Partner for automation with CANopen, Modbus-TCP and EtherCAT
For smooth cooperation: CANopen, Modbus-TCP- and EtherCAT solutions from Festo

Products, systems and customised solutions with added value can only be created in an environment where knowledge and innovation are a matter of course and high-quality expertise abounds. This is especially true of field-buses like CANopen, Modbus-TCP and EtherCAT. To enable these fieldbuses to achieve maximum productivity in your company, Festo focuses on four topics. They all share a mechatronic approach:

1. State-of-the-art knowledge
2. Products and solutions
3. Mechatronics
4. Advantages on the bus

Positioning and potentials of the individual bus systems on the field level

Application complexity (sensors and actuators)

- Communication
- Motion control
- > 20% regulated
- Pre-processing
- > 20% analogue
- > 90% digital

Machine/system design (dimensions and structures)

- Compact manual workstations
- Automation cell
- Interlinked, station-based machines
- Automated systems

- EtherNet TCP/IP
- Industrial EtherNet
- Drive bus
- Fieldbus
- I/O bus
Fuel for innovation: state-of-the-art knowledge.
As a member of all leading fieldbus organisations, our experience goes right back to the start. This allows us to pass on our information advantage. As the inventor of valve terminals, we give our customers a clear competitive edge by ensuring our innovations are at the core of modern automation systems. Integration of functions, such as motion control, proportional technology, measurement, control and diagnostics, make Festo valve terminals the automation platform for the 21st century: more economical, reliable and efficient.

Trend-setting and economical: products and solutions. Festo was the first supplier to deliver I/O modules rated to IP65 for valve terminals. And, with the patented modular I/O concept for the CPX electric terminal, it takes controlling automation solutions into a new dimension. The combination of valve terminals MPA or VTSA with the CPX terminal results in a standardised platform for pilot valves, remote I/O, classic pneumatics, measurement, control and diagnostics. Everything is integrated, including motion control. The integration of the motion control functions with electric and servopneumatic drives makes it the perfect platform for trend-setting mechatronics.

Standardised automation links process automation and factory automation applications. These control cabinets, which all share the same modular construction, make maintenance and diagnostics easier.
Compact fieldbus nodes, valve terminals and I/O modules solutions and delivery with a single part number. The range also includes control cabinets with matching control technology and visualisation for subsystems and solution packages, e.g. for process automation or the food industry.

Integration and combination: advantages on the bus. Optional connection technology makes integrating bus systems in existing standards child’s play. The combination of a fieldbus device and remote control via the embedded CoDeSys controller creates undreamt of synergies in practical applications and results in autonomous, intelligent sub-systems. Consistent diagnostic concepts and forward-looking condition monitoring systems with OPC interfaces provide clarity from the device level to mechatronic sub-systems and even up to the control system for pneumatic and electrical engineering components and motion control. This significantly reduces or avoids downtime.

3 Specially for industries: mechatronic systems that fit. Fieldbus systems and valve terminals are customised for specific industry applications, for example via connection technologies compliant with AIDA for the automotive industry, fast start-up for robots, interlock functions for the semiconductor industry, EX-i versions or clean design in IP69K for food production. Solution packages in handling technology, from consultation to turnkey/ready-to-install

Fast tool change thanks to Quickconnect

Robust metal designs for body assembly and welding

Compact fieldbus nodes, valve terminals and I/O modules
Successful automation – everything from a single source
Everything matches because the technology is provided by a single source. From controllers to pneumatics, electrical engineering and networking to networking on all levels. The advantages at a glance:

Networking – synergies through function integration
• Can communicate up to web level: Ethernet and web-based diagnostics concepts, e.g. remote diagnostics via fieldbus, Ethernet, integrated web server
• Selectable pre-processing, including through valve ASIC for the simplest of valve diagnostics, integrated mini control system (remote or embedded control) and extensive monitoring functions

Pneumatics – innovation is always built in
• Robust, flexible, modular, can be diagnosed, high flow rate
• Standardised, universally or application-optimised, such as Clean Design
• Safety technology, pressure control technology and servo-pneumatics built in
• Always 100 % checked, pre-assembled and easy to install

Electrical engineering – flexibility for communication
• High degree of freedom and independence thanks to modular electrical I/O terminals, installation systems and a direct fieldbus connection for valve terminals
• Maximum connection versatility
• Extensive electrical peripherals, I/O modules on terminals or separately
• Open to all established fieldbus standards, from AS-interface to the Ethernet
• Universally integrated diagnostics concept, such as condition monitoring and channel-oriented diagnostics

Clean Design for maximum ease of cleaning and corrosion resistance.
Networking: mounting plate with valve terminal and air preparation unit
Pneumatics: optimised by simulation
In-house expertise: own R&D, labs and production
There are five big trends which Festo pursues with its pneumatics, electrical engineering and networking concepts.

- Networking concepts – a central prerequisite for
- installation
- function integration
- diagnostics
- energy efficiency

They are all ingredients for successful automation. The most important trend with regard to industrial communication is undoubtedly the networking concept. It directly affects, to varying degrees, the system and machine options – regardless of whether it’s about installation, function integration, diagnostics or energy efficiency.

Festo’s many years of experience as a market and technological leader for valve terminals provide an answer to the requirements demanded by today’s and tomorrow’s market. Reliable products in pneumatics and electrical engineering for all types of industrial communication – worldwide! Integral solutions and universal system concepts are the central success factors.

See the Festo homepage for more information on the mega-trends:
www.festo.com
› Products
› Valve terminals

The 5 big trends

<table>
<thead>
<tr>
<th>Networking</th>
<th>Installation</th>
<th>Function integration</th>
<th>Diagnostics</th>
<th>Energy efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve terminals from Festo are very adaptable!</td>
<td>Improved cycle times of up to 35%!</td>
<td>Enhanced efficiency of up to 60%!</td>
<td>Up to 35% less downtime!</td>
<td>Reduce energy costs by up to 60%!</td>
</tr>
<tr>
<td>Different levels, different requirements.</td>
<td>Central, decentralised or hybrid machine concept, modular or compact.</td>
<td>By means of the most extensive function integration, e.g. with a CPX terminal</td>
<td>Active diagnostics management and condition monitoring can save up to €10,000 per minute!</td>
<td>By means of energy savings along the production processes.</td>
</tr>
</tbody>
</table>
Maximum productivity will be greatly influenced by industrial communication in the future. To control and analyse individual processes with high efficiency, it is mandatory that the communication levels, which are still often separated today, be networked, using, for example, CANopen, Modbus TCP and/or EtherCAT.

The “control technology pyramid” shows the different communication requirements on each individual level.

**Management level – holistic communication all the way to the office**

**Ethernet**
- Remote diagnostics and maintenance of controls and devices from the office network
- Networking of applications and machines
- Storage of process and device information
- Use of Ethernet infrastructure components (wireless LAN)

**Field/device level – indicates on-site safety/reliability**

**CANopen**
- Fast device exchange via DIP switches
- Easy identification of the network status of field devices
- Definition of device behaviour in the event of a communication error
- Integration of diagnostic telegrams (emergency messages)
- On-site diagnostics with LEDs and HMI
- Configuration of network characteristics by means of baud rates

**EtherCAT**
- Fast device exchange (without switches)
- Easy identification of the network status of field devices
- Definition of device behaviour in the event of a communication error
- On-site diagnostics with LEDs and HMI

**Control level – monitoring of production and processes**

**Ethernet and Modbus TCP**
- Integration of device status and diagnostics in PLC programs or in visualisation systems
- Bridging long distances using Ethernet technology

**Modbus-TCP**
At the centre of networking: CANopen, Modbus TCP and/or EtherCAT

**Typical control platforms**

**Schneider Electric**
Industrial automation, control systems, checking, protecting and monitoring machines and systems in industry, infrastructure and buildings.

Typical products:
- Controllers: Supporting the “Premium” modular control system, as well as the larger “Modicon Quantum” control system
- Typical fieldbuses: Modbus TCP and CANopen
- Software tools: “Unity Pro” programming software with extensions for network configuration

**Beckhoff**
Automation technology, frequently using PC-based control technology with the segments: industrial PC, embedded PC, fieldbus components, drive technology and automation software

Typical products
- Controllers: CP industrial PCs, CX embedded PCs
- Typical fieldbuses: EtherCAT, CANopen, Profibus
- Software tools: “TwinCAT” with “System Manager” for network and device configuration, as well as “PLC Control” for programming

Additional useful information about the networks and their commissioning
For example:
- Info about CANopen at www.can-cia.org
- Info about EtherCAT at www.ethercat.org
- Info about Modbus TCP at www.modbus.org

**At the centre of networking: CANopen, Modbus TCP and/or EtherCAT**
The communication components:

**CANopen**
The CANopen communication protocol, based on CAN (Controller Area Network), is primarily used in automation technology and to network complex equipment. Specified device profiles stored in the object directories describe the application parameters and the functional characteristics of the device classes.

CANopen networks provide point-to-point connections for the service data objects (SDO, e.g., parameters and diagnostics) and multicast connections for the process data objects (PDO). As each device “listens” to every other device, this is a multi-master system. The network management function is initiated by the CANopen Manager.

**Modbus TCP**
Although Modbus TCP is very similar to the Modbus RTU data transmission technology, Modbus TCP uses TCP/IP packages to transmit the data. The simply structured data model is based on a client/server architecture, in which the control system acts as the client and the devices answer requests as servers. Function codes are used to communicate different Modbus services and to transmit process and service data. As Modbus TCP is completely based on the TCP/IP software structure, it is fully compatible with standard Ethernet networks.

Modbus TCP enables communication over long distances; however, the network performance depends on the design of the Ethernet network, the Ethernet peripherals used (e.g., switches) and the performance of the devices used.

**EtherCAT**
Short cycle times and low jitter frequency for precise synchronisation: these are the key points of EtherCAT (Ethernet for Control Automation Technology). Data selection ensures faster cycle times: when the standard Ethernet frame is sent out, the EtherCAT slave devices only remove the data that is intended for them, whilst the telegram passes through the device, while adding input data to the telegram at the same time.

The device profile definitions were adopted from existing fieldbus technologies and integrated into EtherCAT (e.g.: CoE, CANopen over EtherCAT). In EtherCAT, great importance is placed on real-time capability, which means that primarily EtherCAT telegrams are transmitted. It is therefore only possible to communicate standard TCP/IP packages (e.g. for software services) subordinately. Data is fed in via separate switchports.

Example: CANopen topology

Example: Modbus topology
At the centre of networking: advantages of the field level ...

Solution expertise: always built into the product at Festo

The ideal combination of maximum performance and process reliability for every conceivable application in pneumatics, electrical engineering and networking: Festo’s valve terminal range. Unique, intelligent solutions that can be adapted to all the requirements of your systems – and with a convincing price/performance ratio.

Field level:

Fast device exchange via DIP switches
• Reduce downtimes by quickly replacing products
• Set the bus address and baud rate for CANopen

CANopen
  • Sub-D (IP65)
  • 2xM12 Open Style
  • Klemme (IP20)
  • Sub-D (IP20 Stack)

Modbus-TCP
  • RJ45 (IP65)

EtherCAT
  • 2xM12 (D-coded)
  • Integrated switch
Easy identification of the network status of field devices
- Can be very quickly recognised via LEDs

Definition of device behaviour in the event of a communication error
- Fail-safe: defined status of the valves and electrical outputs in the event of communication errors
- Parameterise a preferred actuator state depending on the machine concept

Integration of diagnostic telegrams (emergency messages)
- Festo valve terminals support the “node guarding” and “heartbeat” technologies. This makes it possible to configure the diagnostic messages of the CANopen devices so that they can be interpreted by the control system.

On the spot diagnostics
- Localise errors ultra-fast with LEDs or device diagnostics
- Get extended on-site data without existing network infrastructure: with CPX-MMI or CPX-FMT

CTEU-CO
CTEU-EC
CPX-MMI
CPX-FMT
At the centre of networking: advantages ... up to control/management level

**Control level:**

- **Changing and saving device parameters via the fieldbus network and configuration tools**
  - EDS files (CANopen) or XML (EtherCAT) for integrating devices and information into software tools
  - Start-up configurations of the parameters can be stored in the fieldbus master via CANopen device objects
  - Significantly reduces time and probability of error as pre-configured parameters can be activated directly from the controller

- **Integration of device status and diagnostics in PLC program or in the visualisation systems**
  - Basic status of the valve terminal: simply transferred as optional status bits within the process data
  - Status interface for additional information via CPX: optional via process data
  - Targeted changing and querying of parameters and diagnostics: optimum data access via CANopen-specific “object model” during PLC start-up and acyclically during the program run

**Device status and diagnostics with network tools**

- Read out module status or error trace of the CPX terminal online: enhanced diagnostic data
- Festo maintenance tools, such as CPX-FMT for maximum transparency and exceptional convenience even without an operating network infrastructure

**XML files**

**TwinCAT**

**Test of function**
Management level:

Remote diagnostics and maintenance of controls and devices from the office network
- Access via the network can be realised with CPX-FMT from various computers for more transparency without additional investments in the infrastructure
- Simple and cost-effective: project planning using the PLC Ethernet connection via the PC network

Networking of applications and machines
- Ideal, thanks to data bandwidth and flexibility: Industrial Ethernet
- For decentralised control concepts: communication with a higher-order controller via EtherCAT, CANopen and Modbus TCP thanks to the remote control mode of the CPX fieldbus node

Storage of process and device information (documents, websites)
- Extended device, machine and system information can be stored centrally on data servers within an Ethernet network. Status and diagnostic data can also be queried on the CPX terminal with Modbus TCP via an installed web server.
- The CPX web monitor HTML software package is optimised for visualising the CPX terminal via a web browser (e.g. in combination with CPX-FEC or CPX-CEC)
- Fast and easy access from all computers

Use of Ethernet infrastructure components (wireless LAN)
- The existing infrastructure for industrial Ethernet makes integration in the automation environment or of special components for remote maintenance via the Internet (via VPN, for example) quick and inexpensive
- CPX Modbus TCP node on standard Ethernet technology is compatible with the infrastructure components

Transparency for process reliability – even remotely

CPX web server

![CPX web server](image-url)
Overview: The world of Festo valve terminals

Your selection matrix for valve terminals ... will guide you quickly to the right solution, enabling you to choose from a comprehensive variety of valve terminals. The matrix shows the most important technical features, together with recommendations to meet industry-specific requirements or for specific applications.

<table>
<thead>
<tr>
<th>Valve terminals</th>
<th>Electrical periphery</th>
<th>Flow rate (litres/min. per valve, max.)</th>
<th>Electrical inputs (max. per valve terminal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSVA/VTIA – ISO 15407-1</td>
<td>Modular, individual connectors M8/M12, C-type</td>
<td>500</td>
<td>8</td>
</tr>
<tr>
<td>CPX/VTSA/VTSA-F – ISO 15407-2 and 5599-2</td>
<td>Modular, high pneumatic functionality, with electrical I/O</td>
<td>550/700</td>
<td>16</td>
</tr>
<tr>
<td>CPX/MPA-S/MPA-F/MPA-L</td>
<td>Universal, modular, flexible, serial valve control, with electrical I/O</td>
<td>360</td>
<td>2</td>
</tr>
<tr>
<td>CPV</td>
<td>Universal, compact, high performance</td>
<td>400</td>
<td>1</td>
</tr>
<tr>
<td>VTUG</td>
<td>Universal, compact sub-base, high flow rate</td>
<td>200</td>
<td>2</td>
</tr>
<tr>
<td>VUVB/VTUB</td>
<td>Universal, highly economical</td>
<td>400</td>
<td>4</td>
</tr>
<tr>
<td>VTOC</td>
<td>Compact, flexible 2x 3/2-way pilot valves</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>CDVI</td>
<td>Clean Design IP65/67</td>
<td>650</td>
<td>1</td>
</tr>
<tr>
<td>CPX terminal multifunctional, modular, flexible periphery. Independent platform, comprehensive diagnostics and function integration. Options: remote I/O, remote control and motion control.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPX-system decentralised installation system. Up to 16 I/O modules and valve terminals. 3 platforms, for I/O modules, valve terminals and master modules.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTEU/CAPC</td>
<td>Flexible fieldbus and installation concept for up to 2 I/O modules or valve terminals.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Quick planning aid: the valve terminal configurator in Festo’s electronic catalogue. At www.festo.com, you can configure almost 20 valve terminal series to suit your requirements.
<table>
<thead>
<tr>
<th>No. of valves</th>
<th>Valve type</th>
<th>Pressure zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1)</td>
<td>1)</td>
</tr>
<tr>
<td>2</td>
<td>2)</td>
<td>2)</td>
</tr>
<tr>
<td>3</td>
<td>3)</td>
<td>3)</td>
</tr>
<tr>
<td>4</td>
<td>4)</td>
<td>4)</td>
</tr>
</tbody>
</table>

1) Via CPI system
2) For example: manual pressure regulators, pressure gauges, flow control plates, flow control/shut-off plates (hot-swap), pressure supply, integrated non-return valves/back-pressure valves
3) Via CTEU/CAPC system, up to 32 inputs or 96 valves
4) MPA-L only
5) Master connection in preparation

For MPA-L (without MPA-L), up to 7 valves

<table>
<thead>
<tr>
<th>No. of valve coils (max. per valve terminal)</th>
<th>Diagnostic</th>
<th>Protection</th>
<th>Electric connection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Valve properties</td>
<td></td>
<td>Communication protocol</td>
</tr>
<tr>
<td></td>
<td>Electrical connection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Function</td>
<td>Integration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Class</td>
<td></td>
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</tr>
</tbody>
</table>

For MPA-L, up to 32 40 48 56 64 128 512
At the centre: CANopen as a platform at Festo

Holistic mechatronic motion solutions from one source: from controllers to ready-to-install handling systems.

From modular and compact control concepts for standard pneumatics, servo-pneumatic and electrical positioning to sensors and compact camera systems for process diagnostics and quality assurance.

Industrial Ethernet

Modular, flexible, universal: control concepts and motor controllers from Festo

- Motor controller
  - SFC-DC
  - SFC-LACI

- Servo motor controller
  - CMMP-AS*
  - CMMS-AS
  - CMMD-AS

- Stepper motor controller
  - CMMS-ST

- Servo motors
  - EMMS-AS
  - EMMS-ST

- Stepper motors
  - EMMS-ST

- Servo motors
  - MTR-DCI

Linear motor axes
- ELGL-LAS
- DNCE-LAS

Gantry axes
- EG6C-TB/BS
- ELGA-TR-G

Cantilever axes
- EGSK/EGSP
- ELG
- DGE

Slide unit
- EGSN
- SITE with DC motor

* EtherCAT option
1 Modular controller CECX
- Universal controller with fieldbus master, programming with CoDeSys,
- Multi-axis motions for individual ptp (point-to-point) axes or interpolation in 2.5D.

2 Modular electrical peripheral CPX with “motion” function integration
- CoDeSys embedded controller CEC-C1 with PLC functionality and CANopen master. As CEC-M1, the module controls up to eight electric axes synchronously in 2.5D, incl. Softmotion library
- Modules for electric drives: CM-HPP/CMXX for single axis/multi-axis operation
- Modules for servopneumatic drives: CMHX/CMXX for SoftStop and position controller
- Remote I/O
- Servo motor controller: highly functional CMMP-AS or standard CMMS-AS and double controller CMMD-AS.
- Stepper motor controller CMMS-ST (ServoLite functionality)
- Intelligent servo motor MTR-DCi
- Linear motor controller SFC-LACi
- Stepper motor controller SFC-DC

3 Compact Vision System SBOx-Q, Intelligent camera with integrated CoDeSys PLC:
- For activation of electric axes
- For position and type detection, quality inspection of moving and stationary parts, OCR and reading of 1 and 2D codes
- CANopen Master with CoDeSys
- Standardised Ethernet interfaces, integrated 24 V I/O
- Protection class IP65/IP67

4 Integrated controller FED-CEC. Controls up to eight individual electric ptp axes asynchronously, CoDeSys integrated, including Front End Display, integrated CANopen master.

Standard handling Systems

Pick & Place
Linear gantry (2D)
Three-dimensional gantry (3D)

Advanced handling systems

T-gantry (2D)
H-gantry (3D)
Tripod
Customised solutions
If you require a certain amount of added individuality beyond valve terminals, electrical peripherals, function integration and sector orientation, then you’re in the right place.

It doesn’t matter whether you choose AS-interface, fieldbus or Ethernet, our customised solutions meet all current and future market requirements. As always, pneumatics, electrical engineering, motion and networking are all provided by a single source.

Build it yourself or have it built?
The decision is yours. But complete systems can save you as much as 50%. With ready-to-install systems you no longer need to undertake complex working processes.

Tell us what your requirements are and we will design, order, compile, test and deliver. We can also assemble and commission your system on request. You concentrate on your core tasks; that not only saves time and money, but brings maximum reliability with regard to function and optimal settings.

Ready-to-install solutions

Complete control cabinets with remote I/O and valve terminals give you a total solution, either stand-alone or with a fieldbus connection to your host system.

Ready-to-install mounting plates (pressure gauges, valves, service units): a turnkey, complete solution for a machine unit at the AS-interface.

We offer:
• Engineering
• Documentation
• Assembly
• Testing
• Commissioning
• Servicing during the operating phase

Special designs
Individual solutions:
• On integrated blocks
• On printed circuit boards
• Modular control units
• Under safety guards

Optimised and customised AS-interface solutions:
• Electric
• Pneumatic
• Mechatronic
• Integrated in machine profiles

Services and support – for more added value
Engineering
The optimum valve terminal right from the start:
• Correct selection thanks to software configuration
• Highly scalable thanks to extremely modular equipment design
• Diagnostics and condition monitoring service: from analysis and consultation right up to programming services
• Modular CAD models

Commissioning service
Know-how on request:
• Fast installation, fast connection, fast commissioning
• Additional ready-to-install solutions with further components available on request
• Circuit diagrams in EPLAN 5.1 and P8

After-sales services
Reliable operation of your valve terminal with:
• Technical hotline
• Online spare parts service
• Repair service, including express
• 24 h emergency service for registered customers
• On-site after-sales service
• Modular service contracts, preventative or for emergencies

Procurement service
Simplified procurement and logistics:
• Pre-assembled and checked modules and systems configured to the customer’s specific requirements – Festo plug and work®
• Order code: configure once and order using the same part number again and again
• Labelling service: valve terminals labelled as required

Strong support:
CAD models for valve terminals
Brief instructions for anyone requiring CAD models (2D/3D for valve terminals from Festo:
• Festo website www.festo.com
• Click through to the Festo “Online Shop/Catalogue”
• Register if you haven’t already done so
• Log on
• Search for product, e.g. MPA
• Is the CAD symbol active?
If so, the CAD files are available
• Configure valve terminal (and put in shopping basket if necessary)
• Click the CAD symbol to generate/order the CAD files

Our services support you every step of the way, from planning to operation, and make the process faster, more reliable and more efficient. And as far as TCO is concerned, we help you to recognise and achieve potential savings.

Training courses by Festo Didactic. Festo Didactic is the global market leader in technical training and vocational education; over 42,000 participants benefit from our training courses every year. You and your employees can attend an event in one of the 20 training facilities throughout Germany.

Or book a customised event in your company:
• Festo valve terminals CPX – commissioning, conversion and troubleshooting (TERMINAL-CPX)
• Reliable pneumatic and electrical design of machines and systems (SEP-PILZ)

• Energy efficient system design, appropriate use of pneumatics (DESIGN 1 and 2)
• Pneumatics refresher and update (P-NEU)

Other courses and consulting services:
www.festo-tac.de