

Safely on the way in the automotive and Tier 1 supplier industry

FESTO



Reach your destination of maximum machine availability and machine safety – without detours and safely.

Our navigation system for safe machines

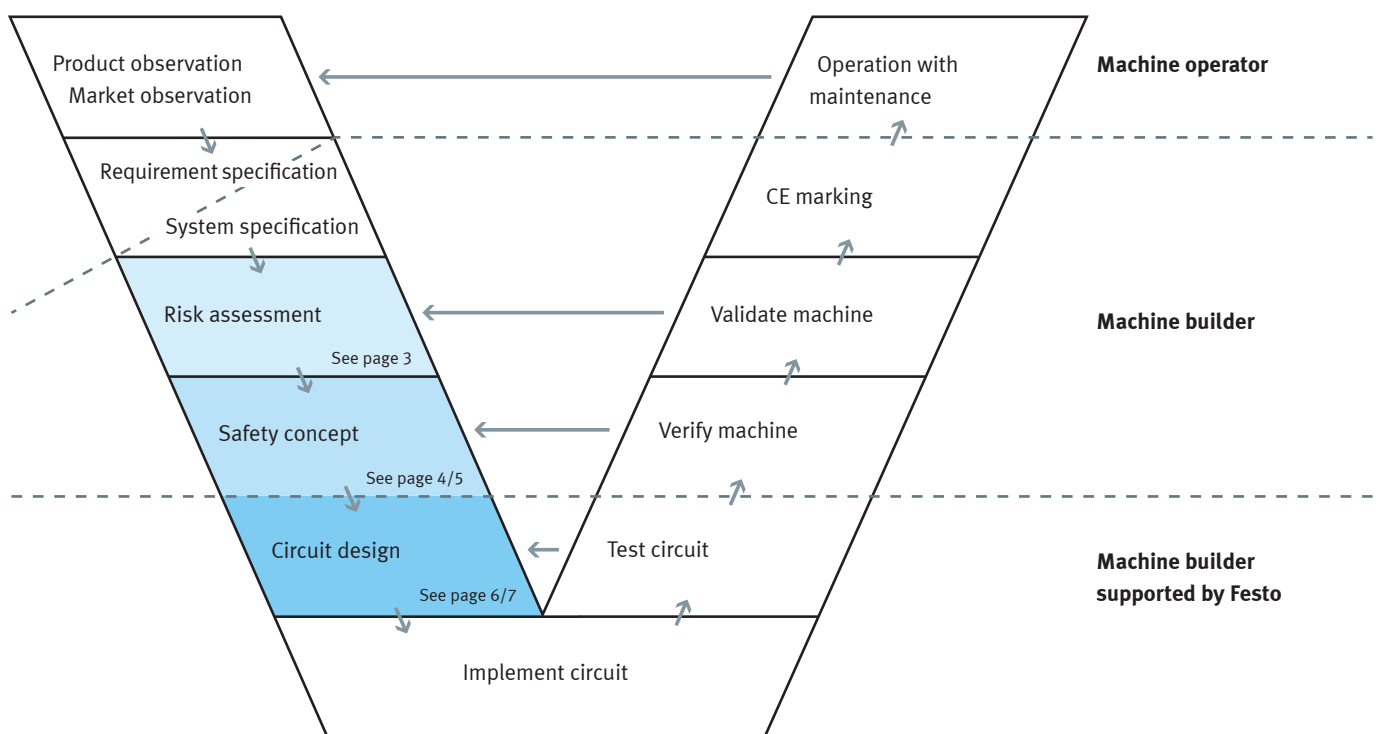
Identify and minimise risks

In the age of Industry 4.0, cooperation between people and machines has never been closer. In pioneering sectors such as the automotive industry, people and machines often work together closely without any safety barriers, for example in pick & place systems in final assembly. Machine safety is therefore increasingly important, especially as the process of identifying possible risks becomes more complex. At the same time, ever more sophisticated technology and growing time and cost pressures are making the implementation of protective measures difficult.

To ensure that the protective measures implemented comply with the standards, Festo provides expert knowledge and solutions for operation, set-up, maintenance and other process steps in the form of intelligent, safety-related automation technology. We regard machine safety as a crucial quality aspect, whether for supplying compressed air for robots, clamping panel parts in welding jigs in body shop or handling parts in engine and transmission production.

Your route to a safe machine

The V-model illustrates the necessary steps:



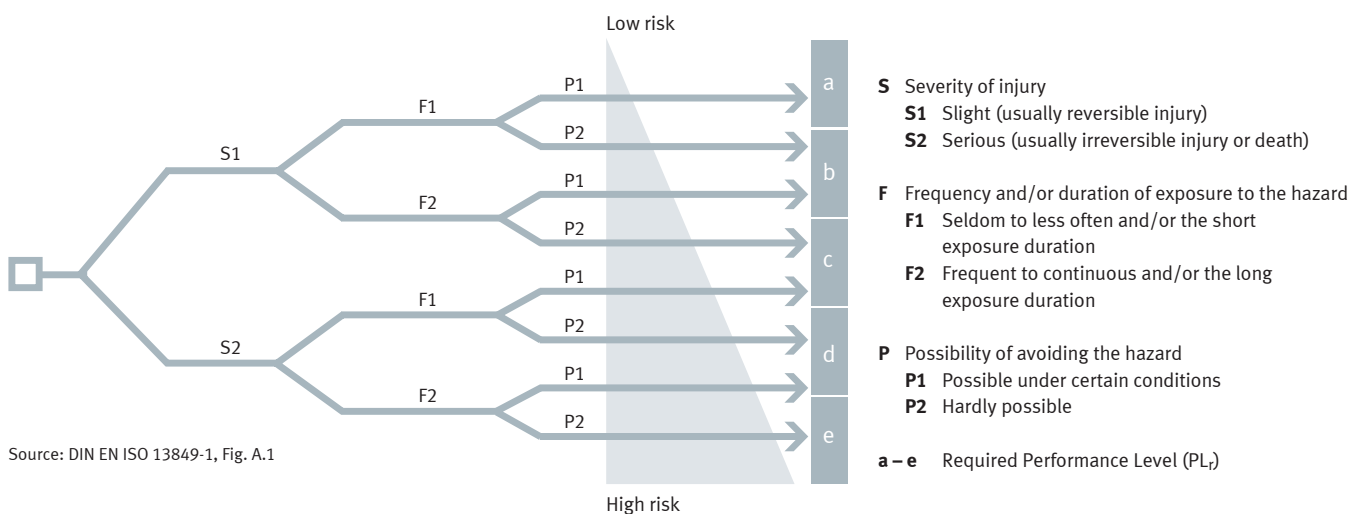
This brochure focuses on three steps in particular: risk assessment, safety concept and circuit design. Following these steps carefully and knowledgeably minimises the need for correction and rework, which would otherwise generally occur during the early stages of operation. Our expertise helps you to achieve a shorter time to market.

Risk assessment

To ensure that machines can be built and operated safely, legal regulations such as the Machinery Directive 2006/42/EC apply worldwide. Almost all directives prescribe a risk assessment for the identification of possible risks. This can be used to determine and implement measures aimed at minimising risk.

Many of the tasks carried out at machines by operating and maintenance staff pose a risk. What happens if the operator reaches into the machine while it is running, there is a power failure or the robot controller fails? Minor incidents often lead to more serious accidents. Risk assessments are the key to preventing this from happening through protective measures that are both effective and economical. Whether you want to build, retrofit or link machines carrying out a careful risk assessment is crucial. An assessment based on Performance Levels allows you to investigate the machine functions in terms of the risk they pose.

A **risk chart** makes it easier to define the degree of protection:



To be able to assess risks reliably, the recommendations of the EN 62061 standards can also be applied, as they evaluate risks based on similar criteria, i.e. the severity of the possible damage and the likelihood of damage occurring.

Safety concept

The necessary protective measures and their requirements are defined in the safety concept. In the case of a safety circuit, these are the element safety function(s) to be implemented, the required Performance Level (PLr) and the desired category. Risk reduction measures are generally required for Performance Level c and above.

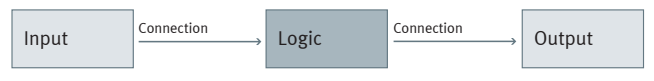
Performance Level c, category 1

Single-channel architecture

In a category 1 architecture, a single fault leads to failure of the safety function. However, this may be sufficient as a protective measure in applications that are accessed infrequently.

Safety category PL c

of the risk graph can be implemented with a category 1 architecture.



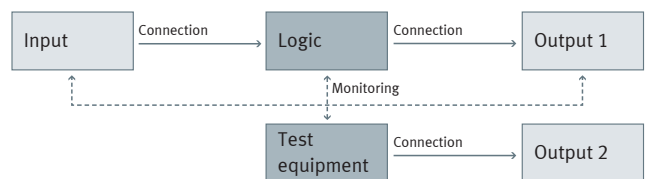
Performance Level d, category 2

Dual channel architecture with regular function tests using test equipment

In circuits with a category 2 architecture, function tests of the components are carried out at regular intervals. If a fault occurs between function tests, the safety function may fail. Many faults are then detected during the next function test, so that the application can be brought into a safe state with the second output.

Safety category PL d

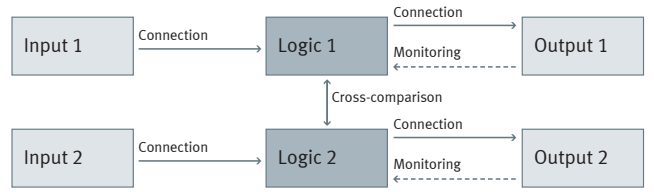
of the risk graph requires a category 2 or 3 architecture.



Performance Level d, category 3

Dual channel architecture with partial monitoring

In circuits with a category 3 architecture, individual faults are detected in good time before or during a safety requirement. However, an accumulation of unknown faults may result in failure of the safety function.



The connections with dashed lines mean that a fault can feasibly be detected.

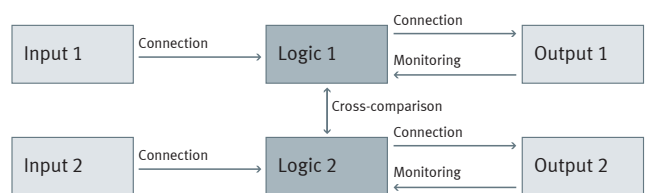
Performance Level e, category 4

Dual channel architecture with full monitoring

A fault in category 4, the highest category, is detected as a second fault with high probability before or during a safety requirement. However, an accumulation of unknown faults may result in failure of the safety function.

Safety category PL e

of the risk graph requires a category 4 architecture.

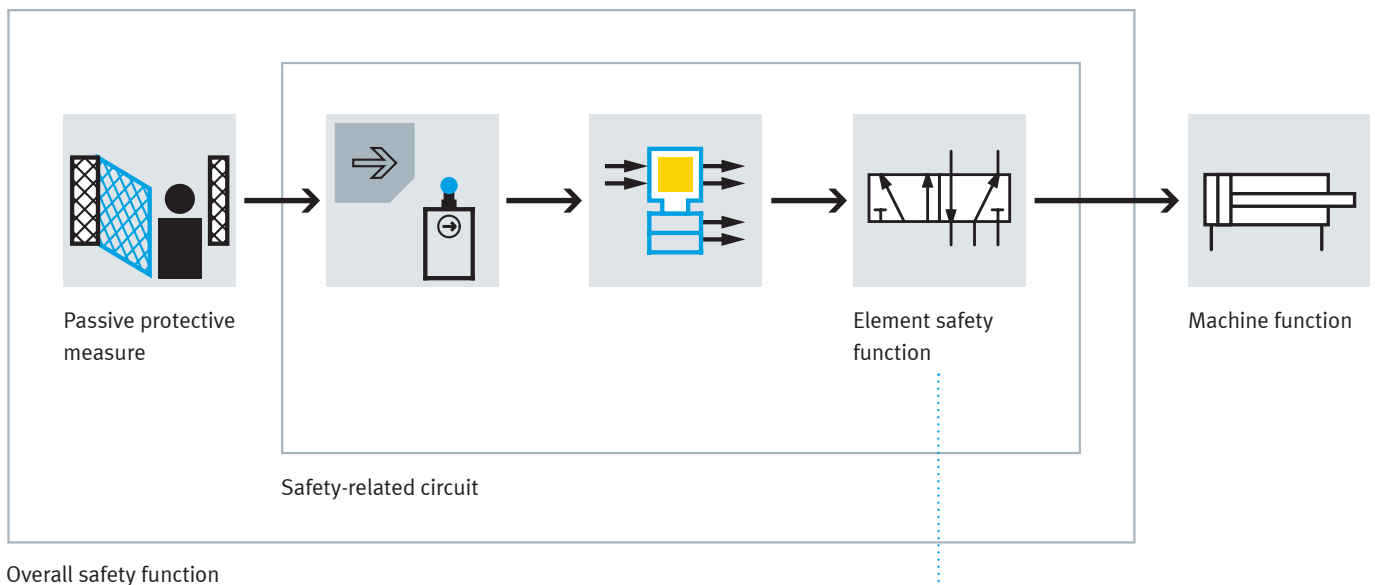


The solid connections represent a higher degree of diagnostic coverage than category 3.

Overall safety function

The overall safety function is a protective measure for risk reduction that can be used to reach or maintain a safe machine state. It takes specific risk events or situations into account.

An example is the separation of the operator from the hazard zone. To allow the operator access, the hazardous drive movement is stopped and maintained in that state. The overall safety function thus consists of, as a minimum, a passive protective measure, the sensor (input), the logic (safety switching device) and the valve combination (output).



Important: element safety functions

Element safety functions are part of a safety function that is performed by a component or a group of components.

A typical example is disconnection from the power supply by a power switching device such as a valve, motor controller or contactor (relay).

Pneumatic safety circuit as an example of PL d, category 3

As a rule, the components for implementing a machine function are defined first, e.g. a double-acting cylinder for moving parts. Suitable valves can now be selected using the specific element safety function(s) and the required safety category.

In the example on the next page, the valve Q20 is used to implement the Safe Torque Off (STO) stop function with category 1, PL c. After execution of this stop function, the valves Q20 and Q22 guarantee the safety function “Prevention of Unexpected Start-up” (PUS) to category 3, PL d.

A failure in the compressed air supply during operation is detected by the pressure switch B22 and the safety controller can prevent a restart with the valve Q22. Otherwise, the safety doors could open in the event of a power failure, which would allow the operator to access the hazard zone. An automatic restart of the cylinder must also be prevented. Depending on time, the downstream pneumatic system is therefore only pressurised when the safety control system permits the restart. At precisely this moment, the soft-start valve Q21 ensures

that the application can be brought into the normal position in the case of 5/2-way valves.

Thanks to the manual on/off valve S1, the service unit first offers the option of disconnecting the compressed air supply manually and exhausting the pneumatic system. Its filter F1 in turn ensures that the compressed air is adequately filtered to supply all subsequent pneumatic components with the compressed air quality required for their design. Finally, the pressure regulator R1 is used to set the operating pressure to a value at which the application can work satisfactorily and prevent an excessively high operating pressure. The pressure indicator P1 can then be used to check the pressure or to determine whether the subsequent pneumatic system is exhausted.

Common element safety functions

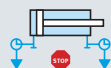
STO



Safe Torque Off

The compressed air supply to the pneumatic system is disconnected and the pressure in the piston chambers is diverted. This means that force can no longer be generated for a hazardous movement.

SS1



Safe Stop 1

After the compressed air is trapped in the piston chambers of the pneumatic drive, thus bringing the movement to a stop, the pressure in the piston chambers is diverted so that no more force can be generated for a hazardous movement (STO).

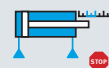
SOS



Safe Operating Stop

The pneumatic drive is held in position using compressed air and thus withstands external forces without needing further measures.

SS2



Safe Stop 2

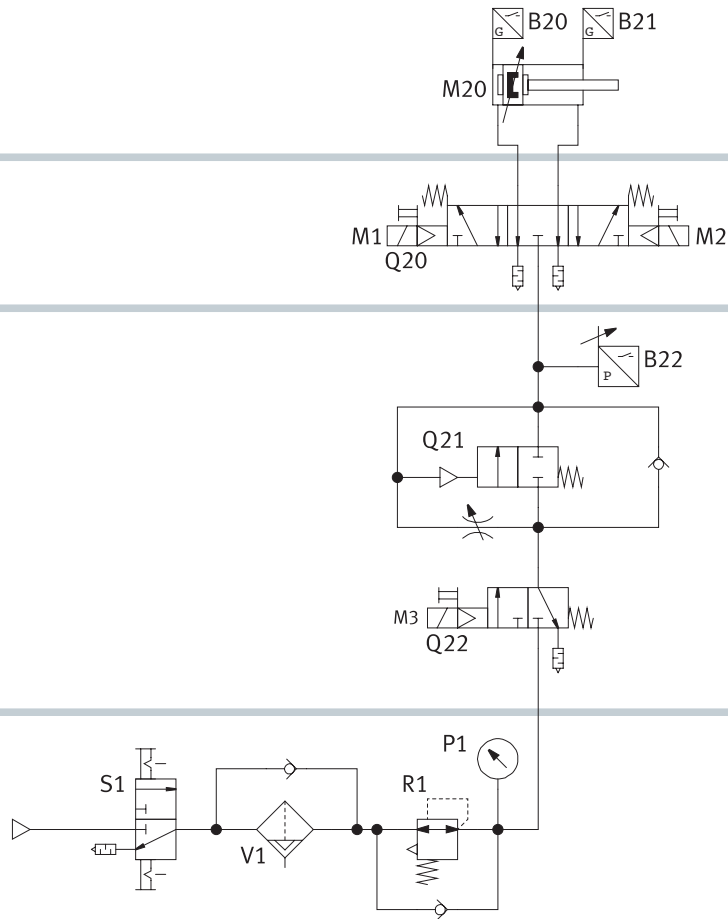
To stop the movement, the compressed air supply or exhaust from both piston chambers is reduced. The pneumatic drive is then held in position using compressed air and withstands external forces without needing further measures (SOS).

Components for implementing the machine function

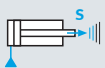
Components for implementing the safety function

Components to protect against hazard in case of a change in the energy supply

Service unit



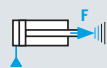
SLS



Safely Limited Speed

The flow of compressed air is limited so that the pneumatic drive cannot exceed the permissible speed.

SLT



Safely Limited Torque

The pressure is limited so that the pneumatic drive cannot exceed the permissible force.

SSB



Safe Stopping and Blocking

After the pneumatic drive comes to a stop as a result of the compressed air being trapped in the piston chambers, frictional locking blocks its movement.

PUS



Prevention of Unexpected Start-up

The unexpected start-up of a pneumatic drive is prevented by using technical measures. Some of the element safety functions mentioned earlier may be suitable for this purpose.

Our solution portfolio at a glance

The safety of people and machines is always paramount in all production areas – from the press shop and body shop to final assembly. Festo offers safety-related automation solutions for the complete range of applications. Whether you choose CPX/VTSA or MS6-SV and CAMC, these solutions can generally be integrated seamlessly into your application.

The perfect platform for your safety concept: electrical terminal CPX and valve terminal VTSA

With CPX, you can integrate pneumatic and electrical control chains easily, quickly and flexibly into all automation concepts – and in compliance with company-specific standards. The voltage concept of the electrical terminal permits safe deactivation via external safety devices, safety control outputs or via the integrated PROFIsafe shut-off module.



**PROFIsafe input module
CPX-F8DE-P**

Application:
Reliable detection and evaluation of input statuses

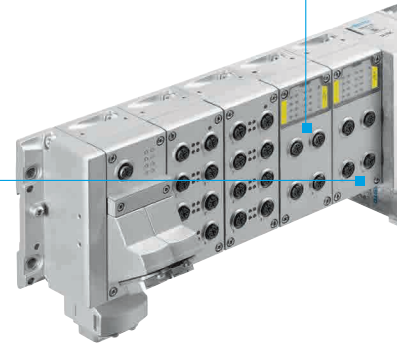
Safety functions:

- Category 4
- Performance Level e
- Control architecture: two channels and up to eight inputs
- Safety component to MD 2006/42/EC



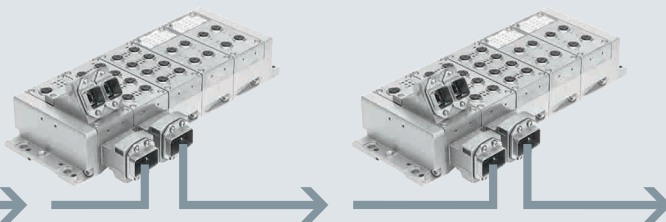
**PROFIsafe output module
CPX-FVDA-P2**

Application:
Dual channel, self-monitoring, electrical switch-off of the supply voltage to the valves in combination with PROFIsafe-capable controllers



Safety functions:

- Category 3
- Performance Level e
- Control architecture: two channels
- Safety component to MD 2006/42/EC



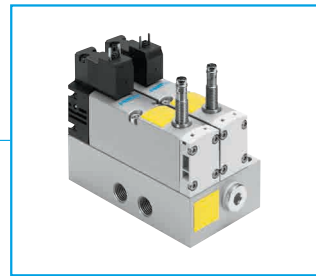
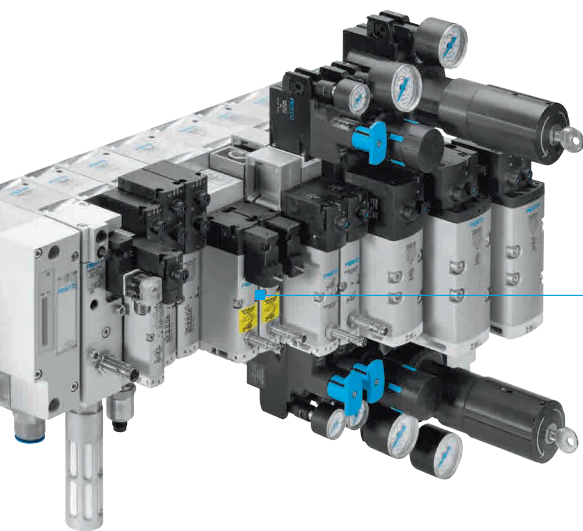
CPX inside – metal outside: CPX-AIDA

Ideal protection against welding spatter with comprehensive function and system integration of I/O modules and connection blocks in an all-metal design. With connection technology for PROFINET and power supply based on the push/pull principle in compliance with AIDA*.

*Automation Initiative of German Domestic Automobile Manufacturers

Safety@Festo with VTSA

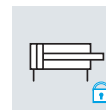
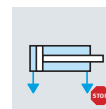
The sturdy, highly flexible and modular design of the VTSA makes it extremely attractive for the automotive industry. Never before has a standards-based valve terminal offered this degree of freedom. Both the flow-optimised VTSA-F with maximum output and the valve terminal VTSA with versatile implementation options for safety functions contribute to this success. This is what Safety@Festo is all about – safety directly in the application. All safety valves also comply with ISO standard 13849-1 and the EC Machinery Directive.



Control block with safety functions VOFA

Application:

Component that is also available with decentralised individual connections for reversing a movement, such as a press cylinder in the event of an emergency stop, or for disconnecting and exhausting the downstream pneumatic system



Safety functions:

- Category 4
- Performance Level e
- Control architecture: two channels
- Safety component to MD 2006/42/EC
- IFA certificate

The benefits at a glance:

- On/off and soft-start valves for greater process reliability during switch-on
- Multiple voltage zones on one valve terminal
- Switching position sensing for better fault detection, such as for press actuation (single/dual channel)
- Switchable pilot air supply as protection against unexpected system restarts up to max. PL d in accordance with EN 13849-1

(also possible in the case of double solenoid valves with fault exclusion)

- Special valves for manual pneumatic clamping devices, lifting cylinders and rotary cylinders
- Optional: check valves actuated by the pilot air valve (dual channel) for pneumatic holding

Motor controller CMMP-AS-...-M3

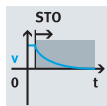
The safety module CAMC-G-S3 integrates functional safety into motor controllers from the series CMMP-AS-...-M3 in the form of a plug-in card. External safety switching devices are therefore no longer needed in many applications.



Safety module CAMC-G-S3

Application:

For safe switch-off, stopping, protection against unexpected start-up and for a safely limited speed

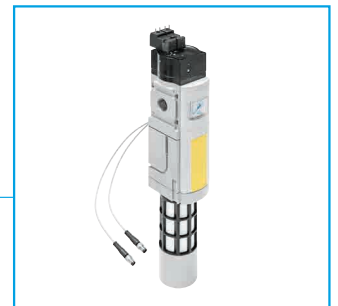
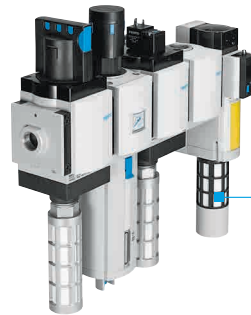


Safety functions:

- Category 4
- Performance Level e
- Control architecture: two channels
- Safety component to MD 2006/42/EC

MS series service units

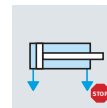
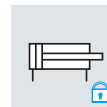
The safety valve MS6-SV-... integrates safety functions into the MS6 series service units, thus providing a perfect combination of sensors and safety.



Safety valve MS6-SV-D/E

Application:

For safe, quick exhausting with no residual pressure as well as gentle starting (functional only) through integrated soft-start function

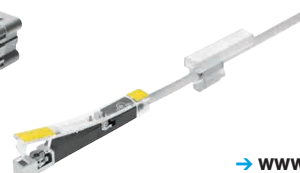
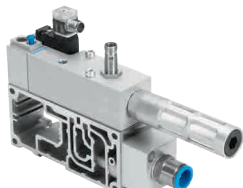
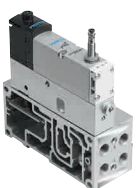


Safety functions:

- Category 3/4
- Performance Level d/ e
- Control architecture for exhaust function: two channels
- Safety component to MD 2006/42/EC
- Connection for AS-Interface with MS6-SV-E

Other solutions from Festo

Suitable components for safety-related applications can be found in our Online Shop, e.g. pneumatic braking and holding devices, standards-based valves for lifting and rotary cylinders, soft-start/quick exhaust valves, electric axes as well as sensors for reliable position sensing.



→ www.festo.com/onlineshop

Knowledge as the way to greater safety

We provide you with free information in the form of our safety engineering guidelines, for example. Or you can opt for training from Festo Didactic. The more you know about safety concepts and measures, the safer you make your working environment – without compromising on machine availability and efficiency.



Safety engineering guidelines

The Festo safety engineering guidelines offer answers to the main questions about safety-related pneumatic and electric systems. They deal in greater detail with the issues referred to in this brochure, describe standards and offer suitable solutions.

Click on this link to download it:

→ www.festo.com/safety

If you require more information, our specialists worldwide will also be happy to help.



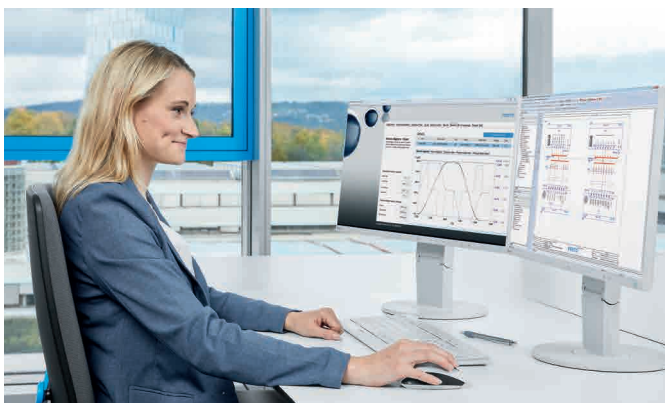
Safety begins with knowledge

Safety is more than simply the hardware and appropriate circuit diagrams. Safety begins with knowledge. For comprehensive training on the subject of safety, Festo Didactic provides specific training and consulting solutions.

Benefit from over 40 years of experience and facilitators with practical, international know-how who will optimally prepare you for your safety tasks. They will also be happy to work with you on site.

Find out more on our website:

→ www.festo-didactic.com

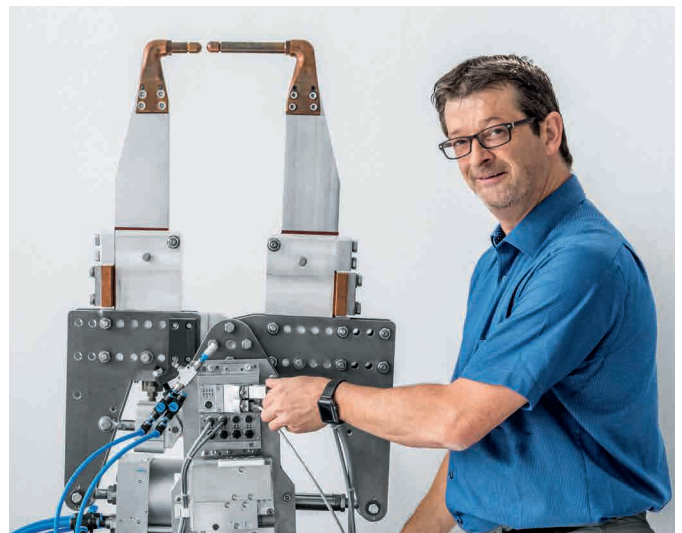


Festo Sistema database

The safety-related characteristic values of Festo components are available as part of the Sistema library and can be downloaded from our website:

→ www.festo.com/safety

“Machine safety is a challenging topic in the automotive industry. The high level of automation requires a detailed understanding of the machines in operation. With our expertise and a portfolio of suitable solutions, we help you to combine maximum productivity with the highest possible level of safety. Make your life easier – just contact us!”



Reinhard Keller

Head of Automation Engineering,
Automotive and Tier 1 Supplier Industry
at Festo

You want that feeling of security.
You require uninterrupted production.
We bring you safety and reliability.

→ **WE ARE THE ENGINEERS
OF PRODUCTIVITY.**