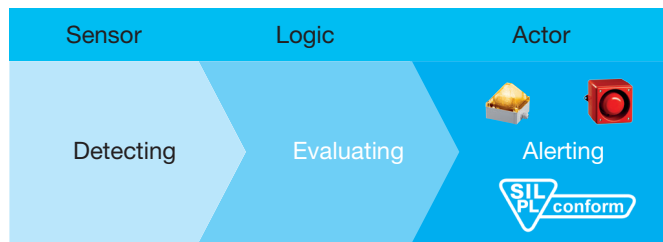


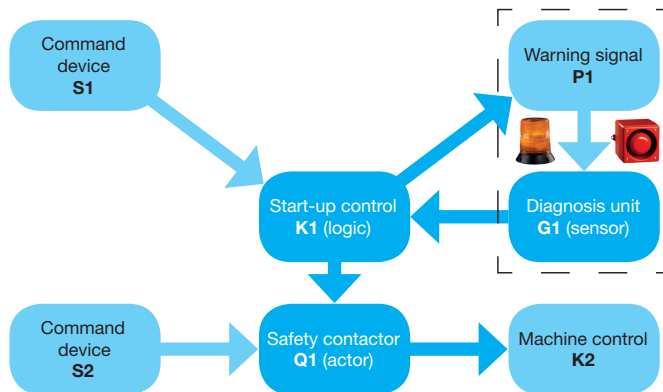
Functional safety

EN ISO 13849-1 (PL)

Safety Instrumented System SIS (Safety Loop)



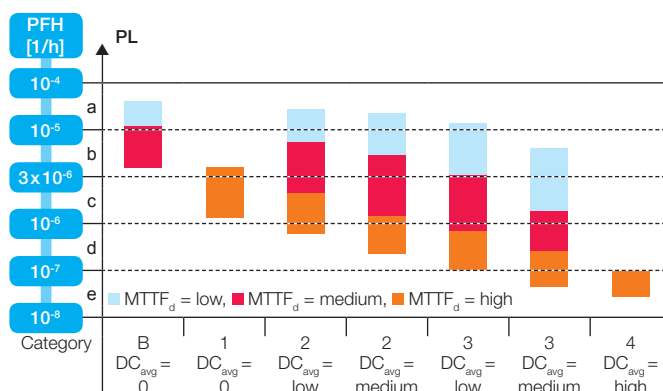
Machine safety, e.g. start-up warning



PL/PFH [1/h] in comparison to SIL			
PL	PFH [1/h]		SIL
a	$\geq 10^{-5} \dots > 10^{-4}$	=	no equivalent
b	$\geq 3 \times 10^{-6} \dots > 10^{-5}$	Δ	SIL 1
c	$\geq 10^{-6} \dots > 3 \times 10^{-6}$	Δ	SIL 2
d	$\geq 10^{-7} \dots > 10^{-6}$	Δ	SIL 2
e	$\geq 10^{-8} \dots > 10^{-7}$	Δ	SIL 3

PL bar chart according to ISO 13849-1

Simplified graphic determination of the PL reached.
Relationship between the category, DC, MTTF_d and PL



Value ranges		
Name	Diagnostic coverage (DC)	Average time until a dangerous failure (MTTF _d)
none	DC > 60%	
low	60% ≤ DC < 90%	3 years ≤ MTTF _d < 10 years
medium	90% ≤ DC < 99%	10 years ≤ MTTF _d < 30 years
high	99% ≤ DC	30 years ≤ MTTF _d < 100 years

Risk assessment

Determination of the required Performance Level (PL_r)

Risk parameters

► S – Severity of the injury

S₁ = minor injuries (normally reversible)

S₂ = serious injuries, including death (normally irreversible)

► F – Frequency and/or length of exposure to the hazard

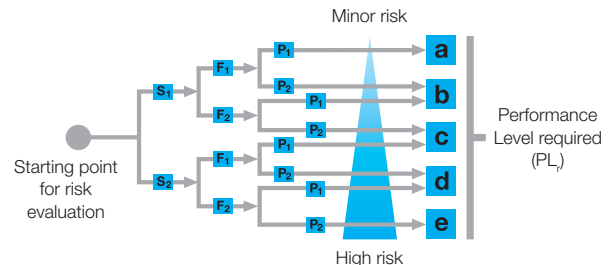
F₁ = rarely to more often and/or short periods

F₂ = frequently to continuously and/or long duration

► P – Possibilities to avoid danger

P₁ = possible under certain conditions

P₂ = barely possible



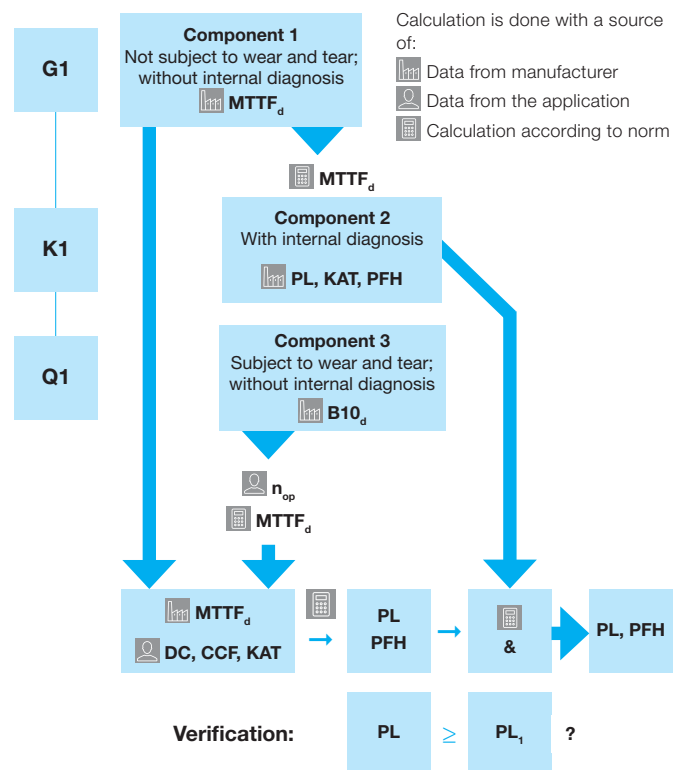
Evaluation of the safety function

Required safety related parameters				
EN ISO 13849-1		Device type		
PL Kategorie T1	-	Units with internal diagnosis		safety control safety switch gears
MTTF _d	DC, CCF, category	Units without internal diagnosis	Without components that are subject to wear and tear	sensors, signaling devices
B10 _d	DC, CCF, category, n _{op}	With components that are subject to wear and tear	With components that are subject to wear and tear	emergency shutdown, relay, switch

CCF: failure due to common cause

DC: diagnostic coverage

Calculation according to EN ISO 13849-1



Verification:

$$PL \geq PL_r ?$$

