Industry 4.0
From vision to reality – Status 2018
Industry 4.0 – a topic for all specialists and managers

What does Industry 4.0 mean for Festo?

Festo is adopting an integrated approach to the change in the world of production which incorporates the interaction between people and technology, training and education as well as technology. Festo is conducting research into new solutions and technologies for future production together with partners from business and science; it is also offering coordinated concepts for basic and further training.

What are the characteristics of the production of the future?

Production systems will become digitally networked throughout.
• Intelligent, self-regulating and self-controlling components for plug and produce
• The system has a virtual image for virtual commissioning and reconfiguration
• Highly flexible production plants: economical manufacturing of batch sizes of 1, fast balancing of the workload in a production network, prompt adjustment to the orders in hand
• Comprehensive condition monitoring helps to avoid downtime and optimises maintenance procedures as well as mobile maintenance
Active in political decision making and standardisation

Festo plays an active role in all relevant standardisation bodies for Industry 4.0 and advises the German federal government on the “Industry 4.0 platform” initiative. Universal, open standard architectures provide significantly more benefits than closed concepts for small and medium-sized machine and system manufacturers, as well as for end users.

Examples:
- OPC UA communication standard
- RAMI reference architecture
- Management shell model
- AML (Automation Markup Language)*

Research

A crucial factor in Festo’s success is its cooperation with its partners in science and business; this accelerates the innovation process and resolves complex technical issues. For example, in the early stages Festo was involved in Smart Factory KL – the model for an adjustable production system – and OPAK, an open engineering platform for autonomous mechatronic automation components.

Currently the focus is, amongst others, on the AutomationML initiative for designing automation components in a uniform engineering file format. As part of the ENTOC research project, Festo is working with partners from the automotive industry and the scientific community on the topic of “virtual commissioning”.

You can find an up-to-date list at www.festo.com/research

Products and services

Industry 4.0 relies on fully networked, adaptive production through intelligent products with “embedded functions” – the cyber-physical systems. Many Festo components already meet the hardware and software requirements. Festo’s newest production plants, such as the Scharnhausen Technology Plant, both produce and use these products, thus paving the way for Industry 4.0.

These products can be incorporated into the following IoT or cloud environments as part of pilot projects:
- Festo Cloud
- Siemens MindSphere
- Rockwell FactoryTalk/TeamONE
- Others available on request

Industry 4.0 begins here and now – just turn the page to find out more.

* In progress
Industry 4.0 – always a finger on the pulse thanks to complete networking and partnerships

Many concepts from the past have been overtaken by the fourth industrial revolution: business models, partnerships, customer interfaces, value chains, and even the traditional automation pyramid – all are undergoing huge change. As an innovator and trendsetter in fieldbus technology, Festo will make a major contribution to reshaping the future with new concepts for Industry 4.0. This includes new products, cloud services, apps, as well as a new online shop with comprehensive, integrated engineering concepts. This will ensure that, in the medium term, data will be available seamlessly and globally on all user devices.
Industry 4.0: things communicate with one another
More communication from controller to controller or subsystem to subsystem, and horizontal as well as vertical connectivity with a single, uniform information model, including the cloud: these are the hallmarks of a fourth industrial revolution – Industry 4.0. The traditional, inflexible automation pyramid will cease to exist in the foreseeable future. Festo CPX and the Motion Terminal VTEM are making an important contribution to this transformation.

Hardware for unlimited communication:
Festo’s IoT gateway CPX-IOT
The industrial Internet of Things gateway is based on the CPX module format. CPX-IOT collects information about Festo devices and their statuses via an Ethernet connection and a standardised communication protocol such as OPC UA, for example. It then sends that information to the cloud via the second Ethernet connection using IoT protocols such as AMQP or MQTT. Suitable IT security mechanisms ensure data security.

Integration as a subsystem or as a non-hierarchical system
Festo products, such as electric and pneumatic drives, valves/valve terminals, I/O terminals, compressed air supply or sensors, can thus be integrated as subsystems from the traditional pyramid if needed, e.g. via decentralised controllers such as CPX or CECC.

Or alternatively they can be integrated directly, with no hierarchy. For example:
• The handling system YXM\(^*\)
• The energy efficiency module MSE6\(^*\)
• The Festo Motion Terminal VTEM\(^*\)
• Or the modular electrical terminal CPX and thus also the valve terminals MPA or VTSA\(^*\)

Festo MyDashboards for CPX/MPA\(^1\), MSE-6\(^2\), YXM\(^*\) and VTEM\(^*\) show all the key characteristics and metrics for the products and subsystems fully predefined in the Festo Cloud – without the need for any programming. As a result, the data is available anywhere in the world and anytime, including on mobile devices.

\(^*\) These Festo products are thus cyber-physical systems in the sense of Industry 4.0. They take in data from the application and from the device itself, precompress it by compiling the data into diagnostic modules in CoDeSys V3 in accordance with VDMA 24582, and then forward that information to the cloud – Festo MyDashboards shown as examples.
Industry 4.0 – networked components and their options in detail

**How the Festo CPX-IOT gateway works in detail**

1. Connect the Festo product with OPC UA communication interface (or third-party devices) to the CPX-IOT gateway via switches.

2. Connect the IOT gateway to the Internet via intranet/NAT.

3. Set the switches to “Boarding”: this enables physical access to the CPX-IOT gateway; guided interaction and confirmation steer users through the process.

4. The CPX-IOT gateway independently connects to the Festo Cloud. A defined login process happens the first time the gateway connects/starts up.

5. Read or Read/Write switch position: the gateway searches for the connected OPC UA stations/servers itself by port scanning and multicast access.

6. The gateway then fetches data from the connected servers via the OPC UA Publish/Subscribe Communication Model (PSCM) and sends this data to the cloud, encrypted in line with the chosen concept and over secure connections.

7. Administration of the gateway can also be carried out remotely via the cloud.
The Festo dashboards thus enable
• greater OEE and thus increased productivity thanks to suitable metrics
• lower costs through improved energy efficiency
• accelerated maintenance thanks to better condition data and services

The available information and data in the Festo terminal CPX in detail
1. The Festo terminal CPX and the valve terminals MPA and VTSA connected to it have been providing comprehensive data for analysis for years. This can be read out via all fieldbus connections.  
2. New: It can be displayed in a cloud without any programming (see example of Festo MyDashboards on page 5).

The Festo dashboards in detail
1. Festo products for which apps with cloud connection/dashboards are available report their diagnostic and condition monitoring data in accordance with the industry standards VDMA 24582.
2. Such predefined dashboards are planned for all key products from Festo.
3. Core elements like energy monitoring, preventive maintenance and OEE metrics are taken into consideration where appropriate.
4. Historical data is stored for one year.

The CPX-IOT gateway can be connected to every installed or new CPX using the CPX-MMI cable. Thus all data is accessible and can be transferred to a cloud. This can be retrofitted on all CPX fieldbus nodes installed in the field.

I4.0/IoT/Cloud protocols: AMQP, MQTT, OPC UA

1. MMI connection
2. Data categories
   • Asset data
   • Diagnostic data
   • Process data (I/Os)
   • Parameter data
   • Smart data like switching cycle counter, timer, UTC (universal time), travel profiles/cam disks

3. Optional information:
   • Cycle times
   • Life cycle information
   • Switching cycle counter per valve with threshold monitoring
   • B10 value comparison
   • Early warning system in case of deviations
   • Automatic reordering of spare parts
Industry 4.0 – integration options in IoT environments

Integration into the IoT environments of Siemens MindSphere and Rockwell FactoryTalk

The MindSphere is a cloud-based, open IoT operating system from Siemens with which your machines and physical infrastructure can be connected to the digital world. This enables you to use huge data volumes from countless smart devices. And gain groundbreaking insights into your entire company.

Festo was the first partner in a pilot project to integrate a smart field device, the energy efficiency module MSE6-E2M, into the MindSphere via its own IoT gateway CPX-IOT. The pilot project demonstrated the following four key aspects:

1. A secure, encrypted connection to the cloud (HTTPS)
2. A connection to the field level for gathering data via OPC UA
3. Siemens MindSphere connection via the MindConnect LIB
4. Easy start-up by the customer via the cloud.

Such Industry 4.0 scenarios provide an opportunity to analyse and above all combine various data in the MindSphere. Examples:

**Basic data and insights**
- Actual air consumption and pressure indication in real time
- Pattern recognition for consumption profiles, leakage
- Selectable tolerance windows for error messages

**Advanced analyses**
1. Position monitoring
   - Time-based and using pQ sensors
   - Comparison with the digital twin
2. Determining cylinder leakage
   - Indirectly, by comparing the leakage with the determined position and the actual or reference position.
   - Using the pQ sensors to determine the cylinder position indirectly during leakage-free operation
   - Separation into internal and external leakage

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**Architecture**

**Data flow**

**Location**

**Functionality**

- Last cycle values
- Historical values
- "Real-time" values
- Notifications

- Mutual TLS authentication with signed server and device certificates
- Only outbound connection on ports 443 (HTTPS) and 5671 (AMQP). No inbound firewall ports required

- Libraries with aggregation functions
- Average, minimum, maximum, sum as aggregation function

- High sampling frequency

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Display of the Festo energy efficiency module in the MindSphere as "E2M-Asset"
Integration into the IoT environment from Rockwell

Rockwell offers several approaches for networking the Internet of Things for industrial devices, machinery and systems and for making effective use of the resulting data: Device Analytics and TeamONE. Festo supports both approaches in this early phase with pilot projects.

Device analytics and “Shelby Appliance”

Shelby works as a kind of black box and does not require configuration. Like the Festo IoT gateway, it automatically scans all devices that are connected and prepared for communication. It then sends their data as telegrams to higher-level units like edge devices or cloud services. Shelby calls the devices cyclically approx. once per minute, offers dashboards and also advanced diagnostic functions.

TeamONE

With TeamONE preventive maintenance tasks can be organised into teams, and all the necessary data from the devices in a system/machine can be displayed. This speeds up troubleshooting. TeamONE is made available as a free app. As with all other third-party providers, the Festo devices are integrated via an embedded module within this app. All the relevant values of the Festo devices can be displayed, as the small mobile phone screenshots in the picture indicate. You can purchase the Festo module via the Festo App World.
Industry 4.0 – software and cloud services make the difference

With the Festo App World, you can update and modify any Festo product anytime and anywhere in the world, or combine a product with other services. Different app types with a variety of apps are available: cloud services, software functions, product-related apps and service apps.

Cloud services: increased productivity for machine builders and end users
Future cloud concepts and services will initially be very heavily dependent on the particular approach, partner or provider selected. Further processing and long-term analysis of data takes place in the cloud, with a dashboard visually presenting the information gathered. Festo supports machine builders and end users on the road to increased productivity.

This includes:
• Simple visual presentation of complex interrelationships in the Festo cloud – worldwide
• Analysis function for rapid data processing
• Greater transparency, e.g. by condition monitoring online
• Optimisation of applications, preventive maintenance, etc.

Data can be quickly integrated using the following platforms:
• Festo Cloud
• Siemens MindSphere
• Rockwell FactoryTalk/TeamONE
• Others available on request

The result is increased productivity through better utilisation (OEE), lower costs through better energy efficiency and fewer downtimes thanks to comprehensive diagnostics, condition monitoring and improved maintenance.

Software functions
• Festo CM-Lib for condition monitoring with the energy efficiency module MSE6-...
• Motion apps for automated motion sequences in our electric drives/handling systems YXMx

Please contact your Festo sales engineer about possible implementations. The dashboard shown should be viewed as a pilot model for joint customisation projects together with customers/users.

Festo Software Market: realising functions digitally
Apps greatly simplify the engineering and use of products and services. Festo will offer apps for numerous technical applications, target systems and working environments.
• Cloud-based apps
• Desktop-based apps
• Apps for mobile devices
• Product/hardware-dependent apps
Quickly accessible and well stocked: the Festo App World

**Product-related apps**
- Motion Apps for the Festo Motion Terminal VTEM. They simplify the programming of automated movements, even without in-depth knowledge of pneumatics.
- Motion Apps for handling systems YXMx with electric drives
- Dashboards for the Festo Motion Terminal VTEM
- Dashboards for the valve terminal CPX/MPA
- Further apps are in development

**Software/service apps**
- Fluid Draw app: CAD functions for electrical and pneumatic circuit diagrams
- Festo Design Tool 3D: a 3D product configurator for generating Festo-specific CAD product combinations with all accessories
- EPLAN schematic services: macro libraries created by Festo for E-CAD software EPLAN Electric P8, version 2.1 or higher

Our website → [www.festo.com/iot](http://www.festo.com/iot) takes you to the latest comprehensive tools, products and services.

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**Mobile apps**
- Tablet, phone, Android, iOS, Windows, BYOD, Internet

**Cloud/web apps**
- Motion analysis, data analysis, dashboards

**Desktop apps**
- Sizing, simulation, engineering

**PLC apps**
- Smart press, welding, gluing, condition monitoring

**Firmware apps**
- Motion algorithms, force/distance control, condition monitoring

- Software for Festo products and solutions
- Software for third-party suppliers
Industry 4.0 – engineering in the virtual and the real world

Engineering and productivity
Our goal is to increase your productivity. State-of-the-art engineering plays an important role in achieving that goal – the kind of engineering which will be central to Industry 4.0 and which will form a cornerstone of your success. That is why we are continuously further developing engineering methods and enhancing our software tools and apps.

Engineering and value creation
We help you tap into unimagined productivity reserves and generate additional productivity along the entire value chain. In every phase of your project, from the initial contact to the modernisation of your machine, you will come across a number of different tools which will be of use to you.*

Engineering and life cycle
To meet your needs even more effectively, we have analysed project workflows and defined eight phases. We then allocated our software tools and apps to the appropriate phases. You benefit by being able to find the right support quickly and easily.

Schematic Solution for EPLAN projects, for example, documents your configured solutions comprehensively and in next to no time. Simply enter the order code and receive the complete plan in just a few minutes – error-free and trouble-free. Instead of tediously having to search for, download and piece together individual components, all the hard work is done for you, cutting the amount of time required from several hours to just a few minutes.

* This document shows just a small selection of the tools we have on offer. Discover our world of software tools: www.festo.com/support
Computer-aided engineering and virtual images are future scenarios that will accelerate development. For example, virtual images will allow the autonomous and continuous improvement and correction of designs. The factory itself will also be redefined. The concept of the future unites the virtual and the real world. The objects produced will be able to communicate amongst themselves in the same way as the tools and machines that produce them, and the processes will virtually run themselves. They will also become more flexible down to a batch size of 1.

For maximum process efficiency: the Handling Guide Online
From project engineering and ordering right up to delivery, the Handling Guide Online* optimises and shortens work flows by combining the virtual with the real world. You can get to the right standard handling system in just three quick and easy steps:
- Select the type of handling system
- Enter your application data (X-Y-Z measurements and load)
- Order as 1 unit in the Festo Online Shop.

Including the finished CAD model for the complete handling system. This will be presented in AML data packets in the future.

Virtual commissioning: CIROS simulation software
With the CIROS simulation software from Festo Didactic, Festo is able to put the study “Parallel kinematic system EXPT (tripod)” into virtual operation. This study is prepared for the descriptive language AML (Automation Markup Language), the future standard of dynamic CAD data and parameter exchange for Industry 4.0.

Scan, look, discover with the Product Key as an Auto ID function
All the information for a modular valve terminal with terminal CPX is contained in the Product Key incorporated in the data matrix code – putting Festo unmistakably on the road to Industry 4.0.

These auto ID functions are small but important building blocks for the transparent, smart and intuitive factory of the future with Industry 4.0. This is underpinned by Festo products with their Product Key and logistics code, providing centralised access to a “digital twin”.

* Not yet available in all countries.
The digital maintenance manager for production managers and system operators is being launched. Festo Smartenance is one of the first exclusively digital products from Festo. It enables our end customers to schedule, monitor and evaluate system maintenance independently of our components. Smartenance is easy to install, self-explanatory and provides a simple, low-cost introduction to the world of digitalisation.

Preventive plant maintenance is a time-consuming process which, astonishingly, is for the most part still documented using pen and paper. Mobile, digital apps now enable faster processing. The clear structure and buttons of Smartenance provide the operator with plain and easy guidance. The digital maintenance schedule from Festo makes maintenance easier, quicker and more reliable.

Reminder, feedback and documentation
Festo Smartenance consists of two parts: a mobile maintenance schedule in the form of an app for smartphones and tablets, and a dashboard in the form of a web page for production managers, where they can manage and document these maintenance tasks. The dashboard can simply be opened in a web browser. The mobile app is downloaded and installed from the Apple and Google app stores.

You can install and set up Smartenance completely independently.

For system operators and production managers alike
The advantages of digital maintenance are plain to see. System operators always have their machines’ maintenance schedule to hand on a mobile device and receive all the necessary information about the tasks directly on their smartphone or tablet.

The production manager can monitor all systems centrally in a dashboard and can see at a glance what tasks need to be completed urgently or what feedback was sent by colleagues for the maintenance tasks. Reciprocal checking by system operators and production managers provides greater reliability. And much of the time-consuming communication and coordination required when tasks are delayed or problems are identified on a system is eliminated.

Licensing via the Festo App World
A Smartenance licence can be purchased via the new Festo App World. After purchasing Smartenance, you will initially see an empty dashboard in which systems and maintenance tasks have yet to be configured. You transfer the tasks and maintenance intervals from the system documentation which you have obtained from the machine builder. The system is then immediately ready for use and every system operator can view and process all tasks. As the production manager, you automatically see all completed and pending tasks at a single glance.

Smartenance is also useful for machine builders. It allows them to transform the maintenance tasks for every system directly into a digital solution and offer their customers added value for the system.
Quick and easy introduction to digital system maintenance

For clearly measurable savings and traceability of all work steps

1. Mobile, digital maintenance instructions – for system operators
   • Enhance maintenance instructions digitally with images and videos
   • Mobile app for Android and iOS smartphones and tablets
   • Simple, intuitive operation

2. Maintenance task reminders and feedback – for system operators
   • Mobile schedule with an overview of upcoming tasks
   • Reminder about pending tasks
   • Feedback function for recommendations or problems

3. Central evaluation of the maintenance tasks – for production managers
   • Clear visualisation of all systems and tasks on the desktop (web portal)
   • Evaluation across all systems in one place
   • Detailed proof for audits

The administration dashboard for production managers in the web browser

The maintenance schedule as a mobile app for machine operators and maintenance personnel
Intelligent apps and appropriate software are a central component of Industry 4.0. They allow the “things” in the Internet of Things to communicate with one another and to initiate or execute processes autonomously. At the same time, software modules, analysis and combinational logic are making functional integration possible as never before. With the app-based Motion Terminal, Festo has catapulted pneumatics into the age of Industry 4.0.

The access to new information and being able to process it boosts knowledge, adds value and puts you a step ahead technologically. It also provides you with huge benefits in engineering, design and programming, and ultimately increases your competitiveness and productivity. With 4.0 products such as the Festo Motion Terminal, you are buying much more than a mere product – you are buying a comprehensive added-value package.

The future of pneumatics – functions assigned at the press of a button
Digitisation will profoundly alter the world of production as digital simplicity is moving into the world of pneumatics.

With the Festo Motion Terminal, we are offering our first standardised solution that intelligently combines mechanics, electronics and software in the form of a “cyber-physical system”. It will enable you to build intelligent machines now for the world of tomorrow, and ensure your systems are truly ready for Industry 4.0, even in terms of pneumatics.

Disconnected: functions and hardware
With the Festo Motion Terminal pneumatic functions are, for the first time, no longer automatically connected to the mechanical hardware, and can be assigned simply using apps. You now require just a single valve type for an extremely wide range of pneumatic movements and functions. The Festo Motion Terminal makes it possible for the first time ever to have the same hardware for a multitude of functions. No modification, no additional parts, no arduous installation: none of that is needed any more. With the matching motion app, you can change functions at the press of a button, whether for a simple change in the directional control valve functions, Soft Stop, energy saving mode (gentle travel in the end positions, energy-efficient movements), proportional characteristics or a format change. The Festo Motion Terminal thus combines the advantages of electric and pneumatic systems.

Motion apps – the first examples
• Directional control valve functions: over 10 valve functions can be reassigned cyclically
• Proportional directional control valve: two proportional flow control systems in one valve
• Soft Stop: self-adapting algorithm for time-optimised positioning without vibration
• Proportional pressure regulation: for both valve outputs
• Model-based proportional pressure control of the complete application, e.g. cylinder and tubing
• ECO drive: for low loads – energy-saving positioning motion with supply air flow control
• Selectable pressure level (ECO): for high loads – reduced, self-adapting pressure level
• Leakage diagnostics: measuring leakage in the application
• Supply and exhaust air flow control for adjusting the supply and exhaust air between 0% and 100%
• Presetting of travel time: self-learning and adapting system for constant, monitored advancing and retracting

Further apps for even more functions are already being planned.
Pneumatics 4.0 – Festo Motion Terminal VTEM, a world first

The Festo Motion Terminal VTEM is opening up radical new dimensions in the world of automation, as it is the world’s first valve to be controlled by apps. It is the first product to truly earn the label “digital pneumatics”. For a multitude of functions which currently require you to order and install more than 50 separate products/positions.

Central component of the Festo Motion Terminal

CPX terminal – electric systems at its most flexible
With CPX, you have the option of using many different control systems and end user specifications, as well as all the usual digital and analogue I/O modules or decentralised “simple” valve terminals.

CPX is available on request with an integrated CODESYS controller and OPC UA for Industry 4.0.

Find out more at www.festo.com/motionterminal

Controller with motion app – software at its most flexible
The core of your Motion Terminal. It enables you to conveniently control numerous functions and to assign them to the individual valves via the Ethernet WebConfig interface.

With the Internet of Things, you can adjust parameters efficiently through the intuitive WebConfig user interface, which you access via a web browser on a computer – no additional configuration software is required. Or you can set parameters in the usual way, easily and directly via the PLC machine controller.

VTEM – pneumatics at its most flexible
The individual control and freely programmable functions of the individual VTEM valves offer a high degree of flexibility.

The integrated stroke and pressure sensors provide optimal control and transparent condition monitoring.

Each VTEM valve contains:
• Valve electronics with sensors
• 4 innovative piezo pilot valves for minimum energy consumption and maximum service life
• 4 diaphragm poppet valves for reliable functional diversity

Highlights
• Many functions in a single component – thanks to apps
• Combines the advantages of electric and pneumatic technologies
• Very high level of standardisation and reduced complexity
• Reduced time to market
• Greater profitability
• Reduced installation effort
• Increased energy efficiency
Detecting states, condition monitoring
All fieldbus/Ethernet, AS-Interface and IO-Link® products are suitable for use as “contributors” in terms of Industry 4.0. Festo offers you a comprehensive IO-Link® portfolio, for example:
- Various sensor ranges
- Actuators such as proportional pressure regulators VPPM
- Vacuum generator OVEM
- Valve terminals
- Electric drives with stepper motor/servo controllers CMMP, CMMO, amongst others

Further areas of research include:
- OPC UA TSN – time-sensitive networks
- IO-Link® wireless

Vision systems
Identify and control intelligent workpieces and workpiece carriers. Several sensor technologies are used in an Industry 4.0 environment, such as RFID as well as vision systems. This includes our code reader SBSI-B, object sensor SBSI-Q and the compact camera systems SBOx-Q.

Industry 4.0 energy management
Reduce energy consumption and control central operating parameters automatically. The energy efficiency module MSE6 prevents compressed air wastage during system downtime (auto-stop function), detects leakages independently, and offers online process monitoring. Suitable for new and existing systems.

Leakage measurement*
When the compressed air supply is shut down, the MSE6 checks the system for leaks. Rapidly dropping pressure indicates excessive leakage. A notification is then sent to the system operator. This allows maintenance which, for the first time, is based on actual requirements.
- Zero compressed air consumption in standby mode
- Checks the system for leaks
- Ensures maintenance in the event of leaks
- Monitors relevant process data
- Communication via PROFIBUS, PROFINET, Ethernet/IP, CODESYS with OPC UA on request

Data can be quickly integrated using the following platforms:
- Festo Cloud
- Siemens MindSphere
- Rockwell FactoryTalk/TeamONE
- Others available on request

* This function is also available on the Festo Motion Terminal. Thanks to the cloud connection (see page 4/5), both components are fully fledged cyber-physical systems for Industry 4.0.
Automation platform 4.0!
Ideal as an automation platform, valve terminal partner or remote I/O – electric, open and direct. CPX – the perfect platform for electrical peripherals. With CPX, you can integrate pneumatic and electrical control chains easily, quickly, flexibly and seamlessly into all automation concepts and company-specific standards – and into Industry 4.0 as well!

Highlights
- Modular and flexible IP65 remote I/O
- Optimised version for IP20 and potentially explosive atmospheres
- Maximum function integration for complete applications
- Falling installation costs and rising productivity
- Decentralised and compact handling systems
- Networked intelligence with embedded CODESYS controller
- Industry 4.0 thanks to OPC UA and CODESYS control V3 and IoT gateway for cloud connection

Data can be quickly integrated using the following platforms:
- Festo Cloud
- Siemens MindSphere
- Rockwell FactoryTalk/TeamONE
- Others available on request

CPX – the new benchmark for perfect networking thanks to:
- Universal communication via fieldbus/Ethernet
- A choice of pneumatic platforms (valve terminals MPA or VTSA, Festo Motion Terminal VTEM)
- Subordinate, decentralised installation systems CPI, IO-Link® or I-Port
- Unrivalled module and application variety

CPX – greater economic efficiency and operational reliability through function integration, such as:
- Front-end control
- A choice of scalable installation concepts
- Comprehensive diagnostics and condition monitoring
- Motion control for electric and servo-pneumatic drives
- Measurement and control
Compact handling system YXMx for desktop applications

The flexible basic platform for a wide variety of desktop applications. Everything from a single source: the coordinated, ready-to-use system kit consists of software, controller and kinematics – and forms the basis for a wide variety of desktop applications such as screwdriving, dispensing, testing, soldering, gripping, opening and closing containers and much more.

- Ready-to-use system kit comprising kinematics,
- controller and software
- Industry 4.0-capable cyber-physical system thanks to motion apps and cloud connection (see page 4/5)

Intelligent sub-systems/solution packages

From the solution package YXMx to the automation platform CPX, Festo provides comprehensive expertise.

Handling systems in the form of linear, planar surface or three-dimensional gantries are available through the Handling Guide Online with the option of individual configuration – or they can be supplied as a predefined, specialised solution package by consulting our experts.

- Planar surface gantry EXCH
- Linear gantry EXCT
- High-speed parallel kinematic system EXPT (tripod)
- Industry 4.0 research project: parallel kinematic system
- CPX/EMCA as robotics without a control cabinet
- Servo press
- Handling systems YXMx

You will find the most up-to-date overview of all our products, solutions and services on the Internet at

www.festo.com/iot
**Servo press kit YJKP for electrical press-fitting applications**

The modular servo press kit YJKP gives you just the software functions you need for your application. You get an extremely precise press-fitting system with a high level of repetition accuracy and an excellent price/performance ratio. Simple, cost-effective and quick to install.

- Software and hardware from a single source
- Less expensive than conventional press systems
- The controller CECC-X with OPC UA interface makes the system ready for Industry 4.0.

**Big data analytics**

After two years, an initial analysis of comprehensive data from the production process of this assembly system made it possible to identify bottlenecks and optimisation potential. Concrete measures could then be introduced and the productivity of the line was increased by approx. 15%. Employees with knowledge of the specific production facility and data science also have an important part to play.

**Servo-pneumatic drive solution for welding guns**

Car body welding requires a high level of precision and robustness. The components from Festo for servo-pneumatically driven welding guns are specially designed to meet this requirement. You decide which is best for you – the X gun or the C gun. Our range of types and designs makes pneumatics for spot welding extremely efficient.

- Very short cycle times
- High quality and outstanding reproducibility of the spot welds
- Excellent value for money
- Individual components fit for Industry 4.0

**Diagnostic capabilities in demand for optimisation**

The new generation of welding guns will be connected to a cloud. By analysing the status data and changes in it, it is possible to make predictions about the future failure of system components and as a result of equipment or production facilities. Maintenance thus becomes predictive and no longer preventive as in the past.

Analysing the data provides in-depth insights into the behaviour of components in a production environment. This results in system optimisations that increase availability and quality.

**Universal structure**

The welding guns are therefore equipped with firmware from Festo. PC or tablets with software from Festo collect the data from every cell and compress it. Test cycles are triggered under certain circumstances; otherwise the data is transferred via an IoT gateway to the appropriate cloud. It is then available for further evaluation, for example for big data analytics, machine learning or for dashboards.
Maximum function integration, robotics-enabled controller and motor controller in IP65 integrated on site
Robotics is getting ready for Industry 4.0 with the high-speed handling system EXPT with CPX/EMCA.

CPX control technology from Festo for an IP65/67 environment and the numerous functions included in the new “integrated drive” EMCA facilitate robotic functionality which is close to revolutionary, with no need for a control cabinet.

• Robot controller without control cabinet – in IP65/67 thanks to CPX
• All-in-one integrated electric drive EMCA
• Very fast, light and compact
• Maximum economic efficiency
• Virtual commissioning with CIROS by Festo Didactic
• Pioneering: OPC UA interfaces for Industry 4.0, CODESYS V3 SoftMotion transformation models with calibration option.

Expanding the limits: inter-system cooperation
Multi-Carrier-System: as a transport and logistics system with maximum flexibility, the Multi-Carrier-System offers several highlights in line with Industry 4.0:
• Maximum electromechanical flexibility with Festo linear motors
• Compatible with all intralogistics systems, simple and seamless inward and outward transfer of the carriers, and thus a fully flexible overall concept
• Control concept including virtual commissioning

Simple implementation, optimum combination
• Existing intralogistics are retained
• Seamless integration
• Efficient engineering
• Proven control platform
• Complete synchronisation of transport and motion control for continuous production processes

Multi-Carrier-System in a closed loop
• The closed-loop circulation of carriers is now also an addition to the existing intralogistics solution, making the MCS ideal for long processes and machines or for compact module solutions.
• The alternative: complete integration or connection.
• Inexpensive servo-controlled toothed-belt solution for the return transport of MCS carriers in a closed loop.

Industry 4.0 functionality
Virtual commissioning (simulation), modular servo controllers, motion controller with optional OPC UA interface and carriers equipped with RFID permit open integration into Industry 4.0 host environments.
Intelligent parallel engine block assembly
Flexible and efficient: engine block, seal, pistons, cylinder head and screws are gripped in parallel and mounted in two steps. This type of parallel engine block assembly is faster and less expensive than sequential production. Furthermore, it can be implemented with either servo-pneumatic or electric axes.

Thanks to decentralised intelligence on the valve terminal CPX/VTSA, the reliable and space-saving grippers are flexible, adaptive and versatile when carrying out different gripping processes. A compact CODESYS controller CPX-CEC with IP65/67 protection controls the gripper unit on-site, and without a control cabinet. The available interfaces include all fieldbuses/Industrial Ethernet as well as Industry 4.0 standard OPC UA.

Flexible loading with end line packaging
We provide you with flexible automation solutions for your loading requirements, whether electric, pneumatic or a combination of both. With all components from a single source, from suction grippers and electric axis systems right up to CODESYS controllers. That allows you to implement dynamic loading processes with fast format changeovers, for example. And we provide you with additional support, from engineering to commissioning and operation.

The application is controlled by a CODESYS controller CPX-CEC with IP65/67 for compact on-site installation – without a control cabinet. The available interfaces include all fieldbuses or Industrial Ethernet as well as Industry 4.0 standard OPC UA.

Optimum food production
Festo provides you with support for optimum food production – with hygienic products and solutions, from valve terminals right up to electric or pneumatic actuators. Also included in our product range: robust, clean-design tubing and fittings. It is the ideal choice for form-fill-seal applications and much more besides.

Industry 4.0 and "big data" using the example of the energy efficiency module MSE6-E2M: evaluate pressure and flow sensors in real time for quick, on-site decisions. Communication via PROFIBUS, PROFINET, EtherNet/IP or Modbus/TCP. OPC UA is available on request.

The application is controlled by a CODESYS controller CPX-CEC. The available interfaces include all fieldbuses or Industrial Ethernet as well as Industry 4.0 standard OPC UA.
Designing an adaptable future in the Scharnhausen Technology Plant

The Scharnhausen Technology Plant is Festo’s main factory for the production of valves, valve terminals and electronics. It will also be a model plant for customers. Designed as a future-ready and adaptable factory, its production systems already embody the first elements of Industry 4.0. In addition, knowledge gained from our research into Industry 4.0 is incorporated into the further development of the Technology Plant.

According to the definitions included in the recommendations made to the German government, there are several action and research areas that constitute a “smart factory” in line with Industry 4.0. These were defined by Acatech within the framework of the working committee on Industry 4.0. A central goal of the smart factory is to have a fully networked factory. Festo is steadily working towards this goal in the Technology Plant. This is an evolutionary process.
Highly flexible, energy-efficient assembly lines
Millions of units every year, but with flexible batch sizes from 10 to 10,000. These are just a few of the features of our latest assembly lines, which are based on findings from the Industry 4.0 research project “SmartFactoryKL”.

This machine, with standardised mechanical, electrical and software interfaces, points the way forward. It is based on up to 600 decentralised cyber-physical systems (CPS).

Energy networking of buildings and production processes – retrofit projects for existing machines
How can you hook your existing machines up to Industry 4.0?

This is a question that many customers/users ask themselves – and we faced the same challenges in our own production.

Festo retrofitted a variety of machines with a small secondary controller and additional sensors in order to uniformly record key metrics like energy consumption and operating data via OPC UA. Then a number of efficiency optimisations were analysed, their cost effectiveness reviewed and initial measures implemented.

All the measures for machines and buildings taken together reduce the energy used for manufacturing at the new site by a few GWh; the retrofit projects therefore have an estimated ROI of 2 to 3 years.

Mobile maintenance for greater efficiency and higher availability
As part of a pilot project, all the data for a machine, such as plans and diagrams, bills of materials, spare parts and repair instructions, were ported to mobile devices and linked up to a central computer system – which in our case is SAP.

This allows on-site maintenance technicians to view, analyse and prioritise all the alarms, and to work their way efficiently from one machine to the next. They can also consult experts online, exchange images and photos, view stocks of spare parts, and directly pick or order stock.

The rollout to all other Festo plants is currently underway. Incredibly, the return on investment is less than six months.

Festo Didactic offers consultancy services for optimising production, assessing production plants and processes in accordance with “fit for Industry 4.0”, and the latest service and maintenance concepts. Ask your Festo sales engineer.
Training for Industry 4.0

Industry 4.0 will permanently change how production work is done and thus the demands on skilled workers. Festo is not only focused on technological developments, but also offers an integrated approach and a special training programme to develop the skills required to use and work with the latest digital industry technologies.

With turnkey training factories, laboratory facilities, innovative learning systems, e-learning and training programmes, Festo Didactic has the training solutions required for forward-looking and practical training in mechatronics and automation technology.

MPS 203 I4.0: Basic principles of Industry 4.0 specifically for mechatronics engineers
The learning system ranges from comprehensive training in the fundamentals of automation technology to the flexible production of customised workpieces. Training content like MES, augmented reality and RFID make MPS 203 I4.0 an ideal learning system for everyone looking for a future-oriented training course with a solid foundation in practical skills.

CP Lab: Modular entry into the world of Industry 4.0
The Cyber-Physical Lab is a professional and compact Industry 4.0 learning system. It includes all the technologies and components needed for the practical and in-depth transfer of Industry 4.0 knowledge. Its modular and flexible structure allows the range of training content to be expanded step-by-step.

CP Factory: The universal Industry 4.0 learning platform
The cyber-physical learning platform CP Factory models the stations of a real production system, allowing trainees to learn system programming, networking and many other topics such as energy efficiency and data management.

The CP Factory is also used for developing and testing flexible software solutions.

Skills development for Industry 4.0
Employees can be steered successfully through the Industry 4.0 change process with targeted skills development. With customer-specific training programmes, customised content and an integrated approach to consulting, Festo Didactic supports companies in equipping their staff with the skills required for digital production. Students benefit from our CP Factory-based course concepts on Industry 4.0 technologies.
The collaborative behaviour of ants, the collective flight behaviour of butterflies, or an extremely versatile gripper modelled on the tongue of a chameleon are revealing new directions for visionary automation technology, exclusively at Festo. Festo’s Bionic Learning Network also studies human learning behaviour and new ways for human-machine interaction, thereby furthering groundbreaking research for Industry 4.0 and the future of production.

**BionicANTS**
The BionicANTS technology carrier has been modelled on the autonomous and cooperative behaviour of ants.

For example, they work together to move loads that a single ant couldn’t manage. Like their role models from the natural world, the BionicANTS work together according to clearly defined rules. They communicate with one another and coordinate their actions and movements.

Each individual ant makes its decisions autonomously but in doing so is always subordinate to the common goal and thereby plays its part in solving the task in hand. The control strategy permits a multi-agent system in which the distributed intelligence of all the BionicANTS together contributes to the process of finding a solution.

**LearningGripper**
Gripping and positioning through autonomous learning

The LearningGripper looks like an abstract form of the human hand. The four fingers of the gripper are driven by twelve pneumatic bellows actuators with low-level pressurisation. Thanks to machine learning, the gripper is able to teach itself to carry out complex actions such as the targeted gripping and positioning of an object. Machine learning reduces the amount of programming required.

The prototype shows how it takes less than an hour for it to learn a mechanical motion strategy, from its first attempt to the reliable execution of the required task. Yet the gripper is only told what it needs to be able to do, not how to do it. The complex strategy required for this is developed independently by the gripper’s learning algorithms – without any further programming.

**BionicCobot**
The way the joints of the BionicCobot are arranged resembles a human arm. With its seven-axis robotic kinematics with pneumatic rotary drives it grips and transports payloads of up to 2 kg quickly and easily, powerfully and precisely. Closed-loop control together with flexibility and adaptability recreate the stretching and bending abilities of human muscles. This inherently safe system that is used for human-robot collaboration, doesn’t require any holding forces.

The modular design allows a variety of gripper systems to be fitted for transporting different loads. The BionicCobot is operated intuitively using a tablet, and can be precisely corrected and adjusted via an infrared tracking system.

The application is controlled by the Festo Motion Terminal with 7x2 chambers and a CODESYS controller CPX-CEC with IP65/67 protection for compact on-site installation – without a control cabinet. The available interfaces include all fieldbuses, Industrial Ethernet and Industry 4.0 standard OPC UA.
As a trendsetter in automation technology, Festo is actively involved in a broad range of areas: our experts advise the German federal government, contribute to the standardisation of communications and software interfaces, and offer basic and further technical training opportunities across the globe. Festo is the only company to offer flexible, decentralised installation concepts and integrated mechatronic solution packages. From the mechanical system to the Industry 4.0-compatible cloud – everything comes from a single source.

**Maximum productivity is a question of ambition – both now and for Industry 4.0**

Sometimes there is only a small step between a very good result and market leadership. But that step is the crucial one. Outstanding productivity is part of that step. If that is your goal, we have the right solutions for you – such as the automation platform CPX together with the highly innovative Festo Motion Terminal VTEM. Whether you are looking for a technically sophisticated system solution or a very economical alternative for components, we are here to support you on the road to success. Ambitious and goal-oriented, with vision and awareness of our responsibilities – everything you expect from Festo and everything we are.