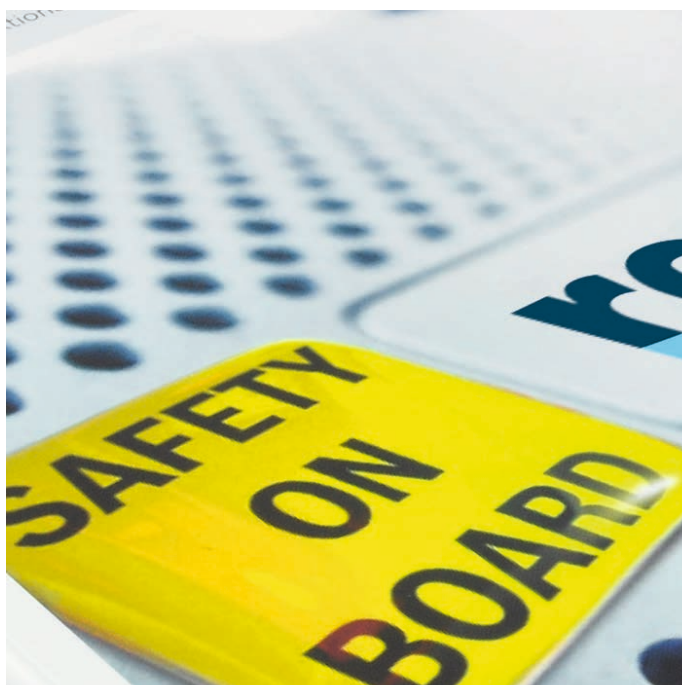


Reliability characteristics $MTTF_D$ regarding the functional safety according to EN ISO 13849

$MTTF_D$ values



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Determination of MTTF_D values in accordance with EN ISO 13849-1:2023

Using reliability characteristics MTTF_D (mean time to dangerous failure) of components, the probability of a dangerous failure per hour, PFH_d, of a machine or system is calculated and kept low, to a justifiable degree.

For hydraulic components, the standard EN ISO 13849-1:2023 specifies an MTTF_D value of at least 150 years if the "basic" and "well-tried" safety principles are complied with. For example, the following is demanded for hydraulic valves used in safety-related parts of control systems:

- ▶ Automatic reaching of the basic position in case of energy failure
- ▶ Safe keeping of the basic position
- ▶ Sufficient overlap with spool valves in basic position

Hydraulic components not satisfying the relevant safety principles are not suitable to be used in safety-related parts of control systems.

Rexroth has carefully tested their products with regard to all relevant "basic" and "well-tried" safety principles according to a method acknowledged by IFA (Institute for Occupational Safety and Health of the German Social Accident Insurance).

Compliance with safety principles, application notes

The products listed in the following are suitable for use in safety-related parts of a control system according to EN ISO 13849-1:2023.

According to EN ISO 13849-2:2012, these products satisfy the

- ▶ **basic** safety principles
- ▶ **established** safety principles.

Furthermore, these valves can be classified as "proven components" for use in control systems of category 1 according to EN ISO 13849-1:2023.

In particular, it is imperative that:

- ▶ Observance of the information in the data sheets.
- ▶ Observe the limits of the intended application conditions, e.g. temperature and shock load.
- ▶ No use under extreme operating states.
- ▶ Compliance with the required oil quality and purity.

For evaluating and interpreting the control system's reliability, use the following characteristics for the products:

MTTF_D = see table page 4 ... 10

T_M = 20 years (maximum period of use according to EN ISO 13849-1:2023)

In this use, please ensure compliance with the subsequently specified application notes.

Application notes:

The following basic safety principles according to EN ISO 13849-2:2012 for the implementation and the operation of the products are to be complied with.

- ▶ For operation and handling of the products, comply with the information in the data sheet and the operating instructions.
- ▶ Only use the hydraulic fluids specified in the data sheets and comply with the oil cleanliness class for the whole period of use.
- ▶ If switching spool valves are not actuated for a longer period of time, the control spool may seize. We therefore recommend switching the valve regularly, at reasonable time intervals.
- ▶ If you use the product for safety-related structures with higher categories (2 ... 4) according to EN ISO 13849-1:2023 Section 6, you must also consider CCF and DC in addition to PLr, software and systematic errors.
- ▶ According to EN ISO 13849-1:2023 the period of use while maintaining oil cleanliness in accordance with ISO 4406:2021 T_M = 20 years. In terms of preventative maintenance, it is recommended already to replace the components before expiry of the maximum period of use.
- ▶ Industrial valves are usually designed for 10 million switching cycles. If the maximum number of switching cycles is exceeded within the period of use, proportionally shorter exchange intervals are to be determined.


Compliance with safety principles, application notes

Conversion of MTTF_D into B_{10D} according to EN ISO 13849-1:2023:

$$MTTF_D = \frac{B_{10D}}{0.1 \times n_{op}}$$

B_{10D} = Mean number of cycles in which up to 10% of the components have failed in a dangerous manner.

n_{op} = Mean number of annual actuations.

 **Notice:**

According to EN ISO 13849-1:2023, higher MTTF_D values can be applied for a limited number of operations per year:

n_{op}	MTTF_D
>1,000,000	150 years
> 500,000 ... 1,000,000	300 years
> 250,000 ... 500,000	600 years
<250,000	1200 years

Use of valves and components with spool position monitoring:

- ▶ The signal of the position switch must not be used for direct activation of a safety-related control function.

Use of valves with on-board electronics for safety-related controls:

- ▶ In case a safety function of a system is required, the voltage supply of the valve electronics is to be switched off by a suitable switching element with appropriate reliability. In the table (page 5 and 9), these valves are marked with the comment "Switch off OBE voltage supply".
- ▶ If persons have to enter the danger zone with activated valve electronics, additional measures for guaranteeing their safety have to be taken for the reasons specified above.

Use of valves with flame-resistant hydraulic fluids HFC:

- ▶ The period of use **T_M** must be reduced for applications with functional safety.

	Life cycle as compared to operation with mineral oil HL, HLP	Maximum period of use T_M according to EN ISO 13849-1
Directional on/off valves, proportional directional valves	30 ... 100%	10 years
2-way cartridge valves, check valves, pressure valves	50 ... 100%	6.7 years

Directional on/off valves

Type	NG	Component series	Data sheet	MTTF _D value in years ¹⁾	Spool position monitoring ²⁾	Admissible control spool versions ³⁾	Maximum longitudinal control spool acceleration	Exceptions / limitations
.WE ...EG...	6	6X	23178	300 ... 2400	Optional QM, QR	A, C, D, B, Y, E, F, G, H, J, L, M, P, Q, R, T, U, W, A9, B9, E67, U10, Y11, J2, X7, X34, X139, L42, D46, A73, D73, B73, Y73, E73, G73, J73, W73	<15 g/11 ms ⁴⁾	Impulse spool design "O" and valves for AC voltage "W" ⁵⁾
.WE ..73...A12...						R73	<10 g/11 ms ⁴⁾	
.WE ...	6	7X	23164	150 ... 1200	–	A, C, D, B, Y, E, G, J	<15 g/11 ms ⁴⁾	–
.WE ...	6	1X	23165	150 ... 1200	–	A, C, D, B, Y, E, G, H, J	<15 g/11 ms ⁴⁾	–
.WE ...E...	10	5X	23340	300 ... 2400	–	A, C, D, B, Y, E, F, G, H, J, L, M, Q, R, P, T, U, W, X34, E4, E67, Q40, U10, Y11	<15 g/11 ms ⁴⁾	–
.WE ..73...A12...						A73, D73, B73, Y73, E73, G73, H73, J73, L73, R73, U73, T73		
.5-WE ...E...	10	5X	23352	300 ... 2400	Optional QM	A, C, D, B, Y, E, F, G, H, J, Q, P, R, W, A7, X7, Y11, E34, E67, G41, J2, J19, P3, U44, X84, X102	<15 g/11 ms ⁴⁾	–
						J, L, M U, U10	<10 g/11 ms ⁴⁾	
4WE ...H...	10	5X	23343	150 ... 1200	Optional QY	C, D, Y, Y11, E, H, J, L, M, U	<15 g/11 ms ⁴⁾	–
Z4WE ...E...	6	3X	23193	150 ... 1200	Optional QM	D24, D27, E51, E53, E56, E63, E68, E127, E129, E130, E131, E132, E134, E135, E136, E137, E141, E144, E145, E146, E166, X161, X163, X181, X183, X188, X250, X252, X253, X254, X255, X256	<10 g/11 ms ⁴⁾	Valves for alternating voltage "W" ⁵⁾
.SEC ...	6	2X	22028	150 ... 1200	–	E35, EB, E	–	–
M-.SED ...	6	1X	22049	150 ... 1200	Optional QMA, QMB	PK, NK, UK, CK	–	–
M-.SED ...	10	1X	22045	150 ... 1200	Optional QMA, QMB	UK, CK	–	–
M-.SEW ...	6	3X	22058	150 ... 1200	Optional QMA, QMB	P, N, U, C	<15 g/11 ms ⁴⁾	630 bar version
M-.SEW ...	10	1X	22075	150 ... 1200	Optional QMA, QMB	U, C	–	
Z4SE ...C	10	1X	⁶⁾	150 ... 1200	–	A, B, E	–	–
.WEH ...6E...; .WH ...	10 ... 32	4X; 6X; 7X	24751	100 ... 800 150 ... 1200	Optional QM	A, B, C, D, E, F, G, H, J, K, L, M, P, Q, R, S, T, U, V, W, Y, Z, U10	<15 g/11 ms ⁴⁾	Impulse spool design type "O"; control spool return hydraulic
4WEH ...	16, 25	1X	24718	75 ... 600	–	Y31, E, E42, G, H, J, L, U	<15 g/11 ms ⁴⁾	–
Z4WEH ...; Z4WH ...	10 ... 22	4X; 5X	24753, 24761, 24768	100 ... 800 150 ... 1200	Optional QM	E62, E63, E68, E50, E51, E52	<15 g/11 ms ⁴⁾	Valves for alternating voltage "W" ⁵⁾

Explanation of the footnotes see page 11.

**Notice:**

Further MTTF_D values for products and special versions not listed here available upon request.

Proportional directional valves

Type	NG	Component series	Data sheet	MTTF _D value in years ¹⁾	Spool position monitoring ²⁾	Admissible control spool versions ³⁾	Maximum longitudinal control spool acceleration	Exceptions / limitations
4WRA(E) ...	6	3X	29128	150 ... 1200	–	E, E1-, W, W1- ⁷⁾	–	Switch off "OBE" voltage supply
4WRA(E) ...	10	2X	29055	150 ... 1200	–	E, E1-, W, W1- ⁷⁾	–	
4WREE ...	6	3X	29105	150 ... 1200	–	E, E1-, W, W1- ⁷⁾	–	
4WREE ...	10	3X	29106	150 ... 1200	–	E, E1, E3, W, W1- ⁷⁾	–	
4WREEM ...	6, 10	2X	29064	150 ... 1200	✓	E, E1-, W, W1- ⁷⁾	–	Analysis of the zero position available upon request; Switch off "OBE" voltage supply
4WRPE ...	6	3X	29118	150 ... 1200	–	E, E1-, W, W1-	<15 g ⁴⁾	Switch off "OBE" voltage supply
4WRPE ...	10	3X	29122	150 ... 1200	–	E, E1-, W6-, W8-	<15 g ⁴⁾	
4WRPF ...	6, 10	3X	29131	150 ... 1200	✓	E, E1-, W, W1-, W6-, W8-	<15 g ⁴⁾	
4WRPEH ...	6	3X	29121	150 ... 1200	–	C1, C3, C4, C5	<10 g ⁴⁾	Except $q_V = 40$ l/min; switch off "OBE" voltage supply
4WRPEH ...	10	3X	29038	150 ... 1200	–	C1, C3, C4, C5	<10 g ⁴⁾	Switch off "OBE" voltage supply
4WRPFH ...	6	3X	29395	150 ... 1200	✓	C1, C3, C4, C5	<10 g ⁴⁾	Except $q_V = 40$ l/min; switch off "OBE" voltage supply
4WRPDH ...	6, 10	2X	29391	150 ... 1200	–	C1, C3, C4, C5	<10 g ⁴⁾	NG10: max. operating pressure 250 bar
4WRKE ...	10 ... 35	3X	29075	75 ... 600	–	E, R, W	<15 g ⁴⁾	
4WRZ(E) ...; 4WRH ...	10 ... 52	7X	29115	75 ... 600 150 ... 1200	–	E, E1, E3, W6, W8, W9; < 20 g ⁴⁾	–	Switch off "OBE" voltage supply
4WRZ(E)M ...; 4WRHM ...	10 ... 25	1X	29117	75 ... 1200 150 ... 1200	✓	E, W	<9 g ⁴⁾	
4WRZ(E) ...402, 4WRH ...402	32	7X	⁸⁾	75 ... 600 150 ... 1200	✓	E, W	<9 g ⁴⁾	
4WRLE ...	10 ... 35	4X	29123	75 ... 600	–	E, E1-, W6-, W8-	NG10, 16: <15 g NG25, 27: <10 g ⁴⁾	
4WRTE ...	10 ... 35	4X	29083	150 ... 1200	–	E, E1, W6, W8, Q2, R	–	

Explanation of the footnotes see page 11.

**Notice:**

Further MTTF_D values for products and special versions not listed here available upon request.

2-way cartridge valves: Directional function

Type	NG	Component series	Data sheet	MTTF _D value in years ¹⁾	Spool position monitoring ²⁾	Admissible control spool versions ³⁾	Maximum longitudinal control spool acceleration	Exceptions / limitations	
LC . A...; LC . B...	16 ... 63	7X	21010	150 ... 1200	-	-	Version "10": <15 g NG40 ... 63: Version "20": <25 g	Version "00" (without spring) and "05": Cracking pressure 0.5 bar	
LC . A...; LC . B...	16 ... 32	8X	21004-01	150 ... 1200	-	-	Version "10": <15 g		
LC . A...; LC . B...	80 ... 100	6X	21010	150 ... 1200	-	-	Version "20": <20 g Version "40": <28 g	Version "00" (without spring) and "05" and "10": Cracking pressure 0.5 bar and 1 bar	
LFA . D...; LFA . H...	16 ... 63	7X	21010	Not relevant	-	-	-	Observe the reliability characteristic of the pilot control valve	
LFA . D...; LFA . H...	80 ... 100	6X							
LFA . G...; LFA . GW...; LFA . KW...	16 ... 63	7X	21010	Not relevant	-	-	-		
LFA . G...; LFA . GW...; LFA . KW...	80 ... 100	6X							
LFA . WE...; LFA . WEM...; LFA . WECA...	16 ... 63	7X	21010	Not relevant	-	-	-		
LFA . WE...; LFA . WE.8...; LFA . WEA9...	80 ... 100	6X							
LFA . E...QM...; LFA . EH2...QM...; LFA . EW...QM...	16 ... 63	7X	21010	150 ... 1200	QM, Q6	CA, CB, CD	Version "10": <15 g NG40 ... 63: Version "20": <25 g		The closed position is the safe spool position; Version "00" (without spring) and "05": Cracking pressure 0.5 bar

2-way cartridge valves: Active logics

Type	NG	Component series	Data sheet	MTTF _D value in years ¹⁾	Spool position monitoring ²⁾	Admissible control spool versions ³⁾	Maximum longitudinal control spool acceleration	Exceptions / limitations
LC2A . D...; LC2A . A...; LC2A . B...	16 ... 100	1X	21040	150 ... 1200	Optional Q7	-	-	Cracking pressure "00" (without spring)

Explanation of the footnotes see page 11.

**Notice:**

Further MTTF_D values for products and special versions not listed here available upon request.

2-way cartridge valves: Pressure function

Type	NG	Component series	Data sheet	MTTF _D value in years ¹⁾	Spool position monitoring ²⁾	Admissible control spool versions ³⁾	Maximum longitudinal control spool acceleration	Exceptions / Limitations
LC . DB ...	16 ... 63	7X	21050	150 ... 1200	–	–	–	Cracking pressure "00" (without spring)
LC . DB ...	16 ... 32	8X	21004-01	150 ... 1200	–	–	–	
LC . DB ...	80 ... 100	6X	21050	150 ... 1200	–	–	–	
LC . DR ...	16 ... 63	7X	21050	150 ... 1200	–	–	–	
LC . DR ...	16 ... 32	8X	21004-01	150 ... 1200	–	–	–	
LFA . DB...; LFA . DBW...; LFA . DBWD...	16 ... 63	7X	21050	150 ... 1200	–	–	–	With pressure relief valve type DBD
LFA . DBS...	40 ... 63	7X	21050	150 ... 1200	–	–	–	
LFA . DBEM...	16 ... 40	7X	21050	–	–	–	–	Observe the reliability characteristic of the pilot control valve
LFA . DB...; LFA . DBW...; LFA . DBWD...; LFA . DBS...	80 ... 100	6X; 7X	21050	150 ... 1200	–	–	–	With pressure relief valve type DBD
LFA . DBE...	16 ... 40	7X	21050	–	–	–	–	Observe the reliability characteristic of the pilot control valve
LFA . DR...; LFA . DRW...	16 ... 50	7X	21050	150 ... 1200	–	–	–	With pressure relief valve type DBD

Explanation of the footnotes see page 11.

**Notice:**

Further MTTF_D values for products and special versions not listed here available upon request.

Check valves

Type	NG	Component series	Data sheet	MTTF _D value in years ¹⁾	Spool position monitoring ²⁾	Admissible control spool versions ³⁾	Maximum longitudinal control spool acceleration	Exceptions / limitations
MS-R . KE...	6 ... 32	1X	20380	150 ... 1200	-	-	Version "05": <16 g	Version "00" (without spring) and "02": Cracking pressure 0.2 bar
S...	6 ... 30	1X	20378	150 ... 1200	-	-	Version "05": NG15, 20: <24 g; NG25: <20 g; NG30: <16 g	Version "00" (without spring) and "02": Cracking pressure 0.2 bar
SV ...; SL ...	6	6X	21460	150 ... 1200	-	-	Version "A": <27G	Version "4": Cracking pressure 10 bar
SV ...; SL ...	10 ... 32	4X	21468	150 ... 1200	Optional QM	-	NG10: Version "A": <27 g; Version "B": <23 g	-
Z2S ...	6	6X	21548	150 ... 1200	-	-	Version "SO40", "SO55": <24 g; Version "SO60", "SO150": <18 g	Only mutual loading of channels A and B with maximum operating pressure 350 bar
Z2S ...	10	3X	21553	150 ... 1200	-	-	Version "SO60", "SO64", "SO150": <18 g	-
Z2S ...	16	5X	21558	150 ... 1200	-	-	-	Only mutual loading of channels A and B with maximum operating pressure 315 bar
Z2S ...	22	5X	21564	150 ... 1200	-	-	-	Only mutual loading of channels A and B with maximum operating pressure 315 bar
SFA ...	50, 63	3X	20485	150 ... 1200	-	-	NG50: <11 g; NG63: <9 g	-

Explanation of the footnotes see page 11.

**Notice:**

Further MTTFD values for products and special versions not listed here available upon request.

Pressure valves

Type	NG	Component series	Data sheet	MTTF _D value in years ¹⁾	Spool position monitoring ²⁾	Admissible control spool versions ³⁾	Maximum longitudinal control spool acceleration	Exceptions / limitations
DBD ...	6 ... 30	1X	25402	150 ... 1200	–	–	–	–
Z.DB ...	6	2X	25771	150 ... 1200	–	–	–	–
Z.DB ...	10	2X	25774	150 ... 1200	–	–	–	–
DB ...	10 ... 32	5X	25802	75 ... 600	–	–	–	–
DBW ...				60 ... 480	–	–	<15 g/11 ms ⁴⁾	–
DBW ...				100 ... 800	–	–	<15 g/11 ms ⁴⁾	–
DBET(E) ...	6	6X	29162	150 ... 1200	–	–	–	Switch off "OBE" voltage supply
DBET(E)(A) ...	6	7X	29263	150 ... 1200	–	–	–	
DBEM(E) ...	10 ... 32	7X	29361	75 ... 600	–	–	–	
DBEM(E) ...	10 ... 32	8X	29362	75 ... 600	–	–	–	
DR . DP ...	6	5X	26564	150 ... 1200	–	–	–	–
ZDR . D ...	6	4X	26570	150 ... 1200	–	–	–	–
Z3DR . VP...	6	1X	26871	75 ... 600	–	–	–	–
Z3DR . V...	10	1X	26874	75 ... 600	–	–	–	–
(Z)3DRE(E)(A) ...	6	2X	29283	150 ... 1200	–	–	–	Switch off "OBE" voltage supply
ZDRE(E) ...	10	2X	29279	150 ... 1200	–	–	–	
DRE(M)(E) ...	10, 25	6X	29276	75 ... 600	–	–	–	
3DREP(E) ...	6	2X	29184	150 ... 1200	–	–	<9 g ⁴⁾	

Explanation of the footnotes see page 11.

**Notice:**

Further MTTFD values for products and special versions not listed here available upon request.

Flow control valves

Type	NG	Component series	Data sheet	MTTF _D value in years ¹⁾	Spool position monitoring ²⁾	Admissible control spool versions ³⁾	Maximum longitudinal control spool acceleration	Exceptions / limitations
Z2FS ...	10	3X	27518	150 ... 1200	–	–	–	–

Pressure switches and sensors

Type	NG	Component series	Data sheet	MTTF _D value in years ¹⁾	Spool position monitoring ²⁾	Admissible control spool versions ³⁾	Maximum longitudinal control spool acceleration	Exceptions / limitations
HED 5 ...	–	3X	50056	60	–	–	–	For max. 24 V and max. 5 mA
HED 8 ...	–	2X	50061	75	–	–	–	
HEDE 10 A1...	–	3X	30277	380	–	–	–	At 40 °C
HEDE 11 A1...	–	1X	30279	844	–	–	–	
HM 20 ..C...	–	2X	30272	1518	–	–	–	
HM 20 ..H...	–	2X	30272	1520	–	–	–	

Inductive position switches

Type	NG	Component series	Data sheet	MTTF _D value in years ¹⁾	Spool position monitoring ²⁾	Admissible control spool versions ³⁾	Maximum longitudinal control spool acceleration	Exceptions / limitations
QM	–	–	24830	224	–	–	–	At 40 °C
	–	–	21015	570	–	–	–	
QR	–	–	24830	228	–	–	–	
QS	–	–	24830	1440	–	–	–	
Q6	–	–	21015, 21040	310	–	–	–	
Q7	–	–	21015, 21040	310	–	–	–	

Explanation of the footnotes see page 11.

**Notice:**

Further MTTFD values for products and special versions not listed here available upon request.

Explanation of the footnotes

- 1) See table on the right.
- 2) Reliability of the position switch see page 10.
The signal at the position switch must not be used for direct activation of a safety-related control function.
- 3) The typical control spool versions mentioned here are suitable for use in safety-related parts of a control system. When selecting the control spool, the user must observe the required safety function, e.g. energy separation or unloading. Suitability or reliability characteristics for non-specified control spool versions available on request
- 4) Adequate control spool overlap according to EN ISO 13849-2:2012 available under sine-shaped shock and vibration load according to EN 60068-2-27:2009. Observe installation position.
- 5) Use mating connector with installed rectifier.
- 6) Installation drawing R900277922, available upon request
- 7) In case of shock load, the control spool overlap can be left for a short time.
- 8) Installation drawing R900270193, available upon request

Notice:

According to EN ISO 13849-1:2023, higher MTTF_D values can be applied for a limited number of operations per year:

n_{op}	MTTF _D
>1,000,000	150 years
> 500,000 ... 1,000,000	300 years
> 250,000 ... 500,000	600 years
<250,000	1200 years

n_{op} = Mean number of annual actuations

Notes

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