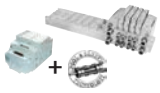
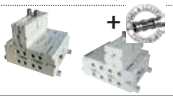
AVENTICS Pneumatic Valve Systems

AVENTICS PNEUMATIC VALVE SYSTEMS

Quick Selection Chart

ports/positions	pipe connections (instant fittings [O.D. (mm)] / internal thread (ØG)) — ports: 2 - 4										1 - 3 -5								12-14			main operating pressure (bar)	flow at 6 bar ΔP 1 bar l/min (ANR)	series	illustration	cabinet mounting	transfert plate	Zoned Safety	I&M Sheet	page
	4	6	8	10	M7	1/8	1/4	3/8	1/2	3/4	6	8	10	12	1/8	1/4	3/8	1/2	3/4	6	M7	1/8								
Pneumatic valve systems, series 501, 502 and 503																													
2 x 3/2 5/2 - 5/3					■										■						■		8	400	501 11 mm + Kits		- -	● -	- ●		**3..10/ 30..44** -
2 x 3/2 5/2 - 5/3						■											■				■		8	650	502 18 mm + Kits		- -	● -	- ●		**11..20/ 30..44** -
2 x 3/2 5/2 - 5/3							■										■				■		8	1400	503 26 mm + Kits		- -	● -	- ●	 	**21..44** **257..294**
2 x 3/2 5/2 - 5/3	Cabinet mounting																						8	400	501 11 mm		●	-	-		**45..50**
Pneumatic valve systems, series 2035																													
5/2 5/3								■	■								■				■		10	3820	2035 41 mm		-	-	-	-	**51**
G3 Electronics																													
Multipol *IP65* **Buslink** *DeviceNet™, Modbus TCP, PROFIBUS-DP®, PROFINET®, POWERLINK, CANopen®, EtherNet/IP™ DLR, EtherCAT®*																									501 502 503 2035		● ● ● -	- - - -	- - - -	-	**73..120**
Buslink *Modbus TCP, PROFINET®, POWERLINK, EtherNet/IP™ DLR, EtherCAT®*																									501 502 503		- - -	- - -	- - ●		**257..294**
580 Electronics																													
2 x 3/2 5/2 - 5/3					■										■						■	■	8	400	580 (501)		●	●	-		**121**
						■											■				■		8	650	580 (502)		●	●	-		**121**
							■										■				■		8	1400	580 (503)		●	●	-		**121**
Sub-Base Mounted Valves to ISO 5599/2																													
5/2 - 5/3							■	■									■				■		16	1420 3165 5730	ISO1 ISO2 ISO3		- - -	● ● ●	- - -	-	**239**
Series 502 & 503 (M12) (ISO 15407-1 / ISO 15407-2 - 18 & 26 mm)																													
2 x 3/2 5/2 - 5/3						■										■						■	10	500	502	ISO 15407-1		-	-	-		**297**
							■										■				■			1200	503			-	-	-		**311**
						■									■						■		8	500	502	ISO 15407-2		-	-	-		**325**
							■										■				■			1200	503			-	-	-		**331**

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AVENTICS PNEUMATIC VALVE SYSTEMS

Quick Selection Chart

ports/positions	pipe connections (instant fittings [O.D. (mm)] / internal thread (ØG)) — ports: 2 - 4											1 - 3 -5								12-14			main operating pressure (bar)	flow at 6 bar ΔP 1 bar l/min (ANR)	series	illustration	cabinet mounting	transfert plate	Ex execution	I&M Sheet	page
	4	6	8	10	M7	1/8	1/4	3/8	1/2	3/4	6	8	10	12	1/8	1/4	3/8	1/2	3/4	6	M7	1/8										
Pneumatic valve systems, series 501 and 502																																
2 x 3/2 5/2 - 5/3		●			●							●			●					●	●		8	400	501 11 mm		-	-			155
2 x 3/2 5/2 - 5/3			●			●							●	●			●			●		●	8	650	502 18 mm		-	-			165
2 x 3/2 5/2 - 5/3	Cabinet mounting																						8	400	501 11 mm		●	-			233
Pneumatic valve systems, series 622																																
5/2						●										●							8	600	622		●	-			229
G3 Electronics																																
Multipol *IP65* **Buslink** *CANopen®, CC-Link, EtherCAT®, DEVICE LOGIX, DeviceNet™, EtherNET/IP™ DLR, MODBUS TCP/IP, POWERLINK , PROFIBUS-DP®, PROFINET®, EtherNet/IP™ DLR*																									501		●	-		-	155
																									G3		-	-			179
																									502		-	-		-	165
																									G3		-	-			179
580 Electronics																																
2 x 3/2 5/2 - 5/3		●			●							●			●					●	●		8	400	580 ATEX (501)		●	-			207
2 x 3/2 5/2 - 5/3			●			●							●	●			●			●		●	8	650	580 ATEX (502)		-	-			

AVENTICS Series 501

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+

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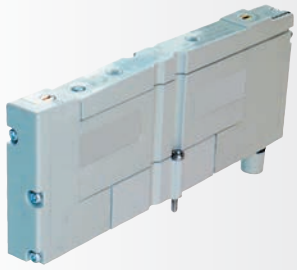
Plug-in Electrical connection



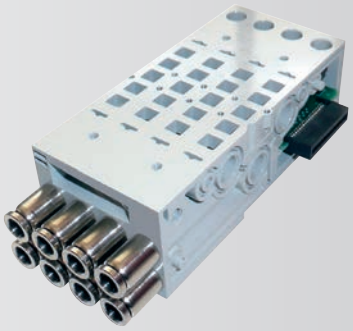
Plug-in valve

Page **3**

+

Subbases

Fourfold Joinable



Pneumatic
pad mount
High flow
400 l/min ANR

+

End plates

With bottom ports

valve platform (11 mm)

Valves technology

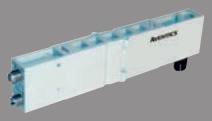
Rubber packed

all pneumatic functions including double 3/2 NC and NO

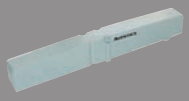
Sandwich Accessories

Plugged between valve and subbase:

Sandwich Speed Control



Shut off



Blank station plate

Pressure regulator

Multiwire or Fieldbus I/O Modules

Multiwire connection

599

or

G3 Electronics

I/O Module Fieldbus

G3

or

580

580 Electronics

+

=

Assemblies

580 Electronics

Page **121**

Valve manifolds

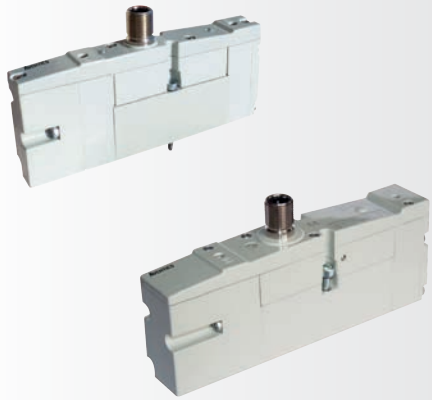
Page **3**

Page **207**

AVENTICS Series 502 & 503

M12 Electrical connection

M12 Valve
ISO 15407-1



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Subbases

Single

ISO 15407-1
502 : 500 l/min ANR
503 : 1200 l/min ANR

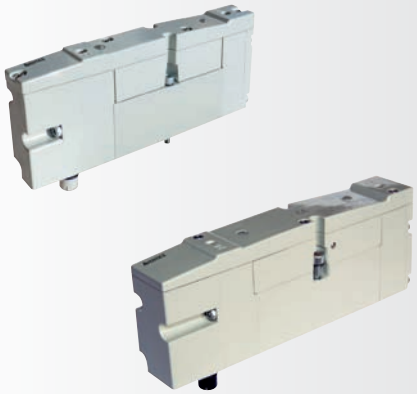
Double Joinable

ISO 15407-1
502 : 500 l/min ANR
503 : 1200 l/min ANR

End plates

Side ports

Plug-in Electrical connection



Plug-in valve

Subbases

Single

Page **311** / **331**

ISO 15407-2
502 : 500 l/min ANR
503 : 1200 l/min ANR

Double Joinable

Page **16** / **27**

ISO 15407-2
502 : 500 l/min ANR
503 : 1200 l/min ANR

Pneumatic
pad mount
High flow
502 : 650 l/min ANR
503 : 1400 l/min ANR

End plates

With bottom ports

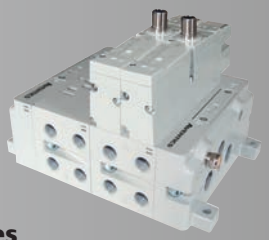
valve platform (18 & 26 mm)

Assemblies

Page **297 / 311**

M12 valve
on ISO 15407-1 single subbase

Page **297 / 311**



M12 valves
on ISO 15407-1 joinable subbases

Valves technology

Rubber packed
all pneumatic functions including double 3/2

Spool & Sleeve
Very high life time > 200 M cycles

Sandwich Accessories

Plugged between valve and subbase

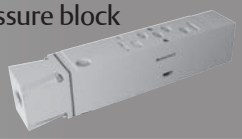
Sandwich Speed Control

Exhaust block

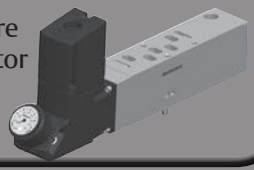
Shut off

Blank station plate

Pressure block



Pressure regulator



Assemblies

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Valve
on ISO 15407-2 single subbase M12 electrical interface on the subbase

580 Electronics

Page **121**
(502 & 503)

+ 502

Page **207**

Multipol ou bus de terrain Modules E/S

Multiwire connection

599

or

G3/580 Electronics

I/O Module

Fieldbus

G3

580

Page **11 / 21**

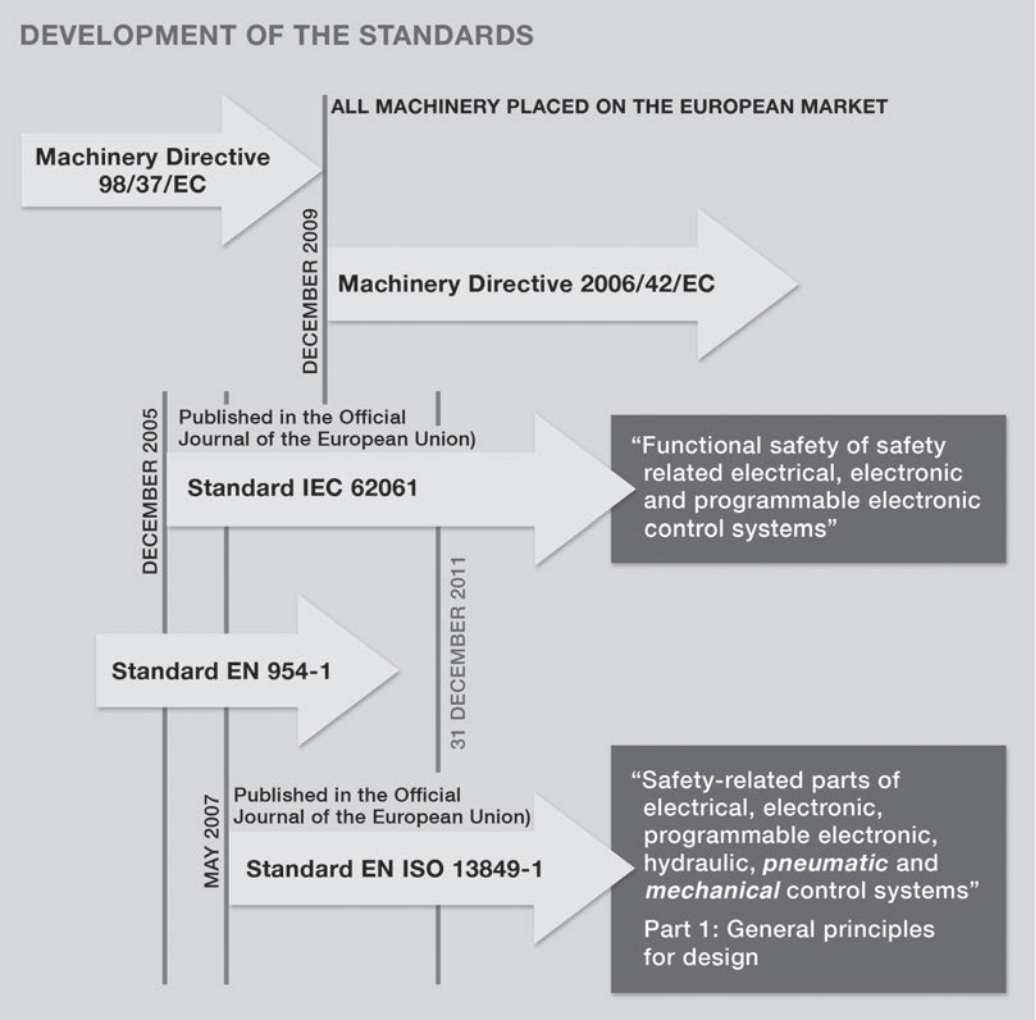
+ 502

Page **165**

Valve manifolds

Principle of the Safety of Machinery:

To guarantee the safety and health of persons exposed to the installation, operation, adjustment and maintenance of machinery.



Three key concepts for the design of machinery and their safety functions have emerged from the implementation of the new Machinery Directive 2006/42/EC:

- A risk analysis prior to design
- A particular consideration of the quantitative aspect of the safety functions in addition to the qualitative approach
- The use of performance levels (PL)

Risk Evaluation:

The manufacturer or supplier of a machine must see to it that a risk evaluation is conducted to determine the health and safety requirements for persons involved in its operation. The machine must then be designed and constructed in accordance with the results of the risk evaluation.

Safety component VERSUS safety related part of a control system (SRP/CS)?

- A safety component is evaluated to operate for a complete safety function.
- A safety-related part of a control system (SRP/CS) is evaluated for its safety level and will be include in a complete safety loop (SRP/CS). The complete SRP/CS must be evaluated according the risk evaluation by the manufacturer or supplier of a machines.

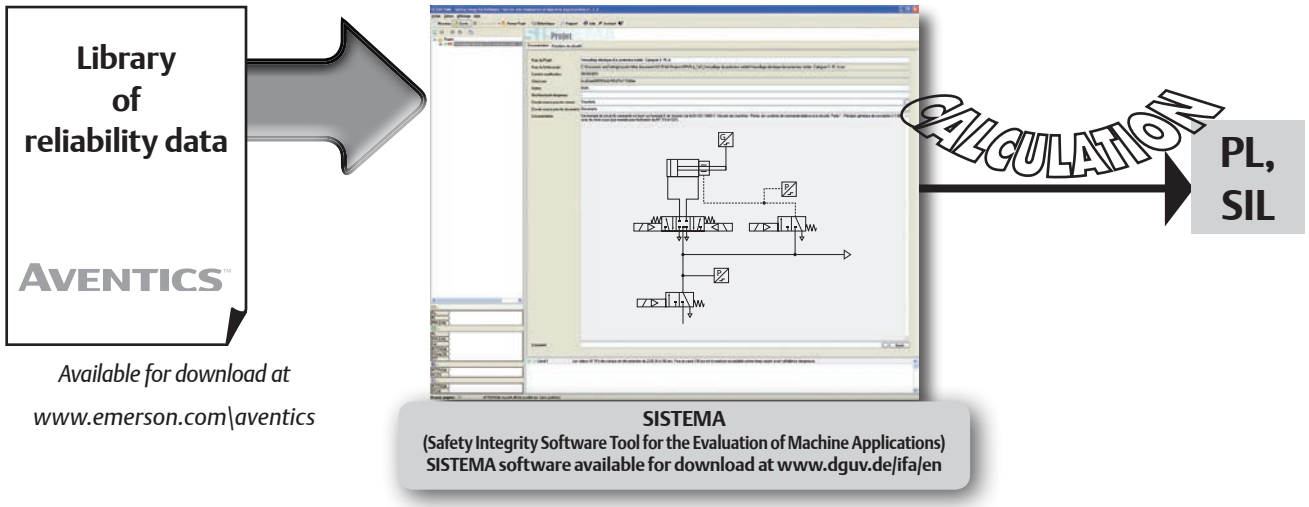
In accordance with the 2006/42/CE machine directive in accordance with EN ISO 13849 the manufacturer or supplier of a machines must estimate the level of performance achieved by the complete safety control system using these components and is responsible for the risk assessment.

AVENTICS™ Risk Evaluation

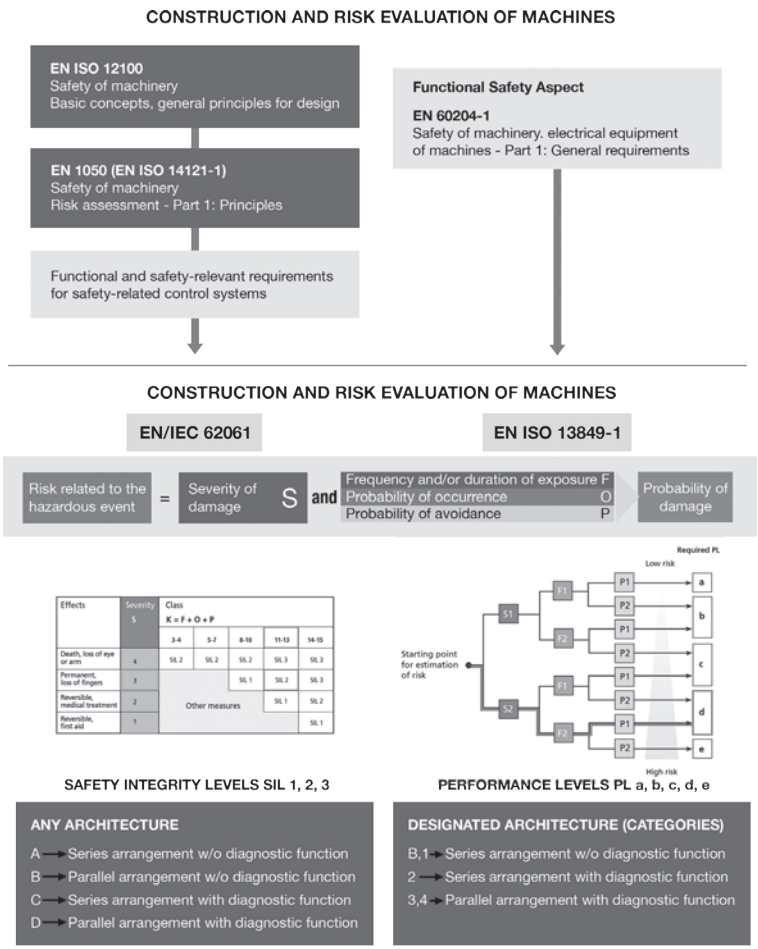
Reliability DATA

The products' reliability data (MTTF, MTTFd, B10, B10d...) gained from reliability tests under standard conditions can be downloaded in the SISTEMA format from our website www.emerson.com\aventics

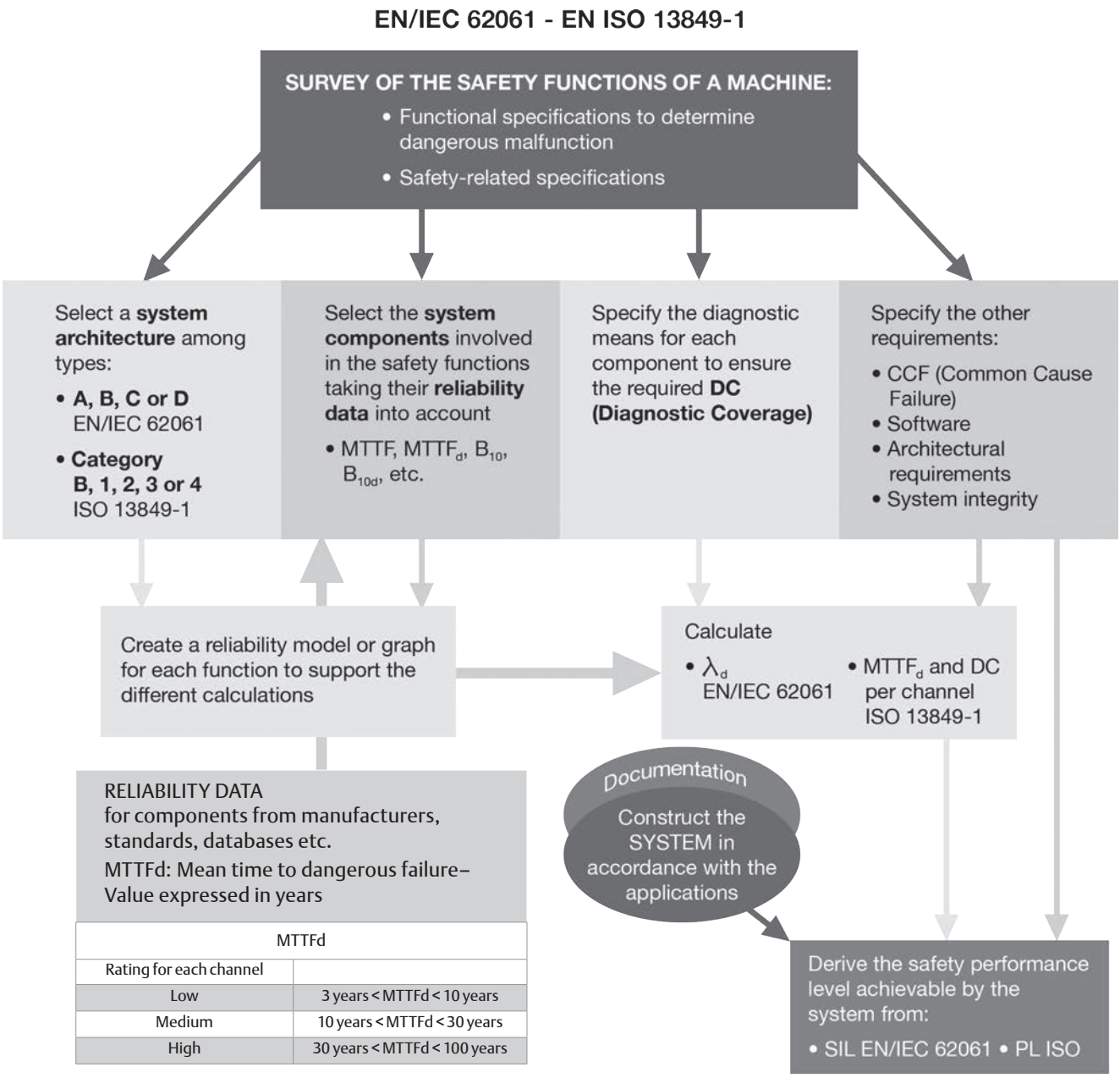
Actuators (pneumatic cylinders) are not taken into consideration in the calculation of performance levels (PL). Since actuators are not an integral part of the control systems, they do not fall under EN ISO 13849-1 requirements. Manufacturers are, however, required to integrate the risks related to a failure of the actuator into their risk evaluation (EN ISO 14121 and EN ISO 12100).



"Good engineering practice + probabilistic calculations"



EN/IEC 62061 - EN ISO 13849-1



MTTFd	
Rating for each channel	
Low	3 years < MTTFd < 10 years
Medium	10 years < MTTFd < 30 years
High	30 years < MTTFd < 100 years

B_{10d}: Number of cycles after which 10% of a random sample of wearing components fail dangerously – Value expressed in number of cycles.

DC: Diagnostic Coverage

Diagnostic Coverage			
None	Low	Medium	High
DC < 60%	60% < DC < 90%	90% < DC < 99%	99% < DC

CCF: Common Cause Failure. Measures to be taken to prevent a given cause (and its effect) from concurrently disabling the multiple channels of a safety circuit.

Mission time T_{10}: In line with "good engineering practice" as recommended in EN ISO 13849-1, components attaining this value must be replaced (precautionary principle).

Only the pneumatic part is described in the form of a subsystem in these examples. Other safety-related components (e.g. protective devices, electrical logic elements) must be added to ensure the safety function is complete.

The examples shown here only relate to the stopping of hazardous movements. In pneumatics, safety measures concerning the interruption of energy sources, the evacuation of potential energy (pressure contained in a part of the circuit), and a “progressive” start-up after an unexpected shutdown should not be omitted.

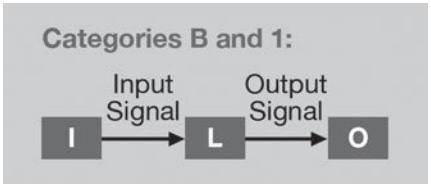
To attain a PL = c, category 1 architecture

Category 1, 1 channel

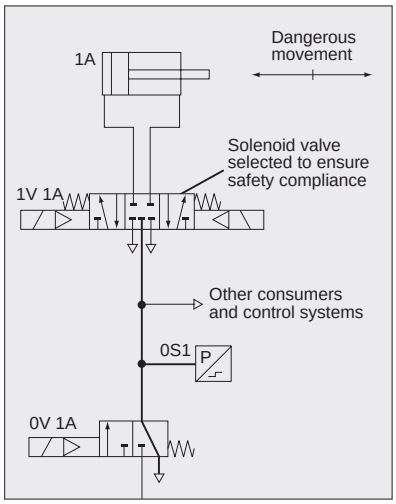
Reliable components of the SRP/CS (DIN EN ISO 13849-2 A.4/B.4/D.4)
0 Fault safety (DIN EN ISO 13849-1 Pt. 6.2.4)
MTTFd ≥ 30 years

Safety function: Stopping of the potentially hazardous movement of cylinder 1A.

- Functional description:



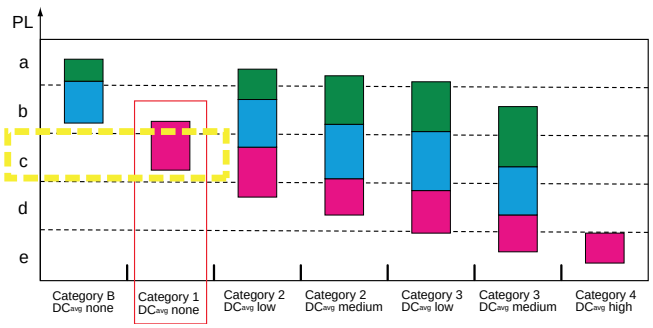
Input ‘I’: not represented, movable guard or light barrier, etc.Logic element ‘L’: not represented, PLC



- Calculation of the probability of dangerous failure:

Safety function	Working hours / day	Working days / year	Cycles / year
1 cycle = 5 s	16 h	240 days	2,764,800 cycles

B_{10d} (1V1A – series 520) = 130,000,000 cycles, i.e. an operating time of 47 years, $MTTF_d$ = 470 years “high”



PL Performance Levels

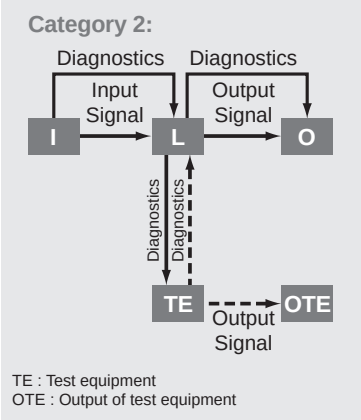
- $MTTF_d$ rating for each channel = low
- $MTTF_d$ rating for each channel = medium
- $MTTF_d$ rating for each channel = high

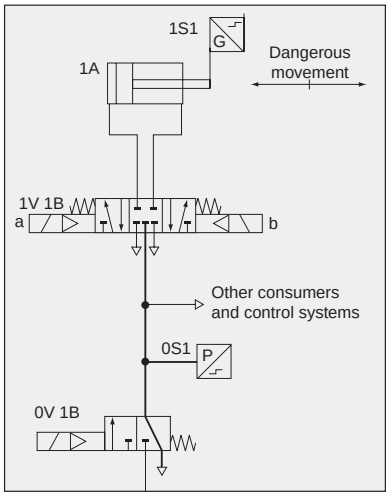
By limiting the valve’s operating time to 47 years, this corresponds to a PL = c

To attain a PL = c, category 2 architecture

Category 2, 1 channel
MTTFD of the test channel has to be greater than half the MTTFD of the functional channel.
The functions are checked at suitable intervals by the machine control system. (test frequency 100 times the frequency of use). At start up of the machine and/or periodically.
0 Fault safety between the test phases (DIN EN ISO 13849-1 Pt. 6.2.5)
or
testing may occur immediately upon demand of the safety function, if the overall time to detect the fault and to bring the machine to a non-hazardous condition (usually the machine is stopped) is shorter than the time to reach the hazard. Here ISO 13855 for the calculation of safety distances is referenced.

- Safety function: Stopping of the potentially hazardous movement of cylinder 1A.
- Functional description:





Input 'I': not represented, movable guard or light barrier, etc.Logic element 'L': not represented, PLC

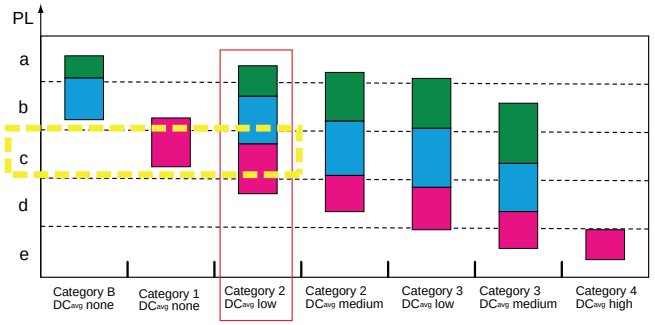
Stop of cylinder ensured by:	Diagnostics ensured by:
Output O: Valve 1V1B	Cross-monitoring in L1 of the supply status coherence of coils 1V1Ba and 1V1Bb and the limit switches 1S1

0V1: Energy isolating valve: ensures the system is exhausted in case of loop failure.

- Calculation of the probability of dangerous failure:

Safety function	Working hours / day	Working days / year	Cycles / year
1 cycle = 5 s	16 h	240 days	2,764,800 cycles

B_{10d} (valve 1V1B - series 542) = 44,912,670 cycles, i.e. an operating time of 16.2 years,
$MTTF_d$ = 162 years "high"
$MTTF_d$ (sensors 1S1) = 45 000 000h, i.e. 11,718 years "high"
The case study shows: DC (Diagnostic Coverage) = 60% "low"



PL Performance Levels
$MTTF_d$ rating for each channel = low
$MTTF_d$ rating for each channel = medium
$MTTF_d$ rating for each channel = high

By limiting the valve's operating time to 16.2 years, this corresponds to a PL = c for the safety loop.

To attain a PL = d, category 3 architecture

Category 3, 2 channels

(DIN EN ISO 13849-1 Pt. 6.2.7) Some, but not all faults are detected before or during the next request
1 Fault safety Multiple undetected faults lead to the loss of SF.

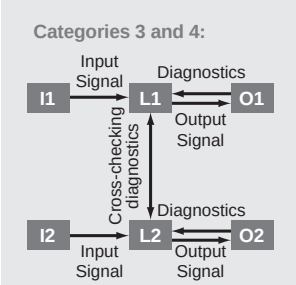
MTTFd ≥ 30 years
Redundancy + partial monitoring

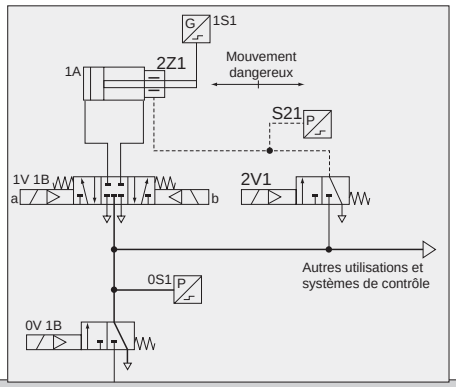
Category 4, 2 channels

(DIN EN ISO 13849-1 Pt. 6.2.7) Every fault must be detected before or during the next request **> 1 fault safety$**

MTTFd ≥ 30 years
Redundancy + PERMANENT monitoring

- Safety function: Stopping of the potentially hazardous movement of cylinder 1A.
- Functional description:





Inputs 'I1' and 'I2': not represented, movable guard or light barrier, etc.
Logic elements 'L1' and 'L2': not represented, PLC

Stop of cylinder ensured by:	Diagnostics ensured by:	
Output O: Valve 1V1B	Cross-monitoring in L1 of the supply status coherence of coils 1V1Ba and 1V1Bb and the limit switches 1S1	Cross-monitoring of L1/L2 status coherence within the PLC
Output O2: Valve 2V1 controlling the rod lock 2Z1	Pressure switch 2S1 for transmission of signal to L2	

0V1B: Energy isolating valve: ensures the system is exhausted.

- Calculation of the probability of dangerous failure:
  Inputs (I1 and I2) : Immaterial barrier Manufacturer data MTTFd 442 year
  Logic (I1 and I2) : safety PLC Manufacturer data MTTFd 1 357 years for a 20 year mission time

Safety function	Working hours / day	Working days / year	Cycles / year
1 cycle = 15 s	16 h	240 days	921,600 cycles

B_{10d} (valve 1V1B - series 542) = 44,912,670 cycles, i.e. an operating time of 48.7 years, $MTTF_d$ = 487 years
B_{10d} (valve 2V1 - series 520) = 20,000,000 cycles, i.e. an operating time of 21.7 years, $MTTF_d$ = 217 years
B_{10d} (dynamic rod lock 2Z1) = 4,000,000 cycles, i.e. a mission time of T10 = 4.34 years, $MTTF_d$ = 43.4 years

Global $MTTF_d$

$$\frac{1}{MTTF_d\,(\text{channel1})} = \frac{1}{MTTF_d\,(I1)} + \frac{1}{MTTF_d\,(L1)} + \frac{1}{MTTF_d\,(O1)}$$

Chanel 1 = 198 years "high" / Chanel 2 = 33 years "high"

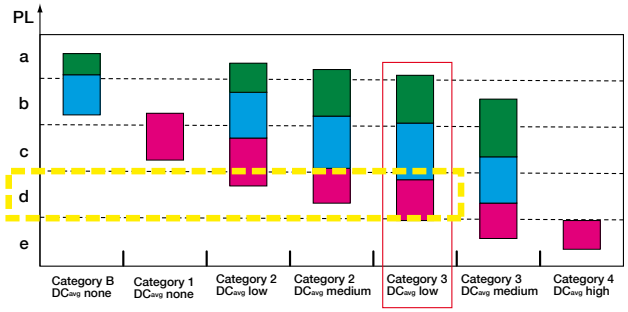
DC (diagnostic coverage)

Inputs (I1 and I2): Manufacturer data: 99%
Logic (L1 and L2): Manufacturer data: 99%
Outputs (O1 and O2)
O1 = 60% / O2 = (2V1) 75% - (1Z1) 75%

Diagnostic coverage (DCavg) total

$$DC_{avg} = \frac{\frac{DC_1}{MTTF_{D1}} + \frac{DC_2}{MTTF_{D2}} + \cdots + \frac{DC_N}{MTTF_{DN}}}{\frac{1}{MTTF_{D1}} + \frac{1}{MTTF_{D2}} + \cdots + \frac{1}{MTTF_{DN}}}$$

DCavg = 81%



PL Performance Levels

- $MTTF_d$ rating for each channel = low
- $MTTF_d$ rating for each channel = medium
- $MTTF_d$ rating for each channel = high

By limiting the operating time of the pressure switch and rod lock to 4.34 years, this corresponds to a PL = d for the safety loop.