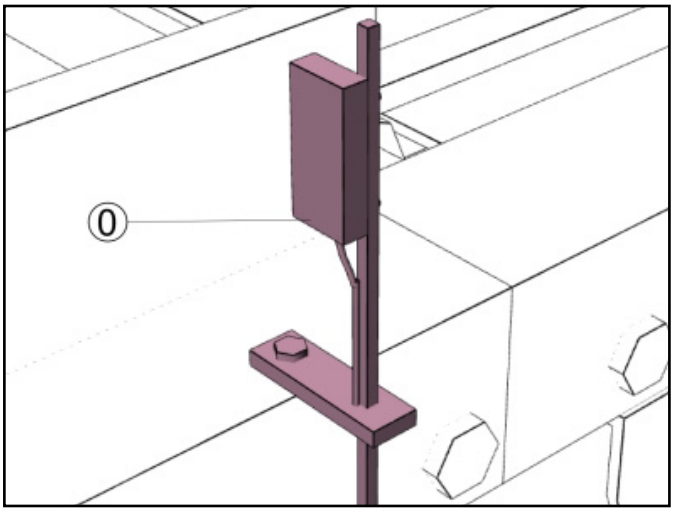

**Suggestions:**

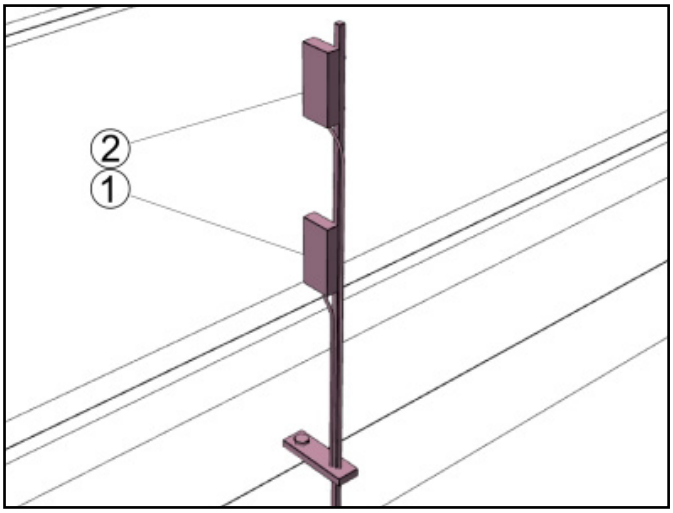
• Start sorting one case at a time. Stop the feeder belt (A) after a case enters the transport table (B). Repeat the process after the case gets shipped to the automatic elevator (F or H).
• Use the transport table (B) as a buffer of cases. Note that the measuring of the case height is done at the entrance of the table (B).
• Change the cases sorting order using a HMI console or a SCADA.

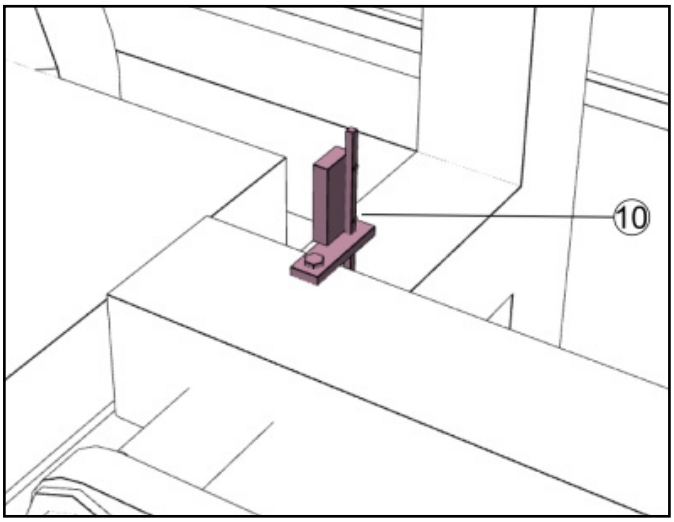
## SORTING - SENSORS

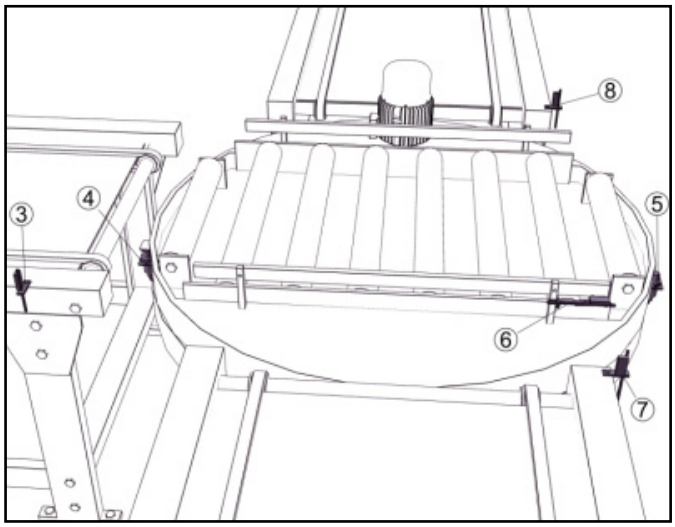
| Sensor | Description |
|---|---|
| **0** | Feeder belt exit detector |
| **1** | Lower case detector |
| **2** | Higher case detector |
| **3** | Exit detector of the entry conveyor tables |
| **4** | Detector of the turntable loading position |
| **5** | Detector of the turntable unloading position |
| **6** | Turntable pallet detector |
| **7** | Entry detector of the exit conveyor table |
| **8** | Entry detector of the exit conveyor table |
| **9** | Exit detector of the exit conveyor table |
| **10** | Exit detector of the exit conveyor table |





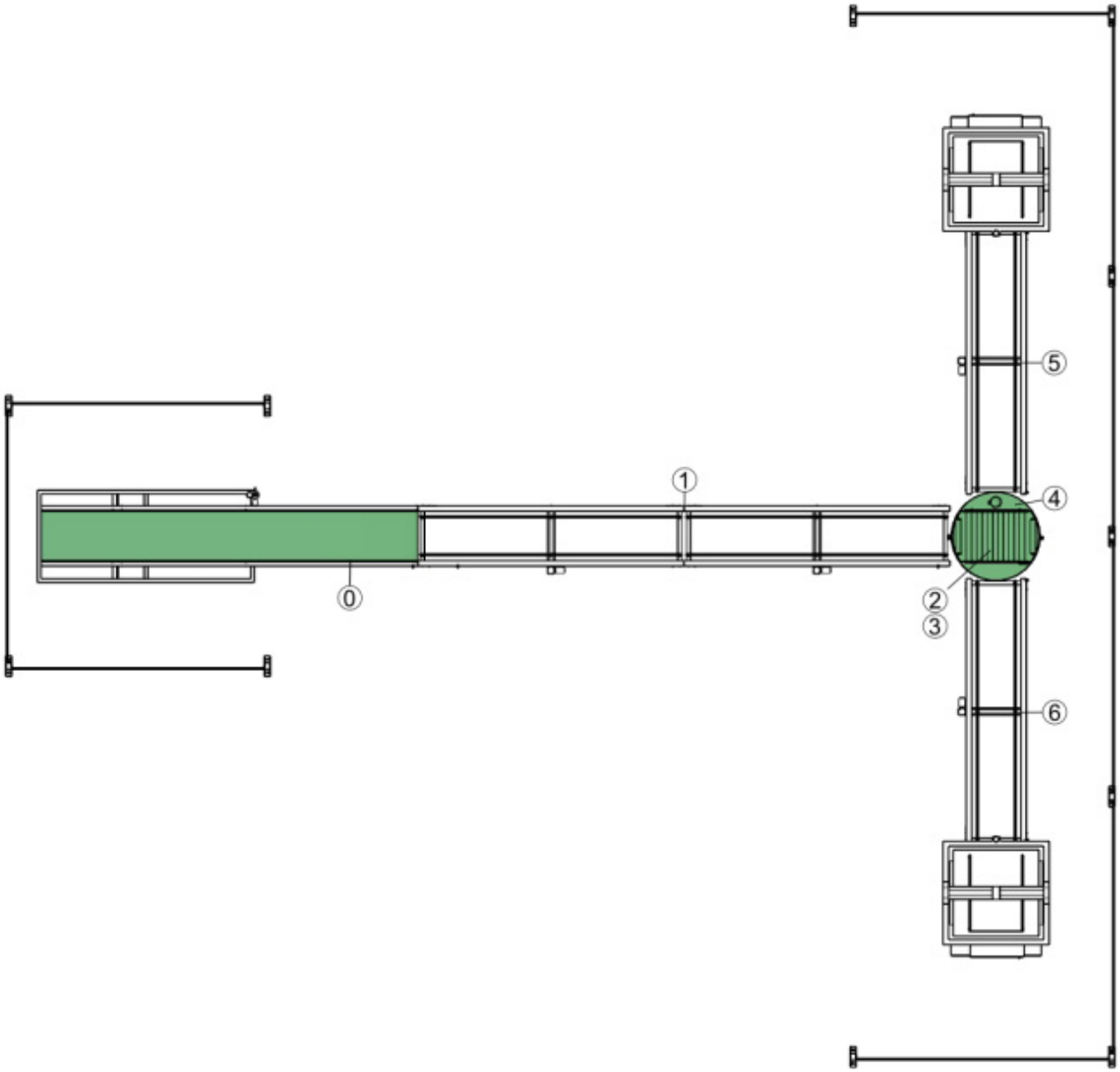



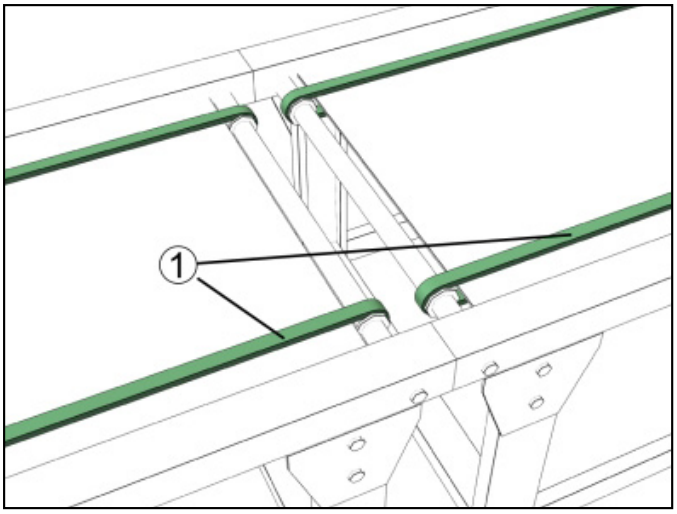



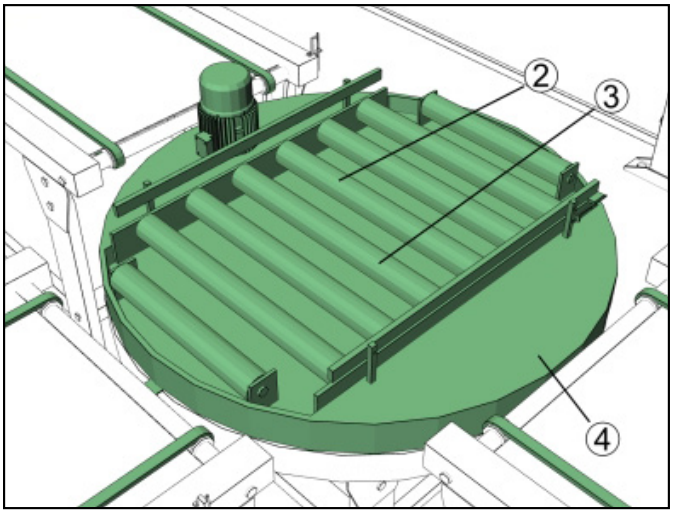



## SORTING - ACTUATORS

| Actuator | Description |
|---|---|
| **0** | Feeder belt |
| **1** | Entry conveyor table |
| **2** | Turntable rollers (loading) |
| **3** | Turntable rollers |
| **4** | Turntable |
| **5** | Exit conveyor table |
| **6** | Exit conveyor table |



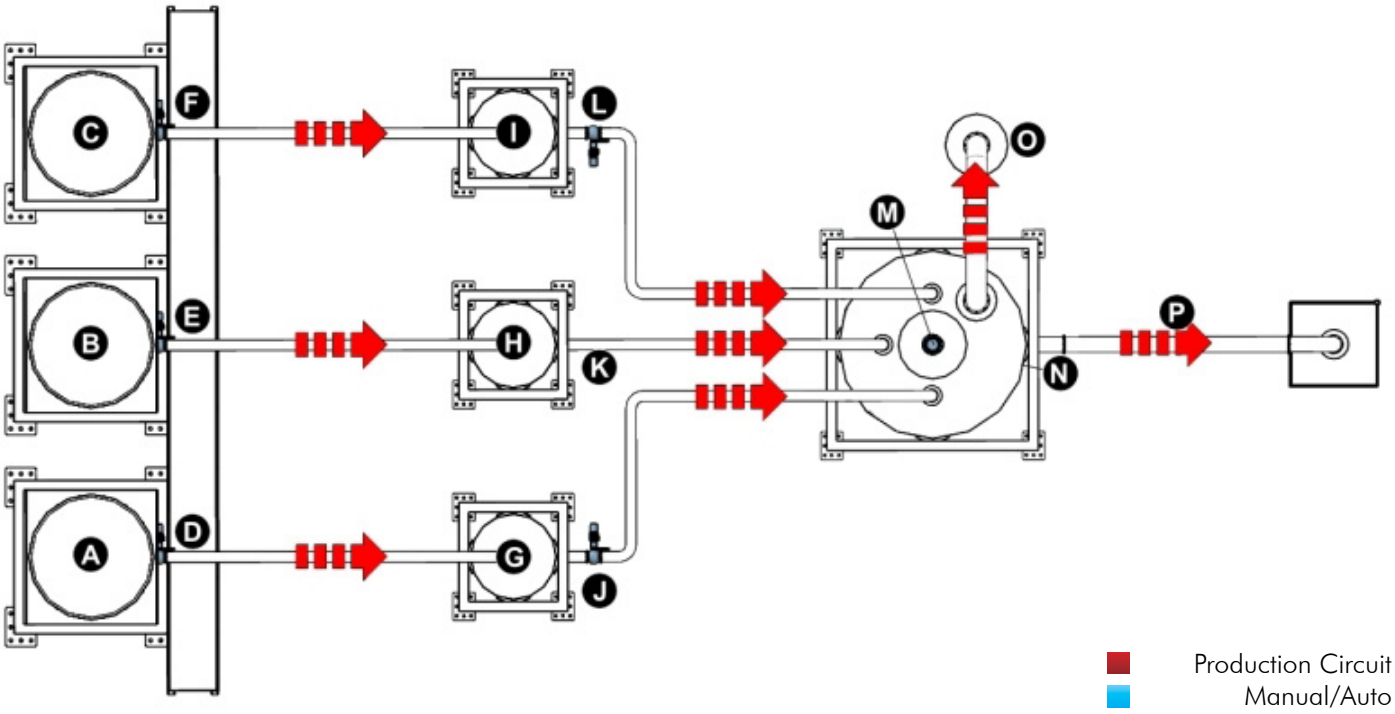



# BATCHING

# BATCHING - SYSTEM DESCRIPTION

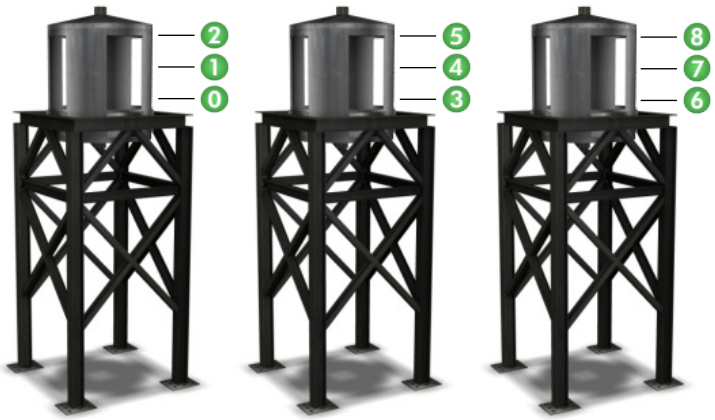
This batching system simulates a process of paint mixing. The objective is to mix three primary colors (red, green and blue) in order to obtain a desired color.




The batching system is composed of three paint reservoirs, three measuring tanks and one mixing tank.

The paint reservoirs (A, B, C) contains red, green and blue paint respectively. The tanks paint is discharged through the valves (D, E, F) to the measuring tanks (G, H, I). Each of these tanks has three measuring points. The paint contained in the measuring tanks is discharged through the valves (J, K, L) to the mixing tank (M). If the discharged paint volume is higher than the tank capacity, the surplus is discharged by the overflow pipe (O). The mixing process must have a minimum duration of five seconds. The final paint is discharged through the valve (N) into the exit pipe (P).

Possible paint colors obtained by combining the level sensors:




Red Paint Measuring Tank | Green Paint Measuring Tank | Blue Paint Measuring Tank

| Level Sensors | | |
|---|---|---|
| 1 | 4 | 7 |
| 1 | 5 | 8 |
| 1 | 4 | 8 |
| 2 | 4 | 8 |
| 1 | | 8 |
| 2 | 4 | 7 |
| 2 | | 7 |
| 1 | | 7 |
| 1 | | |
| 2 | 5 | 7 |
| 1 | 4 | |
| 2 | 4 | |
| 1 | 5 | 7 |
| | 5 | 7 |
| | 4 | |
| 1 | 5 | |
| | 4 | 8 |
| | 4 | 7 |
| | | 7 |

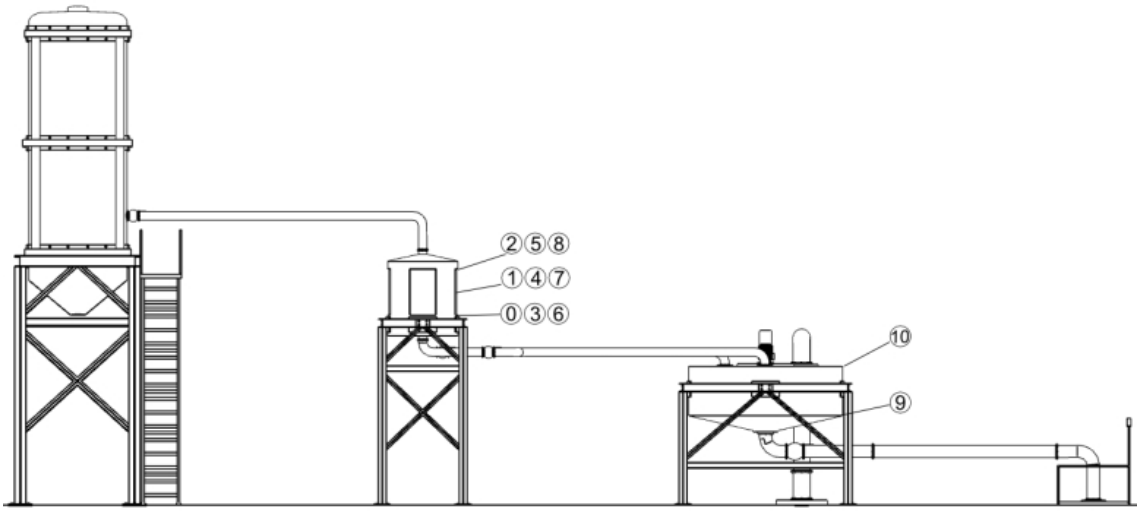
**Note:** It takes five seconds to properly mix the paint.

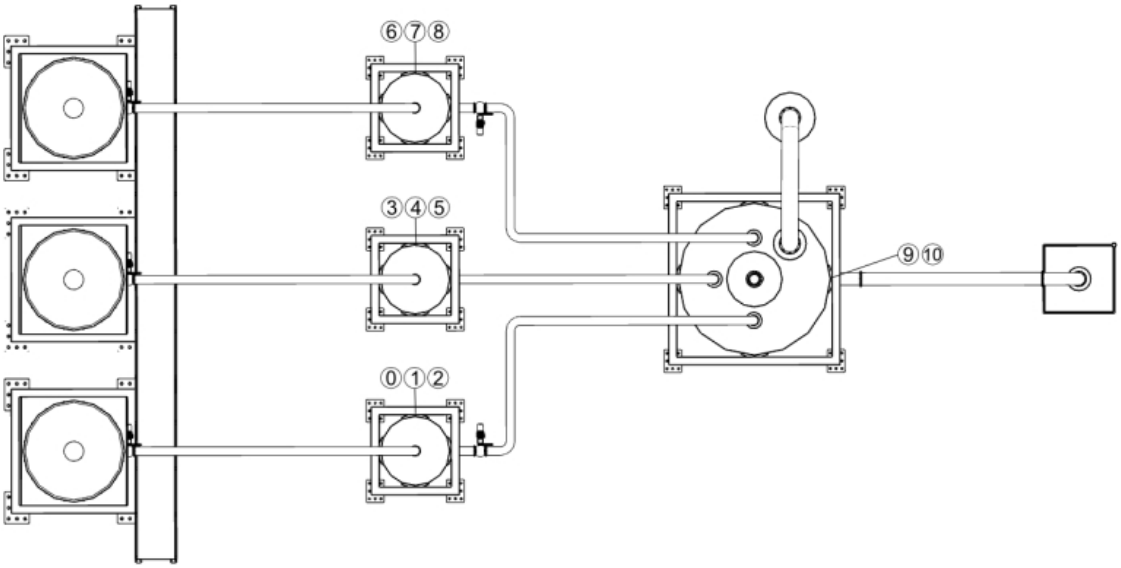
**Suggestions:**

- Start by creating a program that produces one color repeatedly.
- Use timers to measure each paint level, in order to create different colors that are not described in the above table.
- Change the paint color to be produced using a HMI console or a SCADA.

## BATCHING - SENSORS

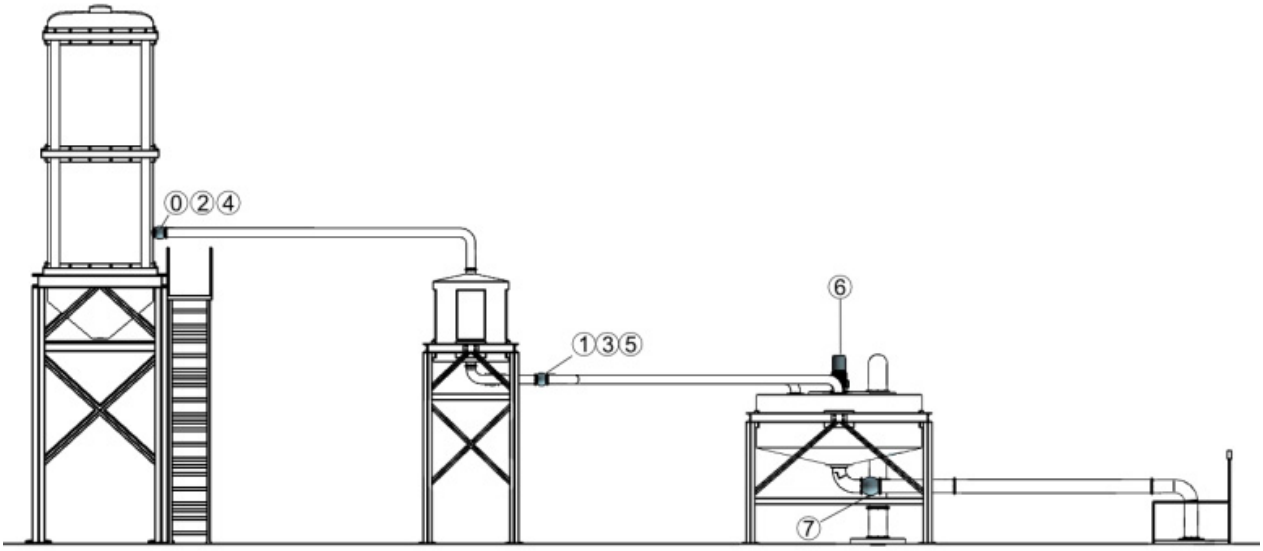
| Sensor | Description |
|---|---|
| **0** | Low level detector (tank empty) of the red paint measuring tank |
| **1** | Mid level detector of the red paint measuring tank |
| **2** | High level detector (tank full) of the red paint measuring tank |
| **3** | Low level detector (tank empty) of the green paint measuring tank |
| **4** | Mid level detector of the green paint measuring tank |
| **5** | High level detector (tank full) of the green paint measuring tank |
| **6** | Low level detector (tank empty) of the blue paint measuring tank |
| **7** | Mid level detector of the blue paint measuring tank |
| **8** | High level detector (tank full) of the blue paint measuring tank |
| **9** | Mixing tank low level detector |
| **10** | Mixing tank high level detector |

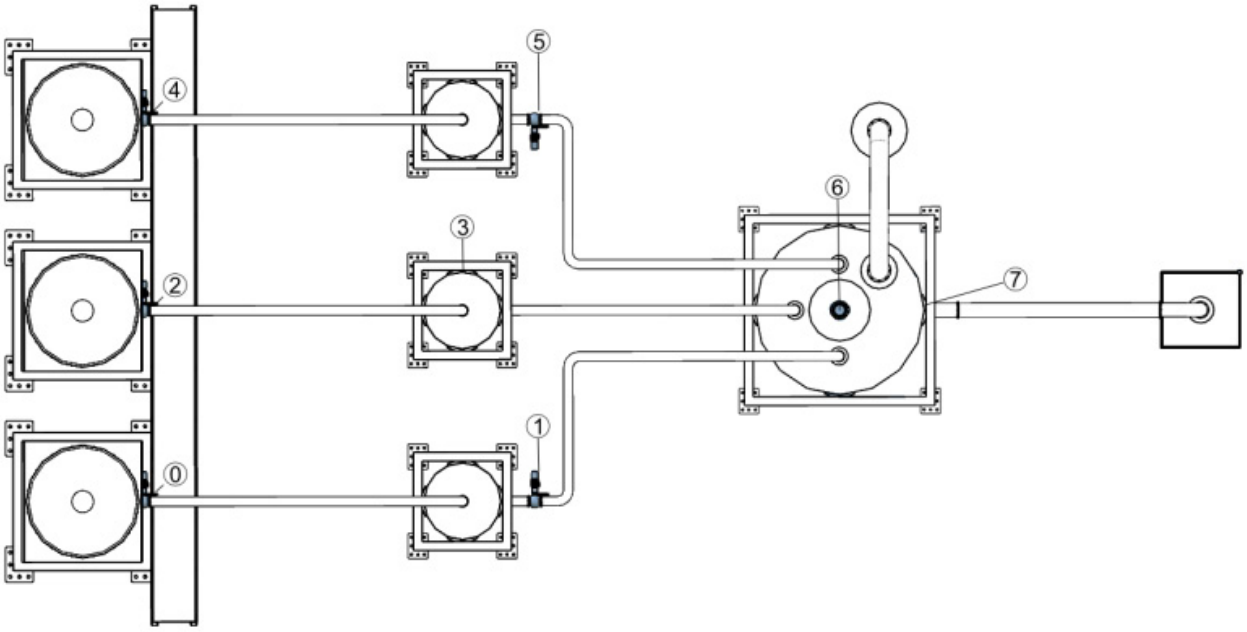


## BATCHING - ACTUATORS

| Actuator | Description |
|---|---|
| **0** | Red paint reservoir discharge valve |
| **1** | Red paint measuring tank discharge valve |
| **2** | Green paint reservoir discharge valve |
| **3** | Green paint measuring tank discharge valve |
| **4** | Blue paint reservoir discharge valve |
| **5** | Blue paint measuring tank discharge valve |
| **6** | Mixer |
| **7** | Mixing tank discharge valve |

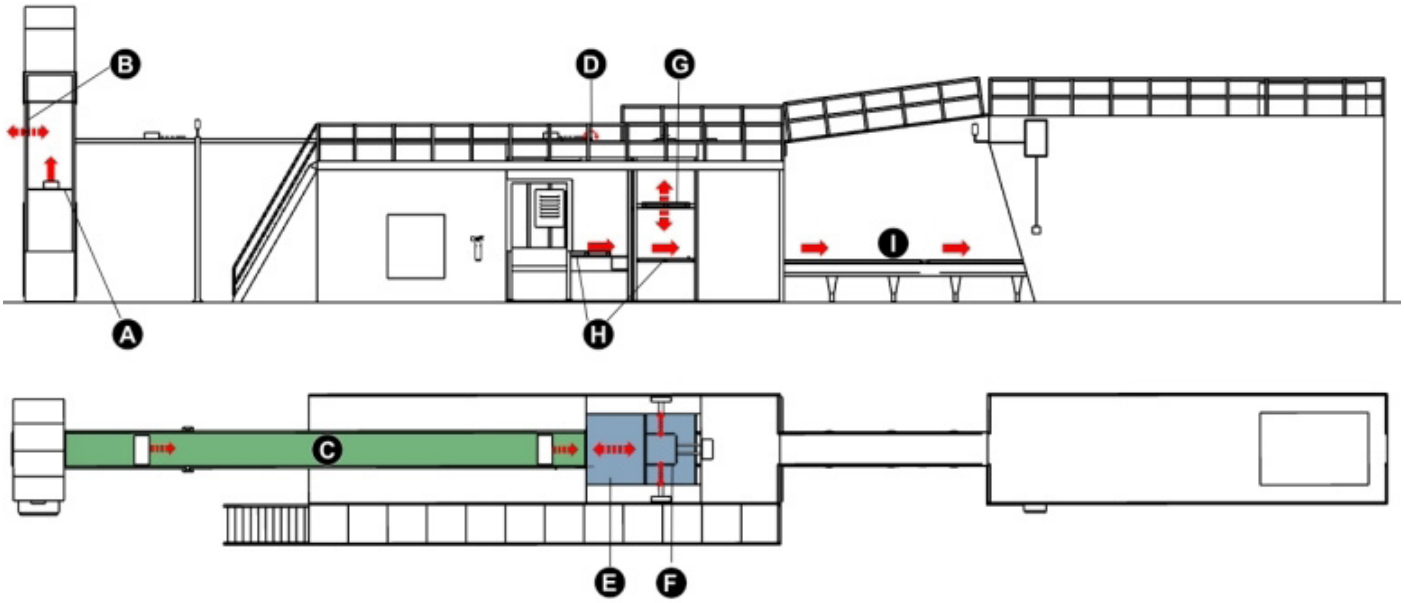


# PALLETIZER

# PALLETIZER - SYSTEM DESCRIPTION

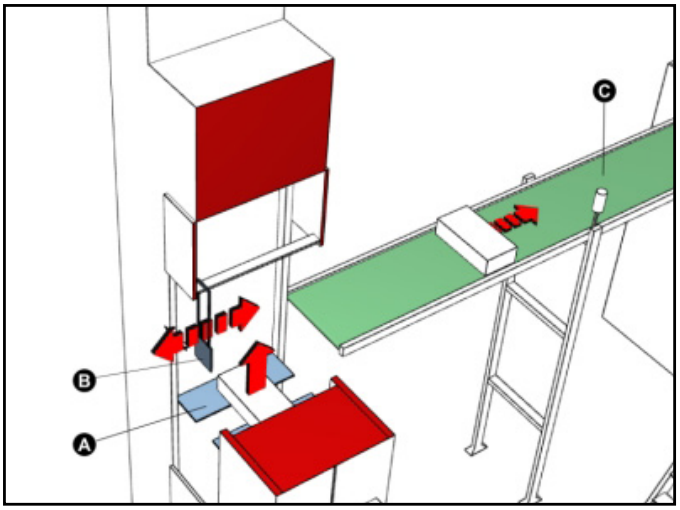
This system simulates a high-level case palletizer. The objective is to palletize cases up to three layers.

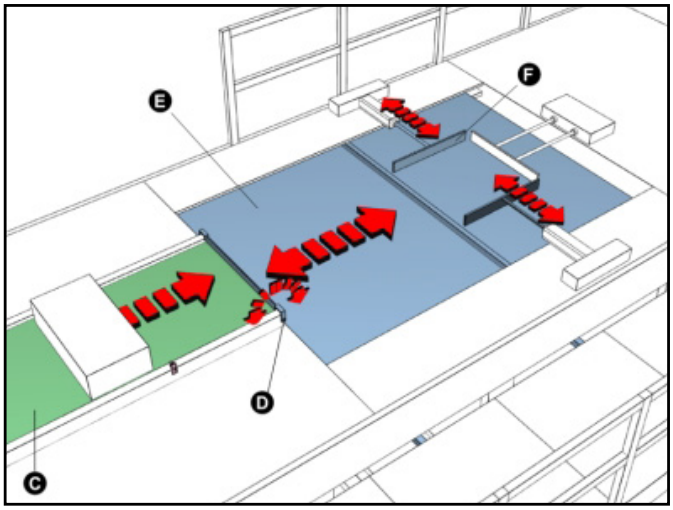


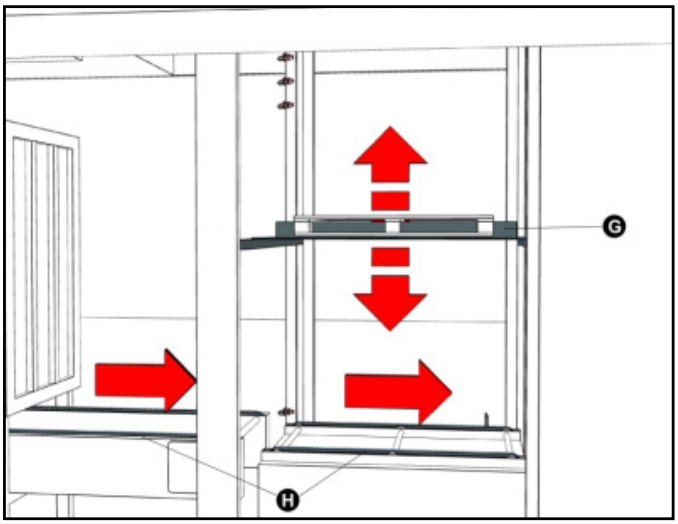

Production Circuit
Manual/Auto
Automatic

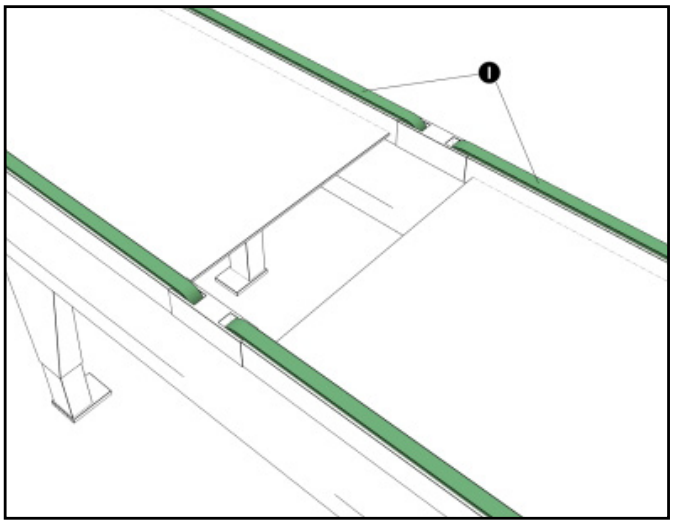
The palletizer system is composed of a case elevator, a central body and an exit bay.

The case elevator (A) feeds an automatic conveyor belt (C) through a cursor (B). The cases are accumulated at the end of the conveyor belt (C) by a holder (D). At this stage the cases are ready to be loaded on the mat (E) and transported to the packing rods (F). The conveyor tables (H) drive the pallets from the pallet feeder to the elevator (G). The elevator, loaded with a pallet, ascends to the upper palletizer level. The cases are palletized with the returning of the mat (E) and with the packing rods (F) at the forward position. This palletizing cycle can be repeated one or two more times, per pallet. After the cases get palletized, the elevator descends to the level of the exit conveyor table (I).



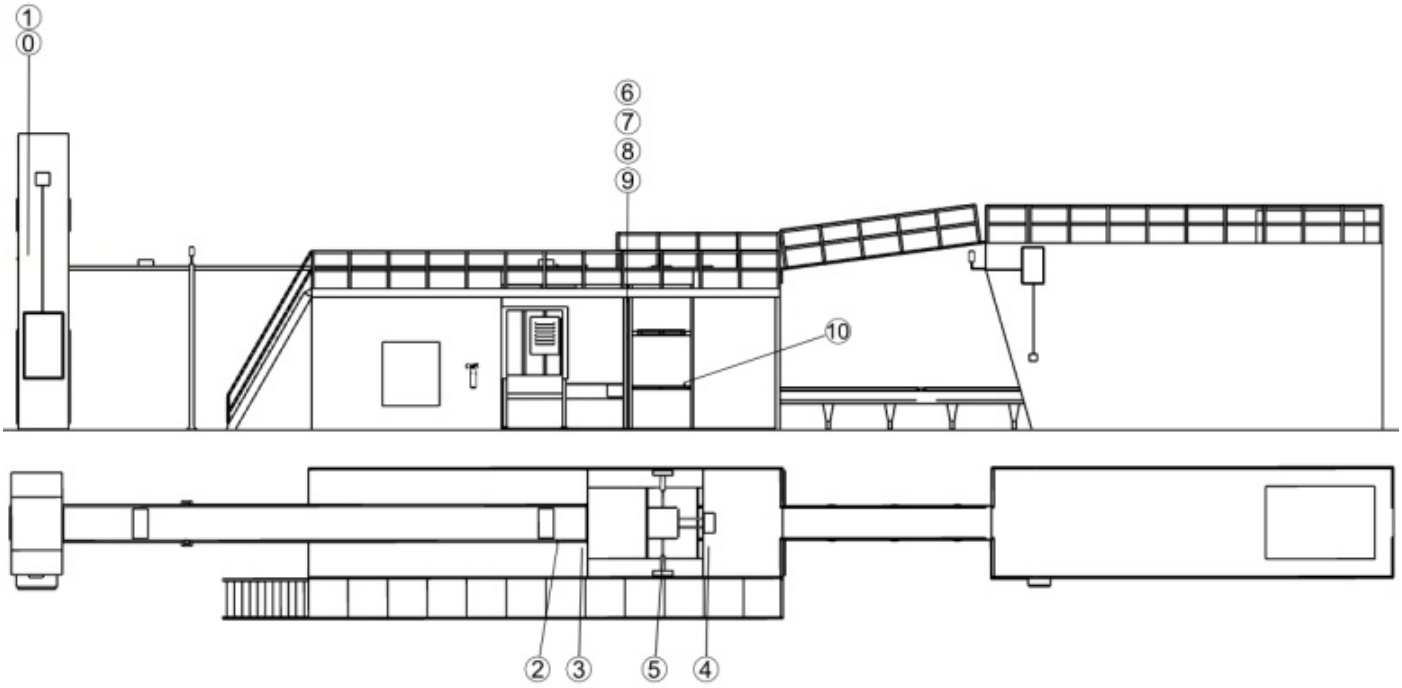

**Note:** The case elevator (A) has a safety device that makes it stop if the cases aren't pushed by the cursor before they get to the top of the elevator.

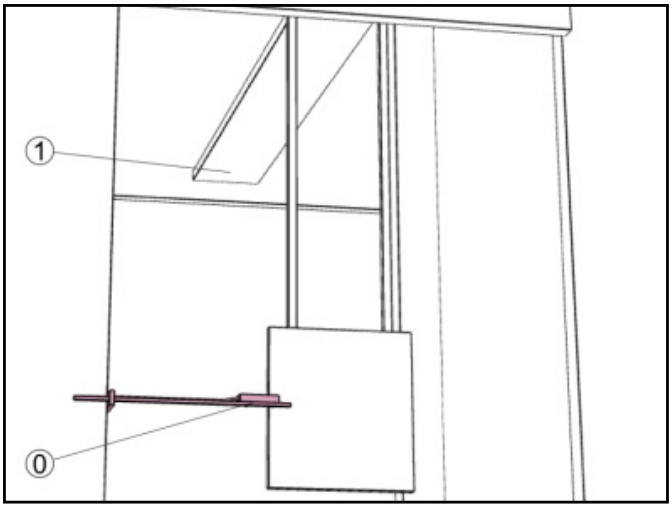
**Suggestions:**

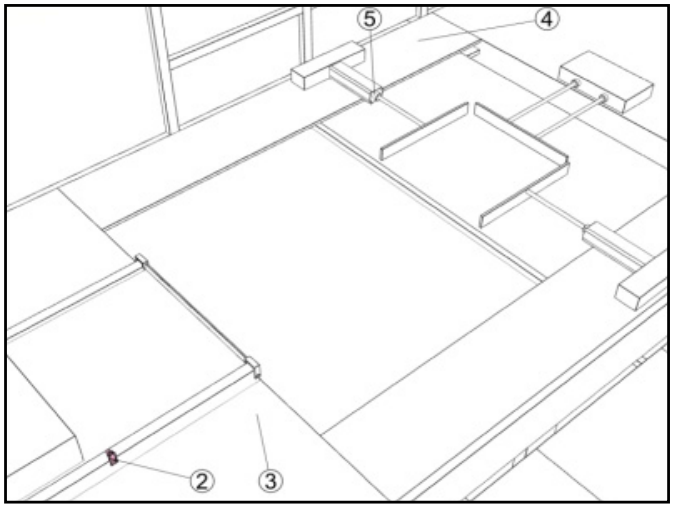
- Don't forget to reset the system before the palletizing cycle begins, in particular retrieve the mat and descend the elevator to the low level position.
- In order to change the number of layers of cases per pallet, use a HMI console or a SCADA.

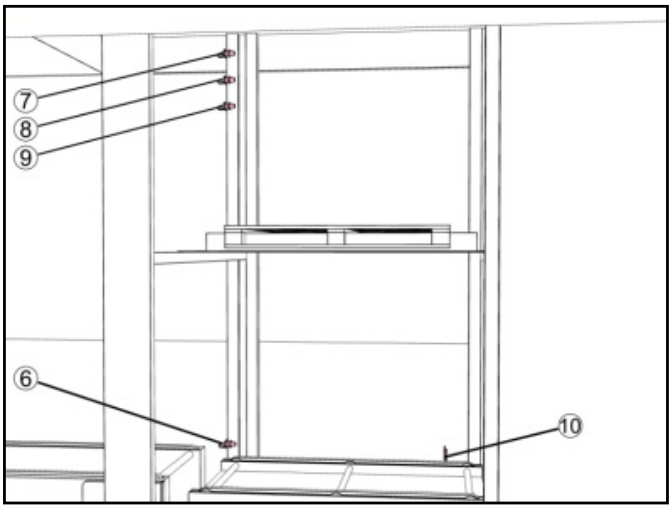
## PALLETIZER - SENSORS

| Sensor | Description |
|---|---|
| **0** | Exit detector of the case elevator |
| **1** | Limit switch of the cursor advance movement |
| **2** | Detector of the conveyor belt buffer |
| **3** | Mat limit switch |
| **4** | Mat limit switch |
| **5** | Packing rods limit switch |
| **6** | Elevator low level detector |
| **7** | Elevator level detector - first cases layer |
| **8** | Elevator level detector - second cases layer |
| **9** | Elevator level detector - third cases layer |
| **10** | Pallet detector |



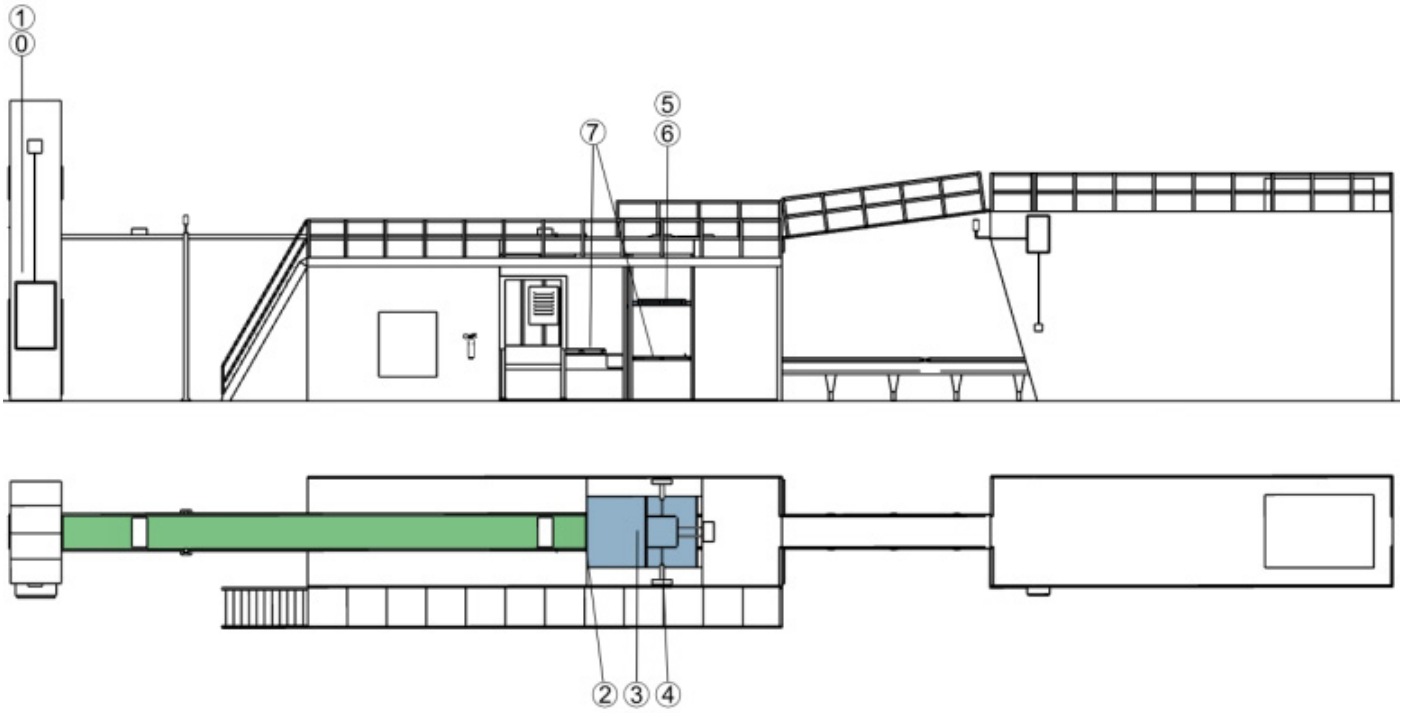


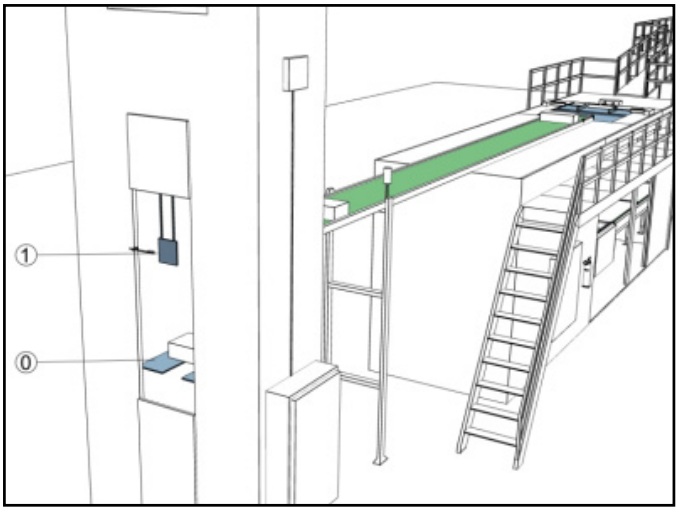



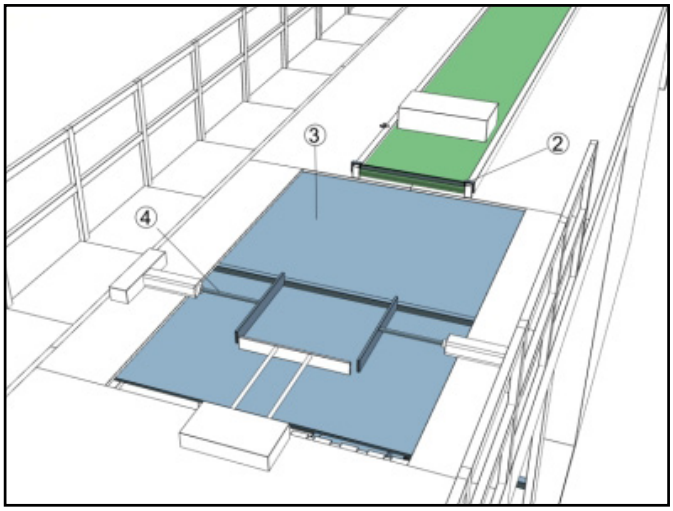



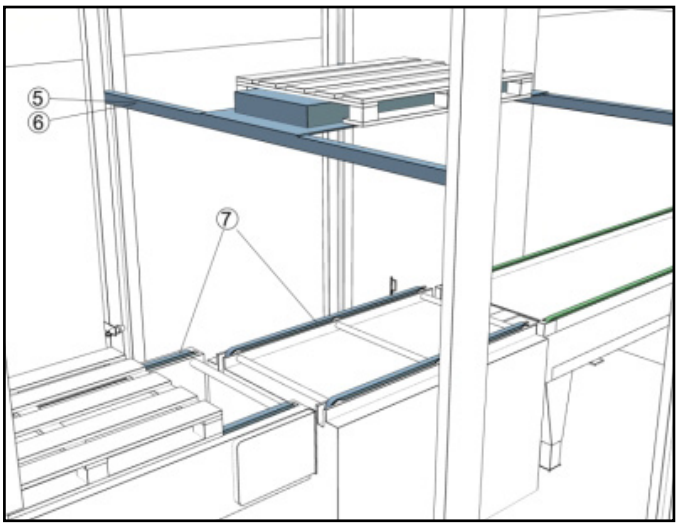
## PALLETIZER - ACTUATORS

| Actuator | Description |
|---|---|
| **0** | Case elevator |
| **1** | Elevator cursor advance |
| **2** | Holder opening |
| **3** | Mat advance |
| **4** | Packing rods advance |
| **5** | Ascending movement of the pallet elevator |
| **6** | Descending movement of the pallet elevator |
| **7** | Conveyor tables |





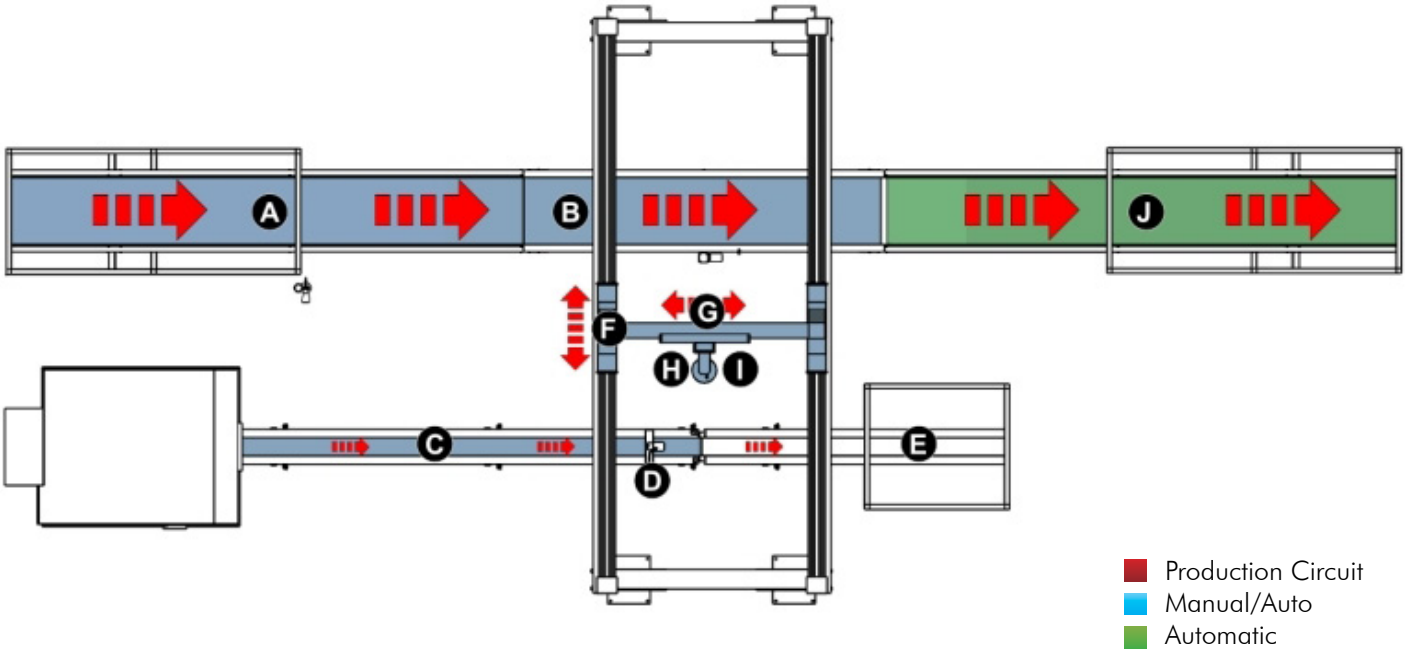



# PICK & PLACE

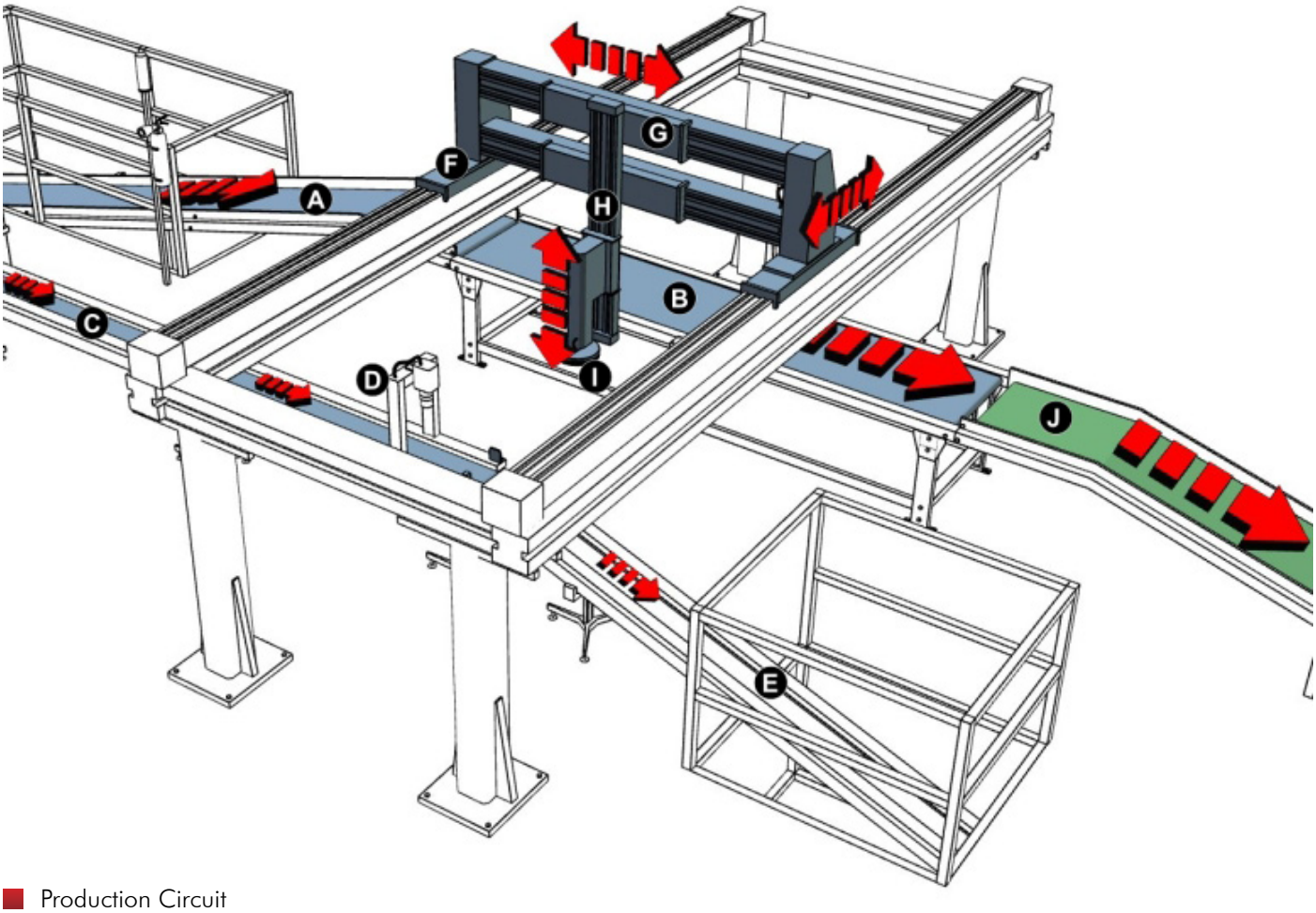
# PICK & PLACE - SYSTEM DESCRIPTION

This is a pick & place system where the objective is to place parts inside boxes through a three axes manipulator.




This pick & place system is composed of an entry/exit bay of metallic parts, a three axis manipulator and an entry/exit bay of boxes.

Boxes are transported by a conveyor belt (A), from the entry bay to the conveyor belt (B) that positions the boxes in the placing area. The conveyor belt (C) transports randomly supplied parts. There are three types of parts, which are detected by a vision system (D). The three axis manipulator (F, G, H) picks the parts using a magnetic gripper (I) and places them in the previously positioned box. The loaded boxes are then transported to the automatic exit conveyor belt (J). The unselected parts are dispatched through the exit ramp (E).



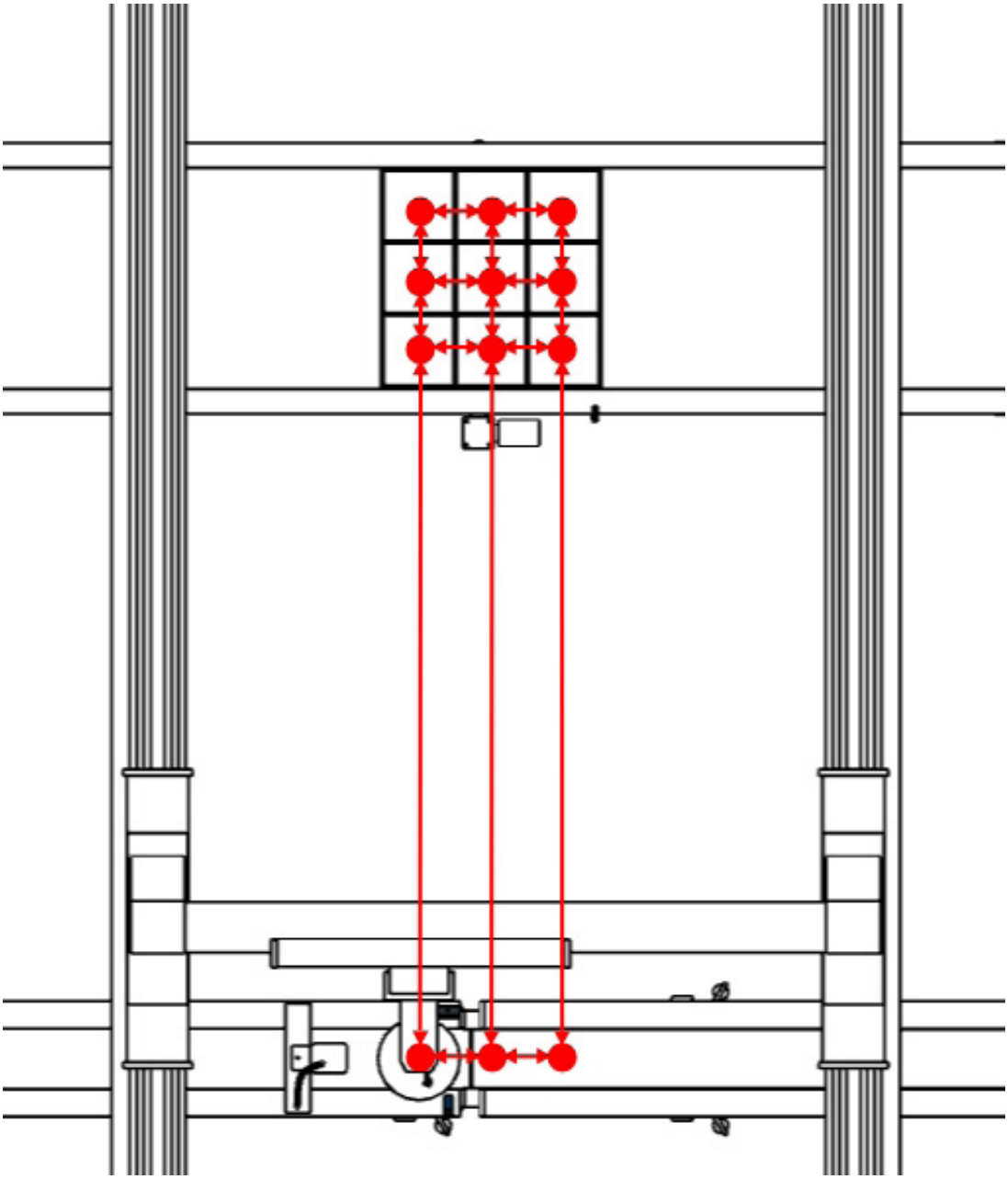

- Production Circuit
- Manual/Auto
- Automatic

Metallic parts encoding:

| Part |  |  |  |
|---|---|---|---|
| Bit 0 | On | Off | On |
| Bit 1 | Off | On | On |

The F and G manipulator axis are incrementally commanded by the ascendant transitions of the command bits. Each incremental axis movement is commanded by two bits.

Possible positions for the manipulator in the horizontal plane:

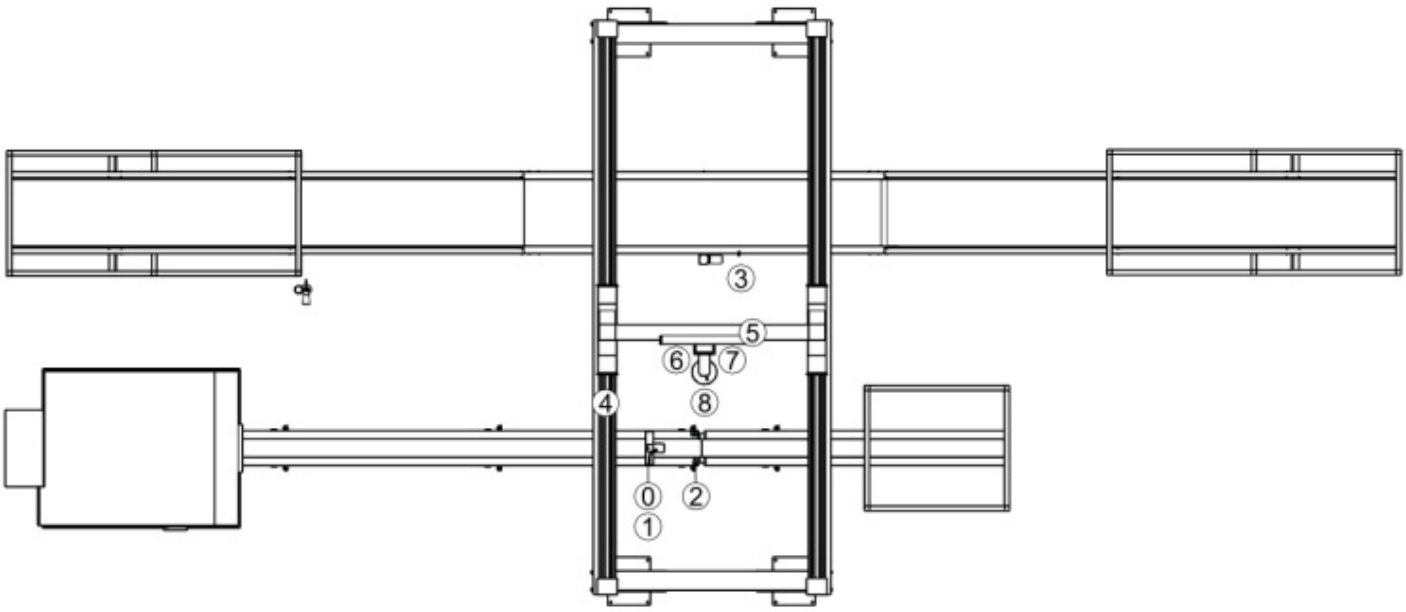


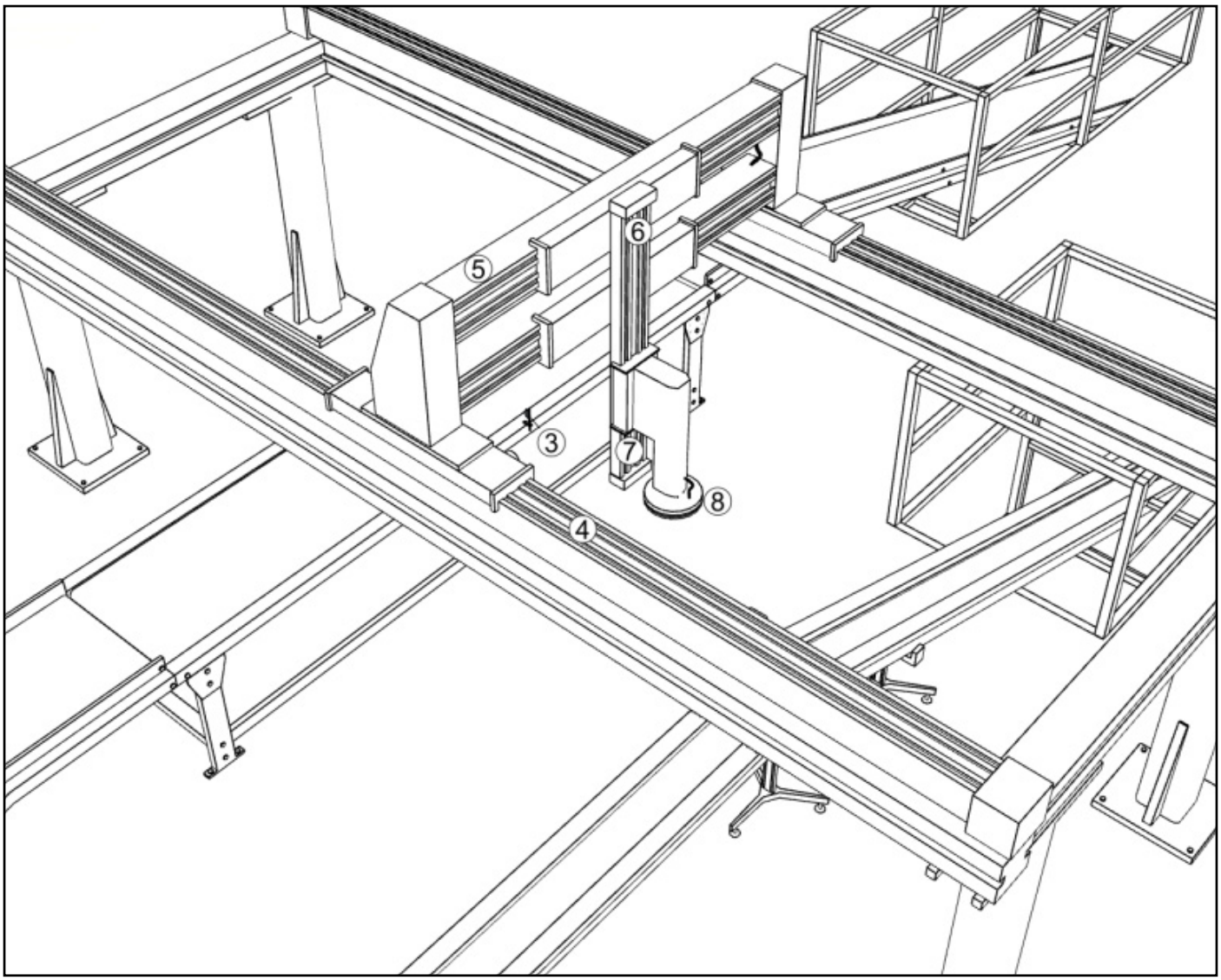
**Suggestions:**

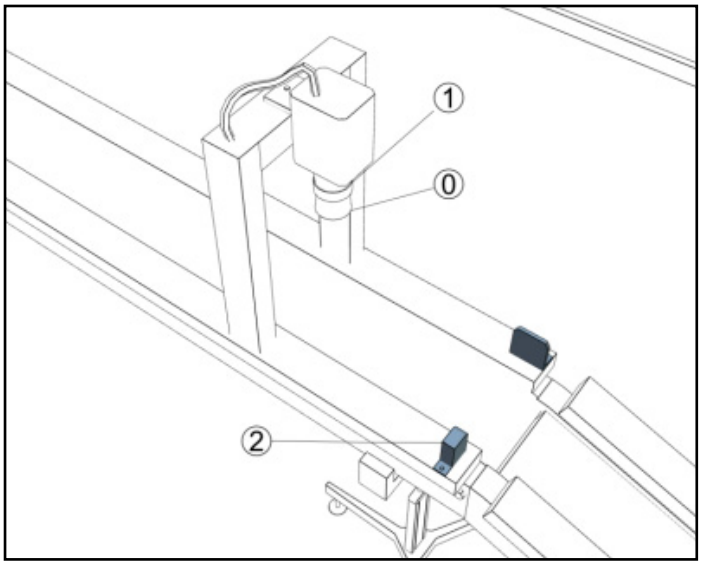
- Try different placing configurations for the parts in the boxes.

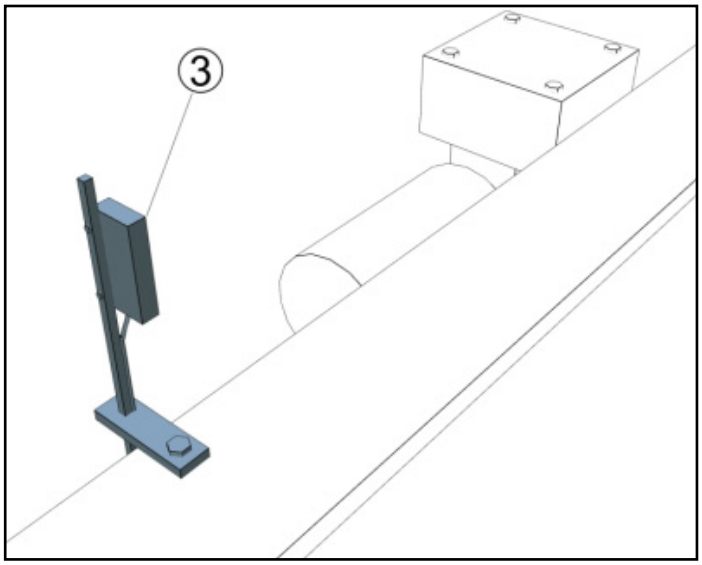
## PICK & PLACE - SENSORS

| Sensor | Description |
|---|---|
| **0** | Part type encoding bit |
| **1** | Part type encoding bit |
| **2** | Part detector at the picking area |
| **3** | Box detector at the placing area |
| **4** | Manipulator detector at zero position (picking area) |
| **5** | Manipulator movement detector |
| **6** | Top limit switch of the manipulator vertical axis |
| **7** | Bottom limit switch of the manipulator vertical axis |
| **8** | Magnetic gripper detector |





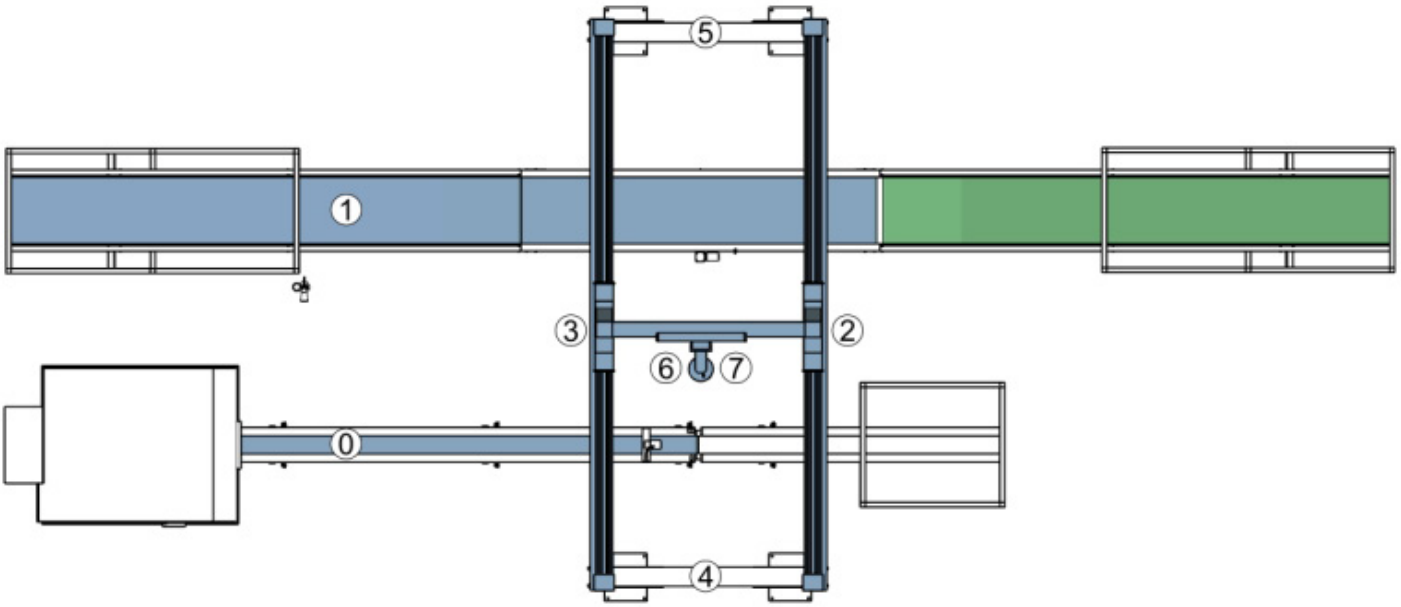



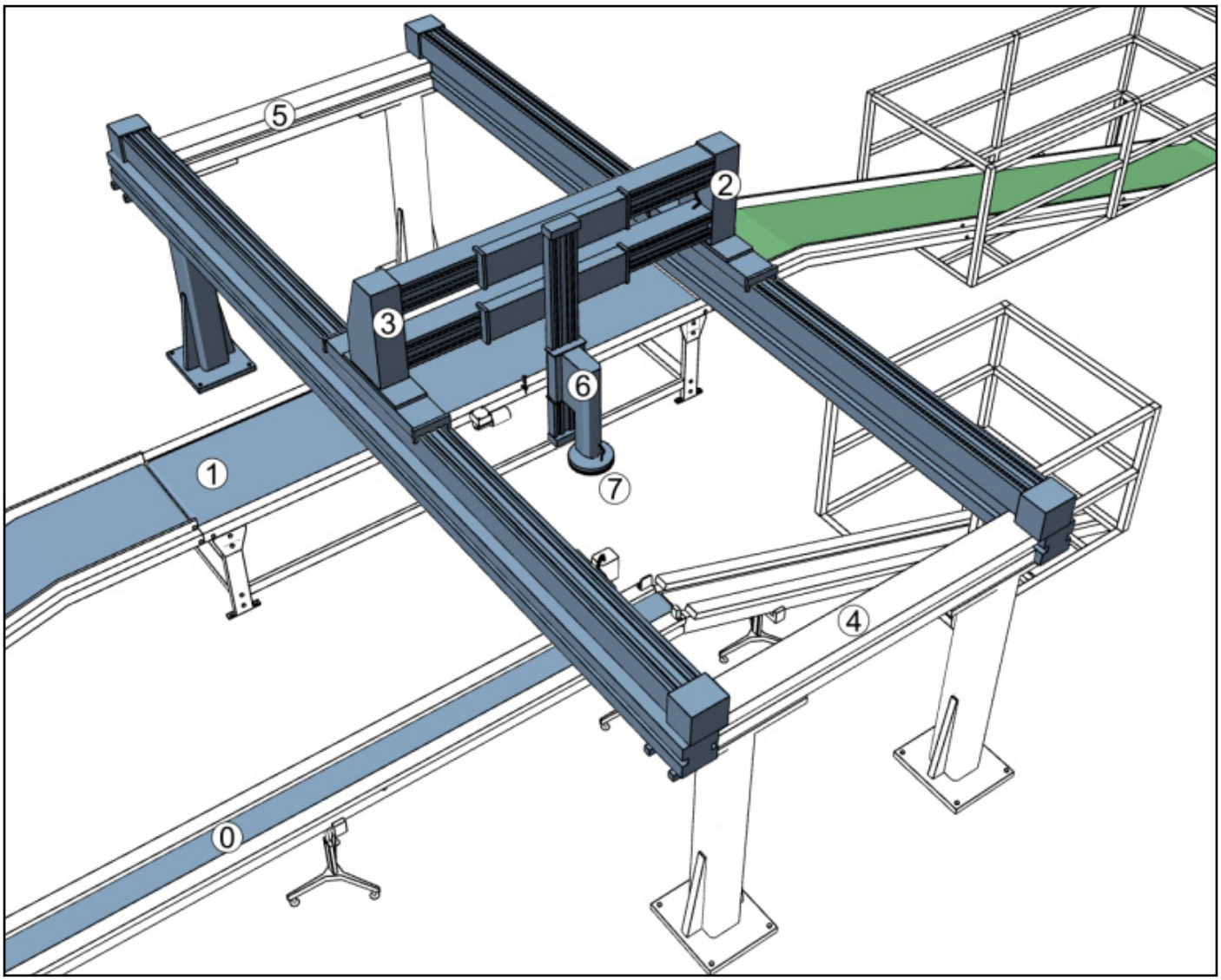

**Note:**

- Sensor 5 is activated when the manipulator is moving (on the horizontal plane).
- You can force the sensors 9 and 10 (not used in this system), to change the placing configuration in the boxes.

## PICK & PLACE - ACTUATORS

| Actuator | Description |
|---|---|
| **0** | Parts conveyor table |
| **1** | Boxes conveyor table |
| **2** | Longitudinal axis movement of the manipulator |
| **3** | Longitudinal axis movement of the manipulator |
| **4** | Transversal axis movement of the manipulator |
| **5** | Transversal axis movement manipulator |
| **6** | Vertical axis descending movement of the manipulator |
| **7** | Magnetic gripper |

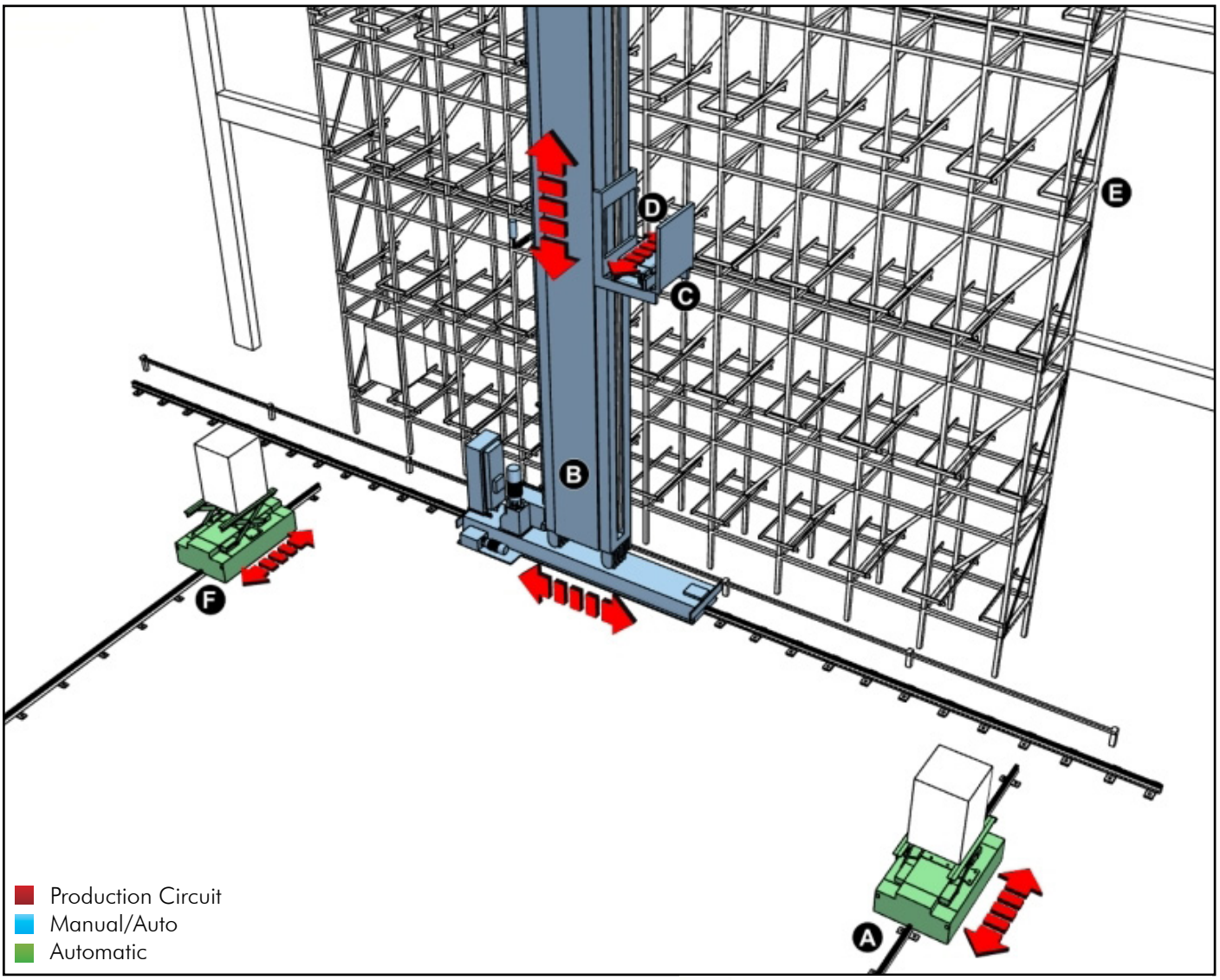





# AUTOMATIC WAREHOUSE

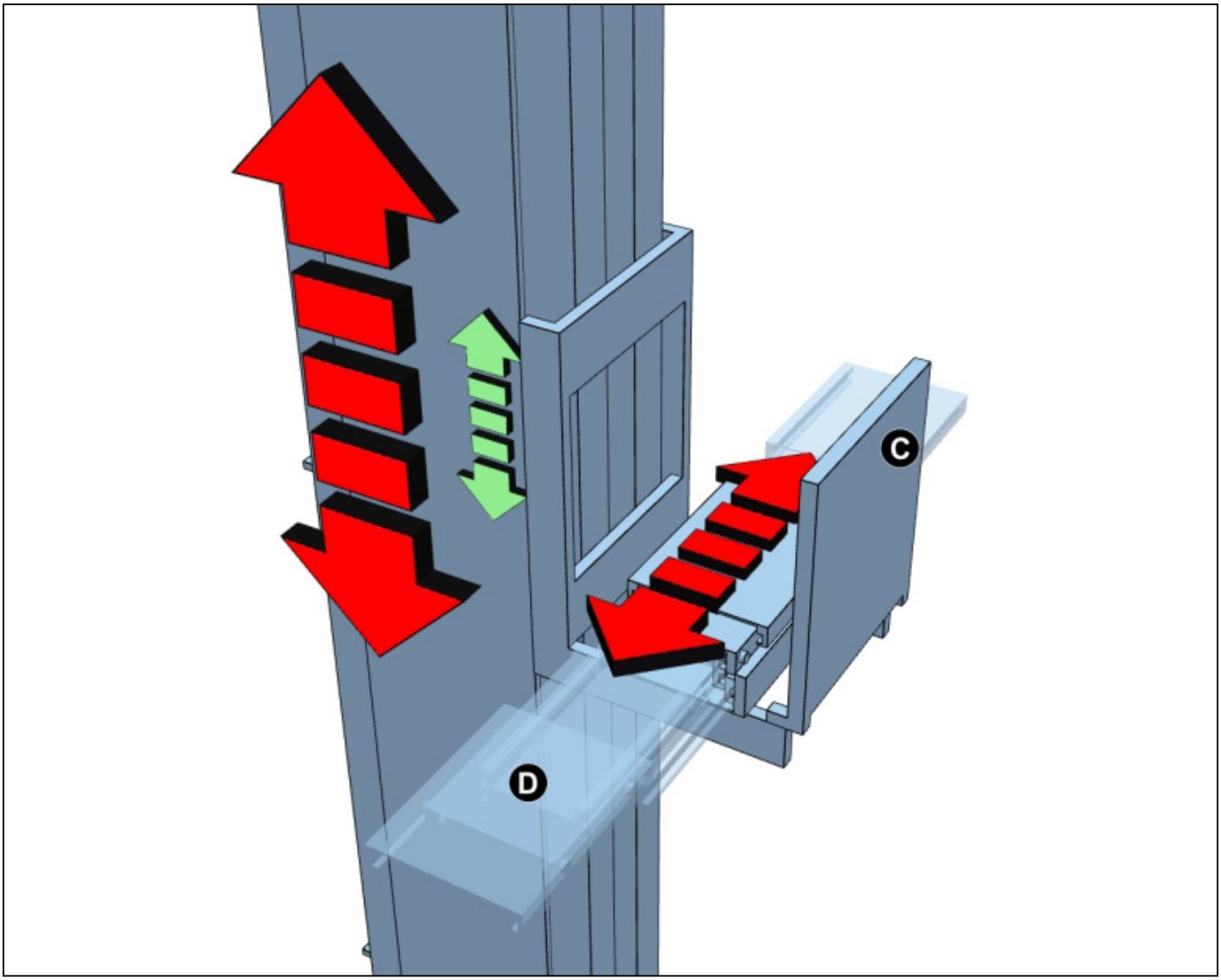
# AUTOMATIC WAREHOUSE - SYSTEM DESCRIPTION

This system simulates an automatic warehouse, where the objective is to transport, store and retrieve boxes from a rack.

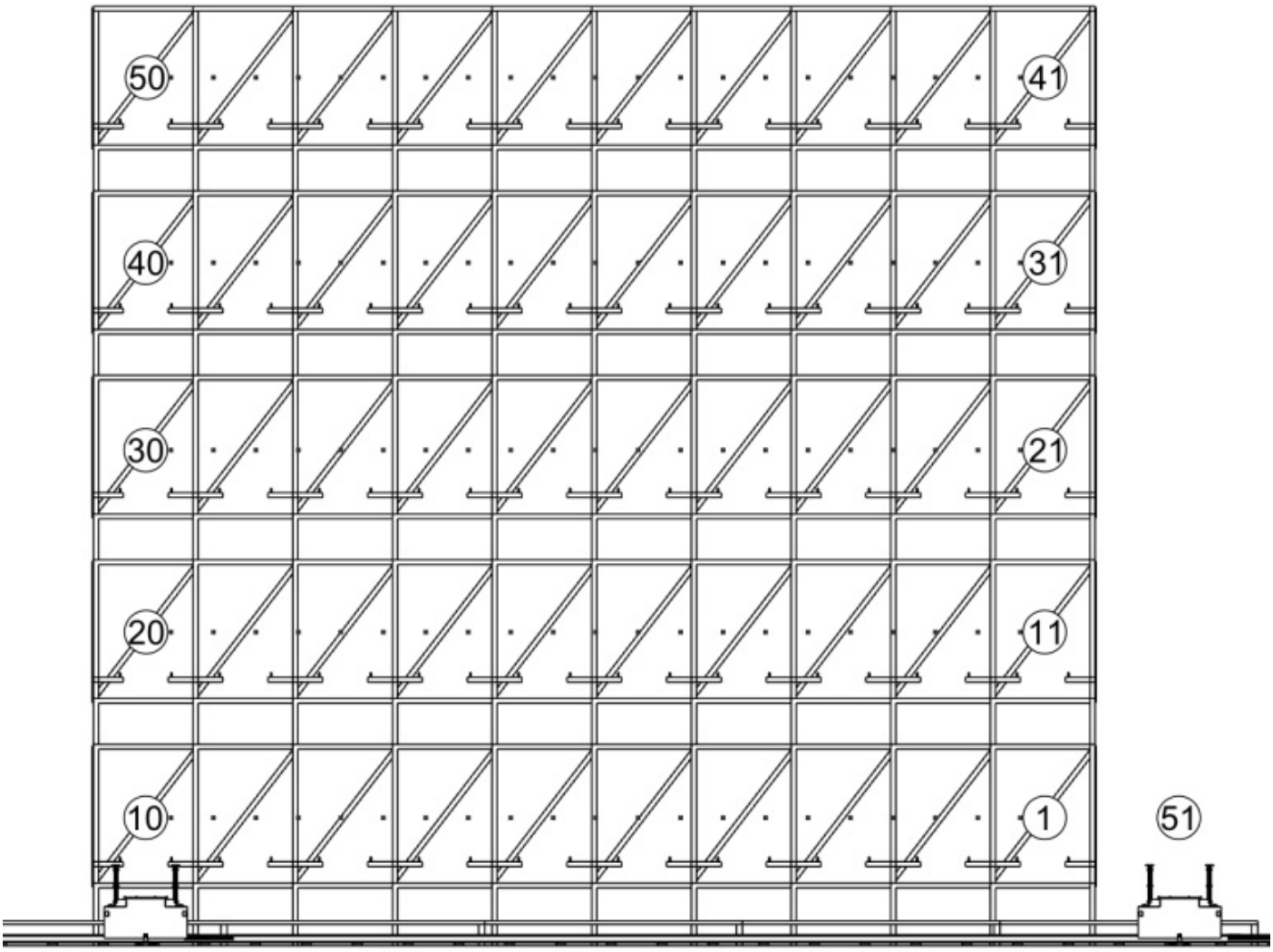



This automatic warehouse system is composed of a transelevator, a rack, an entry bay and an exit bay.

The automatic monorail (A), delivers boxes to the transelevator (B, C, D). The boxes are delivered and retrieved by the forks (D), followed by an automatic movement of the elevator (C). The rack (E) is subdivided into 50 cells, which are identified by a number. The cells identification numbers are encoded by six bits that command the transelevator movement. The monorail (F) retrieves the boxes from the transelevator.



Cells identification numbers and transelevator entry (10) and exit point (51).




**Note:** Use the keys + or - to add or remove a row of boxes from the rack.

**Suggestions:**

- Make sure that you understand the transelevator encoding. Try to move the transelevator to different locations in the rack, in manual mode.
- Start by creating a program that stores one box in the rack and then retrieves it, so you can get familiar with the system operation.
- For each cell set the corresponding number to a word. Attribute the word bits to the actuators (actuators 0,...,5) that command the transelevator movement.
- Through a HMI console or a SCADA, create an interface that makes it possible to introduce storage and retrieval sequences. Organize and visualize the rack storage information.

## TRANSELEVATOR ENCODED POSITIONS:

| Position | Actuators | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 |
| Stop |  |  |  |  |  |  |
| 1 |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |
| 7 |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |
| 9 |  |  |  |  |  |  |
| 10 (Exit) |  |  |  |  |  |  |
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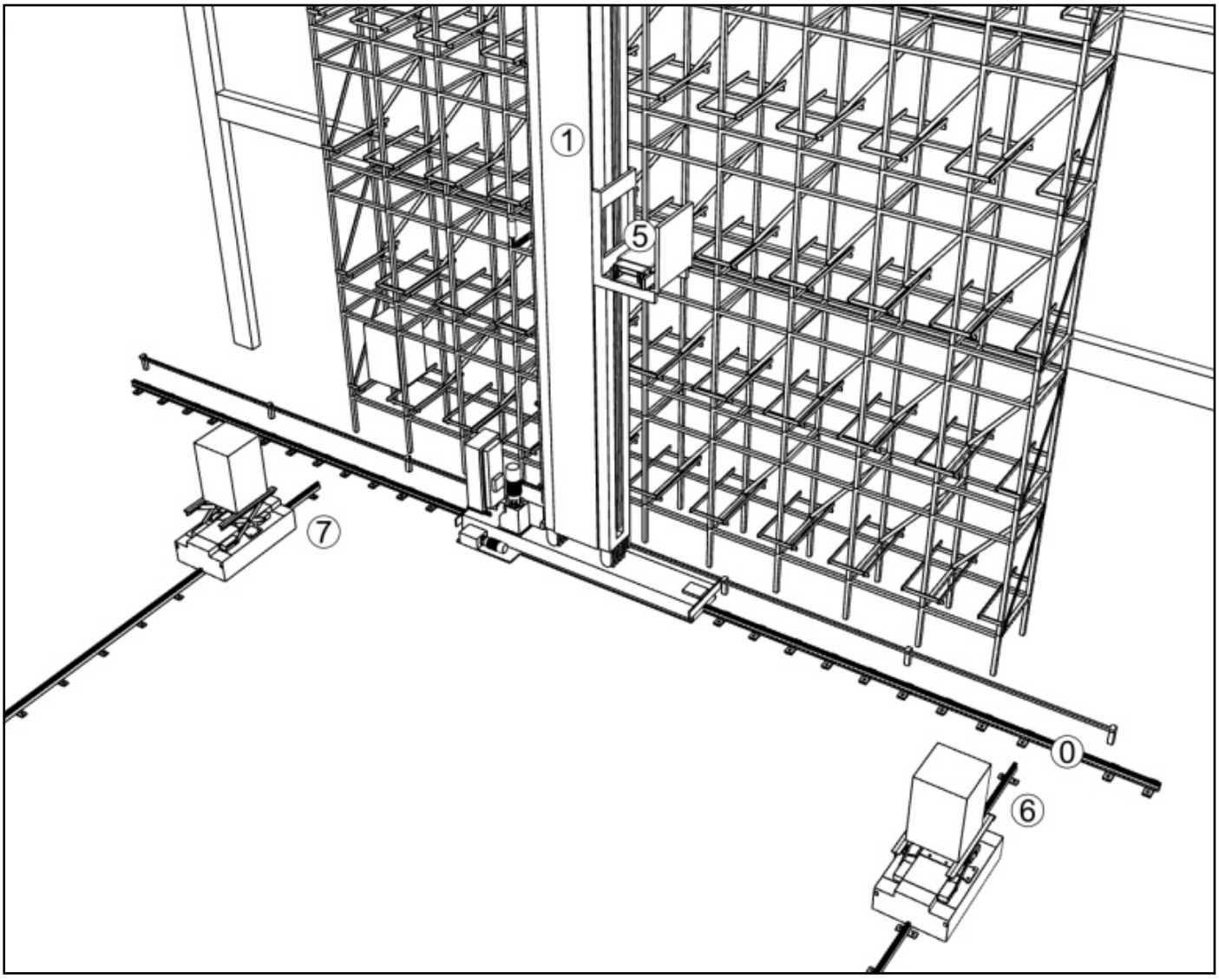
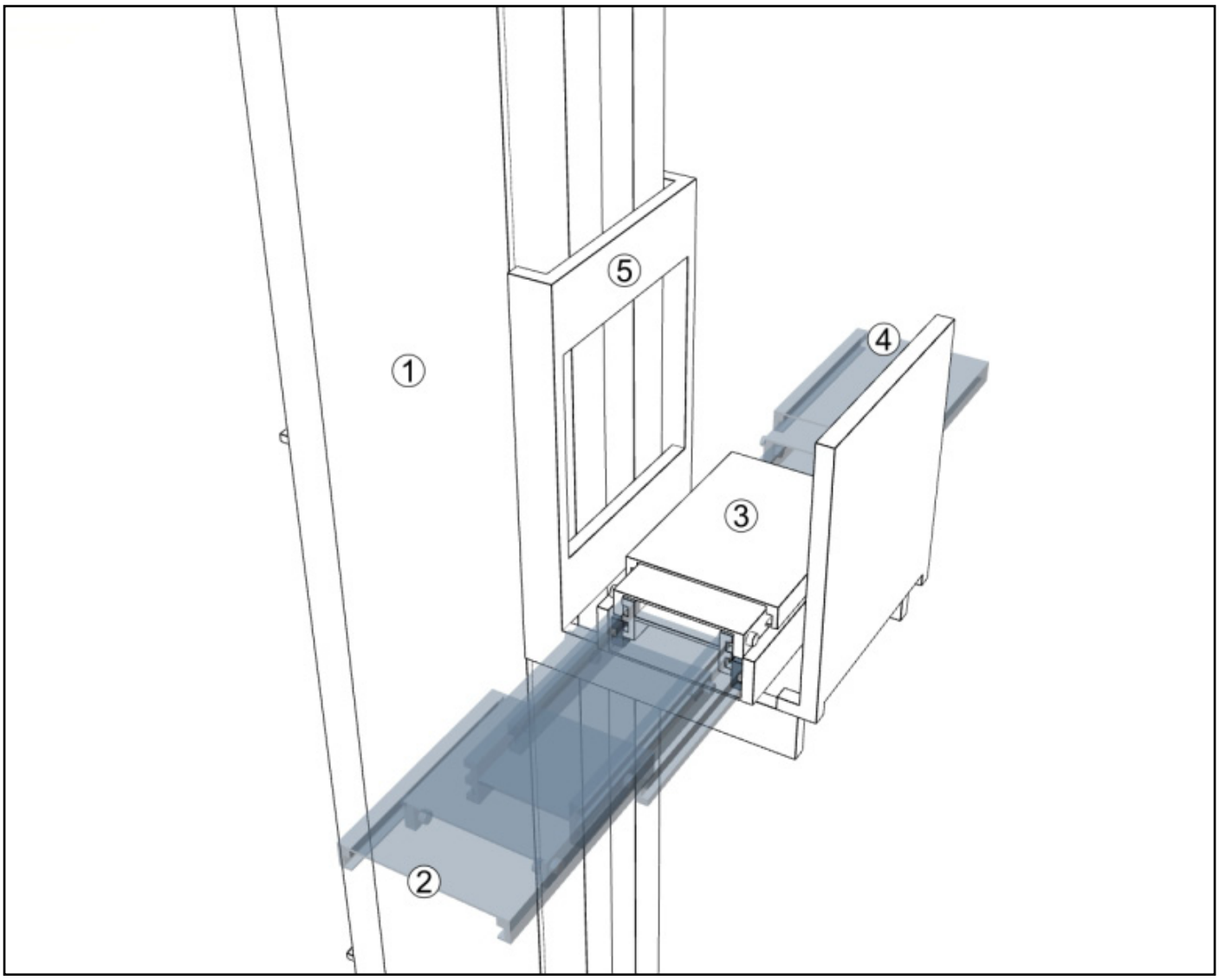
| 50 |  |  |  |  |  |  |
| 51 (Entry) |  |  |  |  |  |  |

| | |
|---|---|
|  | Off |
|  | On |

## AUTOMATIC WAREHOUSE - SENSORS

| Sensor | Description |
|---|---|
| **0** | Transelevator detector at the entry point |
| **1** | Transelevator end of movement sensor |
| **2** | Forks limit switch |
| **3** | Forks detector at the central position |
| **4** | Forks limit switch |
| **5** | Automatic movement sensor of the elevator |
| **6** | Monorail detector at the entry point |
| **7** | Monorail detector at the exit point |

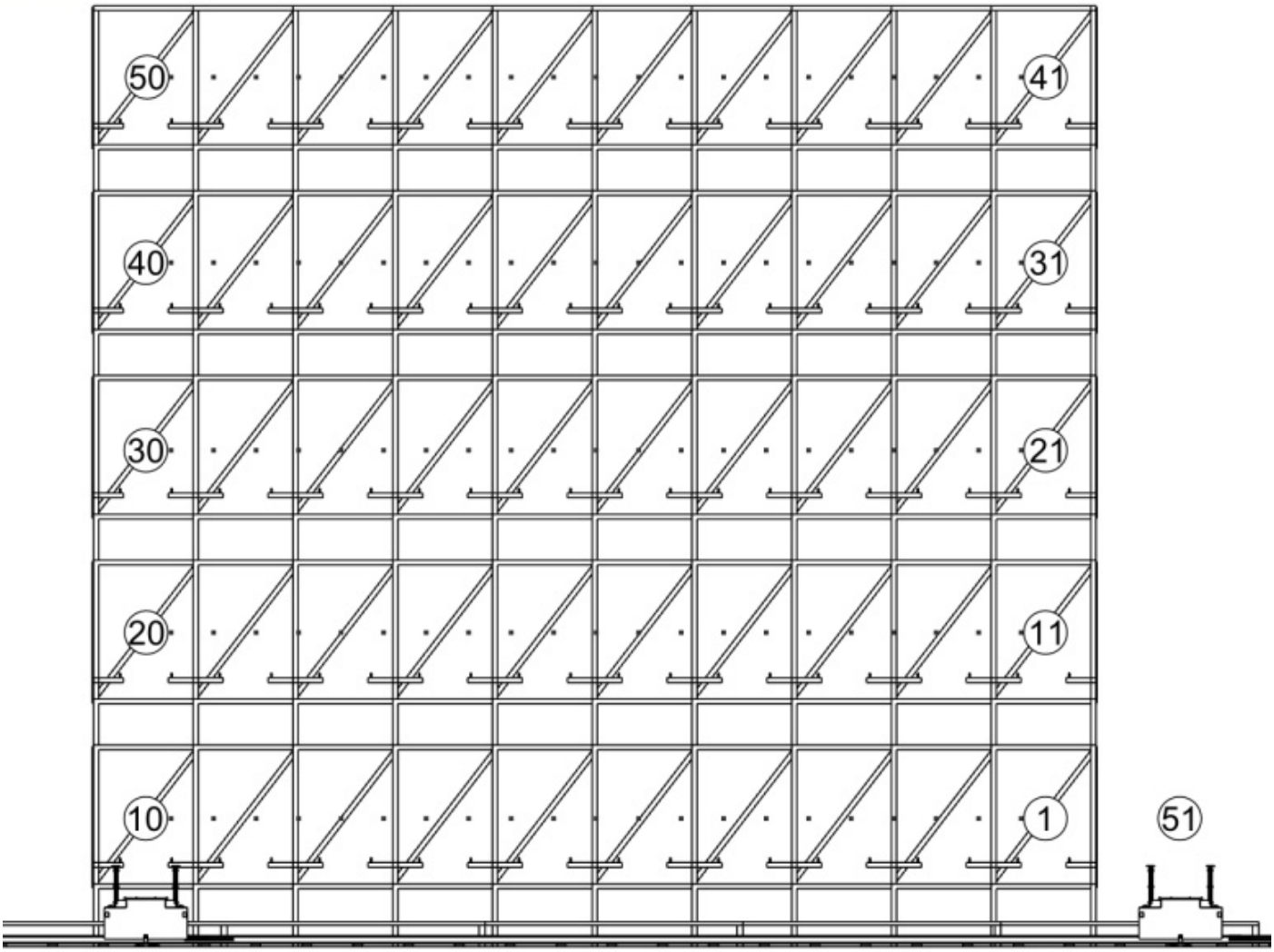


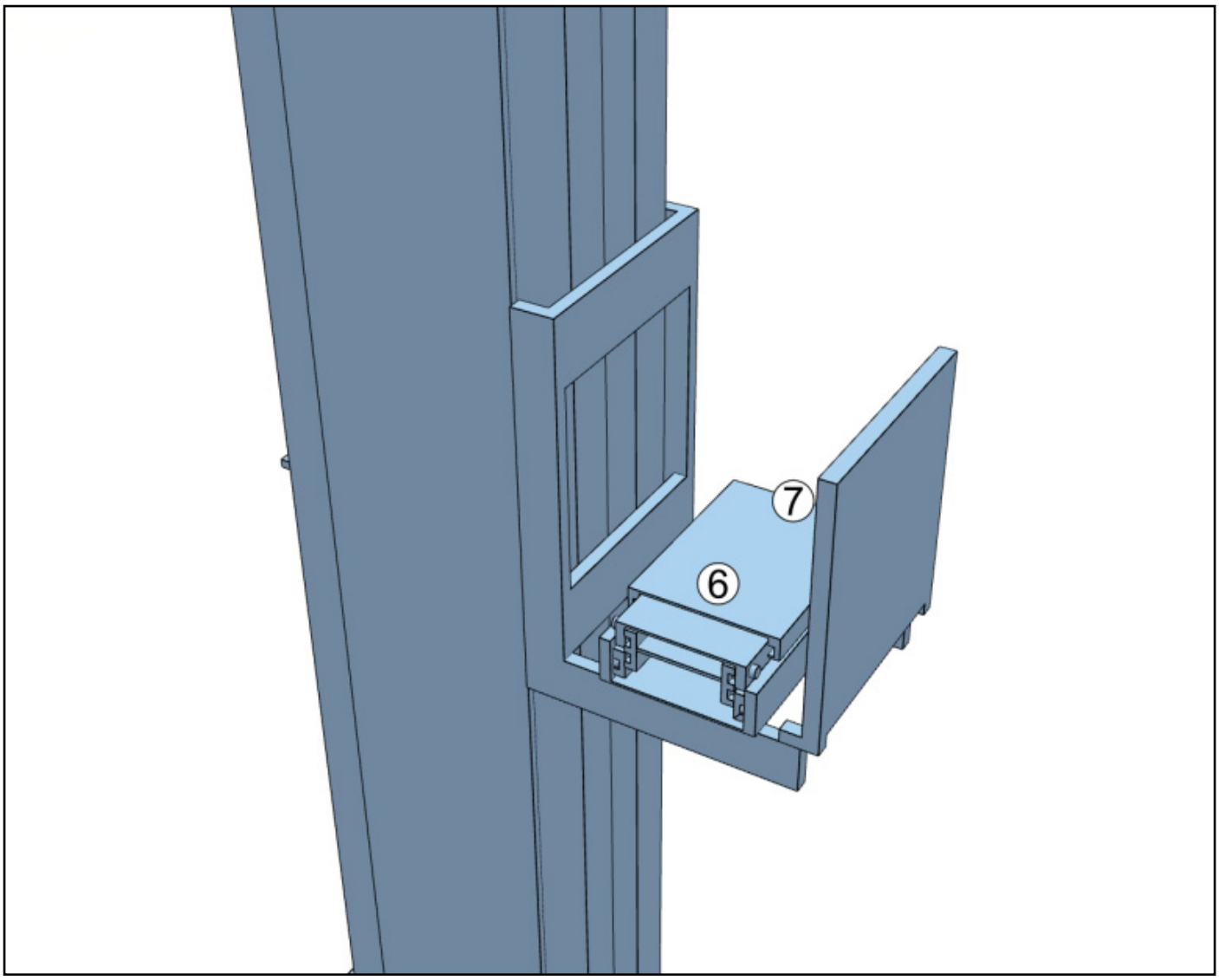



**Note:** Force the sensors 8, 9, 10 (not used in this system) to change the boxes delivery or retrieval order.

## AUTOMATIC WAREHOUSE - ACTUATORS

| Actuator | Description |
|---|---|
| **0** | Transelevator position encoding bit (least significant bit) |
| **1** | Transelevator position encoding bit |
| **2** | Transelevator position encoding bit |
| **3** | Transelevator position encoding bit |
| **4** | Transelevator position encoding bit |
| **5** | Transelevator position encoding bit (most significant bit) |
| **6** | Forks movement towards the monorail |
| **7** | Forks movement towards the rack |





## SUPPORT

We want you to get the maximum advantage from our product. So if you run into technical difficulties, we are here to help.

For the most frequently asked questions, you can easily find answers in the product documentation.

If you still cannot find the answer, gather all the information or questions that apply to your problem, and with the product close at hand, contact us:

**Website:** www.realgames.pt
**Email:** support@realgames.pt

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