CAMOZZI
Automation

SERIES MX SAFEMAX
3/2-WAY QUICK EXHAUST SAFETY VALVES

SERIES MX SAFEMAX
SAFETY AT YOUR FINGERTIPS

The Machinery Directive (MD) 2006/42/EC establishes the safety requirements that a machine must satisfy while in use, in order to protect the health of people. Series MX SAFEMAX valves comply with ISO 13849-1, which refers to the safe design of control systems that perform safety functions.

These valves are equipped with an integrated sensor that detects the position of the spool and checks whether the system is rapidly discharged in case of emergency. The single channel valve is a component classified in category 2 and allows to achieve Performance Level D. The double channel valve is a component classified in category 4 and allows to achieve Performance Level E.

BENEFITS

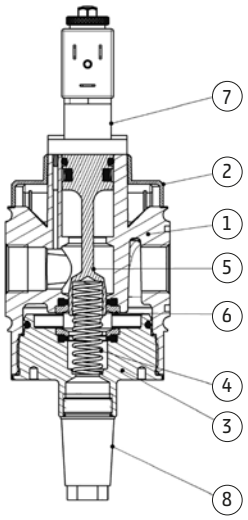
Compliant with Machinery Directive 2006/42/EC

Easy integration with Series MX2 FRL Units

Solutions to achieve up to Performance Level E

GENERAL DATA

Construction	modular, compact, spool-type
Materials	1 = Body — Aluminium 2 = Covering — POM Polyacetal 3 = Cover — Aluminium 4 = Lower spring — Steel 5 = Spool — Stainless steel 6 = Cage element — Brass 7 = Solenoid — Steel, brass, PBT, POM 8 = Silencer — Bronze, Steel Seals — NBR, FKM Sensor — PA body, epoxy resin and PU cable
Ports	G1/2
Mounting	in-line, wall-mounting (by means of clamps)
Operating temperature	-5°C ÷ 60°C
Operating pressure	with internal servo-pilot: 3,5 bar ÷ 10 bar with external servo-pilot: 0,5 bar ÷ 10 bar (pilot 3,5 bar ÷ 10 bar, greater or equal to operating P)
Nominal flow	single version: 1→2 = 5600 Nl/min (ΔP 1) 2→3 = 5000 Nl/min (free flow) double version: 1→2 = 4100 Nl/min (ΔP 1) 2→3 = 5000 Nl/min (free flow)
Fluid	Filtered air in class 7.4.4 according to ISO 8573-1 (In case lubricated air is used, we recommend ISOVG32 oil and to never interrupt lubrication)



COIL SPECIFICATIONS	
Connection	DIN EN 175 301-803-B
Voltage	24V DC (±10%) 3,1W (ED 100%)

SENSOR SPECIFICATIONS	
Connection	with wires, M8
Voltage	10-28V DC
Operation	Magnetoresistive
Type of contact	N.O. PNP
Maximum current	EX version: 200 mA 0,65 W UL version: 100 mA 3 W CE version: 200 mA 5,5W

COMPLIANCE WITH EN ISO 13849-1 STANDARD	
Performance level reachable (PL)	single version: category 2, PLd double version: category 4, PLe
B10d	2.000.000 cycles

SERIES MX SAFEMAX
WITH SOFT START VALVE

The new Series MX SAFEMAX soft start valve enables gradual pressurisation of the system, while maintaining all safety functions.

The compact dimensions and the internal construction of the components allows easy integration of the soft start valve with Series MX2 air treatment units without the need for additional connection interfaces.

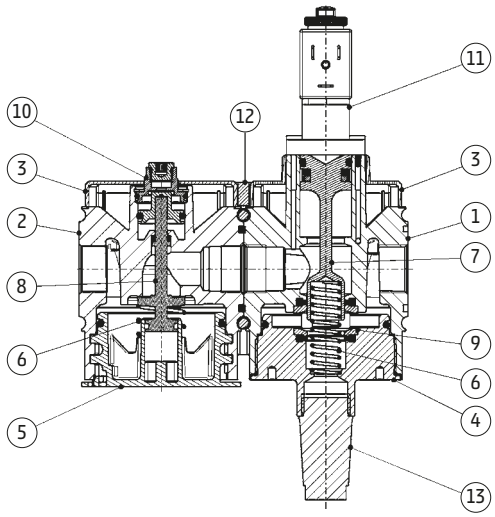
The soft start valve is positioned upstream of the safety valves, so does not interfere with the exhaust air flow and allows the safety valves to quickly discharge the system in the event of an emergency.

BENEFITS

- **Compliant with Machinery Directive 2006/42/EC**
- **Easy integration with Series MX2 FRL Units**
- **Solutions to achieve up to Performance Level E**
- **Integrated soft start valve**
- **No connection interfaces needed**

GENERAL DATA

Construction	modular, compact, spool-type
Materials	1 = Body of solenoid valve — Aluminium 2 = Body of starter — Aluminium 3 = Covering — POM 4 = Valve cap — Aluminium 5 = Soft start valve cover — POM 6 = Springs — Stainless steel 7 = Valve spool — Stainless steel, FKM, PTFE, plastoferrite 8 = Soft start valve spool — Brass 9 = Cage elements — Brass 10 = Upper cap of starter — Brass 11 = Solenoid — Copper, Brass, Stainless steel, PET 12 = Quick clamp — PA66 13 = Silencer and plugs — Stainless steel, Bronze O-Ring and seals — NBR, FKM Sensor — PA body, epoxy resin and PU cable
Ports	G1/2
Mounting	in-line, wall-mounting (by means of clamps)
Operating temperature	-5°C ÷ 60°C
Operating pressure	with internal servo-pilot: 3,5 bar ÷ 10 bar with external servo-pilot: 0,5 bar ÷ 10 bar (pilot 3,5 bar ÷ 10 bar, greater or equal to operating P)
Flow rate (6 bar)	single version: 1→2 = 4100 Nl/min (ΔP 1) 2→3 = 5000 Nl/min (free flow) double version: 1→2 = 3300 Nl/min (ΔP 1) 2→3 = 5000 Nl/min (free flow)
Medium	Filtered air in class 7.4.4 according to ISO 8573-1. In case lubricated air is used, we recommend ISOVG32 oil and to never interrupt lubrication.



COIL SPECIFICATIONS	
Connection	DIN EN 175 301-803-B
Voltage	24V DC (±10%) 3,1W (ED 100%)

SENSOR SPECIFICATIONS	
Connection	with wires, M8
Voltage	10-28V DC
Operation	Magnetoresistive
Type of contact	N.O. PNP
Max. current	EX version: 200 mA 0,65 W UL version: 100 mA 3 W CE version: 200 mA 5,5W

COMPLIANCE WITH EN ISO 13849-1 STANDARD	
Performance level reachable (PL)	single version: category 2, PLd double version: category 4, PLe
B10d	2.000.000 cycles

MACHINERY DIRECTIVE
PRODUCTS AND SOLUTIONS FOR THE SAFETY OF MACHINES

The Machinery Directive 2006/42/EC is a European directive which ensures the free movement of machines within the European market, guaranteeing the minimum level of protection for the health and safety of operators.
The Directive provides the criteria, referring to other standards, how to achieve compliance.

The method for the assessment and reduction of risks is described in EN ISO 12100 which provides the principles and procedures for achieving safety in the design of the machinery. To achieve this, certain parameters have been established that the machine manufacturer must respect:

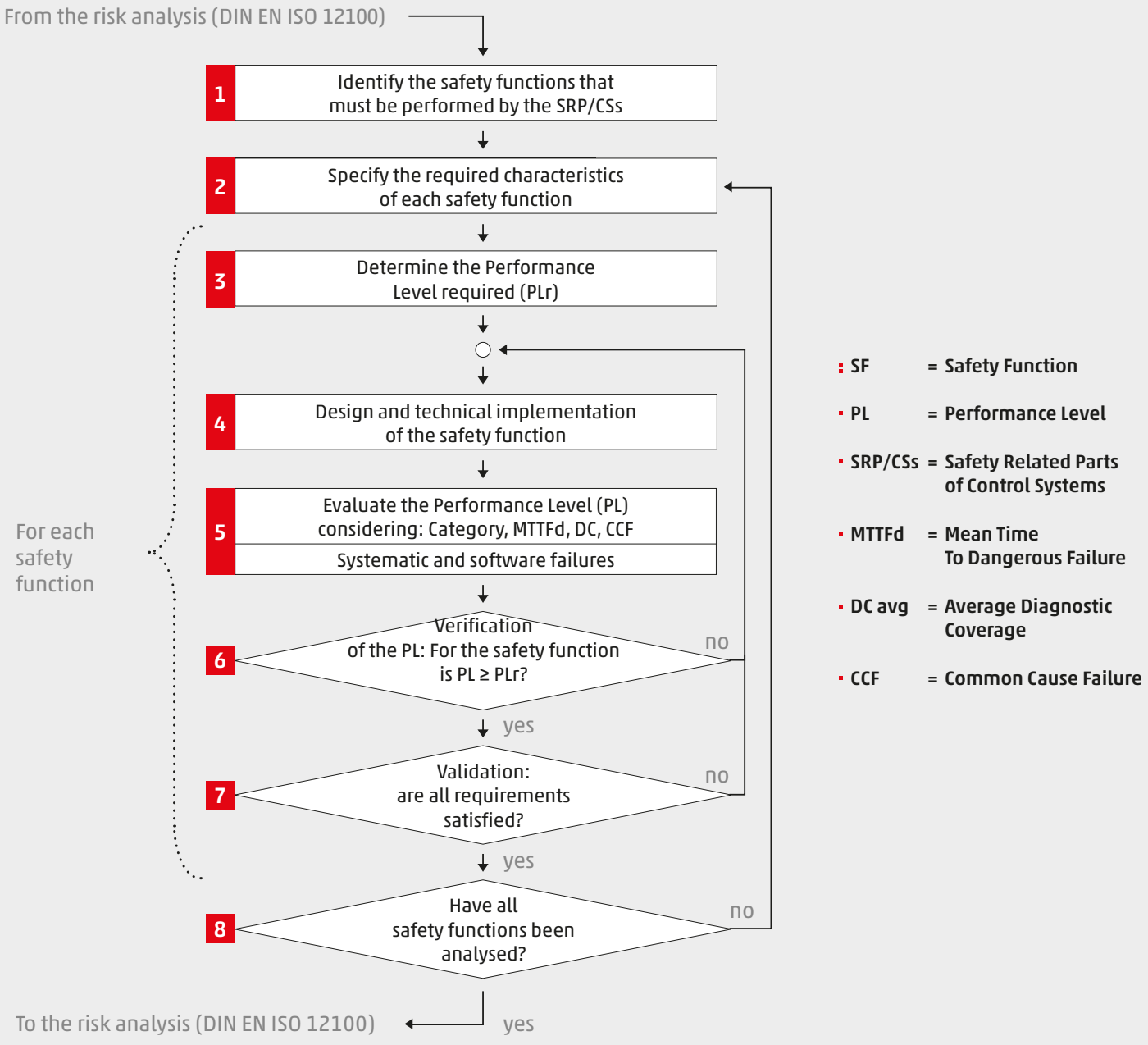
- **CONSTRUCTION OF THE SAFETY SYSTEM ACCORDING TO THE RISK LEVEL**
- **RELIABILITY OF THE SAFETY SYSTEM**
- **ABILITY OF THE SYSTEM TO RECOGNIZE AND RECTIFY FAULTS**
- **SELECTION AND SIZING OF COMPONENTS**

It is the machine manufacturer's task to examine the basic operation of their machine, identify the risks, attempt to minimize them through physical safety devices or unavoidable barriers, adequately choose the components of the safety system and the installation layout.

To guarantee the adequacy and safety of the solutions adopted, a series of harmonized standards have been issued, including ISO 13849-1, which establishes the safety requirements and guidelines on the design and integration of parts of control systems that relate to safety functions (SRP/CS).

Risk assessment

To achieve the safety and functional objectives of the machine, it is essential to follow a structured procedure. The first step of this procedure is to analyse the risk to determine the Performance Level expected by the safety function. After that, it is necessary to verify that the required Level has been achieved.



POINTS 1 and 2 are normally assessed during the development phase of a machine and relate to its safety and refer to the indications of the EN 12100 standards for general safety and EN 60204-1 for electrical safety. In particular, the EN 12100 standard indicates which could be the sources of danger, like for example: electrical, mechanical, from radiation, from contact with dangerous substances and more. The risk assessment through EN14121 requires the adoption of safety measures to reduce the danger, identified with EN 12100, and make the machine safe.

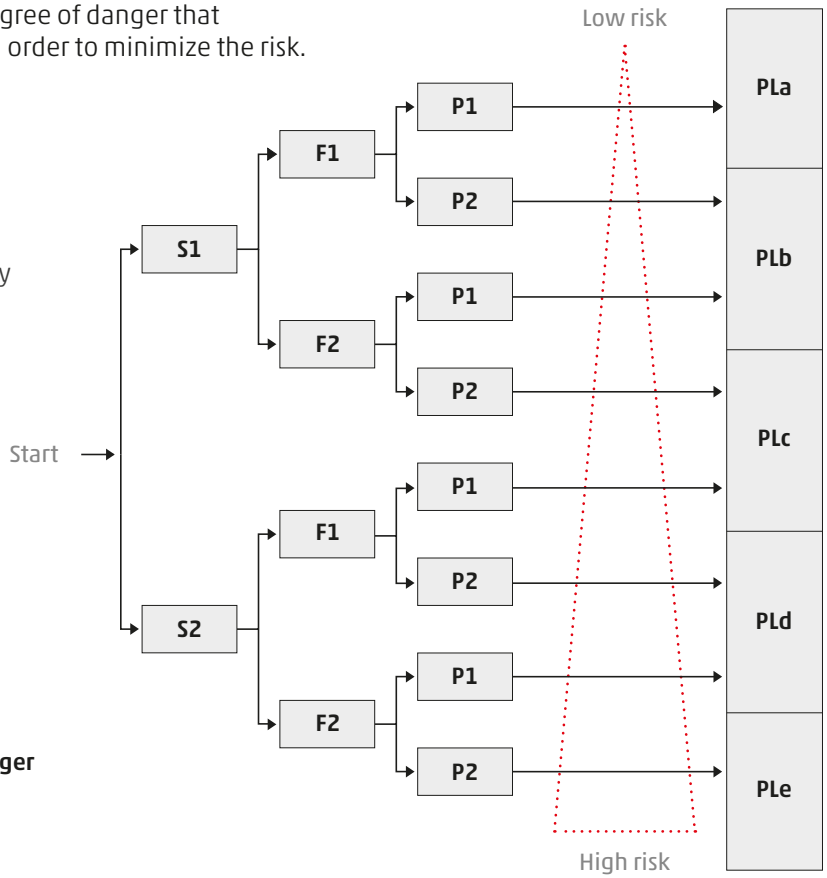
At POINT 3, an assessment must be made whereby, based on the type of danger, severity of the injury that may be caused, a PLr (Performance Level required) value is defined, necessary to reduce these events.

POINTS 4 and 5 require the development of circuit, mechanical or other solutions that enable to obtain the PLr value. To make this part more easier, it is possible to use components with integrated safety functions like the Series MX SAFEMAX of Camozzi Automation. At POINT 6 the Category is defined and once the MTTFd, DC and CCF are checked, it is possible to establish the final PL, that must be higher than the PLr.

CALCULATION OF THE REQUIRED PERFORMANCE LEVEL

The Performance Level (PL) indicates the degree of danger that the identified safety function must satisfy in order to minimize the risk.

The PL required (PLr) by the safety function can be calculated through a risk analysis tree graph which takes into consideration the severity of the damage (S), the frequency of exposure (F) and the possibility (P) that the user can avoid the risk.



- **S = Severity of the damage**
  S1 = slight injury
  S2 = serious injury
- **F = Frequency and / or time of exposure to the danger**
  F1 : rare to infrequent
  F2 : frequent or continuous
- **P = Possibility of avoiding / limiting the danger**
  P1 : possible
  P2 : scarcely possible / not possible

CALCULATION OF THE SAFETY FUNCTION'S PERFORMANCE LEVEL

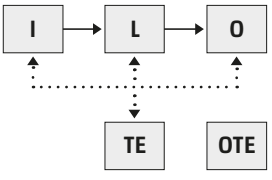
After calculating the required Performance Level, it is necessary to design an adequate SRP/CS, calculate the resulting PL and verify that it is greater than or equal to the PLr. The PL calculation involves the following factors:

• Category

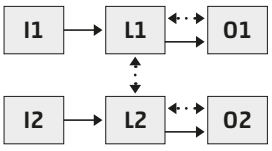
The category of the control circuit indicates the logic structure of the SRP/CS and identifies the effectiveness of the monitoring system in detecting faults.

Category B: Single channel, no redundancy. The occurrence of a failure can lead to loss of the safety function.

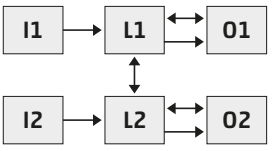
Category 1: Similar to category B, but the probability of a failure is less in relation to that of category B.



Category 2: Includes category 1, but the loss of the safety function is detected by the control.



Category 3: Double channel, redundant.
The single fault is detected and does not lead to the loss of the safety function.



Category 4: Similar to the previous one, but the accumulation of undetected faults does not lead to the loss of the safety function.

- **I = Input** Components that acquire information through the safety inputs.
- **L = Logic** Processing system that controls the actuators to achieve the safety functions.
- **O = Output** Signal to control the actuators.

• Mean time to dangerous failure

Mean Time To Failure (MTTFd) is an indicator that expresses the reliability of a component and is calculated based on its average life (B10d) and the number of operations it carries out on the machine. B10d, necessary for this calculation, indicates after how much time 10% of the components (for example the valve) may have failures and break down.

$$MTTF_d = \frac{B10_d}{0{,}1 \cdot n_{op}} \qquad n_{op} = \frac{d_{op} \cdot h_{op}}{t_{cycle}} \; 3600$$

n_{op} = number of operations/year
d_{op} = operation days/year
h_{op} = operation hours per day
t_{cycle} = time between two consecutive cycles (s)

MTTFd calculation in the case of a complete system:

$$\frac{1}{MTTF_d} = \sum_{i=1}^{\bar{N}} \frac{1}{MTTF_{di}}$$

Classification of MTTFd	
Designation	**Area**
not acceptable	0 years ≤ MTTFd <3 years
low	3 years ≤ MTTFd < 10 years
medium	10 years ≤ MTTFd <30 years
high	30 years ≤ MTTFd ≤ 100 years

MTTFd calculation in the case of a double-channel system:

$$MTTF_d = \frac{2}{3}\left[MTTF_{dC1} \; MTTF_{dC2} - \frac{1}{\frac{1}{MTTF_{dC1}} + \frac{1}{MTTF_{dC2}}}\right]$$

• Diagnostic Coverage

The DC parameter indicates the system's ability to monitor its own failure and is defined as the ratio between the rate of dangerous failure detected and the overall rate of dangerous failure. The values are determined by annex E of EN ISO 13849-1.

Designation	Range
none	DC < 60 %
low	60 % ≤ DC < 90 %
medium	90 % ≤ DC < 99 %
high	DC ≥ 99 %

When the SRP / CS includes multiple elements or blocks, you can consider the DCavg, defined as

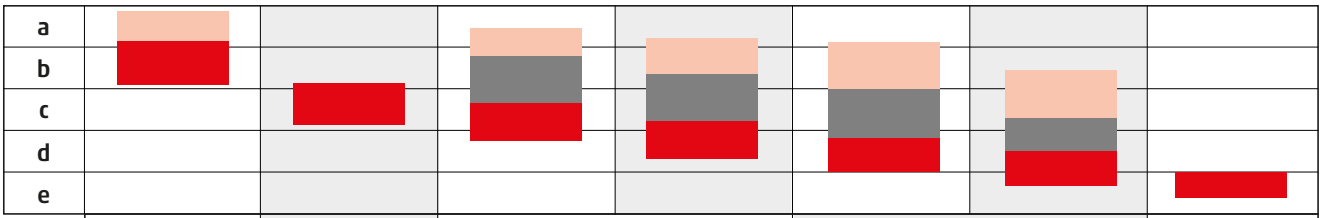
$$\longrightarrow \quad DC_{avg} = \frac{\frac{DC_1}{MTTF_{d1}} + \frac{DC_2}{MTTF_{d2}} + \cdots + \frac{DC_N}{MTTF_{dN}}}{\frac{1}{MTTF_{d1}} + \frac{1}{MTTF_{d2}} + \cdots + \frac{1}{MTTF_{dN}}}$$

• Common Cause Failure

The CCF is an indicator of the common causes of failure, i.e., failures that can occur simultaneously on two or more channels in a redundant architecture. The assessment depends on the type of solutions adopted against the common causes of failure and is determined by the score obtained from the check list of Annex F of EN ISO 13849-1.

DETERMINATION OF THE PERFORMANCE LEVEL

Note this data, the EN ISO 13849-1 standard allows to calculate the PL of the system through the following table. The PL that derives from the calculation must be greater than the requested PL (PLr), otherwise a safer system must be redesigned.



	Cat. B	Cat. 1	Cat. 2		Cat. 3		Cat. 4
	DC < 60%	DC < 60%	60% ≤ DC < 90%	90% ≤ DC < 99%	60% ≤ DC < 90%	90% ≤ DC < 99%	DC ≥ 99 %
	CCF not relevant		CCF ≥ 65 %				

$MTTF_d$ low
3 years ≤ $MTTF_d$ < 10 years

$MTTF_d$ medium
10 years ≤ $MTTF_d$ < 30 years

$MTTF_d$ high
30 years ≤ $MTTF_d$ ≤ 100 years

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