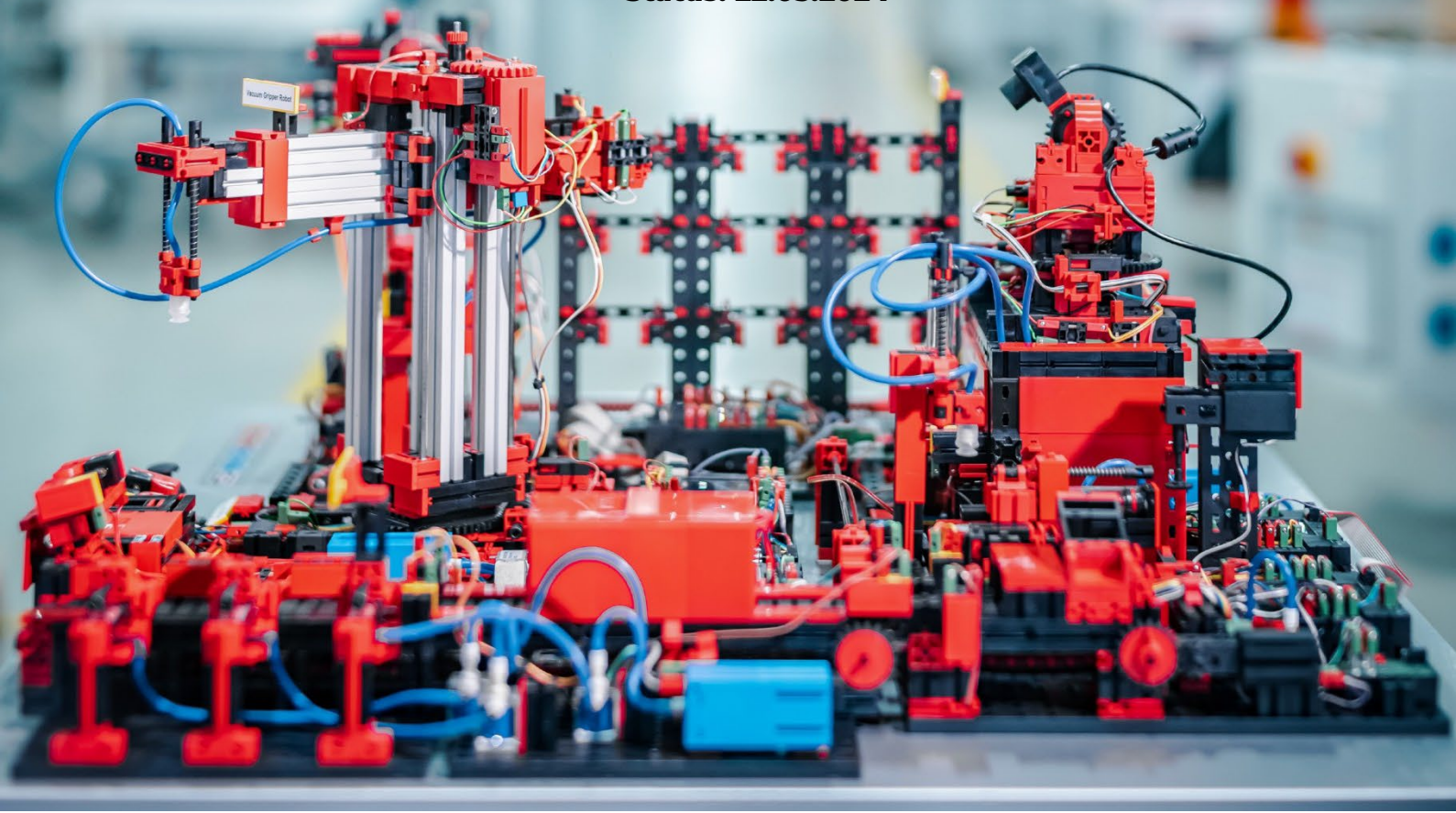
fischertechnik

LEARNING FACTORY 4.0 24V

TRAINING FACTORY INDUSTRY 4.0 24V
FÁBRICA DE FORMACIÓN INDUSTRIA 4.0 24V

Accompanying booklet
Activity booklet
Manual d'accompagnement
Begeleidend boekje
Cuaderno adjunto
Folheto
Libretto di istruzioni
Сопроводительная инструкция
附带说明书

Status: 22.03.2024



Contents

The individual factory components

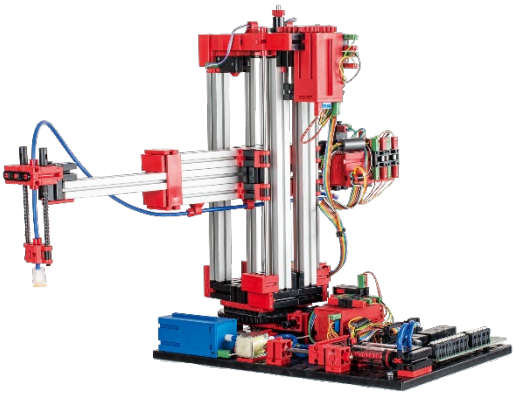
This chapter introduces the individual components of the factory system and briefly explains their function.

What are robots?

The Association of German Engineers (VDI) defines industrial robots in VDI Guideline 2860 as follows:

"Industrial robots are universally applicable automatic motion machines with several axes, whose movements are freely programmable (i.e. without mechanical or human intervention) in terms of movement sequence and paths or angles and may be sensor-guided. They can be equipped with grippers, tools or other production equipment and can carry out handling and/or production tasks."

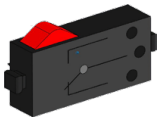
Vacuum suction pad 24V (VGR)



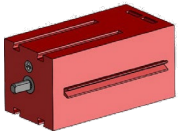
The 3-axis robot with vacuum suction gripper positions workpieces quickly and precisely in three-dimensional space. Working range: X-axis 270°, Y-axis (forwards/backwards) 140 mm, Z-axis (up/down) 120 mm. The 3D vacuum suction gripper is therefore an industrial robot that can be used for handling tasks. With the help of the vacuum gripper, workpieces are
and moved within a workspace. This
The working space results from the kinematic structure of the robot and defines the area that can be approached by the robot's effector.
In the case of the vacuum suction gripper, the suction cup is the effector and the working space corresponds to a hollow cylinder whose vertical axis coincides with the robot's axis of rotation. The geometric shape of the working space results from the kinematic structure shown in the figure, which is made up of one rotational and two translational axes.
The typical work order of such a robot can be divided into the following work steps:

- Positioning the suction pad on the workpiece
- Holding the workpiece
- Transport of the workpiece within the work area
- Storing the workpiece

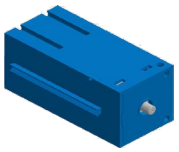
The positioning of the suction gripper or the transport of the workpiece can be defined as a point-to-point movement or as a continuous path. The individual axes are controlled sequentially and/or in parallel and are significantly influenced by obstacles in the work area or predefined intermediate stations. The suction gripper is controlled with the aid of a 3/2-way solenoid valve and two coupled pneumatic cylinders to generate the vacuum.



Button



Encoder motor



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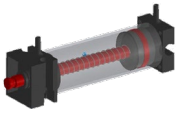
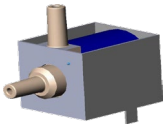
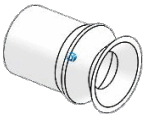


Cylinder

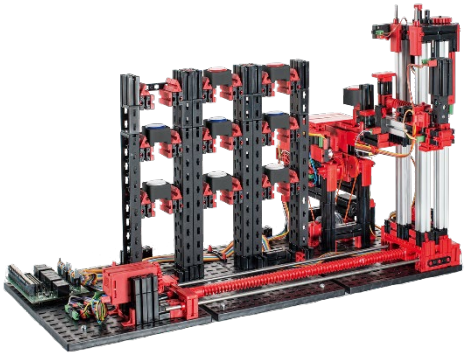


3/2-way solenoid valve



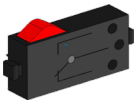
Automated high-bay warehouse 24V (HBW)

What is a high-bay warehouse?



A high-bay warehouse is a space-saving warehouse that enables the computer-aided storage and retrieval of goods. In most cases, high-bay warehouses are designed as pallet racking warehouses. This standardization enables a high degree of automation and connection to an ERP system (Enterprise Resource Planning). High-bay warehouses are characterized by high space utilization and a high investment requirement. Goods are stored and retrieved by storage and retrieval machines that move in an aisle between two rows of shelves. This area is part of the pre-zone, where the goods are also identified. Conveyor technology, e.g. chain conveyors, roller conveyors or vertical conveyors, is used to provide the goods and transfer them to the storage and retrieval machine. If the storage and retrieval machines are automated, no persons may be present in this area. In the case of automated high-bay racking, the goods are provided with the aid of a conveyor belt.

Phototransistor



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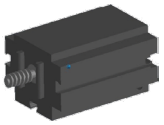
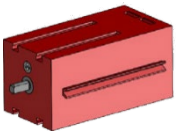


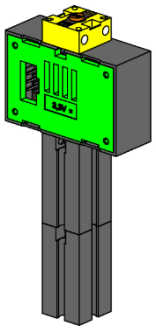
Mini motor



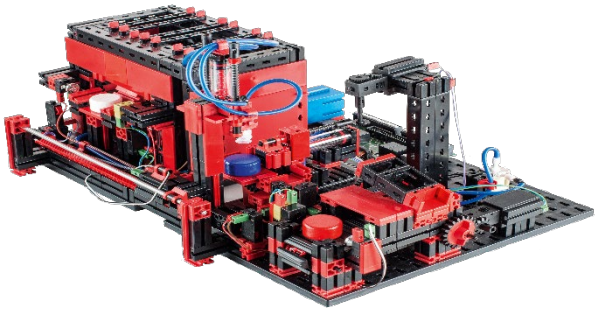
Encoder motor

Environmental sensor

For space reasons, the environmental sensor was built onto the base plate of the high-bay warehouse. However, the electrical connections are on the TXT 4.0 controller.



Multi-processing station with 24V furnace (MPO)



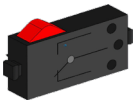
In the multi-processing station with kiln, the workpiece automatically passes through several stations that simulate different processes. Various conveyor technologies are used, such as a conveyor belt, a rotary table and a vacuum suction gripper are used. The machining process begins with the furnace. To initiate processing, the workpiece is placed on the kiln slide. This interrupts the light barrier, which causes the furnace door to open and the furnace slide to be drawn in. At the same time, the vacuum suction gripper, which brings the workpiece to the rotary table after the firing process, is requested. After the firing process, the furnace door is opened again and the furnace slide is extended again. The already positioned vacuum suction gripper picks up the workpiece, transports it to the rotary table and places it there. The rotary table positions the workpiece under the milling machine, remains there for the processing time and then moves the workpiece to the pneumatically operated ejector. This pushes the workpiece onto the conveyor belt, which transports the workpiece to a light barrier and then on to the sorting system. Passing through the light barrier causes the turntable to return to its starting position and the conveyor belt to stop with a time delay.

The program runs in parallel. The program is divided into three units: Kiln, vacuum suction gripper and rotary table. The respective processes communicate with each other and thus ensure, among other things, that there are no collisions.

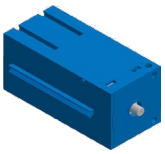
For example, the furnace triggers the movement of the vacuum suction pad at two points during the program sequence, which ensures that the vacuum suction pad is in place in good time but does not reach into the void. The rotary table is also activated by the vacuum suction pad after the workpiece has been set down.

Mini motor

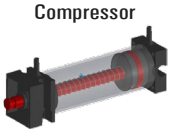
Phototransistor



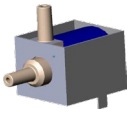
Button



Compressor

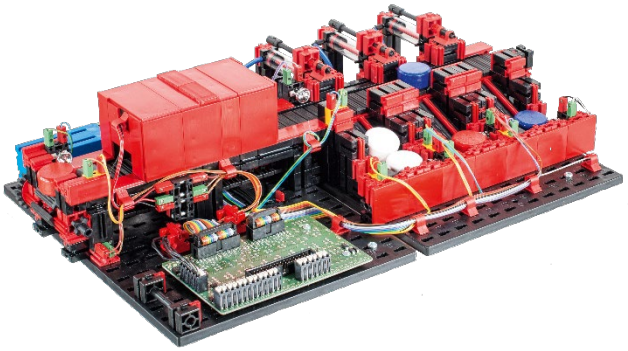


Cylinder

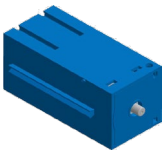


3/2-way solenoid valve

Sorting line with color detection 24V (SLD)



The sorting line with color detection is used for the automated separation of differently colored workpieces. Geometrically identical but differently colored components are assigned to a color sensor with the aid of a conveyor belt and then separated according to their color. The conveyor belt is driven by a motor and the conveying path is measured using a pulse sensor. The workpieces are ejected using pneumatic cylinders, which are assigned to the corresponding storage locations and controlled by solenoid valves. are actuated. Several light barriers monitor the flow of workpieces and whether workpieces are in the storage locations.



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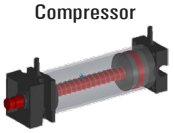
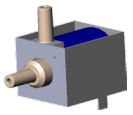
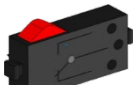


Cylinder

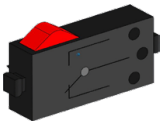


3/2-way solenoid valve



Phototransistor

Color sensor



Mini motor

Color detection is carried out using an optical color sensor, which emits light and deduces the color of a surface based on its reflection. Strictly speaking, the color sensor is therefore a reflection sensor that indicates how well a surface reflects light. The measured value of the sensor is therefore not proportional to the wavelength of the measured color and the assignment of color coordinates or color spaces (e.g. RGB or CMYK) is not possible. In addition to the color of the object, ambient light, the surface of the object and the distance of the object from the sensor influence the reflection quality. For this reason, it is essential that the color sensor is protected from ambient light and that the surfaces of the objects are comparable.

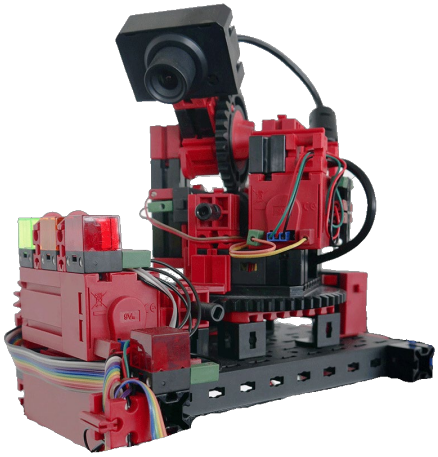
It is also important that the sensor is installed perpendicular to the surface of the object. The colored workpieces are differentiated by threshold values that separate the measured values of the individual colors from each other. As the value ranges of different color sensors differ, it is essential that these threshold values are adjusted.

If a workpiece is placed on the conveyor belt and it interrupts the light barrier, the process is started and the conveyor belt moves off. For color detection, the workpiece passes through a darkened lock in which a color sensor is installed. During this time interval, the minimum value of the measured color values is determined and assigned to the workpiece. During the time it takes for the workpiece to pass the color sensor, the previous minimum value is compared with the current measured value and replaced by it if necessary.

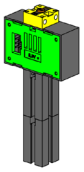
Ejection is controlled by the light barrier located in front of the first ejector. Depending on the detected color value, the corresponding pneumatic cylinder is triggered with a delay after the light barrier is interrupted by the workpiece. The pulse sensor, which registers the rotation of the gear wheel that drives the conveyor belt, is used for this. In contrast to a time-based delay, this approach is robust against fluctuations in the conveyor belt speed. The ejected workpieces are fed to the respective storage locations via three chutes.

The storage locations are equipped with light barriers that detect whether the storage location is full or not. However, the light barrier cannot determine how many workpieces are in the storage location.

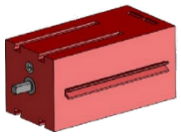
Environmental station with 24V monitoring camera (SSC)



The environmental station with monitoring camera is used to record measured values within the factory. The mobile camera station is mounted on the multi-processing station and is used to visually monitor the system.
The new environmental sensor and a photo resistor enable the measurement of air temperature, humidity, air pressure, air quality and brightness. The values are displayed graphically.

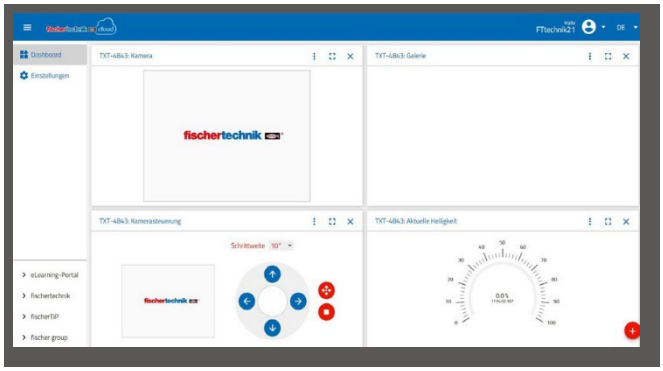


photoresistor, environmental sensor

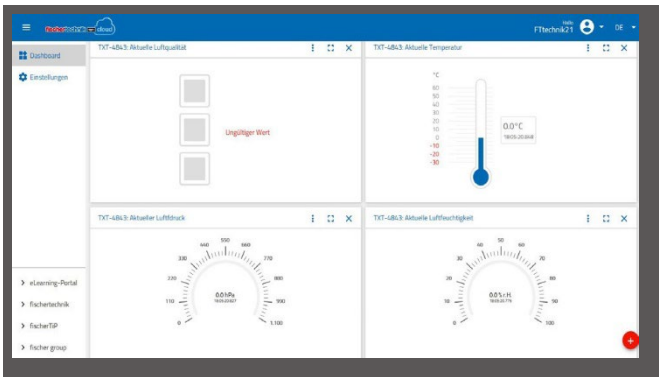


Encoder motor

Camera

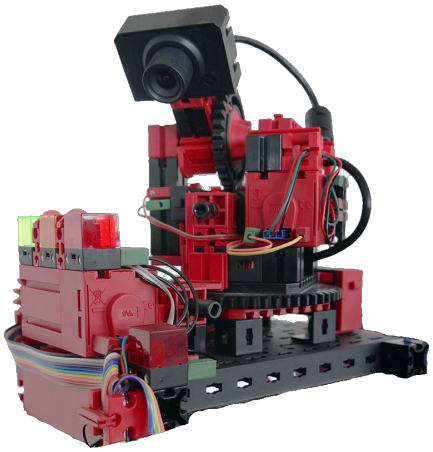


Using a virtual joystick, the camera can be rotated and tilted to monitor the factory. The images are also displayed on the monitoring screen.

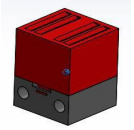


The various sensor data is constantly monitored on a user interface, the "dashboard". The camera's movement axes can also be controlled here. An LED display indicates when the set limit values are exceeded. The red LED always lights up when an image from the camera is transferred to the cloud.

Surveillance camera in multi-processing station

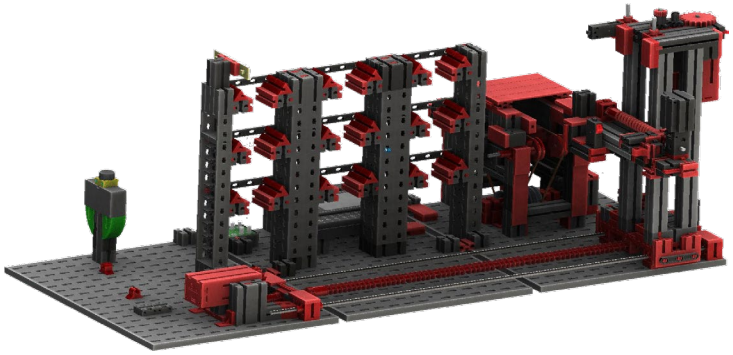


In the factory system, the two modules "Multi processing center and surveillance camera" were combined into one overall module. This has the advantage that the camera is at the highest point in the factory model and can therefore monitor the entire system. The Surveillance camera still has an optical display (red lamp). It flashes to indicate that images are being recorded.



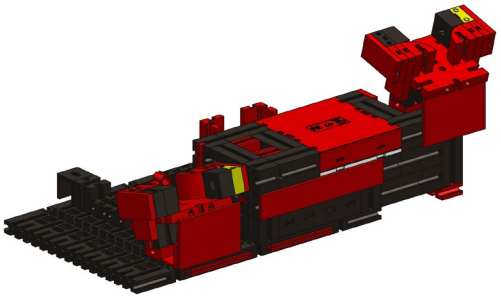
Indicator lamp red

Environmental sensor and photoresistor in high-bay warehouse



The environmental sensor and the photoresistor are located on the high bay module. Both are connected to the TXT 4.0 controller.

Input/output station with color recognition and NFC reader 24V (DPS)



The input/output station consists of a total of 3 work areas:

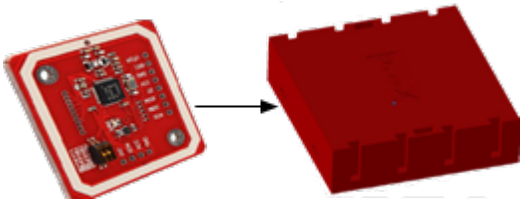
Input and output unit
Color recognition
NFC reader

The light barrier of the input station detects whether there is a workpiece to be stored in it. If this is the case, the information is sent to the program (vacuum suction pad picks up the workpiece).
Before the workpiece is processed further, the color of the workpiece is determined by a color sensor during color detection.
After color recognition, various data is assigned to the workpiece. To do this, the vacuum suction pad places the workpiece on the NFC reader.

Color sensor

Phototransistor

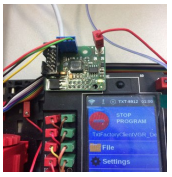
First, all data in the memory is deleted and the workpiece is marked as unfinished.
The reader then writes workpiece-relevant data to the NFC tag NTAG213 in the workpiece.
Important: An NFC tag has a unique ID. This cannot be be changed.



If one or more workpieces are ordered, they are transferred to the output area after various tasks have been carried out. Beforehand, additional production data for the respective workpiece can be saved in the available memory on the NFC tag.

TXT 4.0 Controller

The input/output station also houses the TXT 4.0 controller with connection of the environmental sensor and photoresistor. The camera is also connected here via a USB interface.



Adapter board

TXT Controller

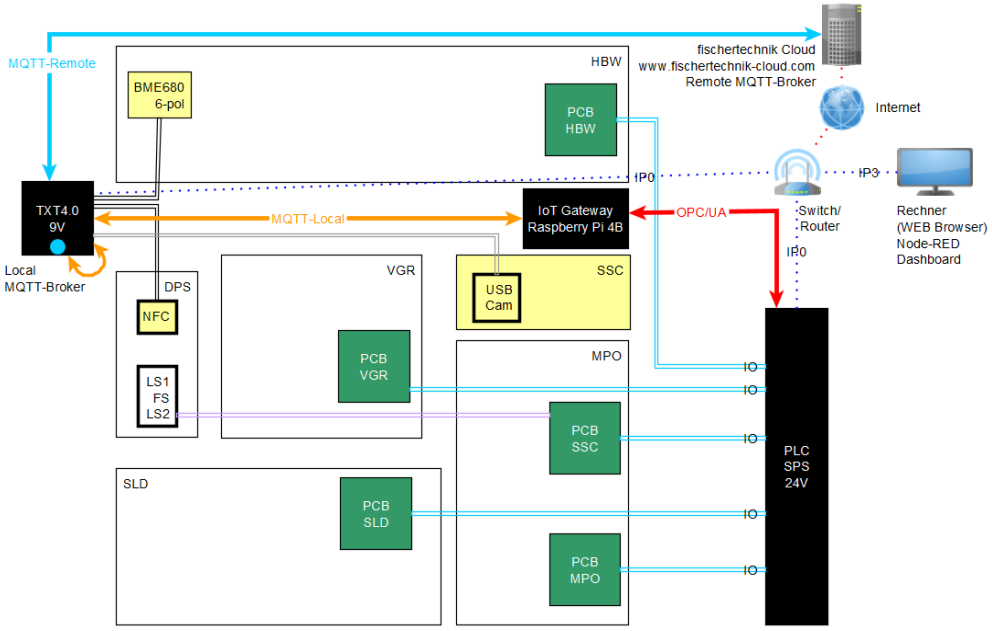
Status display of the factory

The status of the factory is indicated by three LEDs.

Status display

Green means that all stations are in waiting status.
Yellow means that at least one station is active.
Red means an error that must be acknowledged in the dashboard in the cloud so that the learning factory can continue the processes.

Block diagram of the factory plant



The block diagram shows you how the individual factory components communicate with each other and how the system is connected to the Internet and the fischertechnik Cloud. The block diagram also shows which information the user can access via their PC, tablet or smartphone.

ımunicate with each other

-IoT gateway (Node-RED environment as an adapter between OPC/UA and MQTT, dashboard for controlling the model)

-TXT 4.0 Controller (fischertechnik sensors and connection to fischertechnik Cloud)

The PLC contains the sequence control for the entire learning factory.

As the MQTT interface in the PLC controller is not a standard interface, an adapter to the MQTT interface was implemented using an additional IoT gateway (Raspberry Pi 4) with a Node-RED environment. As a server, the PLC provides the IoT gateway with the required data in the local network via the standard OPC/UA interface. The IoT gateway then forwards the messages to the TXT 4.0 controller.

The TXT 4.0 Controller assumes the role of a gateway to the fischertechnik Cloud https://www.fischertechnik-cloud.com.

The camera, RFID/NFC reader, BME680 environmental sensor and a brightness sensor are also integrated here and their data made available to the cloud.

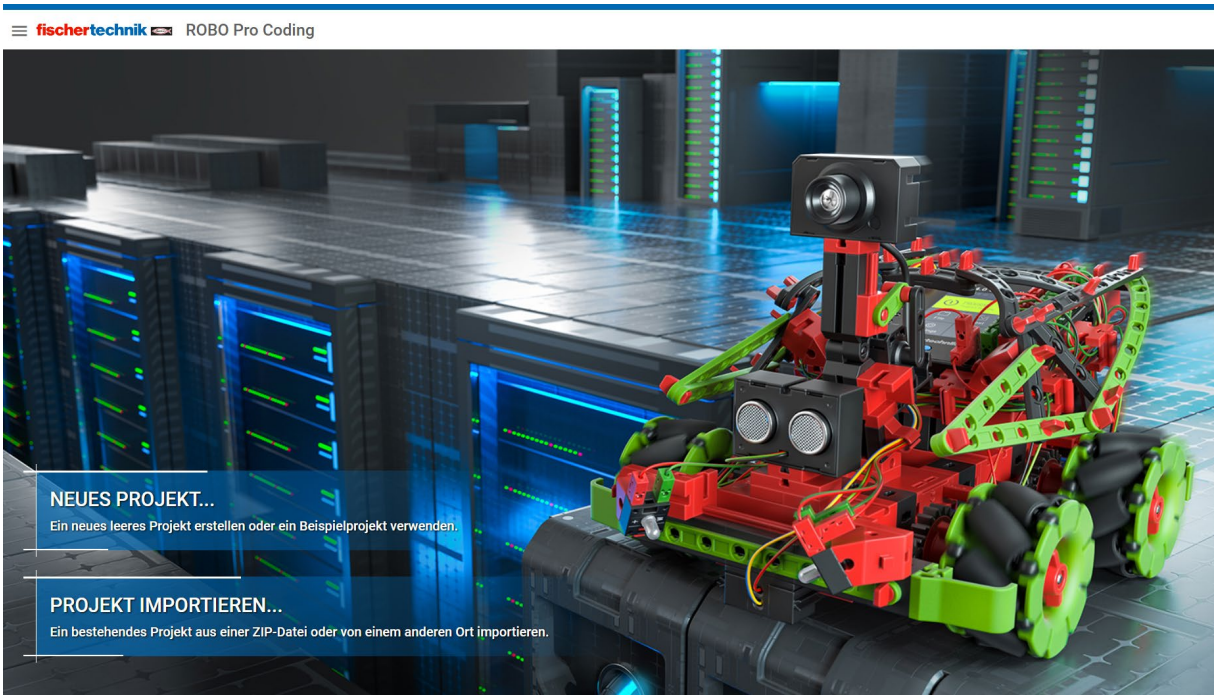
The dashboard of the Node-RED application in the IoT gateway can be accessed via a web browser.

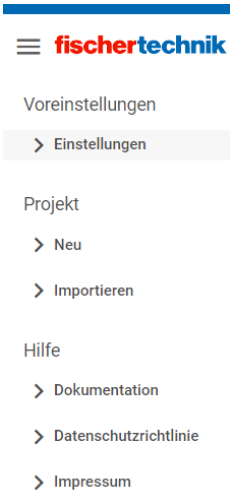
Update programs

When the Learning Factory 4.0 24V is delivered, the two available versions of the "GatewayPLC" program are copied to the main controller in the Learning Factory at the time of production. As the "GatewayPLC" program is constantly being developed further, it is recommended that you always copy the latest program version to the TXT 4.0 controller.

This chapter describes how to update the program.
The ROBO Pro Coding app and an internet connection are required for updating.
Proceed as follows:

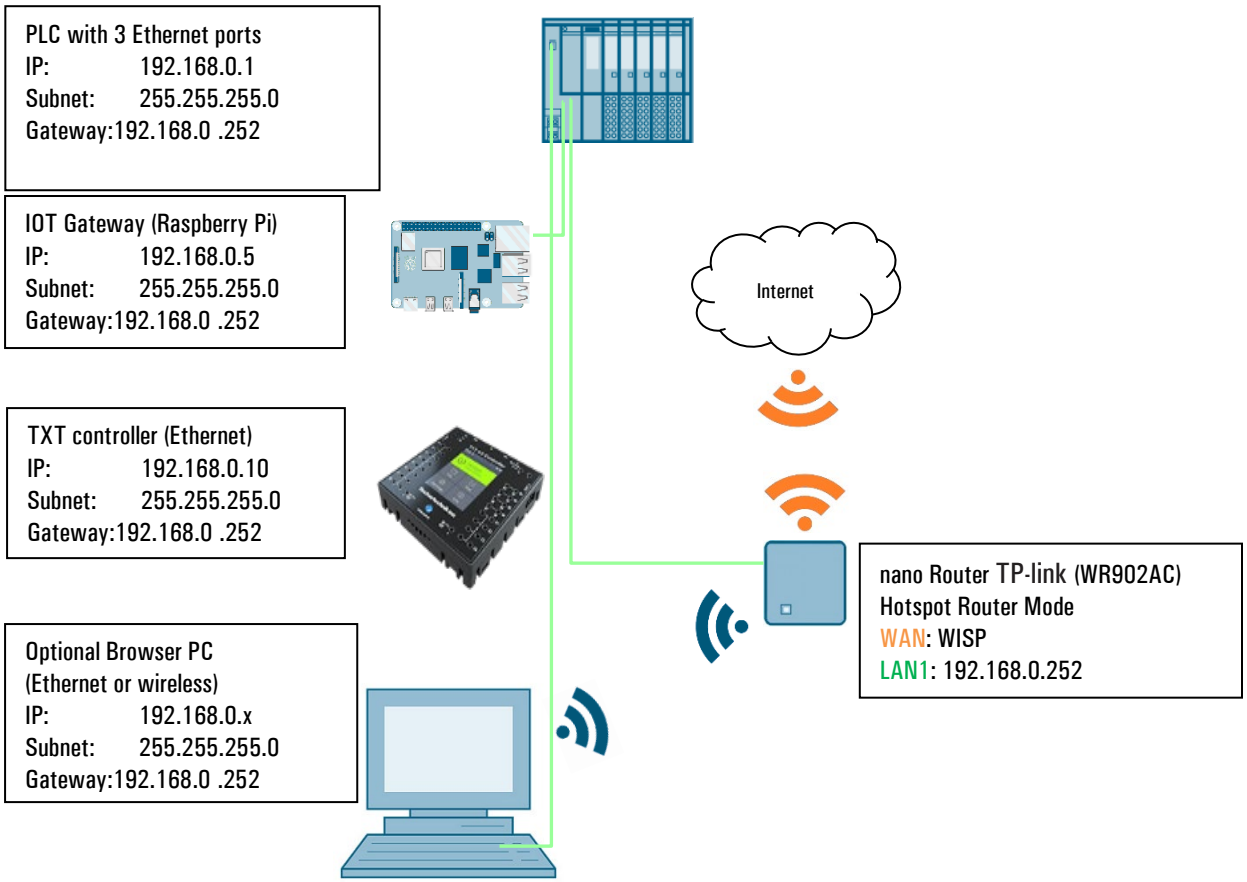
Start ROBO Pro Coding and import the program "GatewayPLC" from fischertechnik Gitlab





Network structure of the factory

The following image shows the network structure and the standard IP addresses used:



The learning factory can be connected to a wireless WAN in online mode with a TP-Link router (TL-WR902AC) in WISP mode. The Ethernet interface of the router must have the IP: 192.168.0.252 and is connected to the PLC (IP: 192.168.0.1). The IOT gateway must have the IP:192.168.0.252 and is also connected to the PLC.

DHCP is activated on the router and ensures that the TXT 4.0 controller is always provided with the same IP address 192.168.0.10 via DHCP. Details on the router settings can be found in the chapter Connecting the Learning Factory 4.0 to the Internet.

NTP time synchronization must be carried out via Internet NTP server. Remote maintenance is not possible.

Important: Please use a suitable internet connection for the Learning Factory 4.0. The following requirements are important: Proxy settings are not supported by the TXT 4.0 Controller, please do not use proxy settings. Ports for MQTT (1883 and 8883) and NTP service must be enabled.