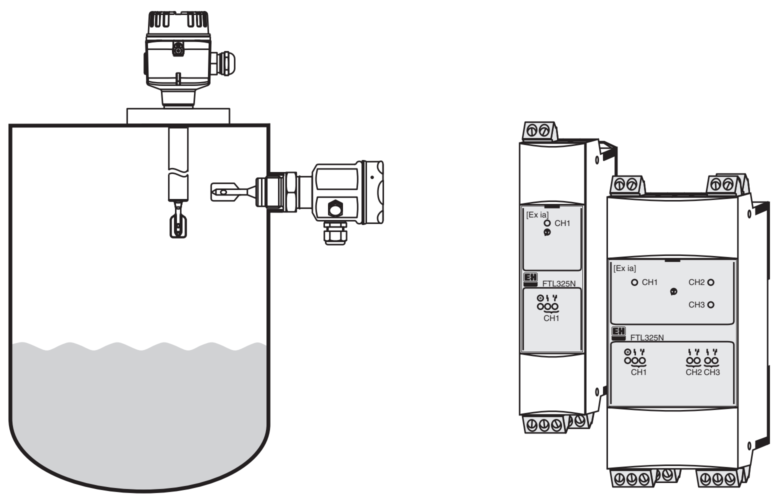
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Functional safety manual

Liquiphant M/S with FEL58 and Nivotester FTL325N

Level Limit Measuring System



Application
Overfill protection or operating maximum detection of all types of liquids in tanks to satisfy particular safety systems requirements to IEC 61508/IEC 61511-1.

The measuring device fulfils the requirements concerning
- For safety functions up to SIL 2
- Explosion protection by intrinsic safety or flameproof enclosure
- EMC to EN 61326 and NAMUR Recommendation NE 21

Your benefits
- For overfill protection up to SIL 2
  – Independently assessed (Functional Assessment) by *exida.com* to IEC 61508/IEC 61511-1
- Monitoring for corrosion on the tuning fork of the sensor
- No calibration
- Fault message for circuit break and short-circuit
- Functional test of subsequent devices at the push of a button
- Protected against outside vibration
- Easy commissioning

SD161F/00/EN/02.10
71110409

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SIL declaration of conformity

Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

SIL-03001d/00/A2

SIL-Konformitätserklärung

Funktionale Sicherheit nach IEC 61508

SIL Declaration of Conformity

Functional safety according to IEC 61508

Endress+Hauser GmbH+Co. KG, Hauptstraße 1, 79689 Maulburg

erklärt als Hersteller, dass das Gerät
declares as manufacturer, that the device

Liquiphant M/S FTL5.-, FTL5.H-, FTL51C-,FTL7.-
+Electronic insert FEL58 + Nivotester FTL325N

für den Einsatz in Schutzeinrichtungen entsprechend der IEC 61508 / IEC 61511 geeignet ist, wenn das Handbuch zur Funktionalen Sicherheit und die Kenngrößen in der folgenden Tabelle beachtet werden:
is suitable for the use in safety-instrumented systems according to IEC 61508 / IEC 61511, if the functional safety manual and the characteristics specified in the following table are observed:

Gerät/Device	Liquiphant M/S + FEL58	Liquiphant M/S + FEL58 + Nivotester FTL325N
Handbuch zur Funktionalen Sicherheit/ Functional safety manual	SD161F/00	
Schutzfunktion/Safety function	Überfüllsicherung/overfill protection	
SIL*4	2	
HFT	0 (einkanalige Verwendung/single channel use*5)	
Gerätetyp/Device type	B	
SFF	82 %	89 %
PFD_{avg} *1 T_1 = 1 Jahr/year	3.0×10^{-4}	3.1×10^{-4}
λ_{sd} *2	84 FIT	84 FIT
λ_{su} *2	189 FIT	531 FIT
λ_{dd} *2	6 FIT	6 FIT
λ_{du} *2	59 FIT	70.5 FIT
$MTBF_{tot}$ *3	332 Jahre/years	131 Jahre/years

*1 Die Werte entsprechen SIL 2 nach ISA S84.01. PFD_{avg}-Werte für andere T_1-Werte siehe Handbuch zur Funktionalen Sicherheit.
The values comply with SIL 2 according to ISA S84.01. PFD_{avg} values for other T_1-values see Functional Safety Manual.
*2 Gemäß Siemens SN29500.
According to Siemens SN29500.
*3 Gemäß Siemens SN29500, einschließlich Fehlern, die außerhalb der Sicherheitsfunktionen liegen.
According to Siemens SN29500, including faults outside the safety fuction.
*4 Betrachtung gemäß IEC 61511-1 Abschnitt 11.4.4
consideration according to IEC 61511-1 clause 11.4.4
*5 Andere Konfigurationen siehe SD264F unter www.endress.com/SIL
Other configurations see SD264F under www.endress.com/SIL

Das Gerät einschließlich Software, wurde auf Basis der Betriebsbewährung bewertet. Bei Geräteänderungen wird ein Modifikationsprozess nach IEC 61508 angewendet.
The device including software was assessed on the basis of proven-in-use. In case of device modifications, a modification process according to IEC 61508 is applied.

Maulburg, 14.01.2010

i.V. (Dr. Arno Götz)
Leitung Zertifizierung / Manager Certification

i.V. (V.Dreyer)
Leitung Projekt / Project Manager

Endress+Hauser
People for Process Automation

SIL-03001D_00_A2

Introduction

Note!
For general informationen about SIL please refer to: www.endress.com/sil

General depiction of a safety system (protection function)

Parameter tables for determining Safety Integrity Level (SIL)

The following tables are used to define the reachable SIL, the requirements pertaining to the “Average Probability of Dangerous Failure on Demand” (PFD_{avg}), the “Hardware Fault Tolerance” (HFT) and the “Safe Failure Fraction” (SFF) of the safety system. The specific values for the Liquiphant M/S + Nivotester FTL325N measuring system can be found in the Appendix.

Permitted probabilities of dangerous failures on demand of the complete safety related system dependent on the SIL (e.g. exceeding a defined MAX level/switch point) (Source: IEC 61508, Part 1):

SIL	PFD_{avg}
4	$\geq 10^{-5} ... < 10^{-4}$
3	$\geq 10^{-4} ... < 10^{-3}$
2	$\geq 10^{-3} ... < 10^{-2}$
1	$\geq 10^{-2} ... < 10^{-1}$

The following table shows the achievable Safety Integrity Level (SIL) as a function of the probability fraction of safety-oriented failures and the "hardware fault tolerance" of the complete safety system for type B systems (complex components, not all faults are known or can be described).

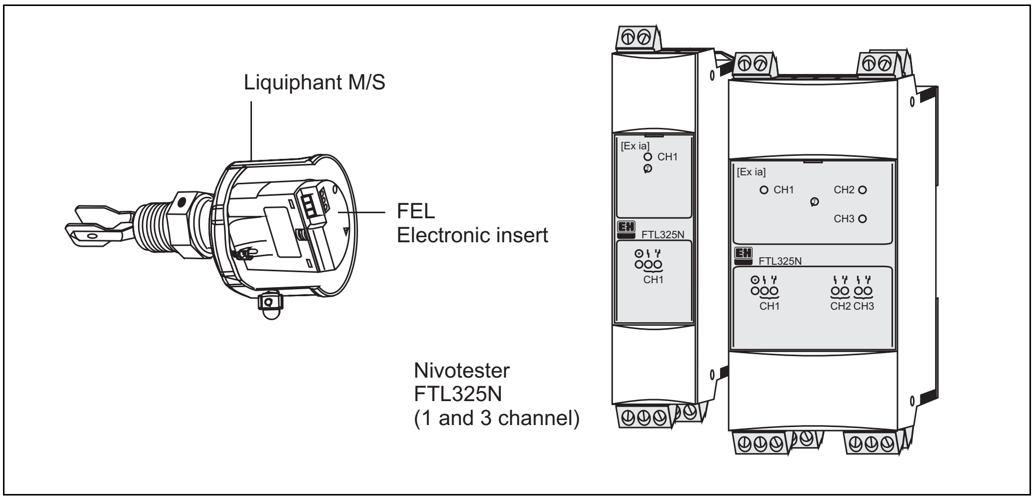
SFF	**HFT**		
	0	**1 (0)**[1)]	**2 (1)**[1]
< 60 %	not allowed	SIL 1	SIL 2
60 % ...< 90 %	SIL 1	**SIL 2**	SIL 3
90% ...<99%	SIL 2	SIL 3	
99 %	SIL 3		

1) In accordance with IEC 61511-1 (FDIS) (Section 11.4.4), the HFT can be reduced by one (values in brackets) if the devices used fulfil the following conditions:
- the device is proven in use,
- only process-relevant parameters can be changed at the device (e.g. measuring range, ...),
- changing the process-relevant parameters is protected (e.g. password, jumper, ...),
- the safety function requires less than SIL 4.
All conditions apply to Liquiphant M/S + Nivotester FTL325N.

Structure of the measuring system with Liquiphant M/S (FEL58) and Nivotester FTL325N

Level limit measuring system

The measuring system's devices are displayed in the following diagram (example).



SD161Fen02

Safety function

The safety function applies to all settings in MAX safety (monitoring of the covered state) and use of the NO contacts of the level relays.

The following settings are permitted for the safety function:

Device	Setting	As-delivered state
Liquiphant	Density switch setting: 0.5 Density switch setting: 0.7	Density switch setting: 0.7
	"MAX" safety	"MAX" safety
Nivotester FTL325N-#3#3	Error current signal < 1.2 mA	Error current signal < 1.2 mA
	All settings **except** "ΔS function" (see Section Settings and installation instructions)	Three-channel operation
	The DIL switch for failure indication (short-circuit and cable break monitoring) must be set into position ON.	Failure switch "ON"
Nivotester FTL325N-#1#1	Error current signal < 1.2 mA	Error current signal < 1.2 mA
		One-channel operation
	The DIL switch for failure indication (short-circuit and cable break monitoring) must be set into position ON.	Failure switch "ON"

The level relay always works in quiescent current safety; i.e. the relay releases when:
- the switch point is exceeded (level exceeds response height)
- a fault occurs
- the mains voltage fails

In addition to the level relay, the alarm relay works in quiescent current safety and releases when:
- one of the following faults occurs:
  - the sensor connection is interrupted
  - the sensor connection short circuits
- the mains voltage fails

Note!
When the alarm relay releases, the level relay also releases.

Permitted combinations of Nivotester FTL325N with Liquiphant M/S for the safety function

The following combinations are permitted for the measuring system:

Nivotester		Liquiphant M + FEL58	Liquiphant S + FEL58
One-channel device	**Three-channel device**		
FTL325N-H### FTL325N-P### FTL325N-T### FTL325N-W###	FTL325N-H### FTL325N-P### FTL325N-T### FTL325N-W###	FTL50-######8###* FTL51-######8###* FTL50H-######8###* FTL51H-######8###* FTL51C-######8####*	FTL70-######8####* FTL71-######8####*

*Permitted device types (# = all device versions permitted); * 8 = FEL58*

Safety function data

The **mandatory settings** and data for the safety function can be found in the Appendix (Page 9).

The measuring system reacts in ≤ 0.9 s.

✎ Note!
MTTR is set at eight hours.
Safety systems **without a self-locking function** must be monitored or set to an otherwise safe state after carrying out the safety function within MTTR.

Supplementary device documentation

The following must be available for the measuring system:

	Technical Information	Operating Instructions
Nivotester FTL325N	For all device types: TI353F	One-channel device FTL325N-#1#1: KA170F
		Three-channel device FTL325N-#3#3: KA171F
Liquiphant M	Types FTL50, FTL51, FTL50H, FTL51H: TI328F	Types FTL50, FTL51: KA143F
		Types FTL50, FTL51: KA163F (with aluminium housing/separate terminal compartment)
		Types FTL50H, FTL51H: KA144F
		Types FTL50H, FTL51H: KA164F (with aluminium housing/separate terminal compartment)
	Type FTL51C: TI347F	Type FTL51C: KA162F
		Type FTL51C: KA165F (with aluminium housing/separate terminal compartment)
Liquiphant S	For all device types: TI354F	Types FTL70, FTL71: KA172F
		Types FTL70, FTL71: KA173F (with aluminium housing/separate terminal compartment)
Relevant contents	Connection data, Installation instructions	Setting, configuration, remarks, function tests

Settings and installation instructions

Installation instructions

Please refer to the Operating Instructions (KA) for information regarding the correct installation of Liquiphant M/S + Nivotester FTL325N.
Since the application conditions have an effect on the safety of the measurement, pay attention to the notes in the Technical Information (TI) and Operating Instructions (KA).

The ambient conditions for the Nivotester FTL325N must correspond to IP54 (in accordance with EN 60529).

Refer to the following documentation for instructions on setting the devices:

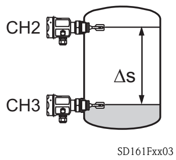
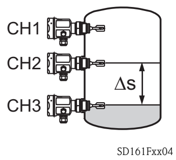
Device	Setting description in documentation:
Liquiphant M/S (FEL58)	KA143F, KA163F, KA144F, KA164F, KA162F, KA165F, KA172F, KA173F, *
Nivotester FTL325N-#1#1	KA170F
Nivotester FTL325N-#3#3	KA171F

(type-dependent, see table: Supplementary device documentation, Page 6)*

Settings for Liquiphant M/S (FEL58):

- The **density switch setting** must be configured according to the density range of the medium.
- The setting of the **safety mode** has an effect on the function. The DIL switch must be set to MAX in a SIL application.

Settings for Nivotester FTL325N-#3#3 (three-channel version):

Setting	Description	Caution!
	Channels 2+3 in ΔS function	THIS SETTING IS NOT PERMITTED FOR THE SAFETY FUNCTION
	Channel 1, independent	Channel 1 is permitted for the safety function. The DIL switch for fault messaging (short-circuit and cable break monitoring) must be set into position ON.
	Channels 2+3 in ΔS function	CHANNELS 2 AND 3 IN THIS SETTING ARE NOT PERMITTED FOR THE SAFETY FUNCTION

Caution!
Observe the following for the Nivotester FTL325N-####: The operator must use suitable measures (e.g. current limiter, fuse) to ensure the relay contact characteristics are not exceeded:
- $U \leq 253$ V AC 50/60 Hz , $I \leq 2$ A, $P \leq 500$ VA at $\cos \varphi \geq 0.7$ or
- $U \leq 40$ V DC, $I \leq 2$ A, $P \leq 80$ W

Caution!
Changes to the measuring system and settings after start-up can impair the protection function!

Response in operation and failure

The response in operation and failure is described in the following documentation.

Device	Setting description in documentation:
Liquiphant M/S (FEL58)	KA143F, KA163F, KA144F, KA164F, KA162F, KA165F, KA172F, KA173F, *
Nivotester FTL325N-#1#1	KA170F
Nivotester FTL325N-#3#3	KA171F

(type-dependent, see table: Supplementary device documentation, Page 6)*

Recurrent function tests of the measuring system

The operativeness of the overfill protection must be checked annually if the PFD_{avg} values given in the Appendix are used.
The check must be carried out in such a way that it is proven that the overfill protection functions perfectly in interaction with all components. This is guaranteed when the response height is approached in a filling process. If it is not practical to fill to the response height, suitable simulation of the level or of the physical measuring effect must be used to make the level sensor respond. If the operativeness of the level sensor/transmitter can be determined otherwise (exclusion of faults that impair function), the check can also be completed by simulating the corresponding output signal.

In the case of recurrent tests, each permitted setting must be checked, especially whether all the alarm switches are set to ON.

Caution!
Note the following points for the function test:
- Each individual channel must be checked e.g. by approaching the level.
- Relay contact switching can be checked by using a hand multimeter at the terminals or by observing the overfill protection elements (e.g. horn, adjuster).
- In multi-channel devices, all channels which do not carry out a safety function must be included in the recurrent function tests if faulty functioning cannot be detected by any other means.
- As a positive test result, a covered tuning fork must be detected and trigger the alarm for overfill protection.
- **If fork covering is not detected during the recurrent test, the monitored process must be set to a safe state by means of additional or other measures and/or kept in the safe state until the safety system is repaired.**

Appendix

Specific values and wiring options for the measuring system Liquiphant M/S (FEL58) and Nivotester FTL325N

The tables show the specific values and wiring options for the measuring system.

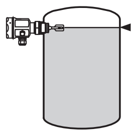
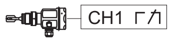
Note!
Note the following points on the tables below:

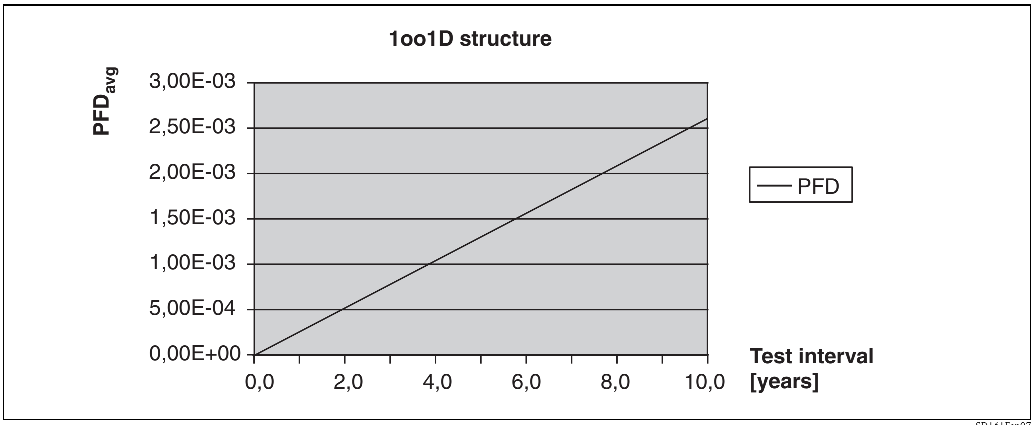
- The PFD_{avg} values for multichannel systems already contain common cause failures for the associated wiring scheme.
- The PFD_{avg} values are only valid for the associated wiring scheme. Wiring schemes other than those shown in the Appendix were not assessed and thus do not bear any information relevant to safety.
  Using NC contacts instead of NO contacts requires further consideration of the installation means.
- The wiring scheme shows the number of devices (Liquiphant and Nivotester) and the limit relay contact circuits (open, when the sensor signals covering).
- For every channel, which performs a safety function, the failure indication (cable break/short circuit) must be switched on.
- With several devices in a wiring scheme, they all indicate the same displayed settings.

⚠ Warning!

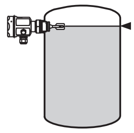
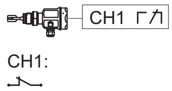
For safety related use of the Liquiphant S for MAX detection, the following application errors must be excluded:

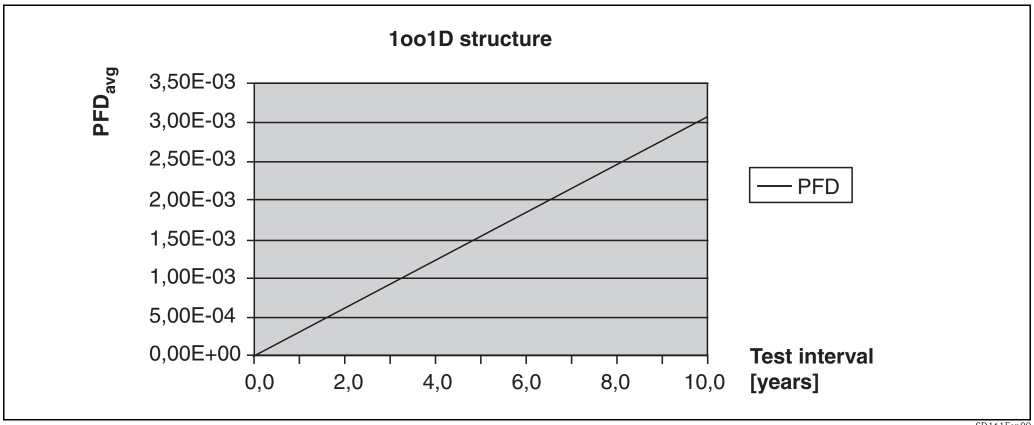
- Hydrogen diffusion at temperatures over 180 °C and over 64 bar.

1oo1 architecture (CONF 1)	
Liquiphant (FEL58) Settings	 1) density 0.7 / 0.5 2) MAX safety
Evaluated NAMUR transmitter	 Error current signal < 1.2 mA SD161Fxx05
SIL	SIL 2
HFT	0
SFF	82.5 %
PFD_{avg} **	2.6×10^{-4}
Wiring scheme	 CH1 SD161Fxx06 Ask the manufacturer in question for the NAMUR transmitter parameters relevant to safety.
Recurrent test e.g. approaching level	** TI (test interval) = annual

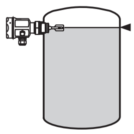
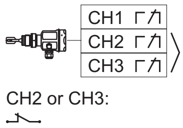


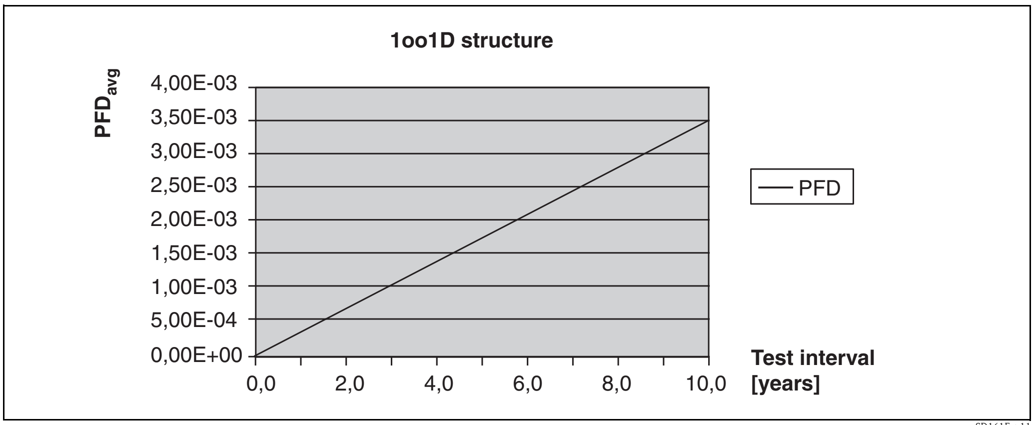
SD161Fen07

1oo1 architecture (CONF 2)	
Liquiphant (FEL58) Settings	1) density 0.7 / 0.5 2) MAX safety
Nivotester FTL325N-#1#1 Settings (One-channel device)	 Error current signal < 1.2 mA SD161Fxx05
SIL	SIL 2
HFT	0
SFF	89.8 %
PFD_{avg} **	3.1 x 10^{-4}
Wiring scheme	 SD161Fxx08
Recurrent test e.g. approaching level	** TI (test interval) = annual

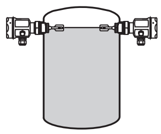
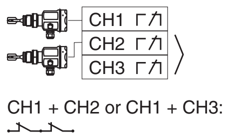


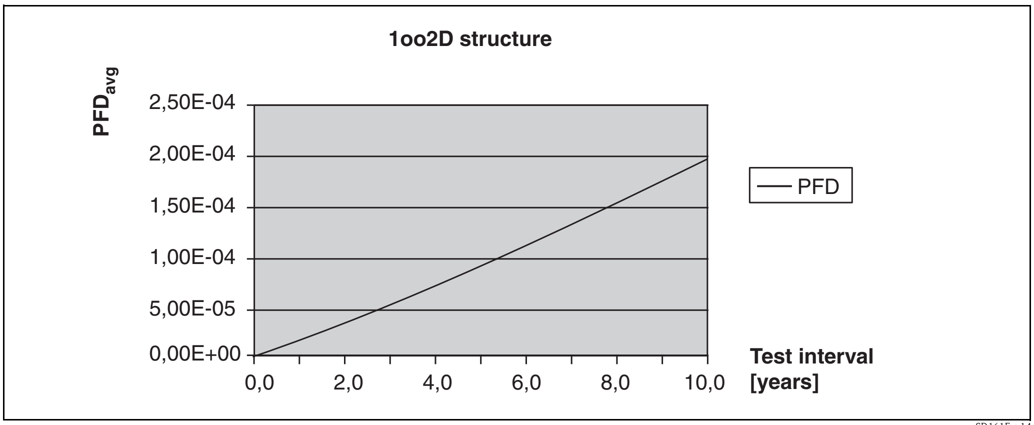
SD161Fen09

1oo1 architecture (CONF 3)	
Liquiphant (FEL58) Settings	 1) density 0.7 / 0.5 2) MAX safety
Nivotester FTL325N-#3#3 Settings (Three-channel device)	 Error current signal < 1.2 mA SD161Fxx05
SIL	SIL 2
HFT	0
SFF	89.5 %
PFD_{avg} **	3.5×10^{-4}
Wiring scheme	 SD161Fen10
Recurrent test e.g. approaching level	** TI (test interval) = annual

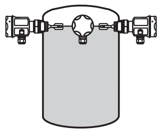
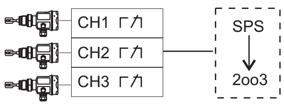


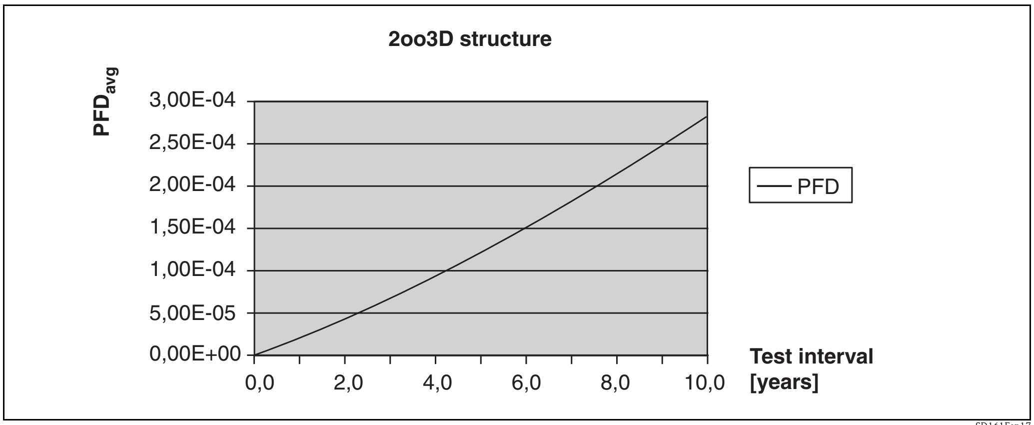
SD161Fen11

1oo2 architecture (CONF 4)	
Liquiphant (FEL58) Settings	1) density 0.7 / 0.5 2) MAX safety
Nivotester FTL325N-#3#3 Settings (Three-channel device)	 Error current signal < 1.2 mA SD161Fxx12
SIL	SIL 2
HFT	1
SFF	89.5 %
PFD_{avg} **	1.8×10^{-5}
Wiring scheme	 SD161Fen13
Recurrent test e.g. approaching level	** TI (test interval) = annual

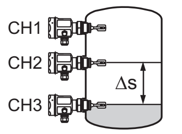
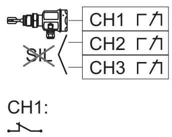


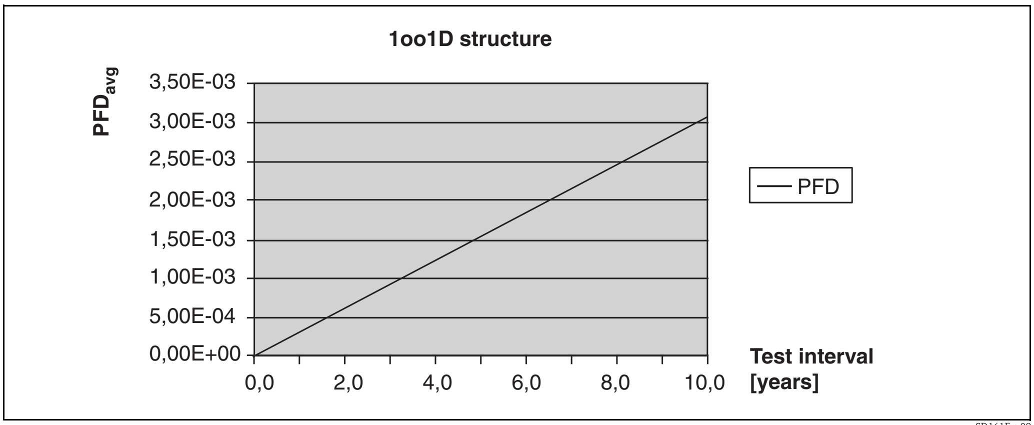
SD161Fen14

2oo3 architecture (CONF 5)	
Liquiphant (FEL58) Settings	1) density 0.7 / 0.5 2) MAX safety
Nivotester FTL325N-#3#3 Settings (Three-channel device)	 Error current signal < 1.2 mA SD161Fxx15
SIL	SIL 2
HFT	1
SFF	89.9 %
PFD_{avg} **	2.0×10^{-5}
Wiring scheme	 SD161Fxx16
Recurrent test e.g. approaching level	** TI (test interval) = annual



SD161Fen17

1oo1 architecture (CONF 6)	
Liquiphant (FEL58) Settings	 1) density 0.7 / 0.5 2) MAX safety
Nivotester FTL325N-#3#3 Settings (Three-channel device)	 Error current signal < 1.2 mA SD161Fxx18
SIL	SIL 2
HFT	0
SFF	89.8 %
PFD_{avg} **	3.1 x 10^{-4}
Wiring scheme	 SD161Fxx19
Recurrent test e.g. approaching level	** TI (test interval) = annual



SD161Fen09

Exida Management Summary

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Management summary

This report summarizes the results of the hardware assessment with proven-in-use consideration according to IEC 61508 / FDIS IEC 61511 carried out on Liquiphant M/S with NAMUR output FEL 58 with software version V1.0 and Nivotester FTL325N for applications with MAX detection. Table 1 gives an overview of the different configurations which have been assessed.

The hardware assessment consists of a Failure Modes, Effects and Diagnostics Analysis (FMEDA). A FMEDA is one of the steps taken to achieve functional safety assessment of a device per IEC 61508. From the FMEDA, failure rates are determined and consequently the Safe Failure Fraction (SFF) is calculated for the device. For full assessment purposes all requirements of IEC 61508 must be considered.

Table 1: Configuration overview

	Configurations
[CONF 1]	FEL 58
[CONF 2]	FEL 58 with Nivotester FTL325N as single channel device
[CONF 3]	FEL 58 with Nivotester FTL325N as three channel device in single channel mode with two output relays in parallel
[CONF 4]	FEL 58 with Nivotester FTL325N as three channel device in dual channel mode with one channel having two output relays in parallel
[CONF 5]	FEL 58 with Nivotester FTL325N as three channel device in three channel mode
[CONF 6]	FEL 58 with Nivotester FTL325N as three channel device in single channel mode

FEL 58 has a current output interface according to EN 60947-5-6 / IEC 60947-5-6.

The failure rates used in this analysis are based on the Siemens standard SN 29500.

According to table 2 of IEC 61508-1 the average PFD for systems operating in low demand mode has to be $\geq 10^{-3}$ to $< 10^{-2}$ for SIL 2 safety functions. A generally accepted distribution of PFD_{AVG} values of a SIF over the sensor part, logic solver part, and final element part assumes that 35% of the total SIF PFD_{AVG} value is caused by the sensor part. For a SIL 2 application the total PFD_{AVG} value of the SIF should be smaller than 1,00E-02, hence the maximum allowable PFD_{AVG} value for the sensor part would then be 3,50E-03.

Liquiphant M/S with NAMUR output FEL 58 is considered to be a Type B[1] component. Nivotester FTL325N is considered to be a Type A[2] component. In the following both subsystems are considered to be Type B components for simplification reasons and as a worst-case assumption.

For Type A components with a SFF of 60% to < 90% a hardware fault tolerance of 0 according to table 2 of IEC 61508-2 is sufficient for SIL 2 (sub-) systems.

Type B components with a SFF of 60% to < 90% must have a hardware fault tolerance of 1 according to table 3 of IEC 61508-2 for SIL 2 (sub-) systems.

Type B component: "Complex" component (using micro controllers or programmable logic); for details see 7.4.3.1.3 of IEC 61508-2.

Type A component: "Non-complex" component (all failure modes are well defined); for details see 7.4.3.1.2 of IEC 61508-2.

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FMEDA including SFF determination and PFD_{AVG} calculation

Project:
Level limit switch Liquiphant M/S
with NAMUR output FEL 58 and Nivotester FTL325N
Applications with level limit detection in liquids (MAX detection)

Customer:
Endress+Hauser GmbH+Co.KG
Maulburg
Germany

Contract No.: E+H 02/6-16
Report No.: E+H 02/6-16 R003
Version V1, Revision R1.1, January 2003
Stephan Aschenbrenner

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As Liquiphant M/S with NAMUR output FEL 58 and Nivotester FTL325N are supposed to be proven-in-use devices, an assessment of the hardware with additional proven-in-use demonstration for the device and its software was carried out. Therefore according to the requirements of IEC 61511-1 FDIS Ed.1 27-09-02 section 11.4.4 and the assessment described in section 5.1 a hardware fault tolerance of 0 is sufficient for SIL 2 (sub-) systems being Type B components and having a SFF of 60% to < 90%.

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Table 2: Summary for [CONF 1]

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years	SFF
PFD_{AVG} = 2,59E-04	PFD_{AVG} = 1,30E-03	PFD_{AVG} = 2,59E-03	> 82 %

λ_{sd} = 8,39E-08 1/h
λ_{su} = 1,89E-07 1/h
λ_{dd} = 6,21E-09 1/h
λ_{du} = 5,92E-08 1/h

Table 3: Summary for [CONF 2]

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years	SFF
PFD_{AVG} = 3,09E-04	PFD_{AVG} = 1,54E-03	PFD_{AVG} = 3,08E-03	> 89 %

λ_{sd} = 8,39E-08 1/h
λ_{su} = 5,31E-07 1/h
λ_{dd} = 6,21E-09 1/h
λ_{du} = 7,05E-08 1/h

Table 4: Summary for [CONF 3]

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years	SFF
PFD_{AVG} = 3,49E-04	PFD_{AVG} = 1,74E-03	PFD_{AVG} = 3,48E-03	> 89 %

λ_{sd} = 8,39E-08 1/h
λ_{su} = 5,89E-07 1/h
λ_{dd} = 6,21E-09 1/h
λ_{du} = 7,98E-08 1/h

Table 5: Summary for [CONF 4]

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years	SFF
PFD_{AVG} = 1,77E-05	PFD_{AVG} = 9,30E-05	PFD_{AVG} = 1,97E-04	> 89 %

Leg 1 (consisting of [CONF 2]):
λ_{sd} = 8,39E-08 1/h
λ_{su} = 5,31E-07 1/h
λ_{dd} = 6,21E-09 1/h
λ_{du} = 7,05E-08 1/h

Leg 2 (consisting of [CONF 3]):
λ_{sd} = 8,39E-08 1/h
λ_{su} = 5,89E-07 1/h
λ_{dd} = 6,21E-09 1/h
λ_{du} = 7,98E-08 1/h

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Table 6: Summary for [CONF 5]

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years	SFF
PFD_{AVG} = 2,04E-05	PFD_{AVG} = 1,20E-04	PFD_{AVG} = 2,82E-04	> 88 %

λ_{sd} = 8,39E-08 1/h

λ_{su} = 6,28E-07 1/h

λ_{dd} = 6,21E-09 1/h

λ_{du} = 8,93E-08 1/h

Table 7: Summary for [CONF 6]

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years	SFF
PFD_{AVG} = 3,09E-04	PFD_{AVG} = 1,54E-03	PFD_{AVG} = 3,08E-03	> 89 %

λ_{sd} = 8,39E-08 1/h

λ_{su} = 5,31E-07 1/h

λ_{dd} = 6,21E-09 1/h

λ_{du} = 7,05E-08 1/h

The boxes marked in green (▇) mean that the calculated PFD_{AVG} values are within the allowed range for SIL 2 according to table 2 of IEC 61508-1 and table 3.1 of ANSI/ISA–84.01–1996 and do fulfill the requirement to not claim more than 35% of this range, i.e. to be better than or equal to 3,5E-03.

The functional assessment according to IEC 61508 has shown that Liquiphant M/S with NAMUR output FEL 58 and Nivotester FTL325N has a PFD_{AVG} within the allowed range for SIL 2 according to table 2 of IEC 61508-1 and table 3.1 of ANSI/ISA–84.01–1996 and a Safe Failure Fraction (SFF) of > 80%. Based on the verification of "prior use" they can be used as a single device for SIL2 Safety Functions in terms of IEC 61511-1 FDIS Ed.1 27-09-02.

A user of Liquiphant M/S with NAMUR output FEL 58 and Nivotester FTL325N can utilize these failure rates in a probabilistic model of a safety instrumented function (SIF) to determine suitability in part for safety instrumented system (SIS) usage in a particular safety integrity level (SIL). A full table of failure rates for different operating conditions is presented in section 5.2 to 5.7 along with all assumptions.

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Supplementary Documentation	Safety in the Process Industry – reducing risks with SIL CP002Z/11

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