

Functional Safety in the Process Industry

27.03.2018

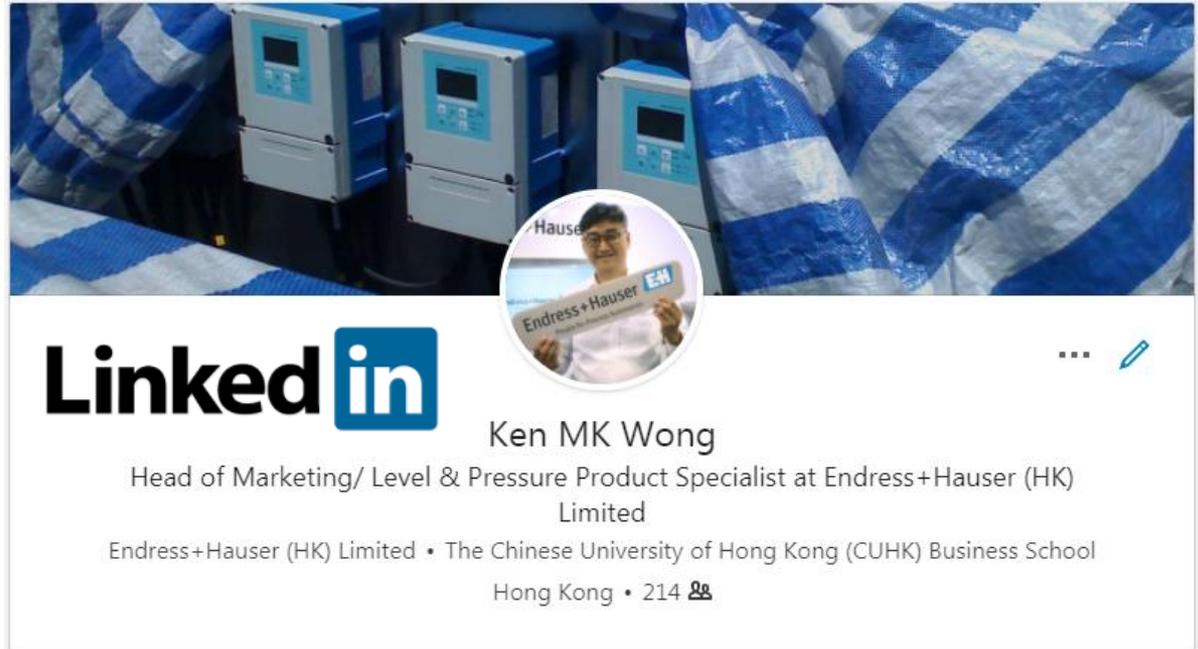


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About the Speaker



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Safety Instrumented Systems (SIS) in the Process Industry

- Definition of “Risk”
- Risk assessment and Risk reduction by SIS
- Safety Integrity Level (SIL)
- Design of Safety Instrumented Systems
- Safety Parameters and SIL determination
- Structure of Safety Instrumented Systems
- Functional Proof Testing
- Order Code and Documentation



BP AMOCO Refinery Explosion Texas City March 2005

Reason:

- safety systems ignored during maintenance process
- inappropriate design of safety systems
- uncontrolled release of fuel from a vent stack
- inappropriate behavior of workers trying to start and remove a truck
- control room with many workers located close to distillation column

→ Safety Culture!

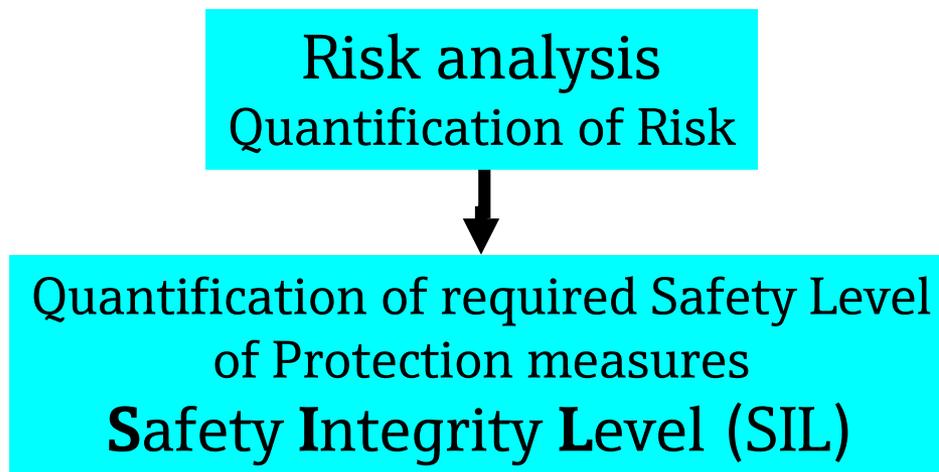
Consequence:

- 15 People KILLED
- 180 INJURED
- estimated costs
US\$1,000,000,000

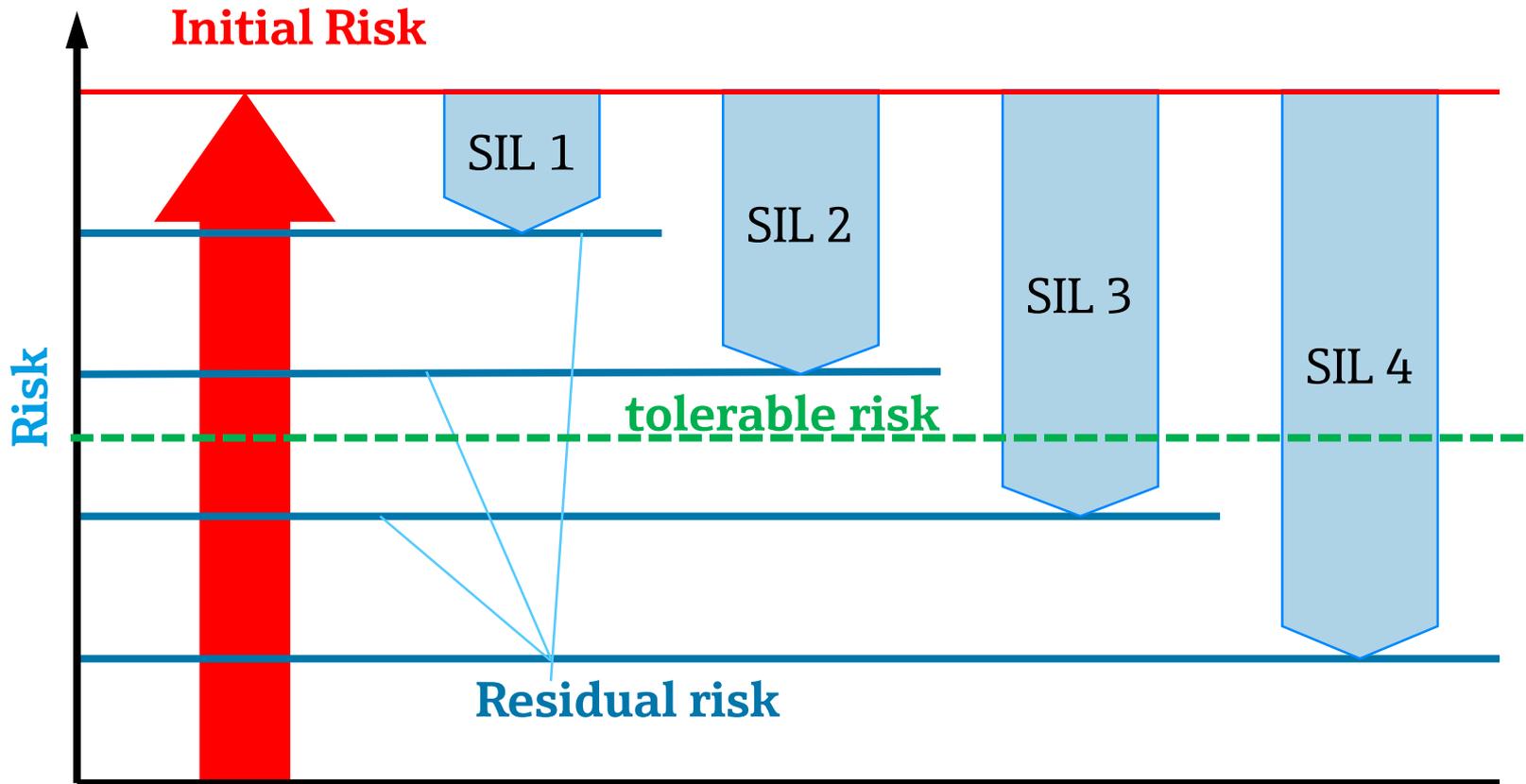


What is “Risk” ?

- Risk = Probability (P) of Event Occurrence x Damage (D)
- Tolerable risk = maximum risk, which is acceptable according to moral concepts (German VDE 2180)
- Risk reduction:
Reduction of initial risk below tolerable risk by organizational, constructional or protection measures (e.g. Safety Instr. Systems)
- Concept of Functional Safety:



Risk Reduction by a Safety System

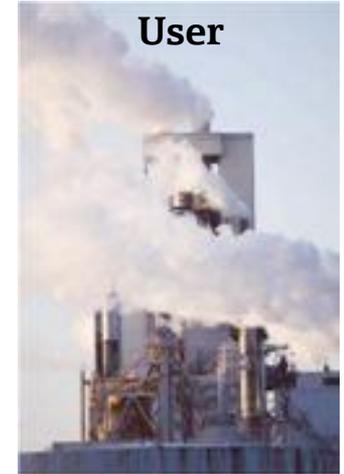


IEC 61508 & IEC 61511: Functional Safety of Electrical/Electronic/Programmable Electronic Systems

Manufacturer



User



safety related system standards

IEC 61508

7 parts

Manufacturers & suppliers of devices

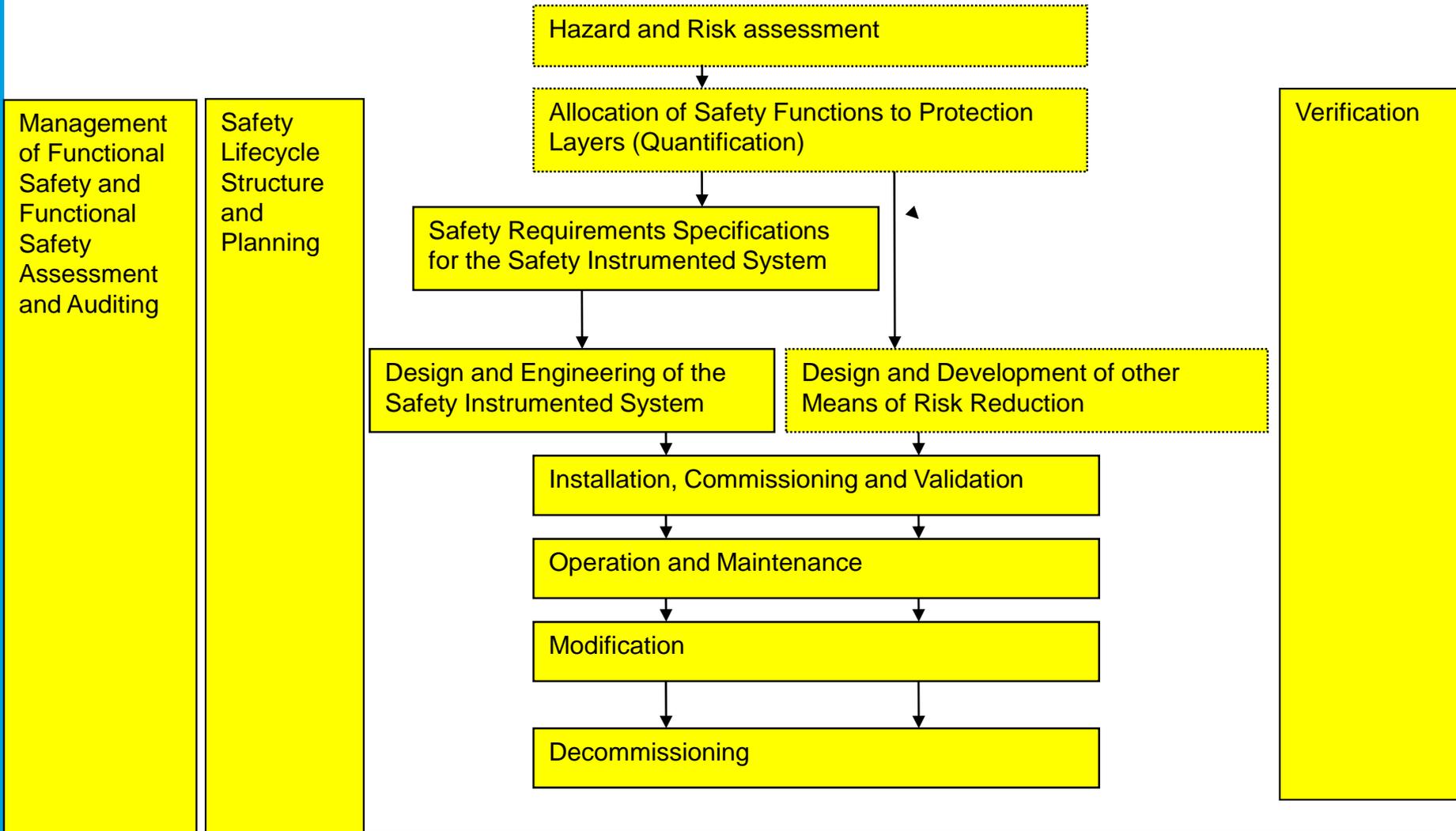
IEC 61511

3 parts

Safety Instrumented Systems Designers, Integrators & Users

American Standard: ANSI/ISA 84.01

Overall Safety Life-Cycle acc. IEC 61511

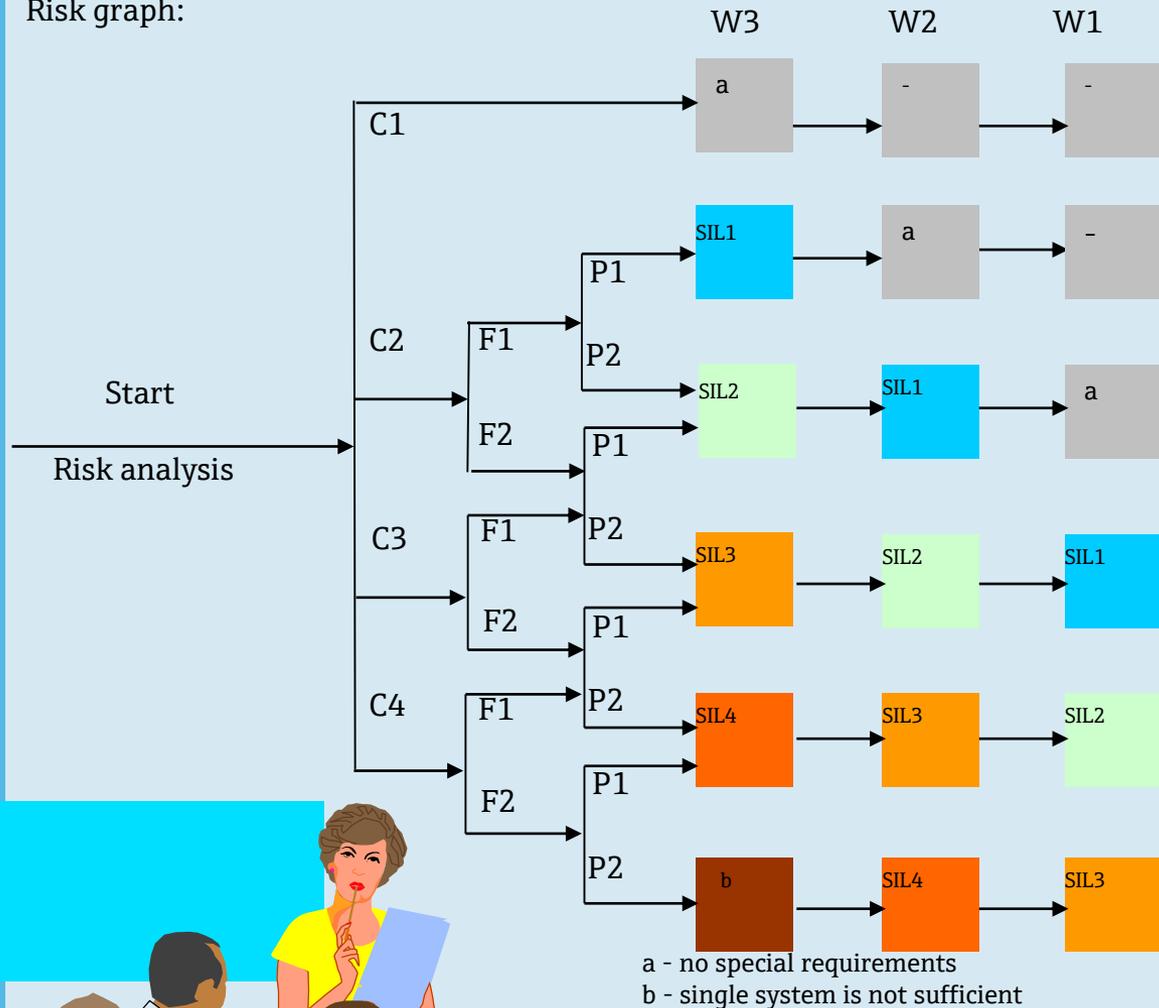


Source: DIN EN 61511-1 Fig. 8



Hazard and Risk Assessment of a Process

Risk graph:

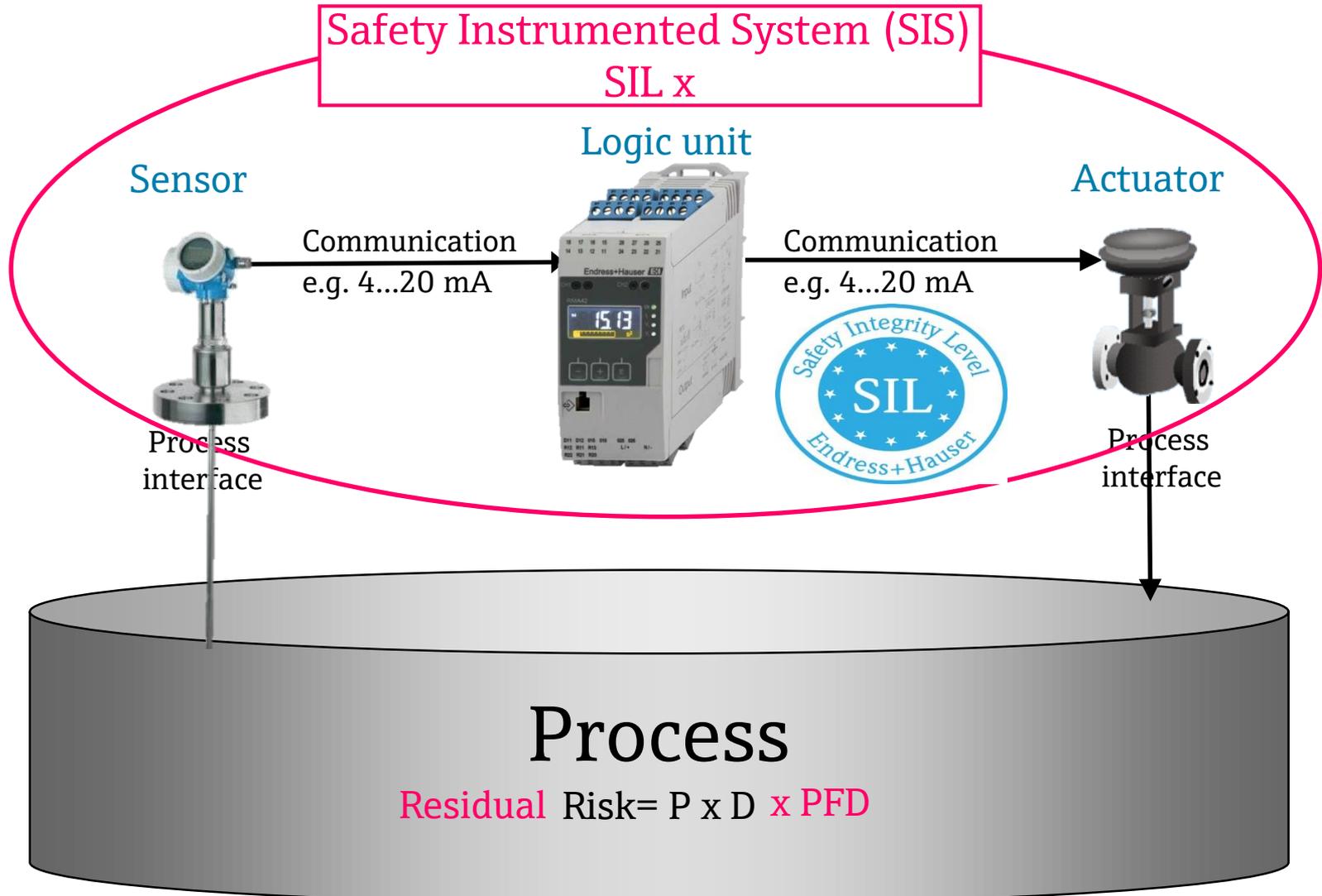


Risk parameters:

- W - Occurrence Probability
 - W1: very low probability < 0,03/year
 - W2: low probability < 0,3 /year
 - W3: relative high probability >0,3/ y
- C- Extent of damage
 - C1: slight injury
 - C2: severe irreversible injury to one or more persons or death of a person
 - C3: Death of several persons
 - C4: Catastrophic consequences, multiple deaths
- F- Exposure time
 - F1: seldom to relatively frequent
 - F2: frequent to continuous
- P- Hazard Avoidance
 - P1: possible under certain conditions
 - P2: hardly possible



Risk Reduction by Safety Instrumented Systems



Operational modes of safety systems

High demand mode (HDM)
or continuous mode
demand of the safety function
more than once a year

Safety function
only active
during demand



Safety function
frequently or
continuously active

Low demand mode (LDM)
demand of the
safety function
once a year or less

E.g. machinery industry

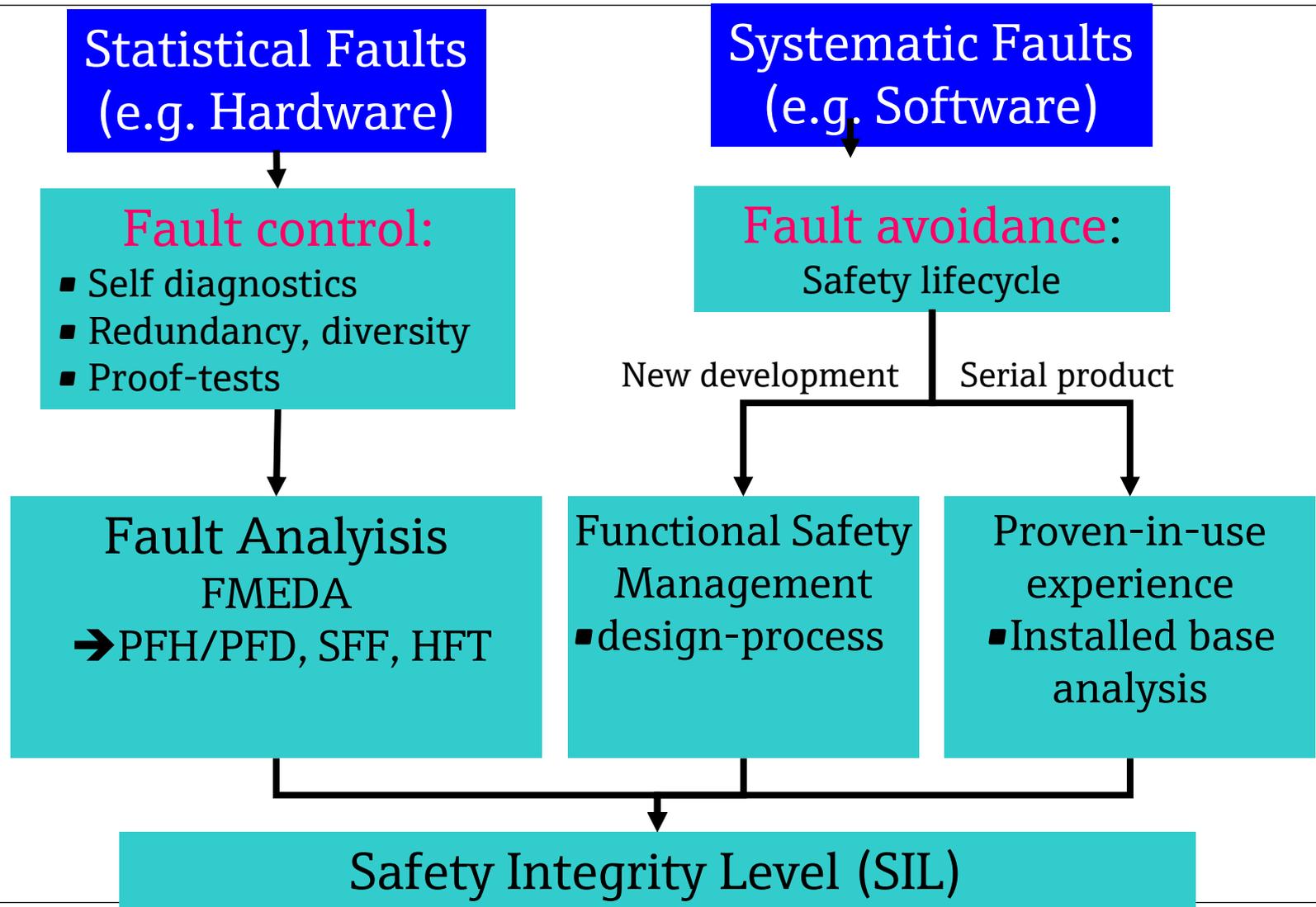
E.g. process industry

„Quantification“ of Risk and Protection Measures

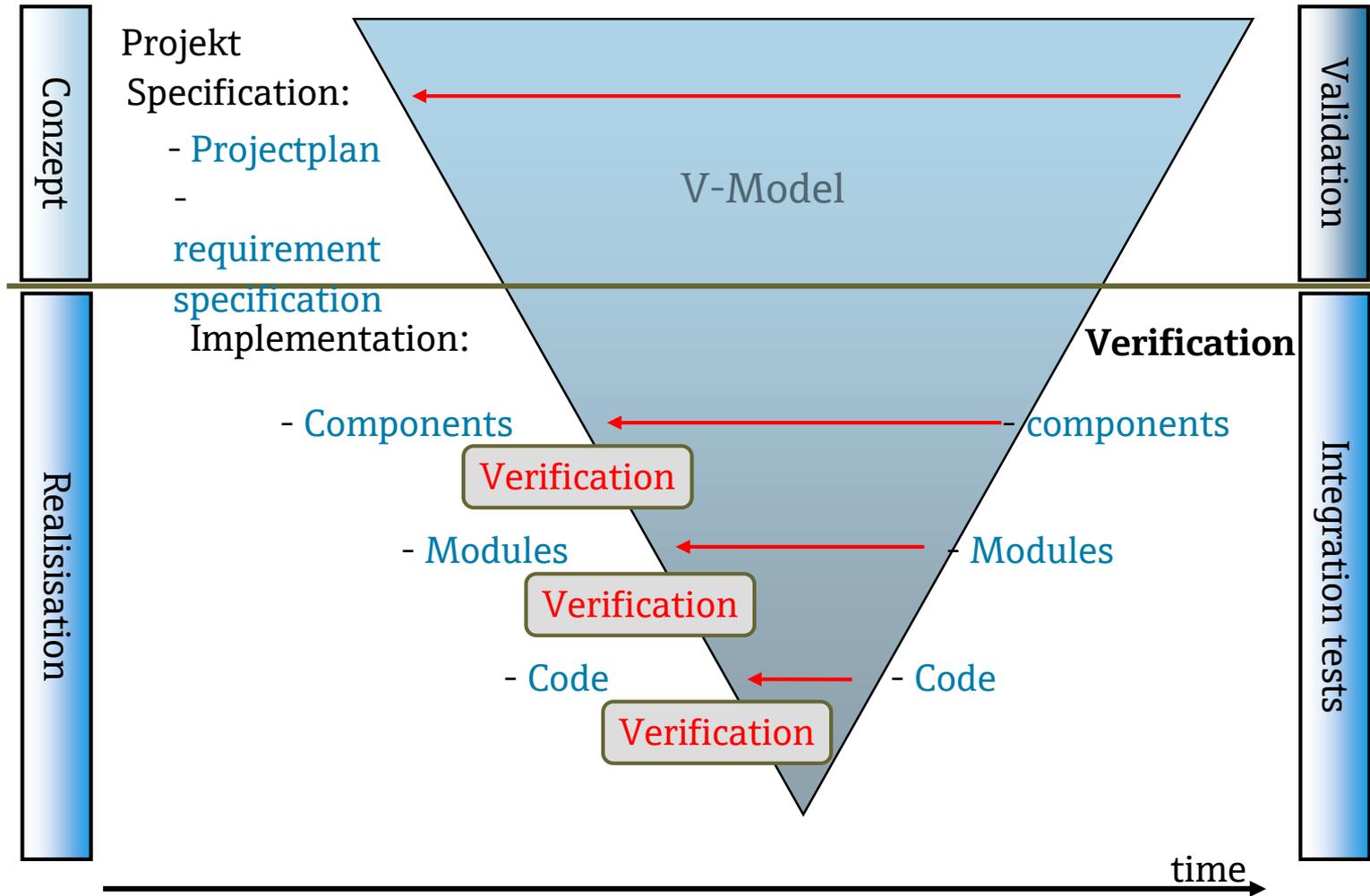
Risk	SIL	Accepted frequency of a failure of the protection measure	Failure rate PFH	Failure probability PFD*
Low	SIL 1	< 1 dangerous fault in 10 years	$<10^{-5}$ 1/h	$<10^{-1}$
Mean	SIL 2	< 1 dangerous fault in 100 years	$<10^{-6}$ 1/h	$<10^{-2}$
High	SIL 3	< 1 dangerous fault in 1000 years	$<10^{-7}$ 1/h	$<10^{-3}$
Very high	SIL 4	< 1 dangerous fault in 10.000 years	$<10^{-8}$ 1/h	$<10^{-4}$

* per demand, assuming 1 demand/year

Reliability of Safety Instrumented Systems



Functional Safety Management - Design Process



Documentation



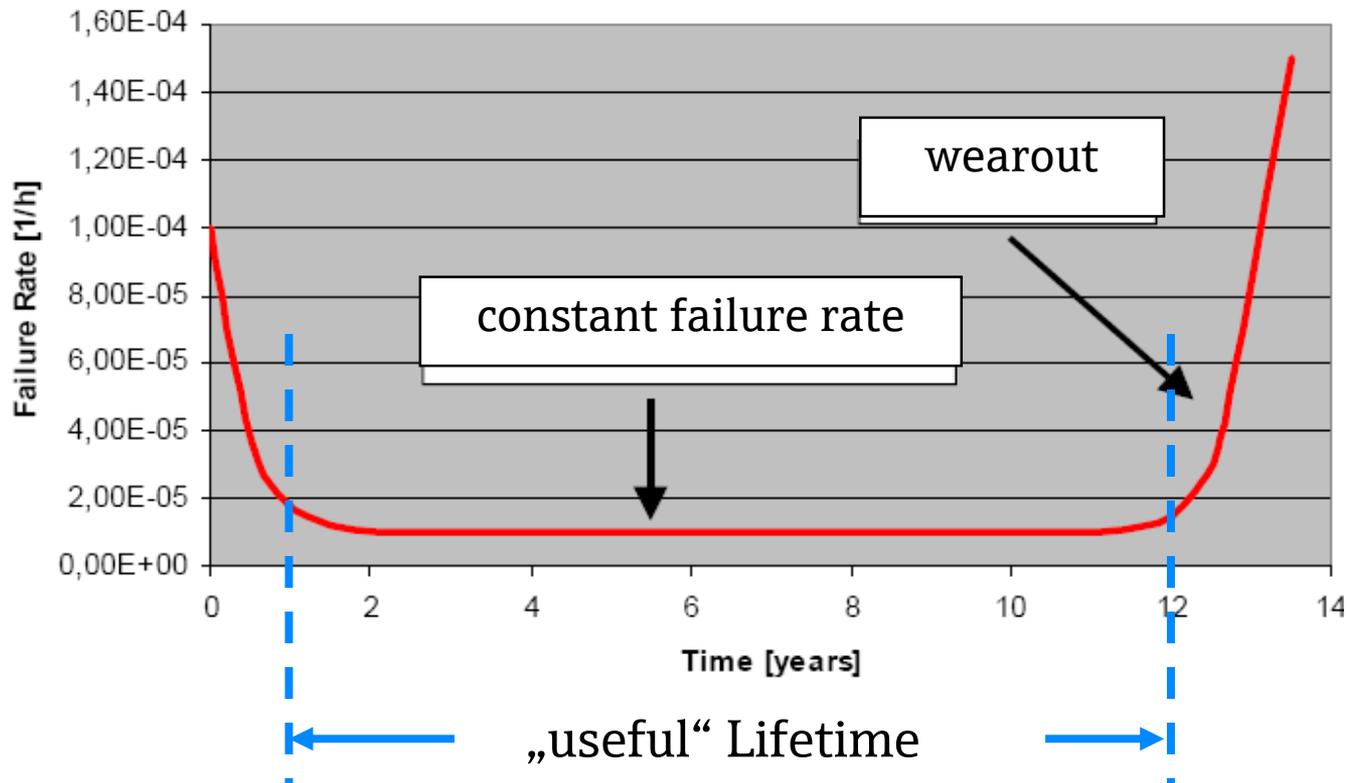
TÜV Certified Functional Safety Management



Safety Level of Safety Instrumented Systems

- Failure Mode and Effect Analysis (FMEA)
- Total Failure Probability (PFD, PFH)
- Architectural Constraints (SFF, HFT)

Random Failures of Electronic Components

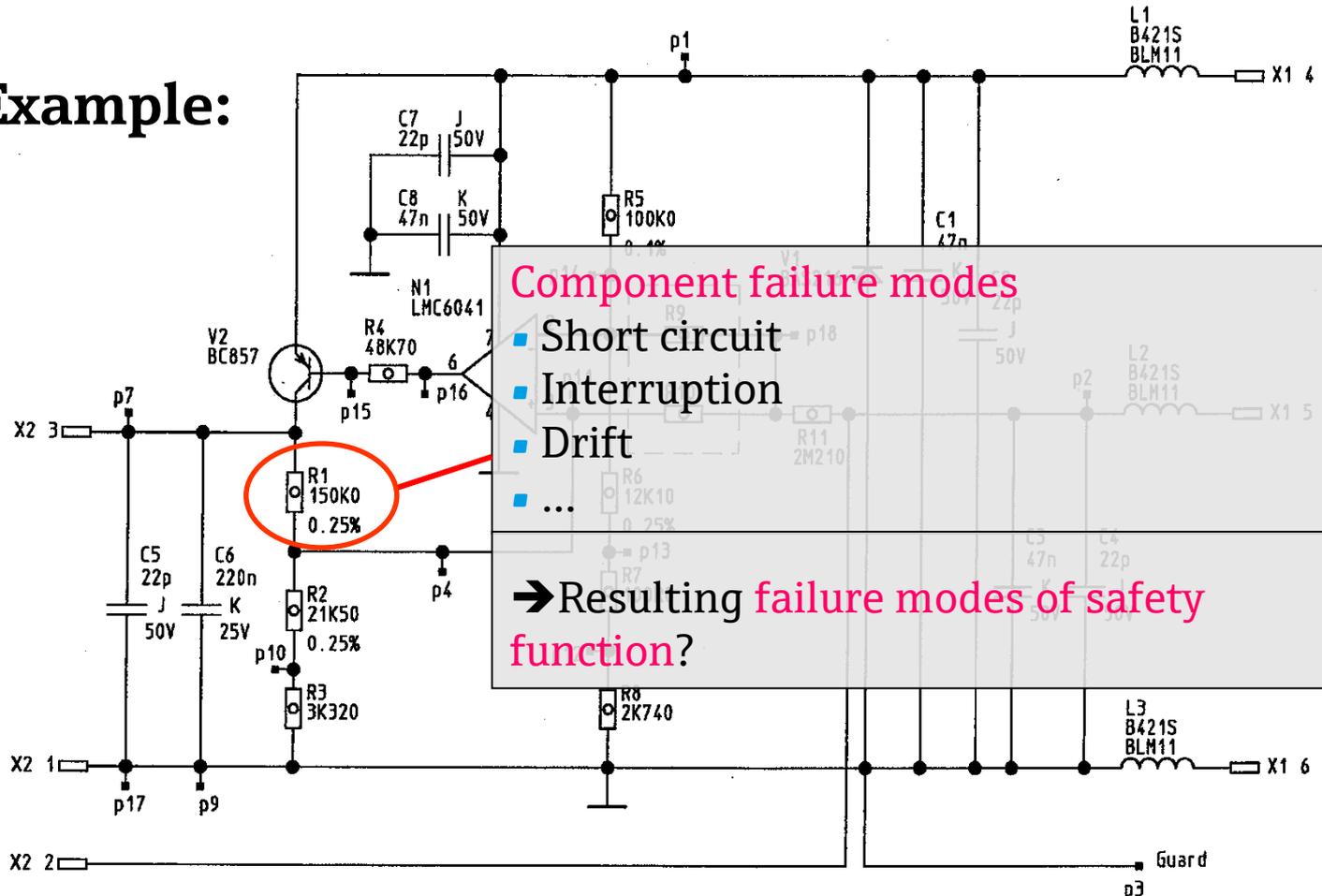


Note: Failure rate often specified in FIT = 1 Failure/10⁹ h = 10⁻⁹ /h



Failure Mode and Effect Analysis (FMEA)

Example:



Additionally: FMEA of mechanical Components (z. B. Sensor)

Failure Mode Effect Analysis (FMEA)

- Pre-condition:
- determine safety path (e.g. 4...20 mA output)
 - determine accuracy under fault condition (e.g. $\pm 2\%$)

Failure modes:

- dangerous faults
- safe faults
- undetected faults
- detected faults

Probability of Failure Modes	Detected faults	Undetected faults
Safe faults	λ_{sd}	λ_{su}
Dangerous faults	λ_{dd}	λ_{du}

$$\lambda_{tot} = \lambda_{su} + \lambda_{sd} + \lambda_{du} + \lambda_{dd} (+\lambda_{not\ relevant})$$

$$MTBF = 1/\lambda_{tot}$$

PFD, PFH

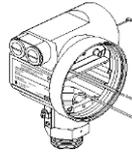
Failure Modes of Safety Function

λ_{sd} = Safe detected Failure

Example (cont. overflow protection):

Short circuit of 4..20 mA-output

→ Current >20 mA indicates overfilling and “Alarm”



λ_{su} = Safe undetected Failure

Example (limit switch 8/16 mA):

Failure leads to 8 mA output

→ Safety function activated (fault alarm!)



PFH, PFD

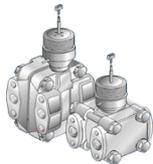
λ_{dd} = Dangerous detected Failure

Example:

Ceramic cell broken in Deltabar

▪ Broken cell could result in a “valid” measured value but...

→ Internal “Diagnostic” in active sensor



λ_{du} = Dangerous undetected fail.

Example:

Output „frozen“ between 4..20 mA independent of the process variable

→ no warning

$$\lambda_{tot} = \lambda_{su} + \lambda_{sd} + \lambda_{du} + \lambda_{dd}$$

$$MTBF = 1 / \lambda_{tot}$$

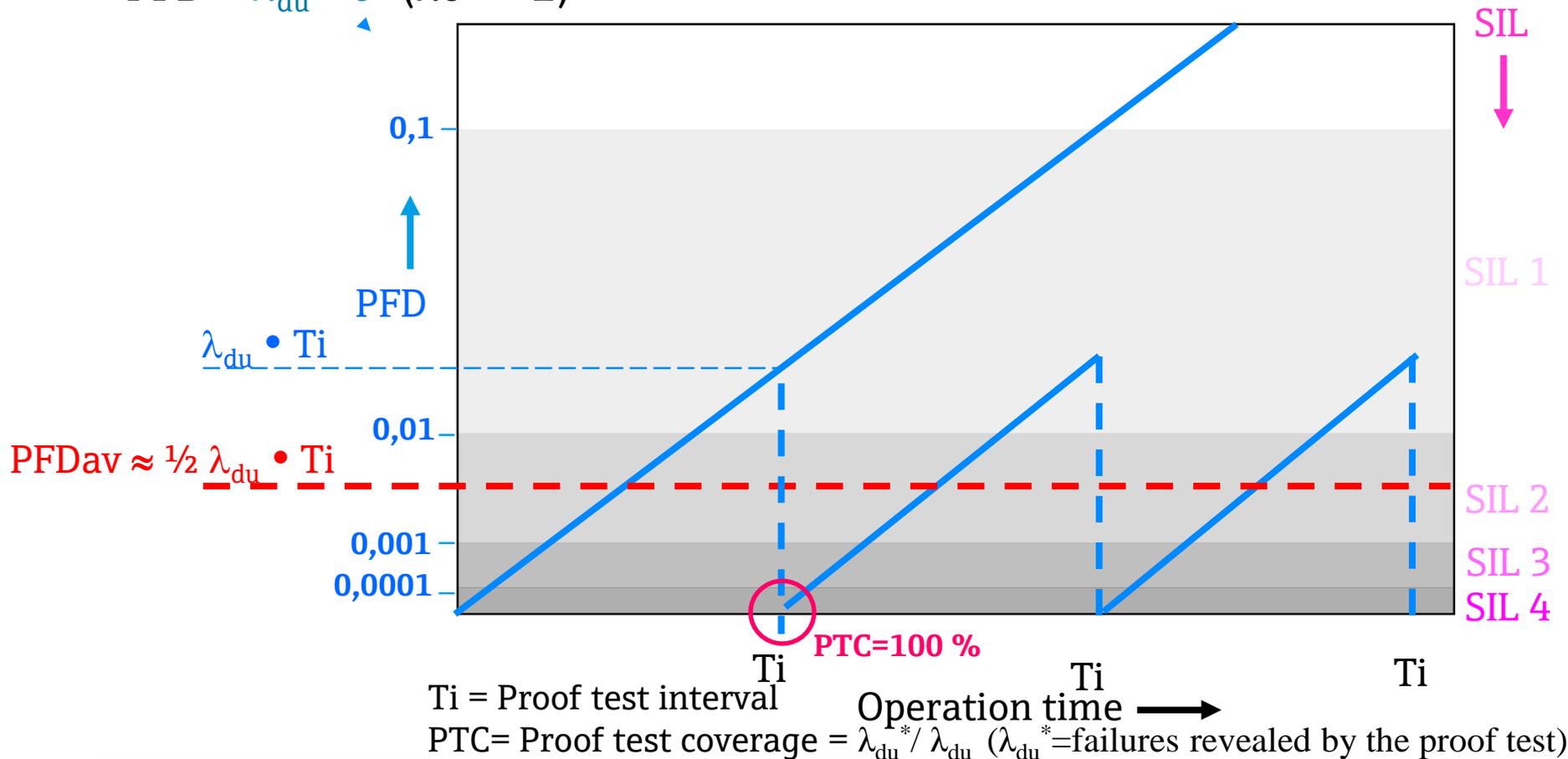
... not available



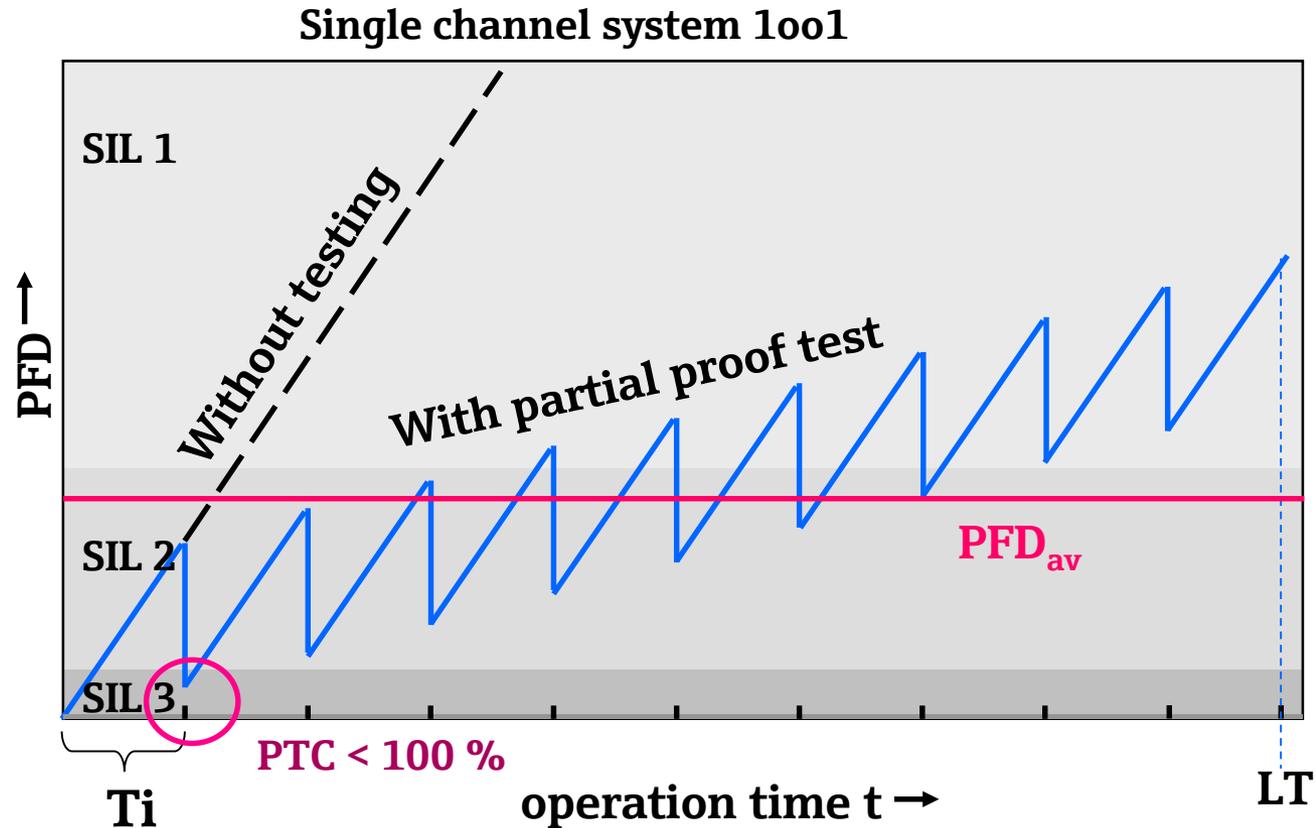
Probability of a failure on demand - PFD

Example: Safety component with low demand frequency ($\sim 1/a$)

$$PFD \approx \lambda_{du} \cdot t \quad (\lambda t \ll 1)$$



Partial Proof Testing (PTC < 100%)



$$PFD_{av} \approx \frac{1}{2} \lambda_{du} \times T_i \times PTC + \frac{1}{2} \lambda_{du} \times LT \times (1-PTC)$$

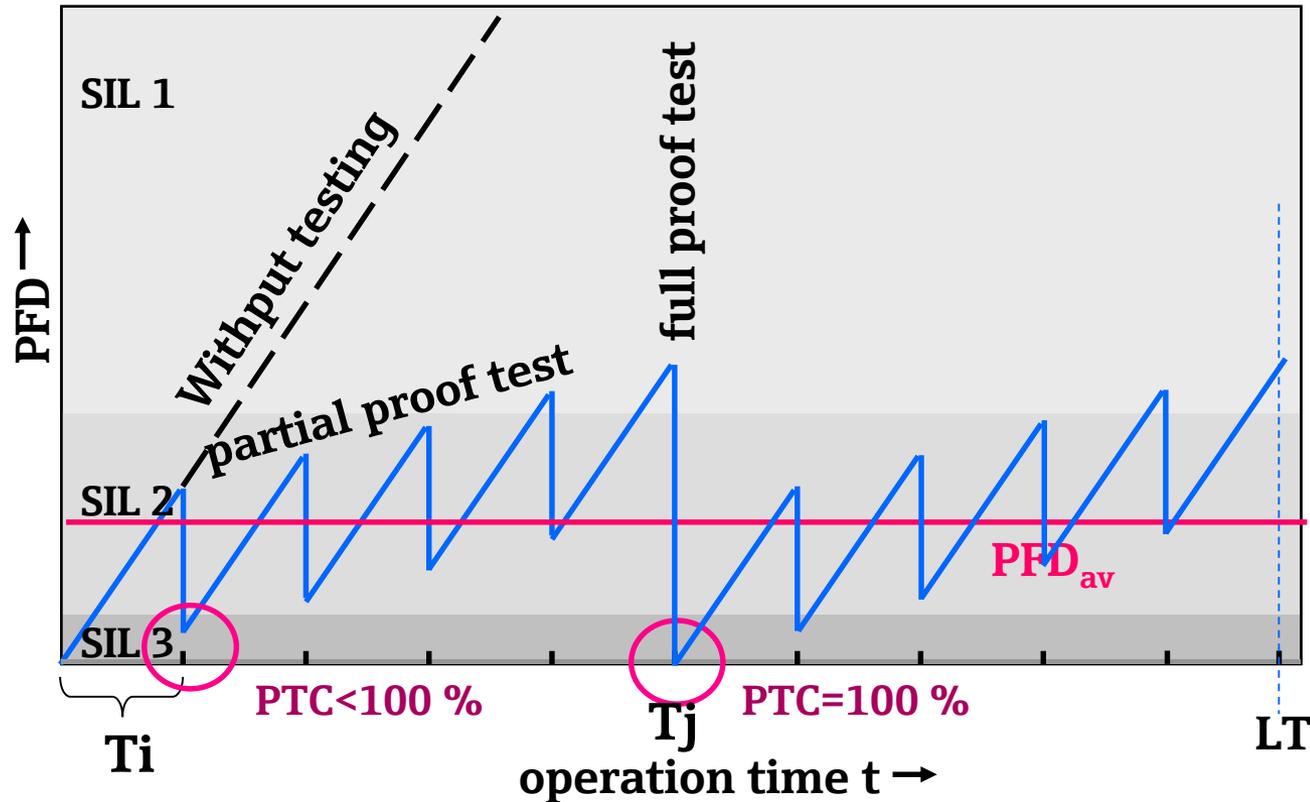
PTC = Proof test coverage (1=100 %)

T_i = Test interval

LT = life time

Partial Proof Testing + Full Proof Test

Single channel system 1ool



$$PFD_{av} \approx \frac{1}{2} \lambda_{du} \times T_i \times PTC + \frac{1}{2} \lambda_{du} \times T_j \times (1-PTC)$$

PTC= Proof Test Coverage (1=100 %)

T_i = Test interval (<100 %) T_j = Test interval (100%)

Constraints of the Hardware Architecture

- Device Type (Type)
- Safe Failure Fraction (SFF)
- Hardware-Failure Tolerance (HFT)

Device Types

- Device Type A (simple devices)

All faults determined

e.g. analogue electronic devices



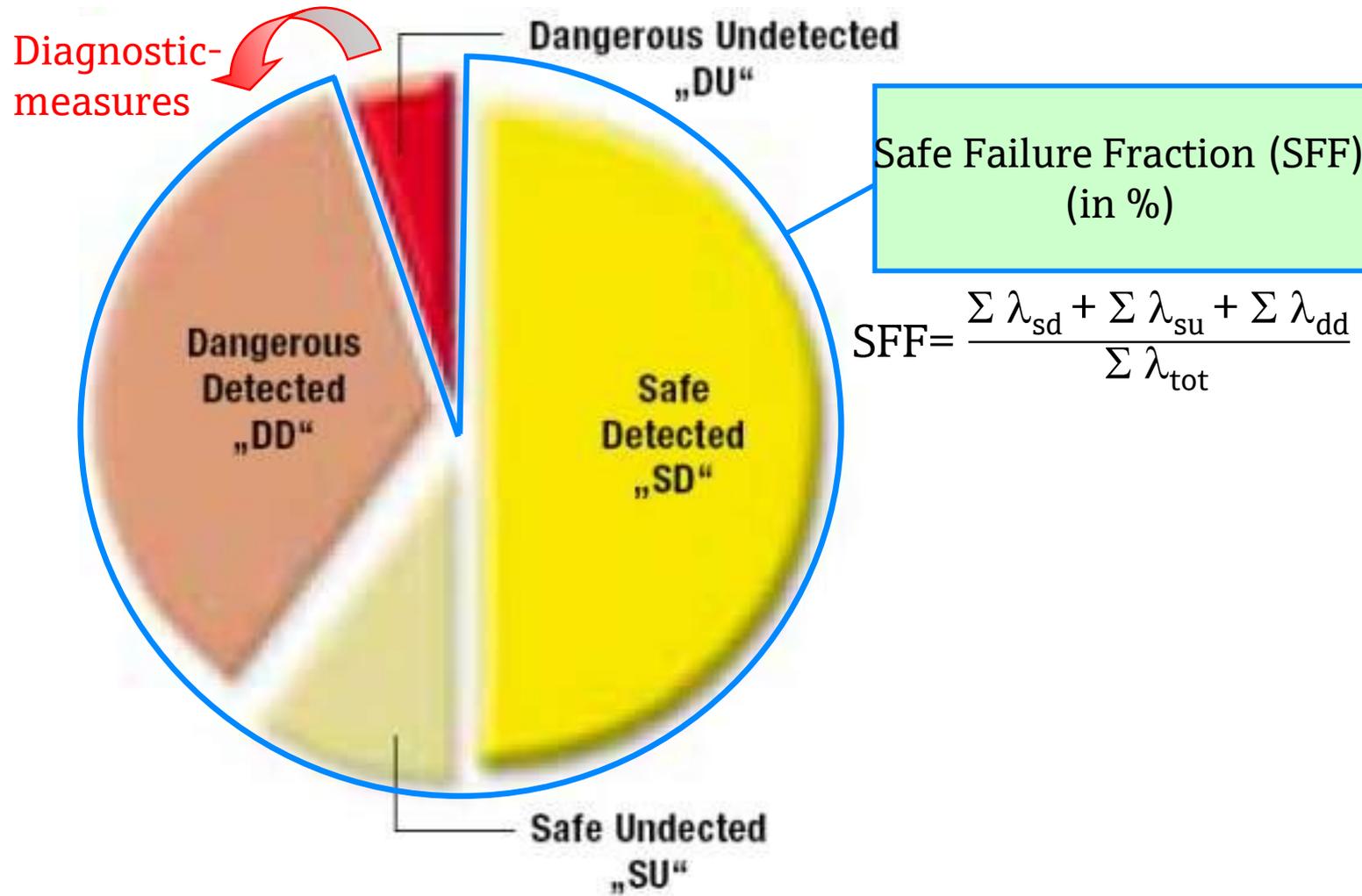
- Device Type B (complex devices)

Not all faults determined

e.g. μ P-controlled electrical/electronic devices

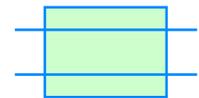
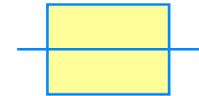


Safe Failure Fraction (SFF)

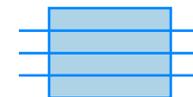
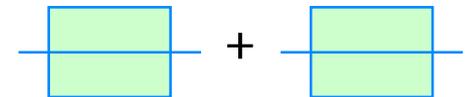


Hardware-Failure Tolerance (HFT)

- **HFT = 0** → no redundancy
1 fault → loss of safety function
- **HFT = 1** → redundant architecture
2 faults → loss of safety function
- **HFT = 2** → 3 channel architecture
3 faults → loss of safety function



oder



oder



How to determine architectural constraints?

Example: Device Type B, HFT = 0, SFF = 92% → SILmax ?

Safe Failure Fraction (SFF)	Hardware-Failure Tolerance (HFT) (Typ B - complex device)		
	0	1	2
< 60%	Not allowed	SIL 1	SIL 2
60% ... < 90%	SIL 1	SIL 2	SIL 3
90% ... < 99%	SIL 2	SIL 3	SIL 4
≥ 99%	SIL 3	SIL 4	SIL 4



Basic Safety Parameters

Probability of Failure on Demand: $PFD_{av} \approx 1/2 \lambda_{DU} \times T_p^*$

Safe Failure Fraction: $SFF = \frac{\sum \lambda_{sd} + \sum \lambda_{su} + \sum \lambda_{dd}}{\sum \lambda_{tot}}$

Hardware Fault Tolerance: $HFT = \text{No. of tol. Faults}$

Device Type: $\text{Type} = \text{A or B}$

* 1 channel System



Safety Integrity Level
SIL 1..4

Design of Safety Instrumented Systems

- Single Channel System
- Multi-Channel System

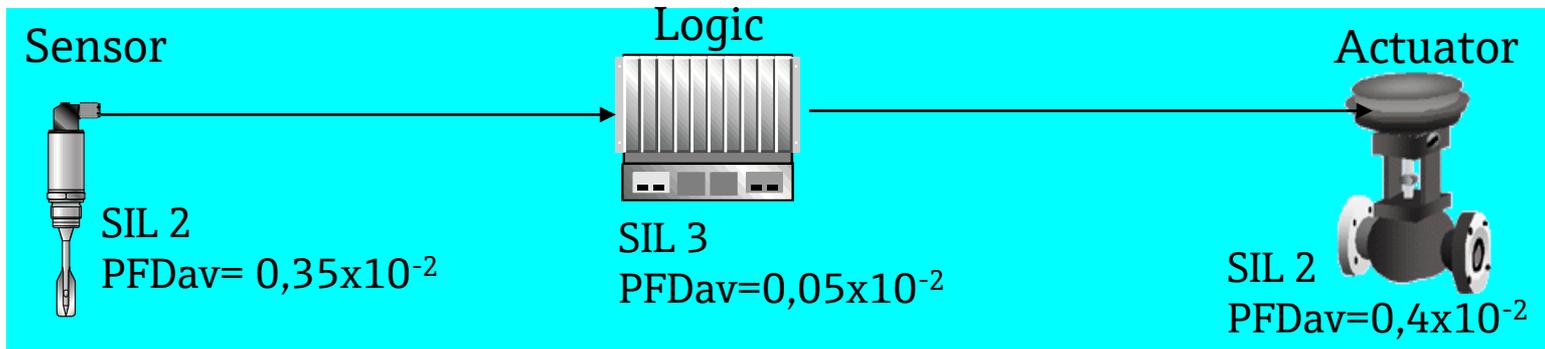
Single Channel System

Design rules

$$SIL_S, SIL_L, SIL_A \geq SIL_{system}$$

$$PFD_S + PFD_L + PFD_A < 10^{-SIL_{system}}$$

Example: single channel overflow protection



	Sensor	Steuerung	Aktor	System
SIL	2	3	2	≤2
PFD _{av}	0,3x10 ⁻²	0,05x10 ⁻²	0,4x10 ⁻²	0,71 x 10 ⁻²

➔ System = SIL 2

Multichannel Architecture

- Homogeneous and diverse Redundancy
- Design rules

Redundancy: Homogeneous or diverse?

Homogeneous Redundancy
(**same** instruments)

SIL 2 SIL 2



+

z.B. 1oo2
→ SIL 3?

Advantage of **homogeneous** system

- Control of random faults
- Simple stock management, commissioning, maintenance ...

Note: Systematic Integrity (e.g. Software) can not be enhanced!

Diverse Redundancy
(**different** instruments)

SIL 2 SIL 2



+

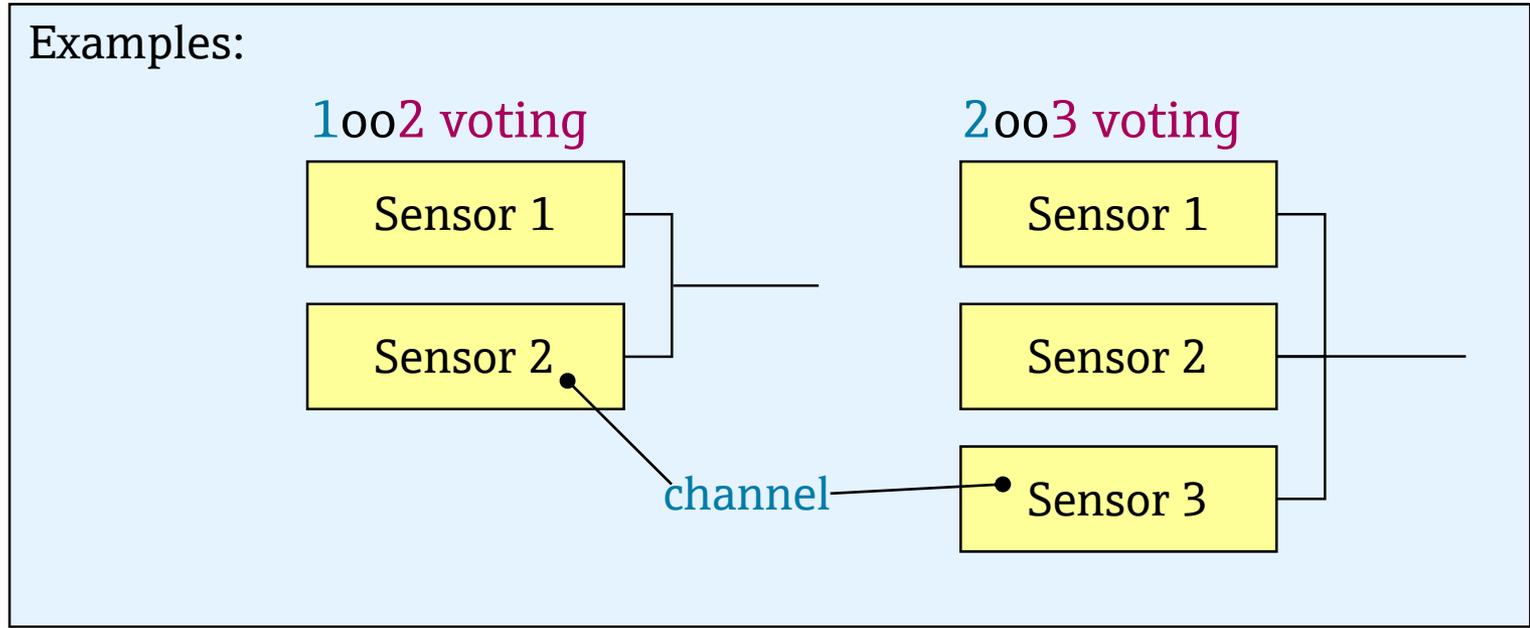
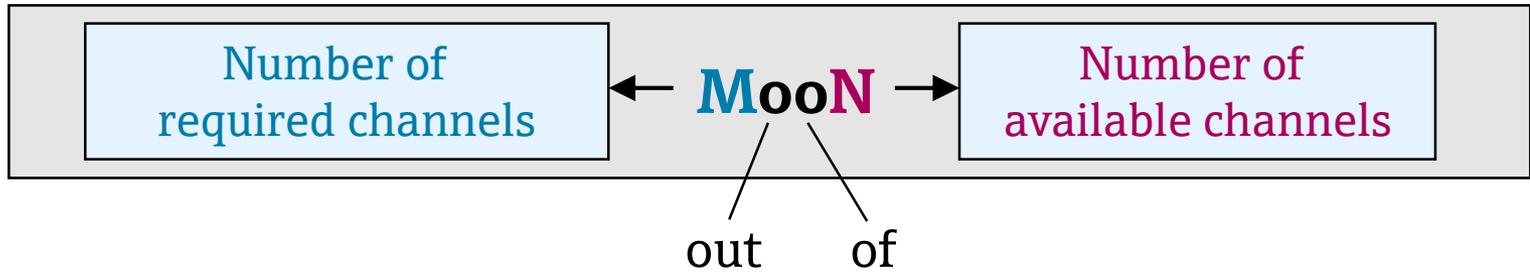
z.B. 1oo2
→ SIL 3

Advantage of **diverse** system

- Control of random and systematic faults (device + process)
- systematic integrity can be enhanced

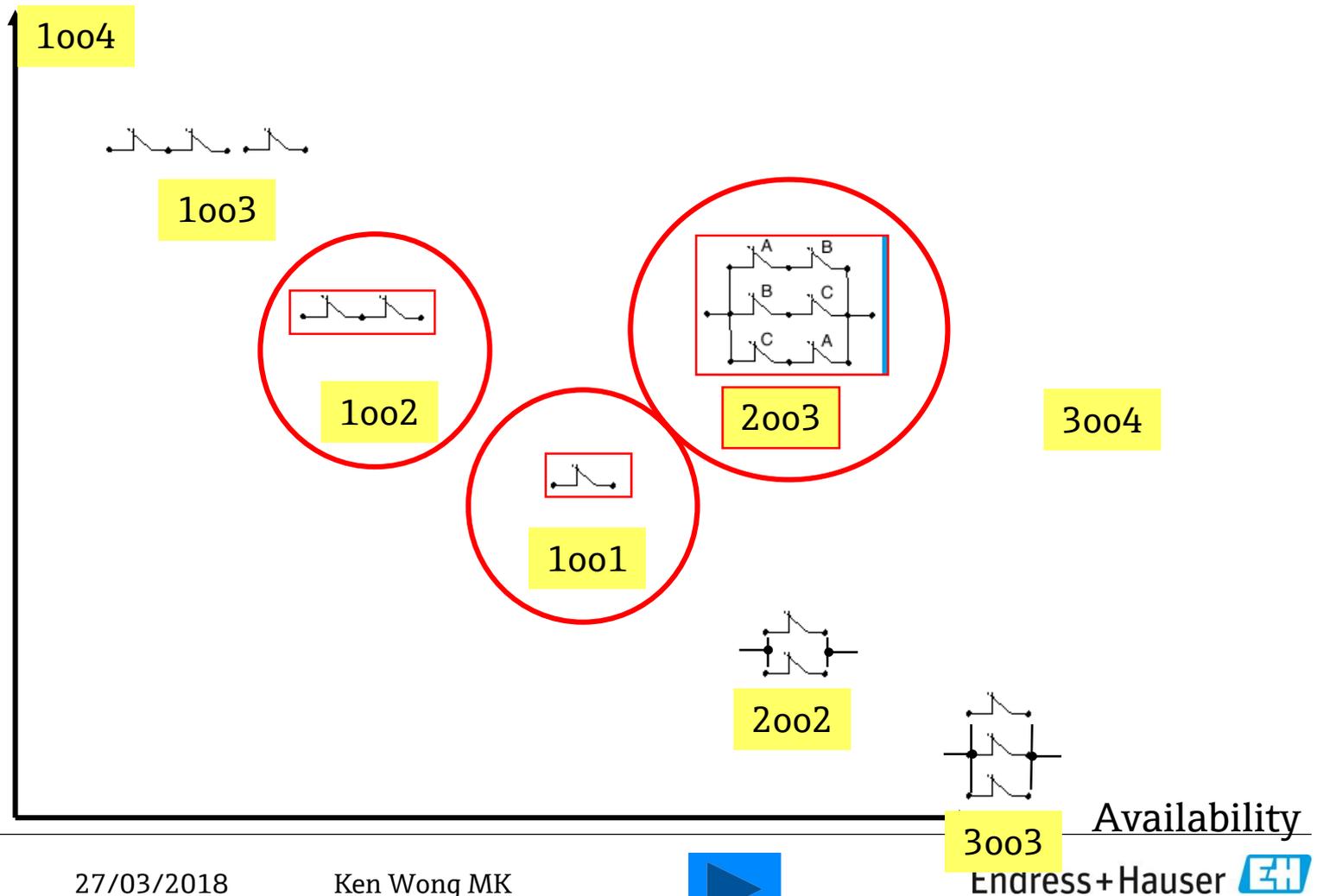


MooN voting rules



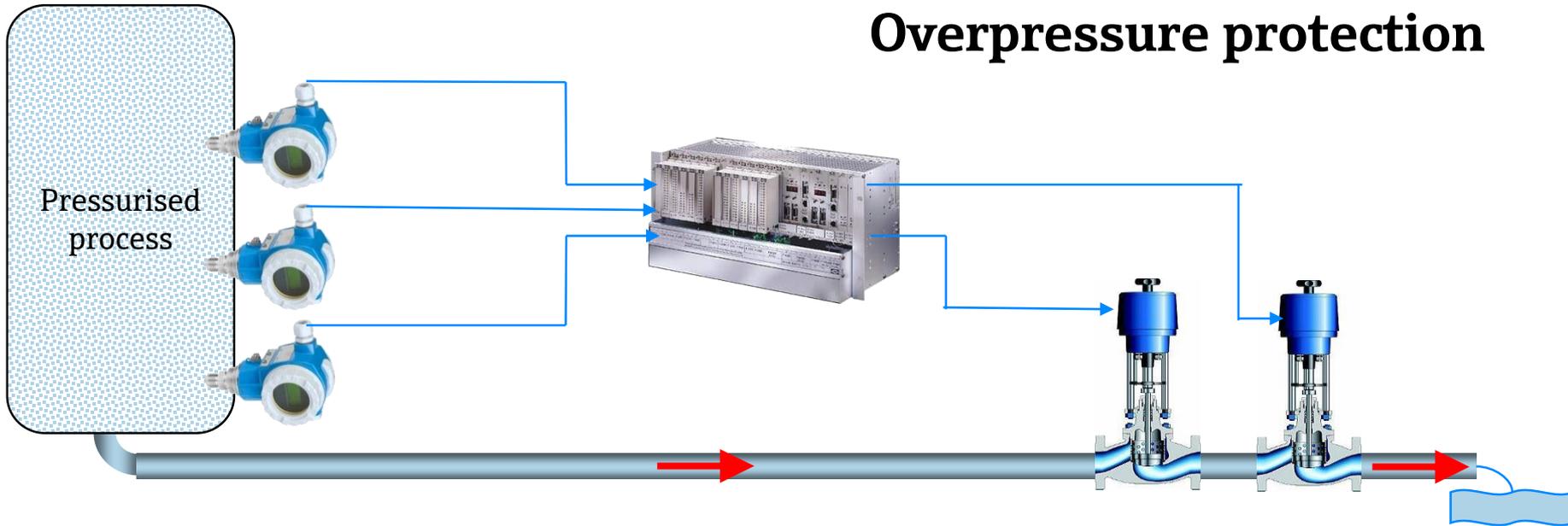
Design of Multi-Channel Systems

Safety

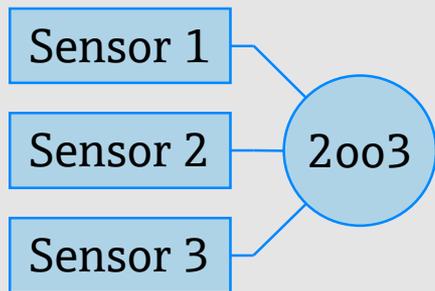


Design Rules of Multi-channel Systems

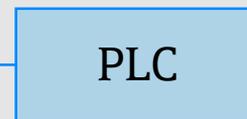
Overpressure protection



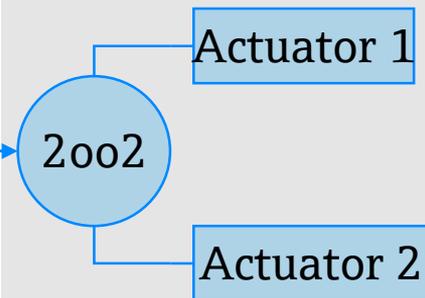
Subsystem Sensor



Subsystem Logik



Subsystem Actuator



Proof-testing with Endress+Hauser Instruments

- The Liquiphant Family
- Level Continuous
- Pressure
- Flow Instruments and Fieldcheck
- Overview of test procedures and parameters

Example 1- Level switch



Liquiphant M FTL 50/51

Liquiphant S FTL 70/71

Liquiphant S FDL 80/81/85 + FTL 825 Fail Safe



The Liquiphant Family – SIL qualified

SIL2 MIN/MAX



Liquiphant M FTL 50/51
Liquiphant S FTL 70/71

Electronic:

FEL51, 2-Wire AC

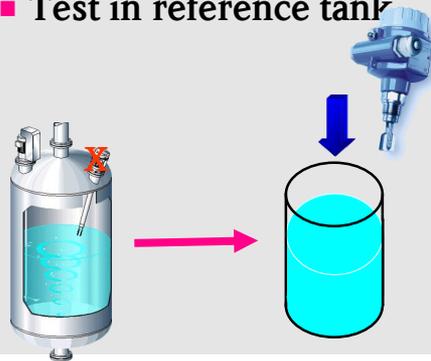
FEL52, 3-Wire DC-PNP

FEL54, AC/DC DPDT

FEL55, 8/16 mA

Periodic proof testing

- Wet testing or
- Test in reference tank



SIL3 MAX



Liquiphant M FTL50/51
Liquiphant S FTL70/71
+ FEL 57+ FTL3x5 P

Periodic proof testing

- Testgenerator (push-button)



Liquiphant M FTL50/51
Liquiphant S FTL70/71
+ FEL 57 + FTL3x5 P

Periodic proof testing

- Testgenerator (push-button)

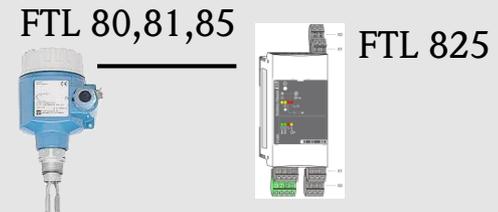
SIL 3 MIN/MAX



Liquiphant M FTL50/51
Liquiphant S FTL70/71
+ FEL 56/58 + FTL325N

Periodic proof testing

- Wet testing or
- Test in reference tank
- Alarm simulation (push-but)



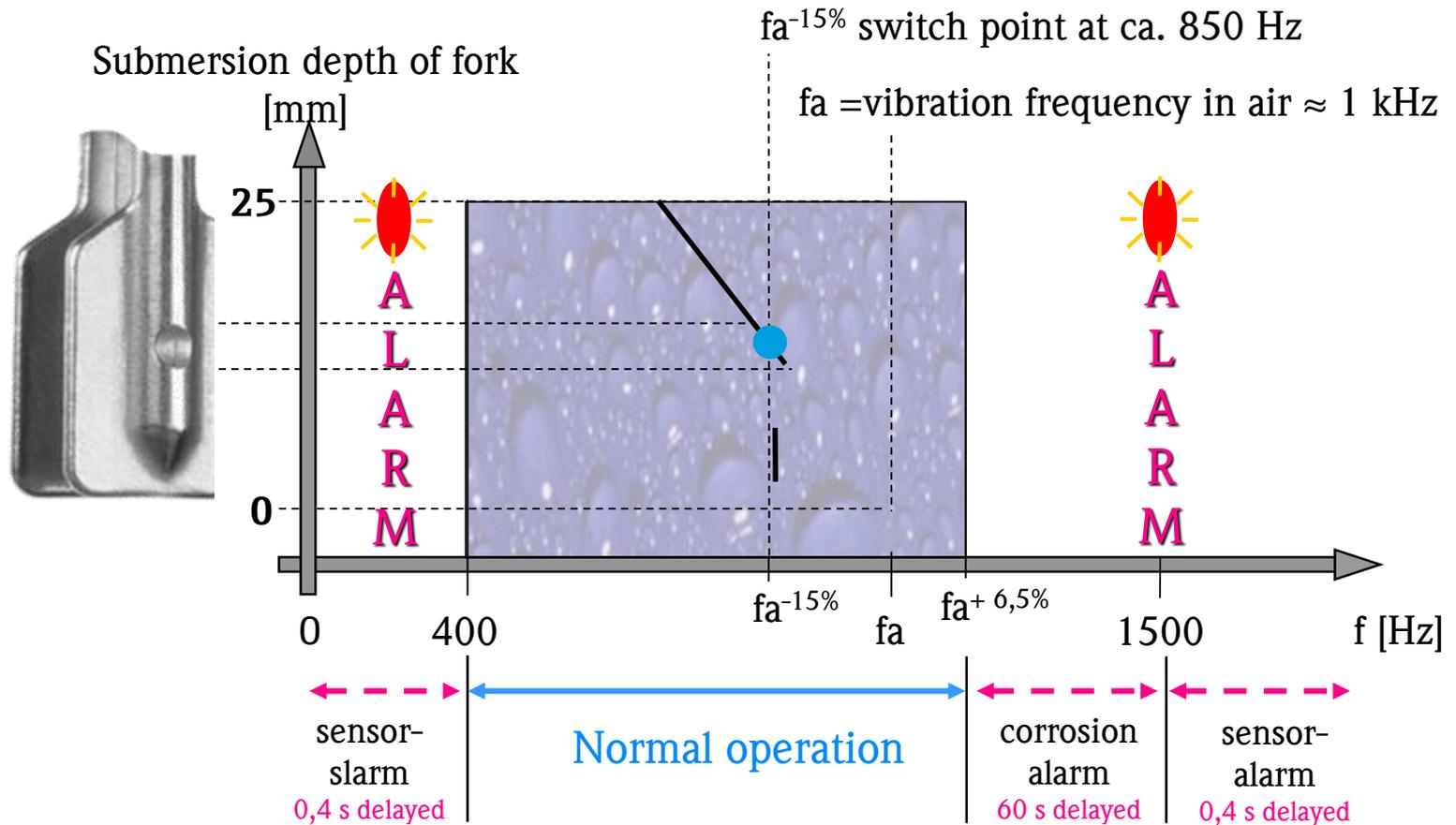
Liquiphant S Failsafe FTL8x
Nivotester FTL825

Periodic proof testing

- Continuous self-diagnostic
- Testgenerator (push-button)
- Proof test interval ≤ 12 years!

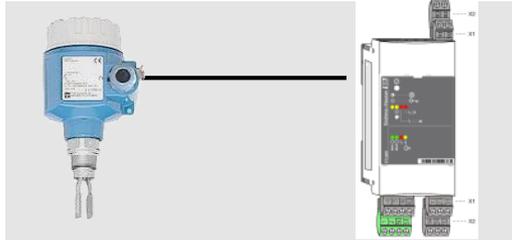
Self Diagnostics Liquiphant M/S (FEL 51... 67)

- Continuous monitoring of vibration frequency
- Reliable alarm funktion with each electronic insert!



New: Liquiphant Fail Safe FTL 80/81/85 + FTL 825

SIL3 MIN/MAX

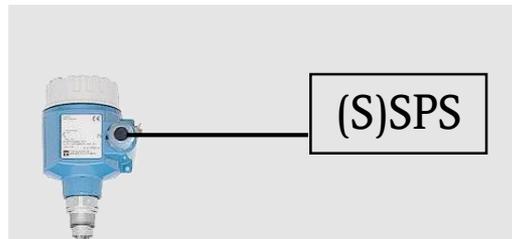


4..20mA +
LIVE-Signal

Liquiphant FailSafe FTL80/81/85
Nivotester FTL825

Safety function

- SIL 3 capable with **single** device
- **min/max safety** function
- **2** safety relay outputs (FTL 825)
- proof test generator with **push-button**
- proof test interval \leq **12 years** !



(S)SPS

4..20mA +
LIVE-Signal
Optional

Liquiphant FailSafe FTL80/81/85



Total Proof test coverage (DC+PTC) according to IEC 61508



Max

Total coverage (DC+PTC)	FTL80/81/85+ FTL825	FTL 80/81/85+ SSPS
Wet test	99% (Procedure IA MAX/MIN)	99% (Procedure IIA MAX/MIN)
Simulation (in situ testing!)	98 % (Procedure IB) (Testbutton: FEL85 od. FTL825)	95 % (Procedure IIB MAX/MIN) (Testbutton: FEL85)

Min

Example 2 – Level Continuous

Levelflex FMP 4x, FMP 5x

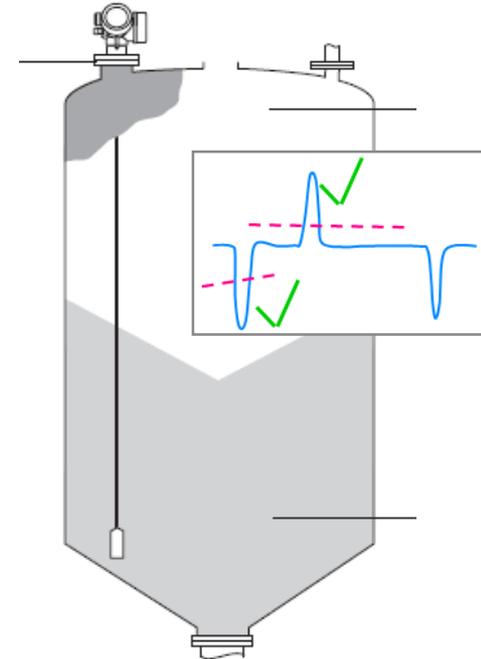
Micropilot M/S FMR xxx



Levelflex FMP 5x

Safety Function:

- **Level** of liquid or bulk solid material (4..20 mA)
- **Interface** between 2 liquids (4..20 mA)
- Min, max, range
- SIL 2 (1oo1), SIL 3 (1oo2)
- LDM, HDM



Proof test procedures:

Test criterion: Trip level $\pm 2\%$

- Wet testing in the application/reference tank (PTC \approx 98 %, Ti= 3 years)
- In-situ level simulation (PTC \approx 92 %, Ti= 1 year)
(no process shutdown required!)

Micropilot FMR 5x

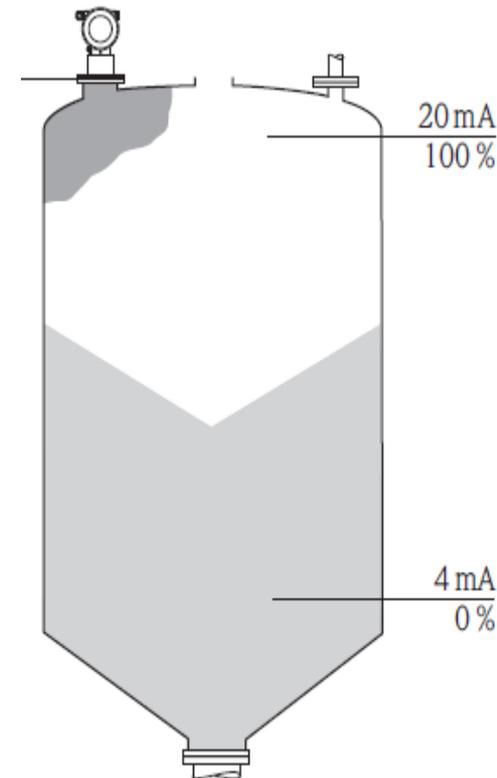
Safety Function:

- **Level** of liquid or bulk solid material (4..20 mA)
- Min, max, range
- SIL 2/3
- LDM, HDM

Proof test procedures:

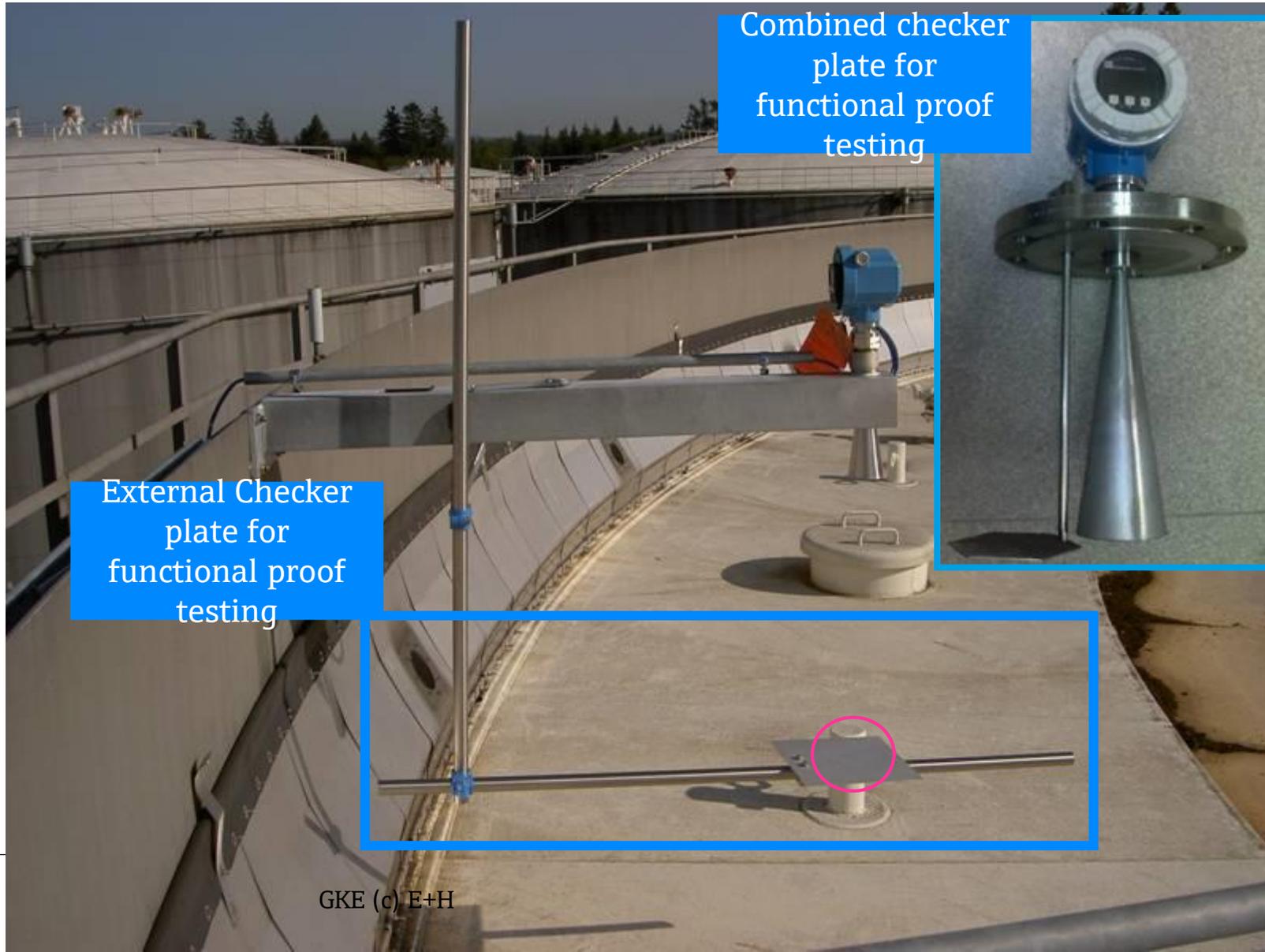
Test criterion: Trip level $\pm 2\%$

- Wet testing in the application (PTC $\approx 98\%$, Ti=2 years)
- Simulation (PTC $\approx 55\%$, Ti=1 year)



Proof testing with Level Radar

Independent High Level Alarms / Radar – Proof Testing external



Combined checker plate for functional proof testing

External Checker plate for functional proof testing



Example 3 - Pressure Measurement

Cerabar S PMC 71, PMP 71/72/75

Deltabar S PMD 70/75, FMD 76/77/78



Cerabar S, Deltabar S

Safety function

- Pressure, Level (4... 20 mA)
- min, max, range
- SIL 2 (1oo1), SIL 3 (1oo2)
- LDM, HDM



Proof test procedures:

- test with reference pressure ($T_i \leq 5$ years, $PTC \approx 99\%$)
- in-situ test with signal simulation ($T_i = 1$ year, $PTC \approx 50\%$)
tool: HART communication or Display keyboards

Test criterion: trip level $\pm 2\%$

Example 4 – Flow Measurement

Promass 80, 83 [Coriolis]

Promag 50, 53 [MID]

Prowirl 72, 73 [Vortex]



Promass 80, 83 Promag 50, 53 Prowirl 72,73

Safety function:

- Volume flow, Mass flow¹, density¹ (4...20 mA) ¹Promass only!
- Min, max, range
- SIL 2 (1oo1), SIL 3 (1oo2) ¹

Proof test procedures:

Test criterion: Trip level $\pm 2\%$

1. in- or off-line test with a **calibration rig** (PTC $\approx 98\%$, Ti ≤ 5 years)
mobile or factory calibration: volume flow, mass flow or density
2. in- or off-line test with the **integrated totaliser** (PTC $\approx 98\%$, Ti ≤ 5 years)
measuring a reference volume or mass
3. in-line test of density by **reference liquids**¹ (PTC $\approx 98\%$)
4. in-line test with the **Field Check** (PTC $\approx 90\%$, Ti = 1 year)
(volume flow, mass flow, density)
„Field Care“ \rightarrow **automatised data recording**
 \rightarrow calibration rig/totalizer test: ≤ 10 years

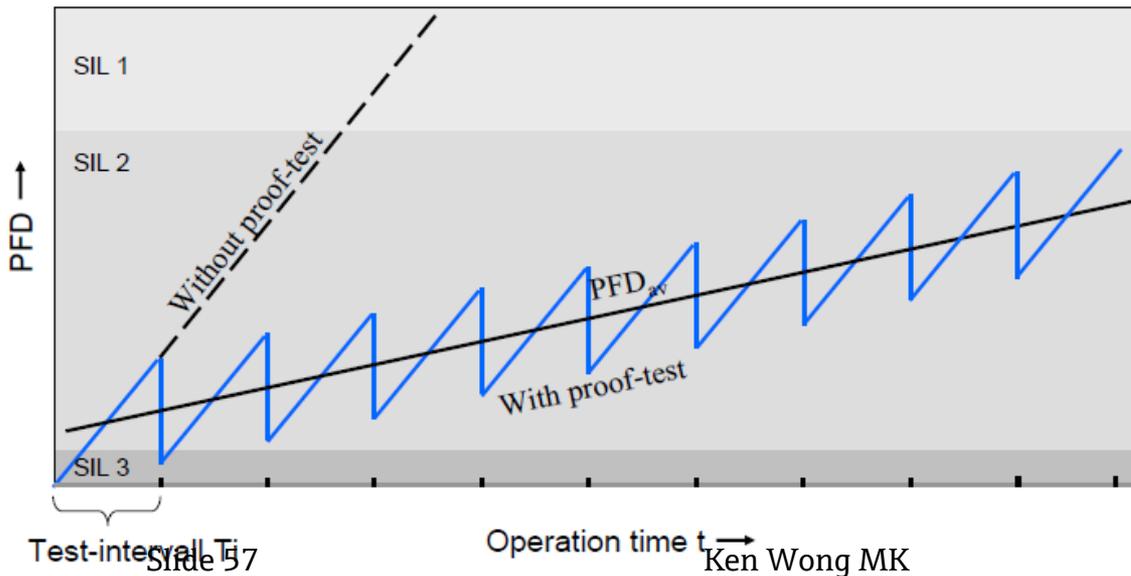
Flow Measurement - Easy proof testing

Example: Promag 50, 53 , Promass 80, 83

Proof-test methods, either

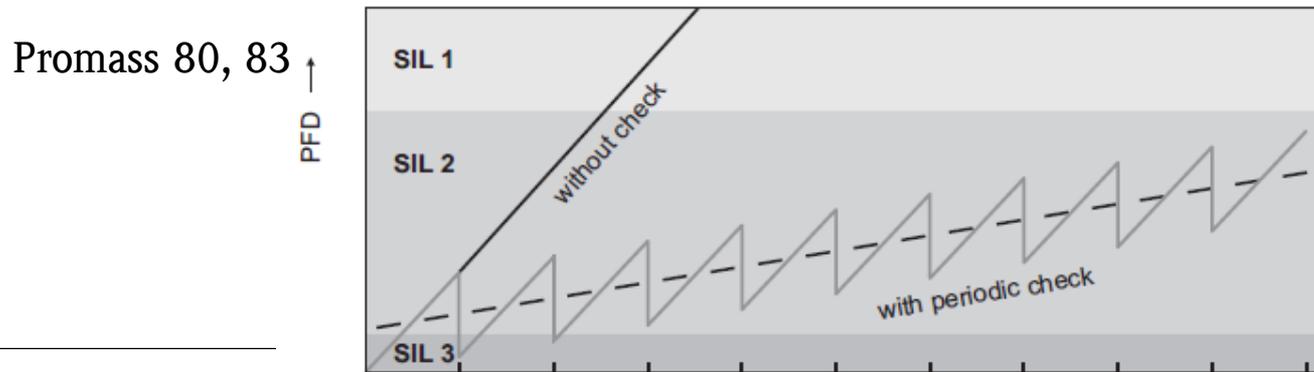
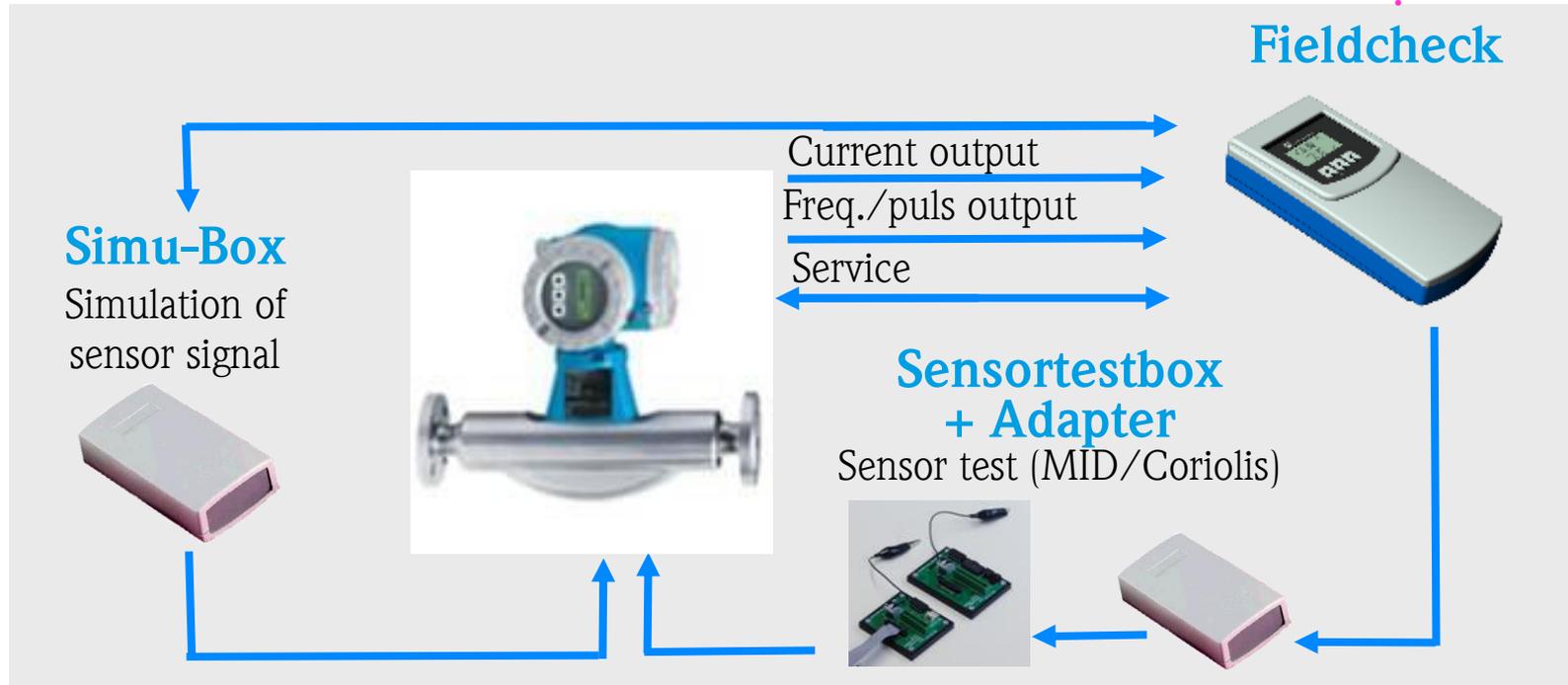
- Off-line proof test with **calibration rig**
- In-line proof test using the **totalizer** with balancing method
- In-line proof test by simulating partial proof-test with **fieldcheck**

Single channel system (1oo1)



Principle of the verification of an electromagnetic flowmeter with FieldCheck.

Partial proof test with Fieldcheck (PTC ≈ 90 %)



Fieldcheck: In-Line Verification Promass, Promag, Prowirl

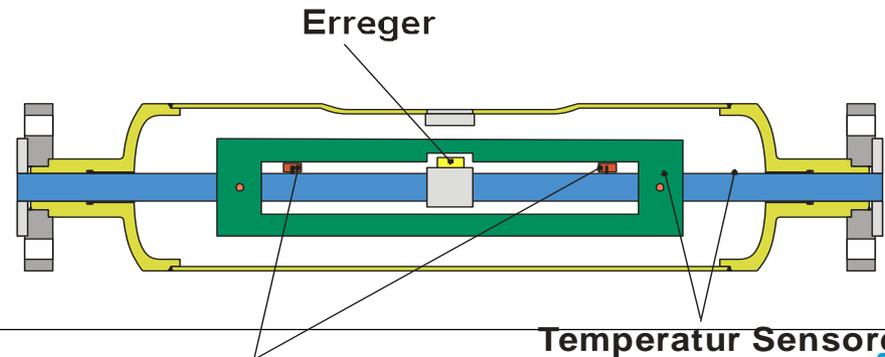
Transformer...

- Zero point verification of outputs
- Verification of signal processing
- Linearity check of measuring amplifier
- Linearity check of output signals



...sensor verification suitable to measuring principle, e.g. Promass

- Stimulating coils
- Signal coils
- Temperatur sensors



Example 5 - Temperature

iTEMP TMT 112/122/162/182



TMT 112



TMT 122



TMT 162



TMT 182



iTEMP TMT 112/122/162/182

Safety function:

- Temperature measurement (4...20 mA)
- Min, max, range
- SIL 2

Proof test procedures:

Test criterion: trip level $\pm 2\%$

- test with reference temperature measurement (PTC $\approx 98\%$)
- simulation with input resistor incl. short circuit/ interruption

Test interval:

- ≤ 1 year with 2/3-wire RTD or thermocouple („low stress“ $\leq 0,1$ g)
- ≤ 5 years with 4-wire RTD („low stress“ $\leq 0,1$ g)

Environmental Effect on Thermocouples/RTDs

Effect on Thermocouples/RTDs

- Failure rates for separate elements with „high stress“ $>0,1 g$ **20x higher!**

Example:

<i>Thermocouple Failure Mode Distribution (close coupled)</i>	Low Stress Fit	Percentage	High Stress	Percentage
Open Circuit (Burn-out)	95	95%	1900	95%
Short Circuit (Temperature measurement in error)	4	4%	80	4%
Drift (Temperature measurement in error)	1	1%	20	1%
	<i>total</i>	<i>total</i>	<i>total</i>	<i>total</i>
	100	100%	2000	100%

Overview Proof-tests E+H Instruments

Device	Type	Electronic	SIL	Safety function	Proof test procedure	Proof test interval	Proof test coverage	Tolerance
Liquiphant M/S	FTL 5x FTL 7x	FEL51,52, 54,55,56,58	2	min/max	Wet test Test-button ¹⁾	≤ 5 years On request	98 % --	--
Liquiphant M/S	FTL 5x FTL 7x	FEL57 (PFM)	2 (3)	min/max max	Wet test Test-button ²⁾	≤ 5 years ³⁾ ≤ 1 year	98 % 90 %	--
Liquiphant FS	FTL 8x		3	min/max	Wet test Test-button ¹⁾	≤ 12 years On request	98 %	--
Levelflex	FMP 5x		2 (3)	min/max/ range Interface	Wet test Test simulation	≤ 3 years ≤ 1 year	98 % 92 %	± 2 %
Micropilot	FMR 5x		2 (3)	min/max/ range	Wet test Test simulation	≤ 2 years ≤ 1 year	98 % 55 %	± 2 %
Cerabar S Deltabar S	PMC PMP		2 (3)	min/max/ range	Wet test Test simulation	≤ 5 years	98 % 50 %	± 2 %

¹⁾ test only subsequent safety loop

²⁾ complete test simulation

³⁾ only low density media (<0,7)

Overview Proof-tests E+H Instruments

Device	Type	Electronic	SIL	Safety function	Proof test procedure	Proof test interval	Proof test coverage	Tolerance
Promass	80,83		2 (3)	volume mass/density Min/max/ range	Calibration Totalizer Field check	≤ 5 years ≤ 5 years ≤ 1 year	98 % 98 % 90 %	Reference accuracy
Promass 200	E200 F200		2 (3)	volume mass/density Min/max/ range	Calibration Totalizer	≤ 5 years ≤ 5 years ≤ 1 year	98 % 98 % 90 %	Reference accuracy
Promag Prowirl	50/53 72/73		2	Min/max/ range	Calibration Fieldcheck	≤ 5 years ≤ 1 year	98 % 90 %	Reference accuracy
Temperatur iTemp	TMT 1x2		2	min./max/ range	Calibration with reference resistor	≤ 1 year ⁴⁾ ≤ 5 years ⁵⁾	98 %	±2 %

⁴⁾ 2/3 wire RTD or thermocouple (low stress environment ≤ 0,1 g)

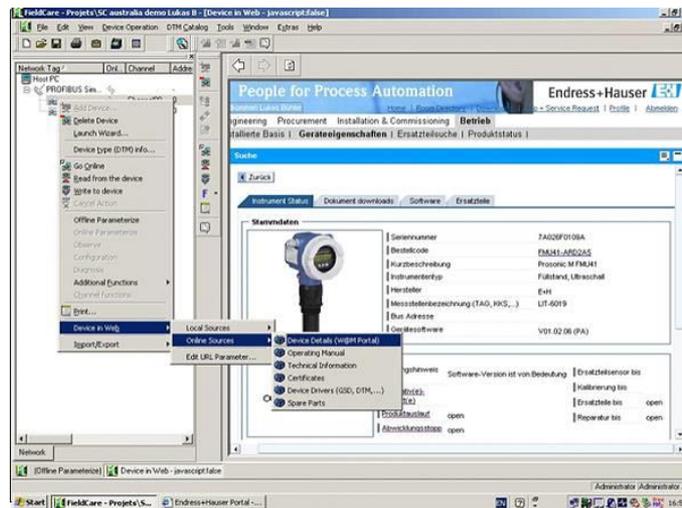
⁵⁾ 4 wire RTD (low stress environment ≤ 0,1 g)

Proof-Test Documentation W@M Lifecycle Management



Proof-Test Documentation with Fieldcare

- Electronic data recording and documentation on PC
- W@M Life cycle management
 - Upload of Data with Fieldcare/Fieldtool into Common Equipment Record (CER)
 - Integration into computer based maintenance systems e.g. SAP Plant Maintenance, IBM Maximo, Datastream7i, Comos PT



Functional Proof Testing of SIS Process Automation

Herzlich Willkommen, Max Muster

Start Planung Beschaffung **Installation, Inbetriebnahme, Betrieb**

Installed Base Assistant Produktstatus Ersatzteilsuche Download Area Statusbericht

Installation, Inbetriebnahme, Betrieb > **Installed Base Assistant**

Navigation Analyse

Ansicht: Standort



- MUSTER AG
 - A - Aufbereitung
 - B - Produktion
 - Abwasserbehandl.
 - Produktion A
 - B 227
 - FIC 220**
 - Leimschmelz
 - LIC 221 -
 - LIC 225
 - LT 101
 - PIC 225
 - QIC 222
 - QIT 002
 - Reserve_Dr.
 - TC 224
 - TC 226
 - TC 227
 - Produktion B
 - C - Logistik
 - D - Unterhalt
 - E - Pumpwerk
 - Rohstoffsilo 1 (Freig)
 - Rohstoffsilo 2 (Freig)
 - Tank 1 - NaOH
 - Tank 2 - HCL
 - Tank 3 - H2SO4
 - Tank 4 - HCL
 - Y - Entsorgung

TAG / KKS FIC 220
 Bestellcode 53H65-A00B1AA0AAAJ
 Gerätetyp Magnetisch-Induktive Durchflussmessung
 Hersteller Endress+Hauser
 Offene Aktivitäten (2)



MUSTER AG
 9403 Goldach
 Schweiz

Übersicht Details Anhänge (9) Ersatzteile **Logbuch** Weitere Produktinformationen

TAG / KKS FIC 220
 Seriennummer 620E4419000
 Bestellcode 53H65-A00B1AA0AAAJ
 Kurzname Promag 53H
 Gerätetyp Magnetisch-Induktive Durchflu
 Hersteller Endress+Hauser
 Herstellungsdatum 2004
 Software Version
 Anmerkungen
 Messbereich
 Messaufgabe



Umgebungsbedingungen Normal
 Kritikalität Hoch
 Instandsetzungsrisiko Gering

Standortinformationen
Produktstatus Verfügbar

People for Process Automation

Herzlich Willkommen, Max Muster

Hilfe

Start Planung Beschaffung **Installation, Inbetriebnahme, Betrieb**

Installed Base Assistant Produktstatus Ersatzteilsuche Download Area Statusbericht

Installation, Inbetriebnahme, Betrieb > Installed Base Assistant

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- Rohstoffsilo 2 (Freig)
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- Tank 2 - HCL
- Tank 3 - H2SO4
- Tank 4 - HCL
- Y - Entsorgung
- Zentrallager
- neu geliefert

TAG / KKS FIC 220

Bestellcode 53H65-A00B1AA0AAAJ

Gerätetyp Magnetisch-Induktive Durchflussmessung

Hersteller Endress+Hauser

Offene Aktivitäten (2)



MUSTER AG

9403 Goldach
Schweiz

Übersicht Details Anhänge (9) Ersatzteile **Logbuch** Weitere Produktinformationen

Ereignisliste		
Datum	Kategorie	
11.03.04	Produktion	
11.08.09	Betrieb	
03.11.09	Kalibrierung	
17.12.09	Kalibrierung	
04.01.10	Betrieb	
12.02.10	Kalibrierung	
25.02.10	Reparatur	
22.03.10	Kalibrierung	
22.03.10	Kalibrierung	
22.03.10	Kalibrierung	
22.06.10	Kalibrierung	
22.06.10	Kalibrierung	
22.06.10	Konfiguration	
12.11.10	Kalibrierung	
01.02.12	Wartung	

15 von 15

Kategorie Wartung

Short Description Wartung

Description Bitte gerät jährlich warten...

Due date 30.09.10

Responsible Max Muster

History
 1.2.2012 Max Muster State changed from:'in_work' to:'done'
 20.9.2010 Max Muster State changed from:'planned' to:'in_work'

People for Process Automation

Herzlich Willkommen, Max Muster

Start | Planung | Beschaffung | **Installation, Inbetriebnahme, Betrieb**

Installed Base Assistant | Produktstatus | Ersatzteilsuche | Download Area | Statusbericht

Installation, Inbetriebnahme, Betrieb > **Installed Base Assistant**

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TAG / KKS FIC 220
 Bestellcode 53H65-A00B1AA0AAAJ
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 Hersteller Endress+Hauser
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MUSTER AG
 9403 Goldach
 Schweiz

Übersicht | Details | **Anhänge (9)** | Ersatzteile | Logbuch | Weitere Produktinformationen

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 Bestellcode 53H65-A00B1AA0AAAJ
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 Hersteller Endress+Hauser
 Herstellungsdatum 2004
 Software Version
 Anmerkungen
 Messbereich
 Messaufgabe



Umgebungsbedingungen Normal
 Kritikalität Hoch
 Instandsetzungsrisiko Gering

Standortinformationen
 Produktstatus Verfügbar

Herzlich Willkommen, Max Muster

Hilfe | Profil | Abmelden

Start | Planung | Beschaffung | **Installation, Inbetriebnahme, Betrieb**

Installed Base Assistant | Produktstatus | Ersatzteilsuche | Download Area | Statusbericht

Installation, Inbetriebnahme, Betrieb > **Installed Base Assistant**

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 - Tank 3 - H2S04
 - Tank 4 - HCL
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 - Zentrallager
 - neu geliefert

TAG / KKS FIC 220
 Bestellcode 53H65-A00B1AA0AAAJ
 Gerätetyp Magnetisch-Induktive Durchflussmessung
 Hersteller Endress+Hauser

Offene Aktivitäten (2)



MUSTER AG

9403 Goldach
Schweiz

Übersicht | Details | **Anhänge (9)** | Ersatzteile | Logbuch | Weitere Produktinformationen

Name	Kategorie	Typ	Version	Sprache
<u>FieldCareConfiguration_100622_Promag / 53 / V1.02.0x.pdf</u>				
Durchflussskalibrierung	Kalibrierprotokoll	Dokument	2004.02.26	Deutsch
<u>Promag 53 PROFIBUS-DP/-PA BeschreibungGerätefunktionen</u>	Betriebsanleitung	Dokument	2001.04.01	Deutsch
<u>Promag 53 PROFIBUS-DP/-PA Betriebsanleitung</u>	Betriebsanleitung	Dokument	2003.10.15	Deutsch
<u>PROline Promag 53 PROFIBUS-DP/-PA ATEX II 2G Ex documentation</u>	Sicherheit	Dokument	2003.12.15	Deutsch
<u>PROline Promag 53 PROFIBUS-DP/-PA ATEX II 3G Ex documentation</u>	Sicherheit	Dokument	2001.11.01	Deutsch
<u>Proline Promag H Sonderdokumentation Specialdocumentation Documentation special</u>	Sicherheit	Dokument	2003.12.01	Deutsch
<u>PROMAG 50/53 H Technische I</u>	Technische Information	Dokument	2004.02.01	Deutsch
<u>Field Service Report</u>	Service Bericht	Dokument	2010.01.05	Deutsch

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Details

Weitere Dokumente finden Sie unter 'Weitere Produktinformationen'

Proof-Test protocol: Example Micropilot S

System-specific data		
Company	Mustermann AG	
Measuring points / TAG no.		
System		
Device type / Order code		
Serial number of device		
Name		
Date		
Signature		
Device-specific commissioning parameters		
Empty calibration		
Full calibration		
Proof-test protocol		
Test stage	Set point	Actual value
1. Current value 1		
2. Current value 2		
3. If necessary current value 3		
4. If necessary current value 4		
5. If necessary current value 5		

Endress+Hauser Service

- Periodic Proof-tests
- Calibration Service



Endress+Hauser Verification and Proof-Test Service

- Periodic **verification** with Fieldcheck
 - Promass
 - Promag
 - Prowirl
- Proof-Test via **Calibration Service**
- Electronic **data recording** and **Documentation**



Order Code Structures for SIL devices

3 Options:

1. Older devices assessed by **proven-in-use experience**
(e.g. Levelflex FMP 4x, Promass 80)
 - order standard device 4...20 mA
 - order safety manual separately or
 - download safety manual from www.endress.com/SIL
2. Cerabar, Deltabar
 - order standard device with SIL –Declaration of conformity (back-pack)
 - device is delivered with safety manual, SIL Declaration of Conformity with serial No. of product, SIL marking
3. New products **developed acc. to IEC 61508**
(e.g. Levelflex FMP 5x, Promass 200)
 - order SIL device (separate order code)
 - device is delivered with safety manual, declaration of conformity/Certificate, SIL marking

Functional Safety - Related documentation

micropilot M FMR 240 Level-Radar
Operating Instructions

Differenzdruck-Transmitter deltabar S
deltabar S FMD 230/630/633 mit 4...20 mA Ausgangssignal
Handbuch zur Funktionalen Sicherheit

ENDRESS + HAUSER

TÜV LTV Standort Berlin-Brandenburg

Conformitätserklärung
Die Sicherheit eines Standarddruckaufnehmers nach (SIEC)1311(FDR):

Häuser GmbH+Co. KG, Hauptstrasse 1, 79689 Maulburg
Hersteller, des der Differenzdrucktransmitter

Delatbar S FMD230, FMD306/633, FMD230, FMD230 (4...20 mA)

Besteht in einer sicherheitsrelevanten Anwendung bei einschließl. SIL 2 entsprechend auf der IEC 61511-1 geeignet zu, wenn folgende Sicherheitsparameter beachtet

Die der sicherheitskritischer und gefährlichen Zustände führt unter der Annahme einer Funktionsstörung folgende Parameter:

Lebensdauer	2
max. Fehleranzahl	0 (unkünftige Verwendung)
FMD230	FMD230
FMD306/633	FMD306/633

Wahrscheinlichkeit für gefährlichen Fehler) : 81,9 % 82,9 %
 (Wahrscheinlichkeit für gefährlichen Ausfall) : 5,89 x 10⁻⁶ 6,55 x 10⁻⁶
 (Wahrscheinlichkeit für gefährlichen Ausfall) : 156 Jahre 141 Jahre
 Fehlerrate (potenzielle einzelne / mehrere Fehler) : 606 FIT 682 FIT
 (max. gefährliche unentdeckte Fehler) : 134,5 FIT 138,2 FIT

Regel 11.4 der IEC 61511
 Das Risiko wird durch SIL 2 (SIL 2) bewertet das für SIL 2 definierten Bereichs,
 an den Nachweis der Betriebszuverlässigkeit wurde das Gerät einschließlich der
 und des Änderungsstands beurteilt.

3.29. Januar 2003
 Häuser GmbH+Co. KG
 Projektleiter

Endress + Hauser
The Power of Know How

Endress + Hauser
The Power of Know How

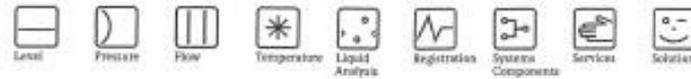
www.endress.com/SIL

Engine

Safety Manual

- includes:
- manufacturer declaration
 - fundamental safety parameters
 - assessment report
 - application information
 - parameter settings





SIL-Konformitätserklärung

Funktionale Sicherheit nach IEC 61508

Gerät/Device	Micropilot FMR50/51/52/53/54/56/57
Handbuch zur Funktionalen Sicherheit/ Functional safety manual	SD001087F/00
Sicherheitsfunktion/Safety function	MIN, MAX, Bereich/Range
SIL	2, 3 * ³
HFT	0
Gerätetyp/Device type	B
Betriebsart/Mode of operation	Low demand mode, High demand mode
SFF	92 %
PFD _{avg} * ¹ T ₁ = 1 Jahr/year (einkanalig/single channel)	1.09 × 10 ⁻³
PFD _{avg} * ¹ T ₁ = 2 Jahre/years (einkanalig/single channel)	2.17 × 10 ⁻³
PFH	2.45 × 10 ⁻⁷ 1/h
λ _{tot} * ²	15 FIT
λ _{su} * ²	520 FIT
λ _{cd} * ²	2438 FIT
λ _{du} * ²	245 FIT
λ _{sc} * ²	3218 FIT
MTBF * ⁴	50 Jahre/years

Safety Manual at “www.endress.com/SIL”

The screenshot shows the product page for Levelflex M FMP 40. The top navigation bar includes: [Homepage](#) [PRODUKTE](#) [Produktprogramm](#) [Füllstand](#) [Kontinuierlich / flüssig](#) [Radar](#) [Geführtes Radar](#) [Ultraschall](#) [Kapazitiv](#) [Hydrostatisch](#) [Differenzdruck](#) [Radiometrisch](#) [Spezifikationsblatt](#). The main content area features the product name **Levelflex M FMP 40** and a description: "Smart Transmitter für kontinuierliche Füllstandmessung in Schüttgütern und Flüssigkeiten. Preiswerte 4...20 mA-Zweidrahttechnik. Geeignet für den Einsatz im Ex-Bereich." Below this is an image of the device and an "Einsatzbereich" section. A red dotted circle highlights the "Download (FMP40)" and "Zertifikate (FMP40)" links. A red arrow points from this circle to the "SIL" option in the "Approval Type" dropdown menu.

Navigation: [Home](#) [PRODUKTE](#) [Produktprogramm](#) [Füllstand](#) [Kontinuierlich / flüssig](#) [Radar](#) [Geführtes Radar](#) [Ultraschall](#) [Kapazitiv](#) [Hydrostatisch](#) [Differenzdruck](#) [Radiometrisch](#) [Spezifikationsblatt](#)

Füllstand

- Zusätzliche Informationen
- FMP 40
- FMP 41 C

Levelflex M FMP 40

Smart Transmitter für kontinuierliche Füllstandmessung in Schüttgütern und Flüssigkeiten. Preiswerte 4...20 mA-Zweidrahttechnik. Geeignet für den Einsatz im Ex-Bereich.

Einsatzbereich
Der Levelflex M dient der kontinuierlichen Füllstandmessung von pulverförmigen bis körnigen Schüttgütern z.B. Kunststoffgranulat und Flüssigkeiten. Alle Sonden mit Prozessanschlüssen ab ¾" und Flansche ab DN40 / 1 ½" verfügbar.

- Seilsonden, vor allem zur Messung in Schüttgütern, Messbereich bis 35 m

Suche
Seitenübersicht
Kontakt
AGB/Disclaimer
[Download](#)
[My Focus](#)

Weitere Info:
[Download \(FMP40\)](#)
[Zertifikate \(FMP40\)](#)

Navigation: [Home](#) [PRODUKTE](#) [Produktprogramm](#) [Füllstand](#) [Kontinuierlich / flüssig](#) [Radar](#) [Geführtes Radar](#) [Ultraschall](#) [Kapazitiv](#) [Hydrostatisch](#) [Differenzdruck](#) [Radiometrisch](#) [Spezifikationsblatt](#)

Füllstand

- Zusätzliche Informationen
- FMP 40
- FMP 41 C

Levelflex M (FMP40)

There are several Approval Types found concerning to the given product. Would you please select an Approval Type, to display them.

Approval Type:

- EC-Declaration
- North America
- FM...
- CSA...
- Others
- MARINE ...
- East Europe...
- ASIA...
- Fieldbus conforma...
- SIL...
- Australia...

Safety Manual

The image shows the cover of the Safety Manual for the Levelflex M FMP 40. The title is "Differenzdruck-Transmitter" with sub-models "deltabar S PMD 230/235" and "deltabar S FMD 230/330/333 mit 4...20 mA Ausgangssignal". Below the title is the text "Bedienung und Funktionsbeschreibung". The cover features several technical diagrams of the transmitter and its components. At the bottom right, the Endress+Hauser logo is displayed with the tagline "The Power of Smart".

Differenzdruck-Transmitter
deltabar S PMD 230/235
deltabar S FMD 230/330/333
mit 4...20 mA Ausgangssignal

Bedienung und Funktionsbeschreibung

Endress + Hauser
The Power of Smart

The Functional Safety Manual

Contents

- Set-up of the safety system
- Description of the safety function
- Safety Parameters
- Ambient conditions, tolerance, restrictions
- Behaviour under normal and fault operation
- Installation and commissioning
- Parametrisation
- Functional proof test
- Maintenance and repair

Level Pressure Flow Temperature Liquid Analysis Registration System Components Services Solutions

Functional Safety Manual

Levelflex
FMP50/51/52/53/54/55/56/57

Guided Level-Radar for Liquids and Bulk Solids
with 4 to 20 mA Output Signal

Application
Operating minimum (e.g. dry run protection), maximum (e.g. overflow protection) and range monitoring of liquids and bulk solids of all types in systems to satisfy particular safety systems requirements as per IEC 61508 Edition 2.0.

The measuring device fulfils the requirements concerning

- Functional safety as per IEC 61508 Edition 2.0
- Explosion protection (depending on the version)
- Electromagnetic compatibility as per EN 61326 and NAMUR recommendation NE 21
- Electrical safety as per IEC/EN 61010-1

Your benefits

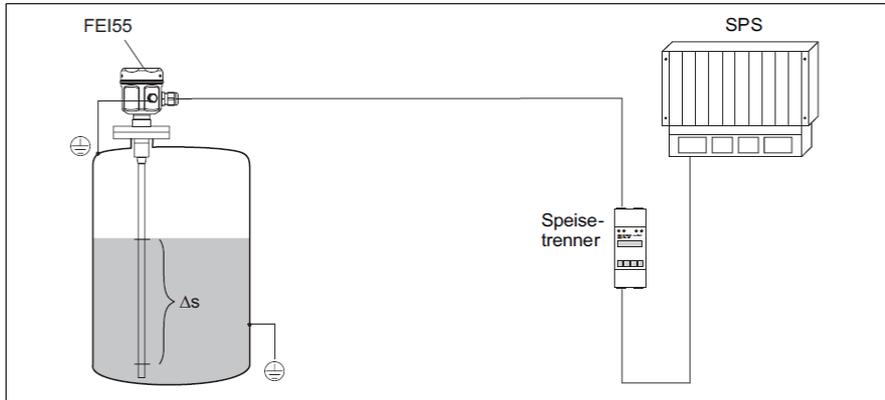
- Used for level monitoring (MIN, MAX, range) up to SIL 2 (single-channel architecture) or SIL 3 (multi-channel architecture, also with homogeneity redundancy)
- Independently assessed and certified by TÜV Rheinland as per IEC 61508 Edition 2.0
- Permanent self-monitoring
- Continuous measurement
- Measurement is virtually independent of product properties
- Measurement is possible even at strongly agitated surfaces and foam
- Easy commissioning
- Also suitable for interface measurement
- Proof-test possible without demounting of the device and without variation of the level

Endress+Hauser People for Process Automation

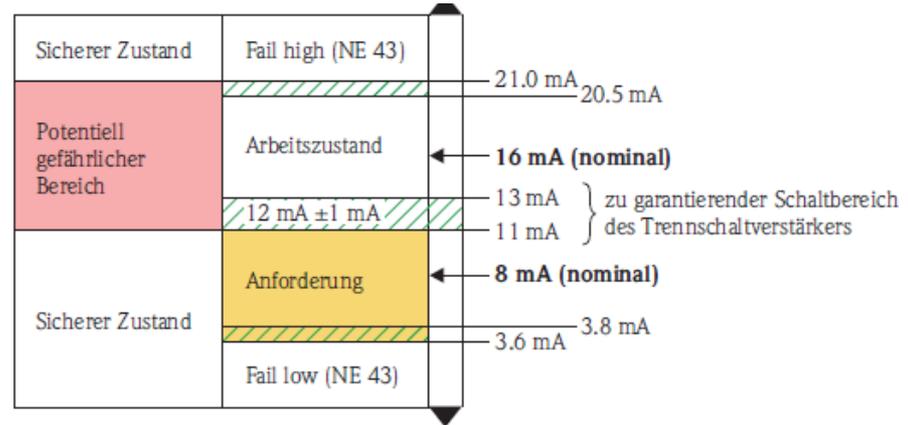
5000257/00/EN/15.11
71151711

The Functional Safety Manual- contents

Set-up of the safety system

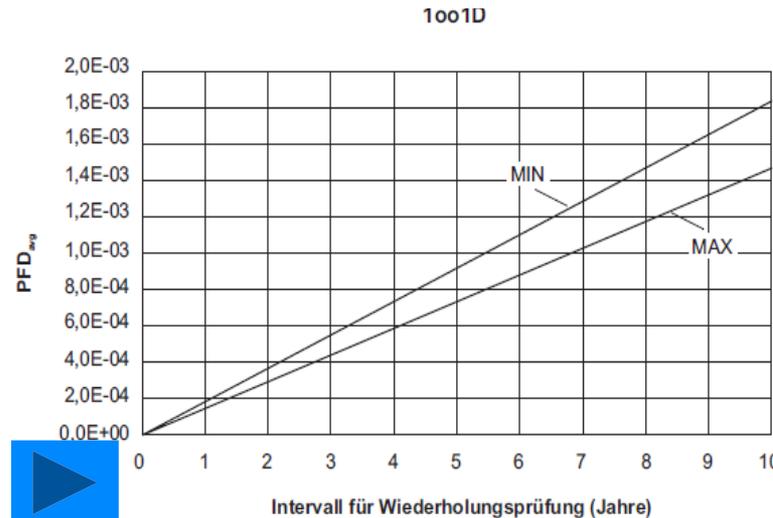


Safety related output signal:



Kenngröße gemäß IEC 61508	Wert	
	MIN-Sicherheit	MAX-Sicherheit
Sicherheitsfunktionen		
SIL (Hardware)	2 (einkanalig), 3 (mit SIL 3-fähiger Auswahlhaltung), → 18, "Anhang"	
SIL (Software)	3	
HFT	0	
Gerätetyp	B	
Betriebsart	Low demand mode	
SFF	92 %	94 %
MTTR	8 h	
Empfohlenes Zeitintervall für Wiederholungsprüfung T ₁	1 Jahr	
λ _{sd}	2 FIT	1 FIT
λ _{su}	334 FIT	341 FIT
λ _{sd}	187 FIT	188 FIT
λ _{du}	43 FIT	34 FIT
λ _{tot} *1	566 FIT	341 FIT
PFDAvg für T ₁ = 1 Jahr *2	1,85 × 10 ⁻⁴	1,46 × 10 ⁻⁴

Proof test interval



Safety by Choice, not by Chance!

Micropilot



Levelflex



Product	Type	Assessment	Rating
Cerabar S	PMC71, PMP71,72,75	EN 61508	SIL 2/3
Cerabar M	PMC 5x	prior use	SIL 2
Deltabar S	PMD 75, 76,77, 78	EN 61508	SIL 2/3
Deltapilot S	FMB 70	EN61508	SIL 2/3
Liquiphant M/S FTL 5x, 7x FEL 5x		EN 61508	SIL 2
Liquiphant M/S FTL 5x 7x, FEL 57 (PFM)		EN 61508	SIL 2/3
Liquiphant FS	FTL 8x	EN 61508	SIL 3
Liquicap M	FMI 50, 51	EN 61508	SIL 2
Levelflex M	FMP 40, 41C, 45	prior use	SIL 2
Levelflex M	FMP 5x	IEC 61508	SIL 2/3
Micropilot M	FMR 230, 231, 240, 244, 245	prior use	SIL 2
Micropilot	FMR 5x	EN 61508	SIL 2/3
Gammapilot M	FMG 60 (limit switch)	EN 61508	SIL 2/3
Promass	80, 83	prior use	SIL 2
Promag	50, 53	prior use	SIL 2
Prowirl	72, 73	prior use	SIL 2
Liquiline	CM 42	IEC 61508	SIL 2
iTEMP	TMT 112, 122, 182, 162	prior use	SIL 2
Transmitter	RMA 422, RMA 42	prior use	SIL 2

Liquiphant FS



Cerabar S Deltabar S



Promag

RMA 42



Promass 80/83



**Thank you very much and much success!
Good Bye!**

