Learning Systems for Industry 4.0

CP Lab 400 Complete Systems

FESTO

CP Lab

Industry 4.0 from the outset

CP Lab – The compact Industry 4.0 learning system

The Cyber-Physical Lab is the professional and compact Industry 4.0 learning system from Festo Didactic. It includes all the technologies and components needed for communicating an in-depth knowledge of Industry 4.0.

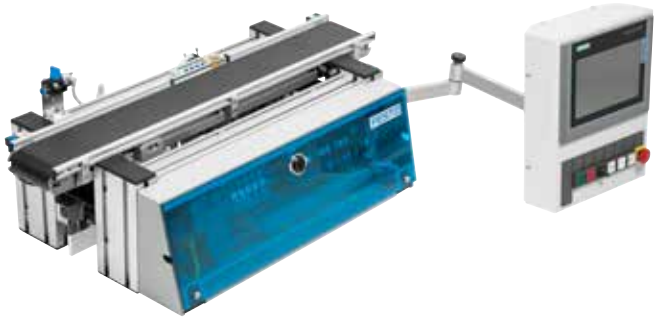
The modular and flexible design has a range of learning scenarios, from individual pallet transfer systems with integrated controller right up to a connected production system with cloud services.

Your benefits

- Modular design
- Flexible learning content
- Easily expandable
- State-of-the-art technology
- Designed for IoT devices
- Seamless transition to the CP Factory
- Expandable using mobile robotics
- Compact and space-saving size: can be used on laboratory tables or trolleys

System overview

Pallet Transfer System and Application Modules



The system consists of an **Application Module** which is placed on a **Pallet Transfer System**.

Main components of the Pallet Transfer System
Every individual Pallet Transfer System consits of the following main components:
– Integrated controller
– Mono-belt transfer system
– Pallet stopper
– 3/2-way valve
– Inductive sensor
– Capacitive sensors at the start and the end of the belt
– RFID read/write system
– Binary ID system
– Optical transmitter and receiver
– AC or DC motor
– Motor controller, bi-directional with 2 speed levels
– Incremental shaft encoder
– IO-Link® master
– IO-Link® device
– Analog I/O using IO-Link®
– Control panel

Options
Control variants:
– Festo CECC with 14 DI/8 DO
– Siemens S7 ET200SP CPU1512-F with 16 DI/16 DO
– Decentralized peripherals Siemens ET200SP with IM155 module

HMI variants:
– Siemens Touch Panel TP700, 7”
– Festo touch panel CDPX, 7”

Motor variants:
– DC motor
– Three-phase motor 230 V
– Three-phase motor 400 V for star/delta circuit

Application Modules
The following application modules can be selected:
– Magazine
– Turning
– Camera inspection
– Tunnel furnace
– Drilling
– Pressing
– Measuring
– Workpiece output
– Labeling
– Pick-by-light
– Bottling

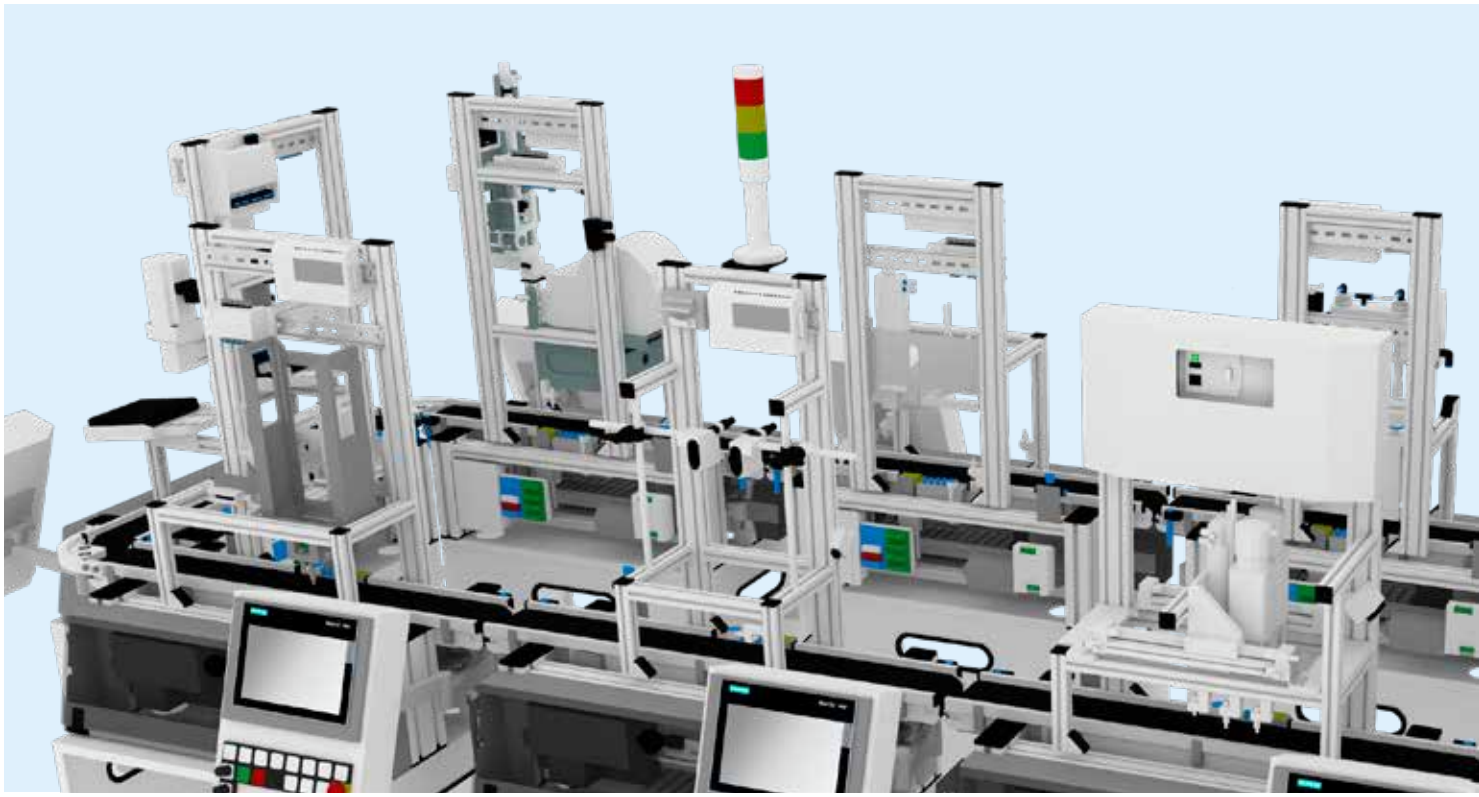
Other application modules on request.

Training content
– Design and structure of the CP Lab:
  – Sensors/actuators
  – Process modules
  – Conveyor belt
  – Network
  – Process and plant management level
  – MES
– Recording information using intelligent sensors
– Control using PLC
– Communication based on bus technologies
– Binary pallet identification
– Identification via RFID
– Plug & produce: quick integration of new application modules using cyber-physical systems
– Manufacturing execution system (MES): creating, managing, controlling and visualizing customer orders

For more details regarding the CP Lab 400, please contact:

➔ Mr Eckhard von Terzi,
eckhard.vonterzi@festo.com

CP Lab 400 Complete Systems



The CP Lab 400 Complete Systems include four predefined systems.

These are compiled based on the experience of many implemented CP Lab systems, and form typical, logical combinations for an introduction to the world of of Industry 4.0.

Fully-equipped with the application modules, each system represents a production process. This enables the diverse areas of Industry 4.0 to be clearly illustrated and taught.

The configurations build upon one another, creating meaningful processes from even the smallest system.

Industry 4.0 topics:

– Digital product memory
– RFID, QR, data matrix
– UID product identification*

– System planning
– System simulation
– SIL/HIL*

– Error control
– Maintenance planning*
– Predictive maintenance*

– Safer networking*
– Remote service concepts*
– Cloud applications*

– Cyber-physical systems
– Embedded controller
– Web technology

– Energy efficiency
– Energy monitoring*
– Energy management*

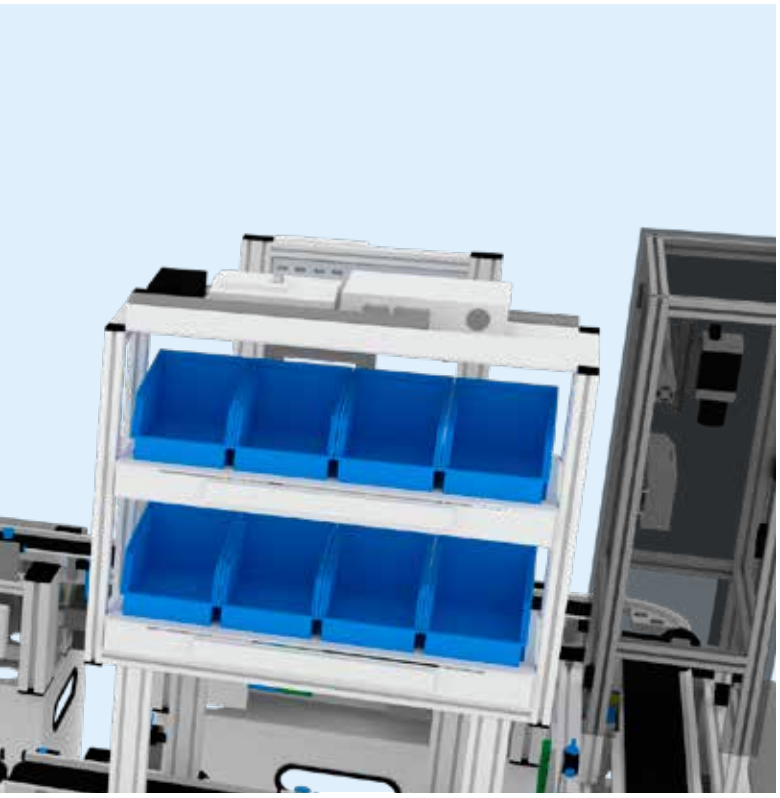
– Modern, decentralized control technology
– HMI, touch panels

– MES
– ERP*
– Web store*
– Data analytics*

– IP communication
– Open industrial standards
– Web standards

Worker guidance
Virtual reality (VR)*
Augmented reality (AR)*

* Optional supplements for CP Lab 400



For example:
Identification and object-related data

Clear product labeling, or UID (Unique Identification), and the storage of product and production data in digital product memory, form the foundation of all flexible and customized production systems. CP Lab 400 uses industry standard technologies, such as RFID, QR code, data matrix, and databases.

For example:
Next generation HMI – AR, smart glasses

The universal availability of decision-relevant and role-specific data and information is an important success factor in varied production. The latest human-machine communication technologies and use of visual data processing are integrated in the CP Lab 400.

CP Lab 404-1

Process operation:
– Feeding components
– Quality inspection I, SPC
– Flexible production with parameters
– Flexible handling, logistics

CP Lab 406-1

Process operation:
– Feeding components
– Quality inspection I, SPC
– Flexible production with parameters
– Feeding components, assembly
– Connecting components, assembly
– Flexible handling, logistics

CP Lab 408-1

Process operation:
– Feeding components
– Quality inspection I, SPC
– Flexible production with parameters
– Feeding components, assembly
– Connecting components, assembly
– Process-dependent operation
– QR code, UID, product tracking
– Flexible handling, logistics

CP Lab 410-1

Process operation:
– Feeding components
– Quality inspection I, SPC
– Flexible production with parameters
– Worker guidance, PCB assembly
– Quality inspection II
– Feeding components, assembly
– Connecting components, assembly
– Process-dependent operation
– QR code, UID, product tracking
– Flexible handling, logistics

CP Lab 404-1

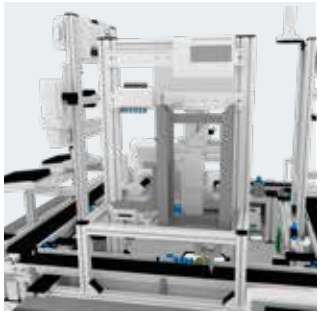
with four Application Modules

How the system works

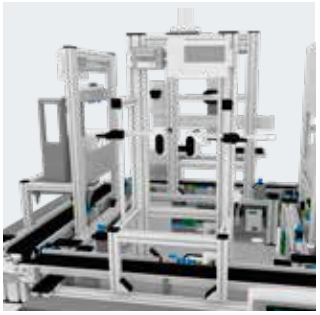
The CP Lab 404-1 system represents a networked production system consisting of four pallet transfer systems with different application modules.

Prerequisites for creating the following process sequence after linking and starting a batch size 1 routing:

- The magazine module provides a housing shell.
- The quality data collection is performed using the measuring module's analog distance sensors.
- The drilling module performs an order-based, simulated drilling operation on the front shell.
- The output module performs the process end: workpiece output.

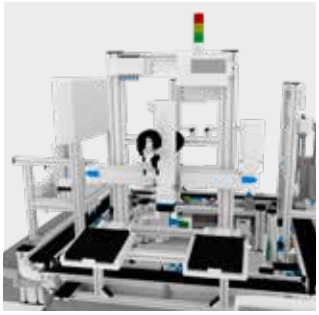


Magazine application module
- RFID
- Process start



Analog measuring application module
- QS
- SPC
- Analytics

Drilling application module
- CPS
- Production parameters
- Variants



Output application module
- Parameter processing
- Flexible handling
- Logistics

CP Lab 404-1	**8092833**

Main components:

4x	Pallet Transfer System
1x	Magazine application module I
1x	Analog measuring application module
1x	Drilling application module
1x	Output application module
4x	Switch
4x	Power supply unit
4x	Trolley
1x	Workpiece set

Services for CP Lab 404-1

Installation and commissioning, 1 day	609400
Technical instruction, 2 days	609404

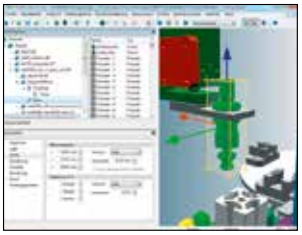
Training content
- CP Lab design and layout:
  - Sensors/actuators
  - Process modules
  - Conveyor belt
  - Network
  - Process and operations management level
- Recording information using intelligent sensors
- Control using PLC
- Communication based on bus technologies
- Binary pallet identification
- RFID identification
- Flexible production, one-off orders
- Quality management and SPC
- Plug & produce: quick integration of new application modules using cyber-physical systems

MES training content
- Define and edit order workflows and process plans
- Read orders and update status
- Sort order lines
- Write goods carrier allocations to the order
- Create a material master, incl. workpiece graphics
- Add machines, incl. power consumption
- Add warehouse data and material buffers
- Add and manage customer data
- Define system layouts with icons
- Generate OEE, SPC and malfunction reports, incl. graphics

Technical data
- Operating pressure: 600 kPa (6 bar)
- Dimensions (W x D x H): approx. 1800 x 1800 x 1800 mm

Included software
- 1x MES4 for CP Lab with six network licenses, incl. 1x PC with TFT monitor

- 1x CIROS® Studio with six network licenses Educational, the professional working tool for creating simulation models



- 1x CP Lab Model Library for CIROS®

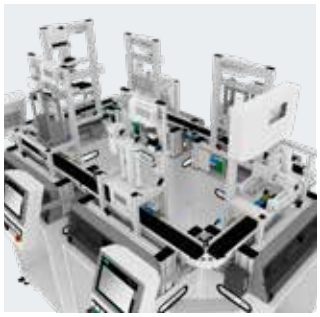
CP Lab 406-1
with six Application Modules

How the system works

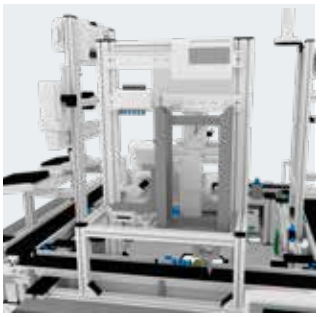
The CP Lab 406-1 system represents a networked production system consisting of six pallet transfer systems with different application modules.

Prerequisites for creating the following process sequence after linking and starting a batch size 1 routing:

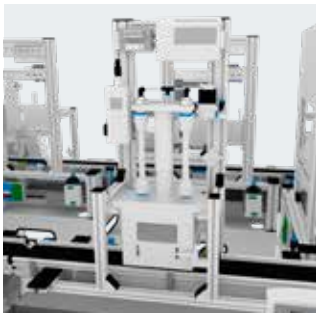
- The magazine module provides a housing shell.
- The quality data collection is performed using the measuring module's analog distance sensors.
- The drilling module performs an order-based, simulated drilling operation on the front shell.
- As an additional assembly step, the rear shell is placed using the magazine module.
- The press module finalizes the product through the pressing process.
- The output module performs the process end: workpiece output.



- **Magazine application module**
- **Analog measuring application module**
- **Drilling application module**
- **Output application module**



Magazine application module
- Rear shell placement



Press application module
- Press parameters
- Joining
- Assembly

CP Lab 406-1	**8092834**

Main components:

6x	Pallet Transfer System
1x	Magazine application module I
1x	Analog measuring application module
1x	Drilling application module
1x	Magazine application module II
1x	Press application module
1x	Output application module
6x	Switch
6x	Power supply unit
6x	Trolley
1x	Workpiece set

Services for CP Lab 406-1

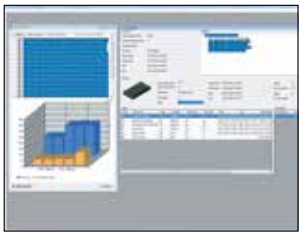
Installation and commissioning, 1 day	609401
Technical instruction, 2 days	609405

Training content
- CP Lab design and layout:
  - Sensors/actuators
  - Process modules
  - Conveyor belt
  - Network
  - Process and operations management level
- Recording information using intelligent sensors
- Control using PLC
- Communication based on bus technologies
- Binary pallet identification
- RFID identification
- Flexible production, one-off orders
- Quality management and SPC
- Plug & produce: quick integration of new application modules using cyber-physical systems

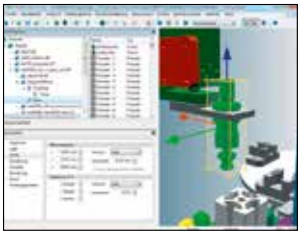
MES training content
- Define and edit order workflows and process plans
- Read orders and update status
- Sort order lines
- Write goods carrier allocations to the order
- Create a material master, incl. workpiece graphics
- Add machines, incl. power consumption
- Add warehouse data and material buffers
- Add and manage customer data
- Define system layouts with icons
- Generate OEE, SPC and malfunction reports, incl. graphics

Technical data
- Operating pressure: 600 kPa (6 bar)
- Dimensions (W x D x H): approx. 2500 x 1800 x 1800 mm

Included software
- 1x MES4 for CP Lab with six network licenses, incl. 1x PC with TFT monitor



- 1x CIROS® Studio with six network licenses Educational, the professional working tool for creating simulation models



- 1x CP Lab Model Library for CIROS®

CP Lab 408-1

with eight Application Modules

– **Magazine application module**
– **Analog measuring application module**
– **Drilling application module**
– **Output application module**
– **Magazine application module**
– **Press application module**

Pick-by-Light application module
– Variant assembly
– Worker guidance

Label printer application module
– QR-Code
– UID
– Product tracking

How the system works

The CP Lab 408-1 system represents a networked production system consisting of eight pallet transfer systems with different application modules.

Prerequisites for creating the following process sequence after linking and starting a batch size 1 routing:

– The magazine module provides a housing shell.
– The quality data collection is performed using the measuring module's analog distance sensors.
– The drilling module performs an order-based, simulated drilling operation on the front shell.
– The Pick-by-Light module enables flexible, complete assembly with worker guidance.
– As an additional assembly step, the magazine module places the rear shell on top.
– The press module finalizes the product through the pressing process.
– The label printer provides the product with a QR code and a customized label.
– The output module performs the process end: workpiece output.

CP Lab 408-1	**8092835**

Main components:

8x	Pallet Transfer System
1x	Magazine application module I
1x	Analog measuring application module
1x	Drilling application module
1x	Pick-by-Light application module
1x	Magazine application module II
1x	Press application module
1x	Label printer application module
1x	Output application module
8x	Switch
8x	Power supply unit
8x	Trolley
1x	Workpiece set

Services for CP Lab 408-1

Installation and commissioning, 2 days	609402
Technical instruction, 3 days	609406

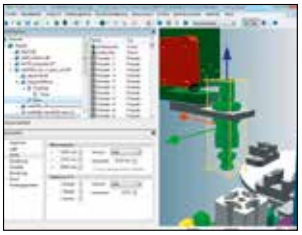
Training content
- CP Lab design and layout:
  Sensors/actuators
  Process modules
  Conveyor belt
  Network
  Process and operations management level
- Recording information using intelligent sensors
- Control using PLC
- Communication based on bus technologies
- Binary pallet identification
- RFID identification
- Flexible production, one-off orders
- Quality management and SPC
- Plug & produce: quick integration of new application modules using cyber-physical systems

MES training content
- Define and edit order workflows and process plans
- Read orders and update status
- Sort order lines
- Write goods carrier allocations to the order
- Create a material master, incl. workpiece graphics
- Add machines, incl. power consumption
- Add warehouse data and material buffers
- Add and manage customer data
- Define system layouts with icons
- Generate OEE, SPC and malfunction reports, incl. graphics

Technical data
- Operating pressure:
  600 kPa (6 bar)
- Dimensions (W x D x H):
  approx. 3200 x 1800 x 1800 mm

Included software
- 1x MES4 for CP Lab with six network licenses, incl. 1x PC with TFT monitor

- 1x CIROS® Studio with six network licenses Educational, the professional working tool for creating simulation models



- 1x CP Lab Model Library for CIROS®

CP Lab 410-1
with ten Application Modules

– **Magazine application module**
– **Analog measuring application module**
– **Drilling application module**
– **Output application module**
– **Magazine application module**
– **Press application module**
– **Pick-by-Light application module**
– **Label printer application module**

Camera application module
– Vision system
– Quality assurance

Turning application module
– Process variance
– Conditional operation

How the system works
The CP Lab 410-1 system represents a networked production system, consisting of ten pallet transfer systems with different, application modules.

Prerequisites for creating the following process sequence after linking and starting a batch size 1 routing:

– The magazine module provides a housing shell.
– The quality data collection is performed using the measuring module's analog distance sensors.
– The drilling module performs an order-based, simulated drilling operation on the front shell.
– The Pick-by-Light module enables flexible, complete assembly with worker guidance.
– The camera module is used for quality assurance and assembly control.
– As an additional assembly step, the magazine module places the rear shell on top.
– The press module finalizes the product through the pressing process.
– The turning module turns the workpiece to prepare it for printing on the front and back.
– The label printer provides the product with a QR code and a customized label.
– The output module performs the process end: workpiece output.

CP Lab 410-1	**8092836**

Main components:

10x Pallet Transfer System	
1x Magazine application module I	
1x Analog measuring application module	
1x Drilling application module	
1x Pick-by-Light application module	
1x Camera application module	
1x Magazine application module II	
1x Press application module	
1x Turning application module	
1x Label printer application module	
1x Output application module	
10x Switch	
10x Power supply unit	
10x Trolley	
1x Workpiece set	

Services for CP Lab 410-1

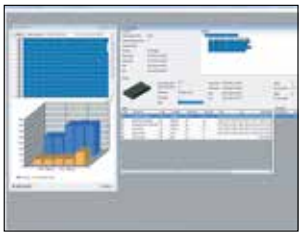
Installation and commissioning, 2 days	609403
Technical instruction, 3 days	609406

Training content
- CP Lab design and layout:
  - Sensors/actuators
  - Process modules
  - Conveyor belt
  - Network
  - Process and operations management level
- Recording information using intelligent sensors
- Control using PLC
- Communication based on bus technologies
- Binary pallet identification
- RFID identification
- Flexible production, one-off orders
- Quality management and SPC
- QR code, UID
- Quality assurance with camera
- Plug & produce: quick integration of new application modules using cyber-physical systems

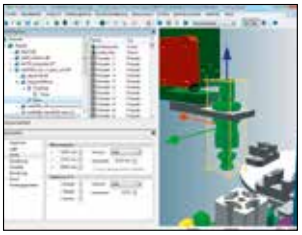
MES training content
- Define and edit order workflows and process plans
- Read orders and update status
- Sort order lines
- Write goods carrier allocations to the order
- Create a material master, incl. workpiece graphics
- Add machines, incl. power consumption
- Add warehouse data and material buffers
- Add and manage customer data
- Define system layouts with icons
- Generate OEE, SPC and malfunction reports, incl. graphics

Technical data
- Operating pressure: 600 kPa (6 bar)
- Dimensions (W x D x H): approx. 3900 x 1800 x 1800 mm

Included software
- 1x MES4 for CP Lab with six network licenses, incl. 1x PC with TFT monitor



- 1x CIROS® Studio with six network licenses Educational, the professional working tool for creating simulation models



- 1x CP Lab Model Library for CIROS®

CP Lab
An adaptable system

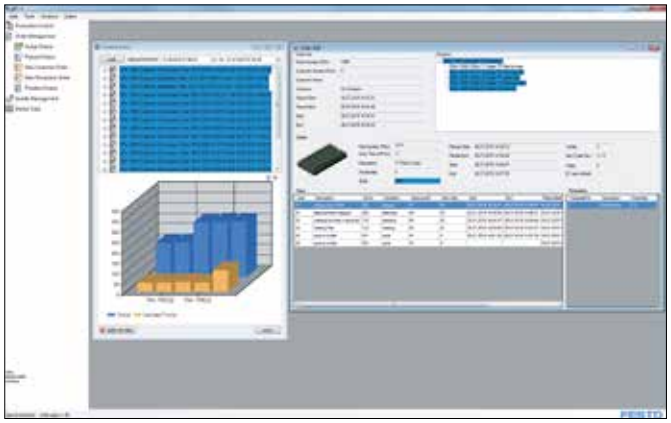
The flexibility of the factory layout is one of the most important features of Industry 4.0. The CP Lab modules can be flexibly combined and expanded in a variety of ways.

In series
Simply connecting the individual modules in series provides combinations of different sizes. This creates a wide range of expansion options.

In a rectangle
The individual modules can also easily be combined to form a rectangle. This enables complete recirculating conveyor systems to be created with just four, six, eight or ten modules.

Combined with a mobile robot
The CP Bridge auxiliary module acts as an interface for transferring workpiece carriers to the Robotino® mobile robot system or the CP Factory. The mobile robots also enable production machines, manual workstations, storage systems and 3D printers to be integrated into the overall concept.

MES and Energy monitoring



MES4

MES4 is a specially prepared manufacturing execution system (MES) with a new design for Industry 4.0 learning platforms. In MES4, orders can be started or finished at every station.

The database is open and can be written to and read from via SQL commands by external programs (e.g. order entry from ERP system). Work instructions for manual workstations can be created or adapted at any time. The individual controllers communicate with the MES4 via TCP/IP.

Scope of delivery
– MES software
– Dongle
– PC with TFT monitor

Training content
– Define and edit order workflows and process plans
– Read orders and update status
– Sort the order lines
– Write allocation of the goods carriers to the order
– Create a material master, including graphic representation of the workpiece
– Create machines, including costs and power consumption
– Create warehouse data and material buffer
– Create and manage customer data
– Define system layouts with icons
– Automatic routing per routing card and machine capabilities
– OEE, PLC and malfunction report generation, including graphic representation

MES4 CP Lab, single license incl. PC	**D15005**
MES4 CP Factory, single license incl. PC	**D15002**
MES4 upgrade from CP Lab to CP Factory, single license without PC	**D15006**
MES4 additional license, single license without PC	**D15007**

Energy measurement system

The energy measurement system with evaluation software is used for flexible and mobile energy measurement. The system is equipped with an energy measurement device for electrical energy and sensors for recording the pressure consumption.

The measurement devices are connected to a CECC controller. It concentrates the energy data and sends it to the energy database via OPC UA for filing and evaluation.

Training content
– Recording, representing and analyzing power and energy measurements
– Providing measurements via Modbus®/TCP and OPC UA
– Determining the energy consumption per workpiece and process step

Technical data
– Structure: EduTrainer® Universal A4 rack
– Electrical power analyzer: PAC3200 with 1-phase measurement of current, voltage, active, reactive and apparent power
– Volume flow sensor for compressed air: thermal measuring principle
– Pressure sensor: Measurement range 0 – 10 bar, piezo-resistive measurement principle
– Controller: Festo CECC-LK
– Interfaces: USB, OPC UA, Modbus®, Ethernet TCP/IP

Energy measurement system	**D34021**

Also order:

Energy monitoring package, incl. PC and software	**D35002**

Germany
Festo Didactic SE
Rechbergstraße 3
73770 Denkendorf
Tel. +49 (711) 3467-0
Fax +49 (711) 347-54-88500
E-mail: did@festo.com

United States
Festo Didactic Inc.
607 Industrial WayWest
07724 Eatontown
New Jersey
Tel. +1 (732) 938-2000
Fax +1 (732) 774-8573
E-mail: services.didactic@festo.com

Canada
Festo Didactic Ltée/Ltd
675, Rue du Carbone
Québec, Québec, G2N 2K7
Tel. +1 (418) 849-1000
Fax +1 (418) 849-1666
E-mail: services.didactic@festo.com

www.festo-didactic.com

en © 2019-02 Festo Didactic SE