FY01005F/00/EN/03.23-00
71613871
2023-05-03

Functional Safety Manual
Nivotester FTL325N

Vibronic
Liquiphant with electronic insert FEL68

Endress+Hauser
People for Process Automation

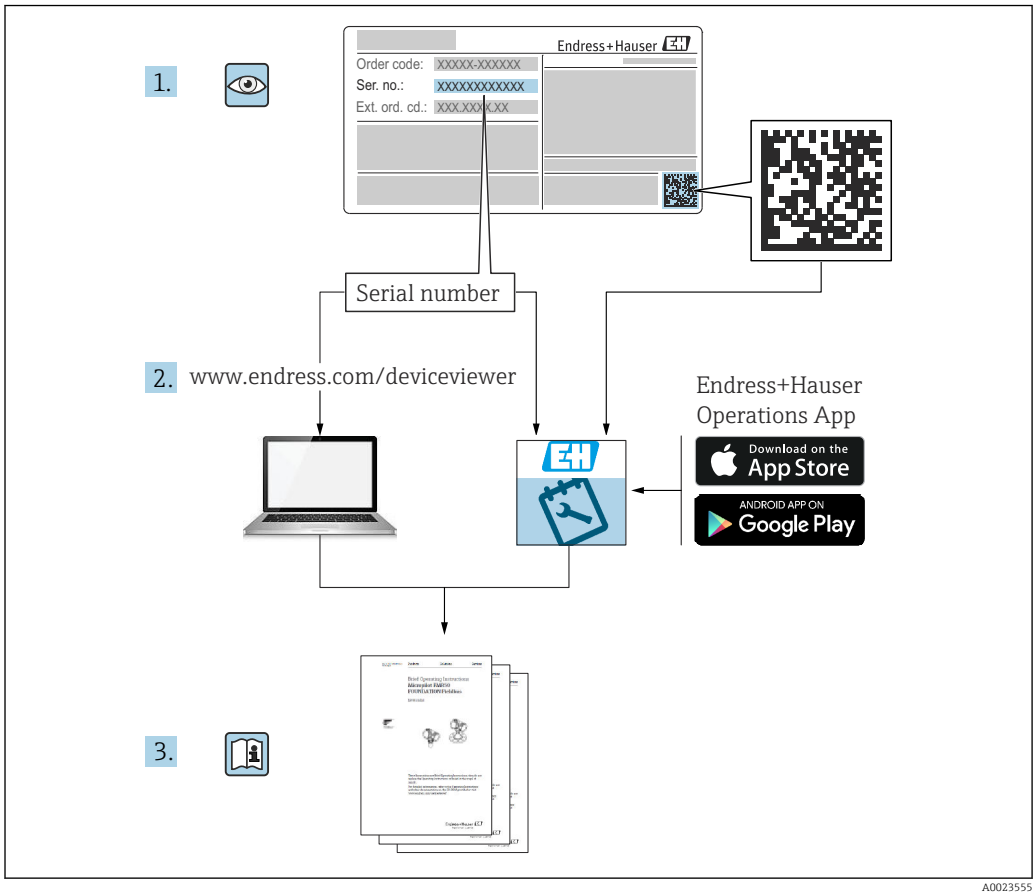

1.
Endress+Hauser
Order code: XXXXX-XXXXXX
Ser. no.: XXXXXXXXXXX
Ext. ord. cd.: XXX XXX XX
Serial number
2. www.endress.com/deviceviewer
Endress+Hauser
Operations App
Download on the App Store
ANDROID APP ON Google Play
3.
A0023555

Table of contents

1 Declaration of Conformity

1.1 Version II wiring

SIL_00358_02.23

Endress+Hauser
People for Process Automation

Declaration of Conformity

Functional Safety according to IEC 61508
Based on NE 130 Form B.1

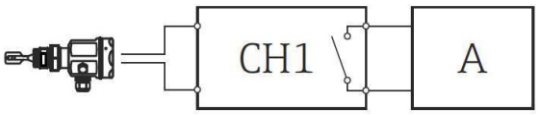
Endress+Hauser SE+Co. KG, Hauptstraße 1, 79689 Maulburg

being the manufacturer, declares that the product

Liquiphant FTL51B / FTL62 / FTL63 / FTL64
(FEL68 + FTL325N-y***)

is suitable for the use in safety-instrumented systems according to IEC 61508. The instructions of the corresponding functional safety manual must be followed.

This declaration of conformity is valid for variant II: One Liquiphant at channel 1 of a Nivotester.



A: Other safety equipment e.g. actuator/safety-related PLC

This declaration of conformity is exclusively valid for the listed products and accessories in delivery status.

Maulburg, February 3, 2023
Endress+Hauser SE+Co. KG

i. V.

E-SIGNED by Thorsten Springmann
on 07 February 2023 08:30:42 CET

Thorsten Springmann
Dept. Man. R&D Devices Level Limit
Research & Development

i. V.

E-SIGNED by Manfred Hammer
on 07 February 2023 08:28:38 CET

Manfred Hammer
Dept. Man. R&D Quality Management/FSM
Research & Development

A0052153

1.1.1 Safety-related characteristic values, version II

SIL_00358_02.23

Endress+Hauser
People for Process Automation

General			
Device designation and permissible types [1]	Liquiphant FTL51B / FTL62 / FTL63 / FTL64 ** A8 * * * * * * ** ** *** + [LA] (FEL68 + FTL325N-y***)		
	/		
Safety-related output signal	Relay		
Fault signal	Open contact		
Process variable/function	Level switch for liquids		
Safety function(s)	MIN / MAX		
Device type acc. to IEC 61508-2	☐ Type A	☒ Type B	
Operating mode	☒ Low Demand Mode	☒ High Demand Mode	
Valid hardware version	FEL68: 01.00.ww / FTL325N: 02.00.ww (ww: any double number)		
Valid software version	FEL58: 01.01.zz (zz: any double number) / FTL325N without SW		
Safety manual	FTL51B: FY01000F / FTL325N: FY01005F FTL62: FY01019F / FTL325N: FY01005F FTL63: FY01096F / FTL325N: FY01005F FTL64: FY01024F / FTL325N: FY01005F		
Type of evaluation (check only one box)	☒	Complete HW/SW evaluation parallel to development incl. FMEDA and change request acc. to IEC 61508-2, 3	
	☐	Evaluation of "proven in use" performance for HW/SW incl. FMEDA and change request acc. to IEC 61508-2, 3	
	☐	Evaluation of HW/SW field data to verify „prior use" acc. to IEC 61511	
	☐	Evaluation by FMEDA acc. to IEC 61508-2 for devices w/o software	
Evaluation through – report/certificate no.	TÜV Rheinland 968/FSP 1388 & 968/FSP 1882		
Test documents	Development documents	Test reports	Data sheets
SIL – Integrity			
Systematic safety integrity		☐ SC 2	☒ SC 3
Hardware safety integrity	Single channel use (HFT = 0)	☒ SIL 2 capable	☐ SIL 3 capable
	Multi channel use (HFT ≥ 1)	☐ SIL 2 capable	☒ SIL 3 capable

FMEDA			
Safety function	MIN	MAX	RANGE
λ_{DU} [2),3)]	75 FIT	60 FIT	/
λ_{DD} [2),3)]	140 FIT	106 FIT	/
λ_S [2),3)]	623 FIT	675 FIT	/
SFF	91%	93%	/
PFD_{avg} (T_1 = 1 year)[3)] (single channel architecture)	$3.29 \cdot 10^{-4}$	$2.61 \cdot 10^{-4}$	/
PFH	$7.51 \cdot 10^{-8}$ 1/h	$5.97 \cdot 10^{-8}$ 1/h	/
PTC [4)] A / B	91% / 59%	91% / 74%	/
Diagnostic test interval [5)]	≤ 60 s, RAM check ≤ 10 min	≤ 60 s, RAM check ≤ 10 min	/
Fault reaction time [6)]	≤ 3 s	≤ 3 s	/

Comments
Max. demand rate 1 per week

Declaration	
☒	Our internal company quality management system ensures information on safety-related systematic faults which become evident in the future

[1)] Valid order codes and order code exclusions are maintained in the E+H ordering system
[2)] FIT = Failure In Time, number of failures per 10^9 h
[3)] Valid for average ambient temperature up to +40 °C (+104 °F)
For continuous operation at ambient temperature close to +60 °C (+140 °F), a factor of 2.1 should be applied
[4)] PTC = Proof Test Coverage
[5)] All diagnostic functions are performed at least once within the diagnostic test interval
[6)] Maximum time between error recognition and error response

A0052154

1.2 Version III wiring

SIL_00359_02.23

Endress+Hauser
People for Process Automation

Declaration of Conformity

Functional Safety according to IEC 61508
Based on NE 130 Form B.1

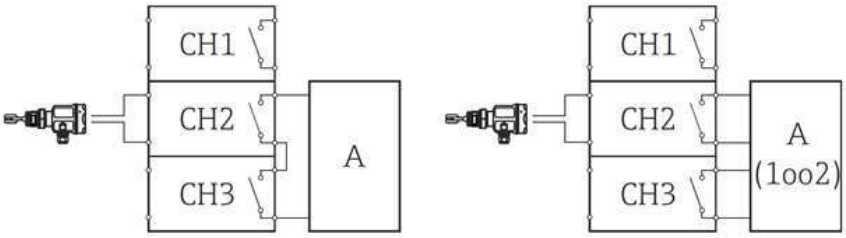
Endress+Hauser SE+Co. KG, Hauptstraße 1, 79689 Maulburg

being the manufacturer, declares that the product

Liquiphant FTL51B / FTL62 / FTL63 / FTL64 (FEL68 + FTL325N-y3*3)

is suitable for the use in safety-instrumented systems according to IEC 61508. The instructions of the corresponding functional safety manual must be followed.

This declaration of conformity is valid for variant III: One Liquiphant with a three channel Nivotester.



A: Other safety equipment e.g. actuator/safety-related PLC

This declaration of conformity is exclusively valid for the listed products and accessories in delivery status.

Maulburg, February 3, 2023
Endress+Hauser SE+Co. KG

i. V.

E-SIGNED by Thorsten Springmann
on 07 February 2023 08:30:47 CET

Thorsten Springmann
Dept. Man. R&D Devices Level Limit
Research & Development

i. V.

E-SIGNED by Manfred Hammer
on 07 February 2023 08:28:44 CET

Manfred Hammer
Dept. Man. R&D Quality Management/FSM
Research & Development

A0052155

1.2.1 Safety-related characteristic values, version III

SIL_00359_02.23

Endress+Hauser
People for Process Automation

General				
Device designation and permissible types [1]	Liquiphant FTL51B / FTL62 / FTL63 / FTL64 ** A8 * * * * * * ** ** *** + [LA] (FEL68 + FTL325N-y3*3)			
	/			
Safety-related output signal	Relay			
Fault signal	Open contact			
Process variable/function	Level switch for liquids			
Safety function(s)	MIN / MAX			
Device type acc. to IEC 61508-2	☐ Type A		☒ Type B	
Operating mode	☒ Low Demand Mode		☒ High Demand Mode	
Valid hardware version	FEL68: 01.00.ww / FTL325N: 02.00.ww (ww: any double number)			
Valid software version	FEL58: 01.01.zz (zz: any double number) / FTL325N without SW			
Safety manual	FTL51B: FY01000F / FTL325N: FY01005F FTL62: FY01019F / FTL325N: FY01005F FTL63: FY01096F / FTL325N: FY01005F FTL64: FY01024F / FTL325N: FY01005F			
Type of evaluation (check only one box)	☒	Complete HW/SW evaluation parallel to development incl. FMEDA and change request acc. to IEC 61508-2, 3		
	☐	Evaluation of "proven in use" performance for HW/SW incl. FMEDA and change request acc. to IEC 61508-2, 3		
	☐	Evaluation of HW/SW field data to verify „prior use" acc. to IEC 61511		
	☐	Evaluation by FMEDA acc. to IEC 61508-2 for devices w/o software		
Evaluation through – report/certificate no.	TÜV Rheinland 968/FSP 1388 & 968/FSP 1882			
Test documents	Development documents		Test reports	Data sheets
SIL – Integrity				
Systematic safety integrity			☐ SC 2	☒ SC 3
Hardware safety integrity	Single channel use (HFT = 0)		☒ SIL 2 capable	☐ SIL 3 capable
	Multi channel use (HFT ≥ 1)		☐ SIL 2 capable	☒ SIL 3 capable
FMEDA				
Safety function	MIN	MAX	RANGE	
λ_{DU} [2),3)]	45 FIT	30 FIT	/	
λ_{DD} [2),3)]	140 FIT	106 FIT	/	
λ_S [2),3)]	888 FIT	938 FIT	/	
SFF	96%	97%	/	
PFD_{avg} (T_1 = 1 year)[3)] (single channel architecture)	$1.99 \cdot 10^{-4}$	$1.32 \cdot 10^{-4}$	/	
PFH	$4.55 \cdot 10^{-8}$ 1/h	$3.01 \cdot 10^{-8}$ 1/h	/	
PTC [4)] A / B	96% / 74%	96% / 86%	/	
Diagnostic test interval [5)]	≤ 60 s, RAM check ≤ 10 min	≤ 60 s, RAM check ≤ 10 min	/	
Fault reaction time [6)]	≤ 3 s	≤ 3 s	/	
Comments				
Max. demand rate 1 per week				
Declaration				
☒	Our internal company quality management system ensures information on safety-related systematic faults which become evident in the future			

[1)] Valid order codes and order code exclusions are maintained in the E+H ordering system
[2)] FIT = Failure In Time, number of failures per 10^9 h
[3)] Valid for average ambient temperature up to +40 °C (+104 °F)
For continuous operation at ambient temperature close to +60 °C (+140 °F), a factor of 2.1 should be applied
[4)] PTC = Proof Test Coverage
[5)] All diagnostic functions are performed at least once within the diagnostic test interval
[6)] Maximum time between error recognition and error response

A0052156

1.3 Version IV wiring

SIL_00360_02.23

Endress+Hauser
People for Process Automation

Declaration of Conformity

Functional Safety according to IEC 61508
Based on NE 130 Form B.1

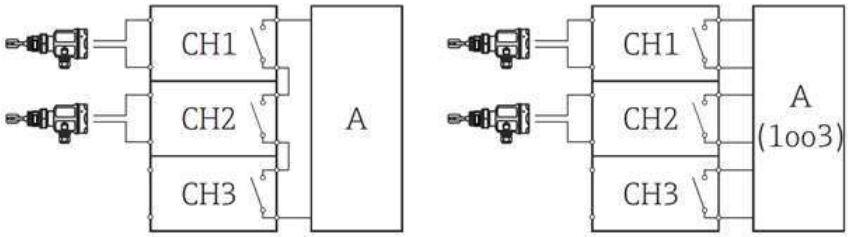
Endress+Hauser SE+Co. KG, Hauptstraße 1, 79689 Maulburg

being the manufacturer, declares that the product

Liquiphant FTL51B / FTL62 / FTL63 / FTL64 (FEL68 + FTL325N-y3*3)

is suitable for the use in safety-instrumented systems according to IEC 61508. The instructions of the corresponding functional safety manual must be followed.

This declaration of conformity is valid for variant IV: Two Liquiphant with a three channel Nivotester.



A: Other safety equipment e.g. actuator/safety-related PLC

This declaration of conformity is exclusively valid for the listed products and accessories in delivery status.

Maulburg, February 3, 2023
Endress+Hauser SE+Co. KG

i. V.

E-SIGNED by Thorsten Springmann
on 07 February 2023 08:30:53 CET

Thorsten Springmann
Dept. Man. R&D Devices Level Limit
Research & Development

i. V.

E-SIGNED by Manfred Hammer
on 07 February 2023 08:28:53 CET

Manfred Hammer
Dept. Man. R&D Quality Management/FSM
Research & Development

A0052162

1.3.1 Safety-related characteristic values, version IV

SIL_00360_02.23

Endress+Hauser
People for Process Automation

General				
Device designation and permissible types [1]	Liquiphant FTL51B / FTL62 / FTL63 / FTL64 ** A8 * * * * * * ** ** *** + [LA] (FEL68 + FTL325N-y3*3)			
	/			
Safety-related output signal	Relay			
Fault signal	Open contact			
Process variable/function	Level switch for liquids			
Safety function(s)	MIN / MAX			
Device type acc. to IEC 61508-2	☐ Type A		☒ Type B	
Operating mode	☒ Low Demand Mode		☒ High Demand Mode	
Valid hardware version	FEL68: 01.00.ww / FTL325N: 02.00.ww (ww: any double number)			
Valid software version	FEL58: 01.01.zz (zz: any double number) / FTL325N without SW			
Safety manual	FTL51B: FY01000F / FTL325N: FY01005F FTL62: FY01019F / FTL325N: FY01005F FTL63: FY01096F / FTL325N: FY01005F FTL64: FY01024F / FTL325N: FY01005F			
Type of evaluation (check only one box)	☒	Complete HW/SW evaluation parallel to development incl. FMEDA and change request acc. to IEC 61508-2, 3		
	☐	Evaluation of "proven in use" performance for HW/SW incl. FMEDA and change request acc. to IEC 61508-2, 3		
	☐	Evaluation of HW/SW field data to verify „prior use" acc. to IEC 61511		
	☐	Evaluation by FMEDA acc. to IEC 61508-2 for devices w/o software		
Evaluation through – report/certificate no.	TÜV Rheinland 968/FSP 1388 & 968/FSP 1882			
Test documents	Development documents		Test reports	Data sheets
SIL – Integrity				
Systematic safety integrity			☐ SC 2	☒ SC 3
Hardware safety integrity	Single channel use (HFT = 0)		☒ SIL 2 capable	☐ SIL 3 capable
	Multi channel use (HFT ≥ 1)		☐ SIL 2 capable	☒ SIL 3 capable
FMEDA				
Safety function	MIN	MAX	RANGE	
λ_{DU} [2),3)]	13 FIT	11 FIT	/	
λ_{DD} [2),3)]	7 FIT	6 FIT	/	
λ_S [2),3)]	1602 FIT	1609 FIT	/	
SFF	99%	99%	/	
PFD_{avg} (T_1 = 1 year)[3)] (single channel architecture)	$5.6 \cdot 10^{-5}$	$4.92 \cdot 10^{-5}$	/	
PFH	$1.28 \cdot 10^{-8}$ 1/h	$1.12 \cdot 10^{-8}$ 1/h	/	
PTC [4)] A / B	91% / 59%	91% / 74%	/	
Diagnostic test interval [5)]	≤ 60 s, RAM check ≤ 10 min	≤ 60 s, RAM check ≤ 10 min	/	
Fault reaction time [6)]	≤ 3 s	≤ 3 s	/	
Comments				
Max. demand rate 1 per week				
Declaration				
☒	Our internal company quality management system ensures information on safety-related systematic faults which become evident in the future			

[1)] Valid order codes and order code exclusions are maintained in the E+H ordering system
[2)] FIT = Failure In Time, number of failures per 10^9 h
[3)] Valid for average ambient temperature up to +40 °C (+104 °F)
For continuous operation at ambient temperature close to +60 °C (+140 °F), a factor of 2.1 should be applied
[4)] PTC = Proof Test Coverage
[5)] All diagnostic functions are performed at least once within the diagnostic test interval
[6)] Maximum time between error recognition and error response

A0052163

1.4 Version V wiring

SIL_00361_02.23

Endress+Hauser
People for Process Automation

Declaration of Conformity

Functional Safety according to IEC 61508
Based on NE 130 Form B.1

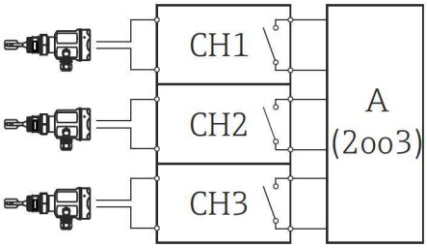
Endress+Hauser SE+Co. KG, Hauptstraße 1, 79689 Maulburg

being the manufacturer, declares that the product

Liquiphant FTL51B / FTL62 / FTL63 / FTL64 (FEL68 + FTL325N-y3*3)

is suitable for the use in safety-instrumented systems according to IEC 61508. The instructions of the corresponding functional safety manual must be followed.

This declaration of conformity is valid for variant V: Three Liquiphant with a three channel Nivotester.



A: Other safety equipment e.g. actuator/safety-related PLC - 2oo3 assessment

This declaration of conformity is exclusively valid for the listed products and accessories in delivery status.

Maulburg, February 3, 2023
Endress+Hauser SE+Co. KG

i. V.

E-SIGNED by Thorsten Springmann
on 07 February 2023 08:18:18 CET

Thorsten Springmann
Dept. Man. R&D Devices Level Limit
Research & Development

i. V.

E-SIGNED by Manfred Hammer
on 07 February 2023 08:14:12 CET

Manfred Hammer
Dept. Man. R&D Quality Management/FSM
Research & Development

A0052164

1.4.1 Safety-related characteristic values, version V

SIL_00361_02.23

Endress+Hauser
People for Process Automation

General			
Device designation and permissible types [1]	Liquiphant FTL51B / FTL62 / FTL63 / FTL64 ** A8 * * * * * * ** ** *** + [LA] (FEL68 + FTL325N-y3*3)		
	/		
Safety-related output signal	Relay		
Fault signal	Open contact		
Process variable/function	Level switch for liquids		
Safety function(s)	MIN / MAX		
Device type acc. to IEC 61508-2	☐ Type A	☒ Type B	
Operating mode	☒ Low Demand Mode	☒ High Demand Mode	
Valid hardware version	FEL68: 01.00.ww / FTL325N: 02.00.ww (ww: any double number)		
Valid software version	FEL58: 01.01.zz (zz: any double number) / FTL325N without SW		
Safety manual	FTL51B: FY01000F / FTL325N: FY01005F FTL62: FY01019F / FTL325N: FY01005F FTL63: FY01096F / FTL325N: FY01005F FTL64: FY01024F / FTL325N: FY01005F		
Type of evaluation (check only one box)	☒	Complete HW/SW evaluation parallel to development incl. FMEDA and change request acc. to IEC 61508-2, 3	
	☐	Evaluation of "proven in use" performance for HW/SW incl. FMEDA and change request acc. to IEC 61508-2, 3	
	☐	Evaluation of HW/SW field data to verify „prior use" acc. to IEC 61511	
	☐	Evaluation by FMEDA acc. to IEC 61508-2 for devices w/o software	
Evaluation through – report/certificate no.	TÜV Rheinland 968/FSP 1388 & 968/FSP 1882		
Test documents	Development documents	Test reports	Data sheets
SIL – Integrity			
Systematic safety integrity		☐ SC 2	☒ SC 3
Hardware safety integrity	Single channel use (HFT = 0)	☒ SIL 2 capable	☐ SIL 3 capable
	Multi channel use (HFT ≥ 1)	☐ SIL 2 capable	☒ SIL 3 capable

FMEDA			
Safety function	MIN	MAX	RANGE
λ_{DU} [2),3)]	15 FIT	13 FIT	/
λ_{DD} [2),3)]	7 FIT	6 FIT	/
λ_S [2),3)]	1972 FIT	1980 FIT	/
SFF	99%	99%	/
PFD_{avg} (T_1 = 1 year)[3)] (single channel architecture)	$6.46 \cdot 10^{-5}$	$5.79 \cdot 10^{-5}$	/
PFH	$1.47 \cdot 10^{-8}$ 1/h	$1.32 \cdot 10^{-8}$ 1/h	/
PTC [4)] A / B	91% / 59%	91% / 74%	/
Diagnostic test interval [5)]	≤ 60 s, RAM check ≤ 10 min	≤ 60 s, RAM check ≤ 10 min	/
Fault reaction time [6)]	≤ 3 s	≤ 3 s	/

Comments
Max. demand rate 1 per week

Declaration	
☒	Our internal company quality management system ensures information on safety-related systematic faults which become evident in the future

[1)] Valid order codes and order code exclusions are maintained in the E+H ordering system
[2)] FIT = Failure In Time, number of failures per 10^9 h
[3)] Valid for average ambient temperature up to +40 °C (+104 °F)
For continuous operation at ambient temperature close to +60 °C (+140 °F), a factor of 2.1 should be applied
[4)] PTC = Proof Test Coverage
[5)] All diagnostic functions are performed at least once within the diagnostic test interval
[6)] Maximum time between error recognition and error response

A0052165

1.5 Version VI wiring

SIL_00362_02.23

Endress+Hauser
People for Process Automation

Declaration of Conformity

Functional Safety according to IEC 61508
Based on NE 130 Form B.1

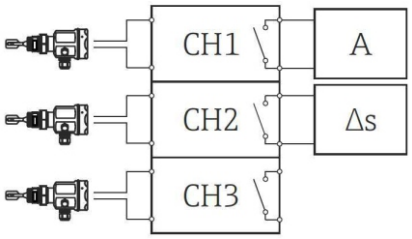
Endress+Hauser SE+Co. KG, Hauptstraße 1, 79689 Maulburg

being the manufacturer, declares that the product

Liquiphant FTL51B / FTL62 / FTL63 / FTL64 (FEL68 + FTL325N-y3*3)

is suitable for the use in safety-instrumented systems according to IEC 61508. The instructions of the corresponding functional safety manual must be followed.

This declaration of conformity is valid for variant VI: One Liquiphant for a safety instrumented function, two Liquiphant for Δs level control (non SIL) with a three channel Nivotester.



A: Other safety equipment e.g. actuator/safety-related PLC
Δs: level control (not SIL)

This declaration of conformity is exclusively valid for the listed products and accessories in delivery status.

Maulburg, February 3, 2023
Endress+Hauser SE+Co. KG

i. V.

E-SIGNED by Thorsten Springmann
on 07 February 2023 08:18:37 CET

Thorsten Springmann
Dept. Man. R&D Devices Level Limit
Research & Development

i. V.

E-SIGNED by Manfred Hammer
on 07 February 2023 08:14:25 CET

Manfred Hammer
Dept. Man. R&D Quality Management/FSM
Research & Development

A0052166

1.5.1 Safety-related characteristic values, version VI

SIL_00362_02.23

Endress+Hauser
People for Process Automation

General			
Device designation and permissible types [1]	Liquiphant FTL51B / FTL62 / FTL63 / FTL64 ** A8 * * * * * * ** ** *** + [LA] (FEL68 + FTL325N-y3*3)		
	/		
Safety-related output signal	Relay		
Fault signal	Open contact		
Process variable/function	Level switch for liquids		
Safety function(s)	MIN / MAX		
Device type acc. to IEC 61508-2	☐ Type A	☒ Type B	
Operating mode	☒ Low Demand Mode	☒ High Demand Mode	
Valid hardware version	FEL68: 01.00.ww / FTL325N: 02.00.ww (ww: any double number)		
Valid software version	FEL58: 01.01.zz (zz: any double number) / FTL325N without SW		
Safety manual	FTL51B: FY01000F / FTL325N: FY01005F FTL62: FY01019F / FTL325N: FY01005F FTL63: FY01096F / FTL325N: FY01005F FTL64: FY01024F / FTL325N: FY01005F		
Type of evaluation (check only one box)	☒	Complete HW/SW evaluation parallel to development incl. FMEDA and change request acc. to IEC 61508-2, 3	
	☐	Evaluation of "proven in use" performance for HW/SW incl. FMEDA and change request acc. to IEC 61508-2, 3	
	☐	Evaluation of HW/SW field data to verify „prior use" acc. to IEC 61511	
	☐	Evaluation by FMEDA acc. to IEC 61508-2 for devices w/o software	
Evaluation through – report/certificate no.	TÜV Rheinland 968/FSP 1388 & 968/FSP 1882		
Test documents	Development documents	Test reports	Data sheets
SIL – Integrity			
Systematic safety integrity		☐ SC 2	☒ SC 3
Hardware safety integrity	Single channel use (HFT = 0)	☒ SIL 2 capable	☐ SIL 3 capable
	Multi channel use (HFT ≥ 1)	☐ SIL 2 capable	☒ SIL 3 capable

FMEDA			
Safety function	MIN	MAX	RANGE
λ_{DU} [2),3)]	75 FIT	60 FIT	/
λ_{DD} [2),3)]	140 FIT	106 FIT	/
λ_S [2),3)]	623 FIT	675 FIT	/
SFF	91%	93%	/
PFD_{avg} (T_1 = 1 year)[3)] (single channel architecture)	$3.29 \cdot 10^{-4}$	$2.61 \cdot 10^{-4}$	/
PFH	$7.51 \cdot 10^{-8}$ 1/h	$5.97 \cdot 10^{-8}$ 1/h	/
PTC [4)] A / B	91% / 59%	91% / 74%	/
Diagnostic test interval [5)]	≤ 60 s, RAM check ≤ 10 min	≤ 60 s, RAM check ≤ 10 min	/
Fault reaction time [6)]	≤ 3 s	≤ 3 s	/

Comments
Max. demand rate 1 per week

Declaration	
☒	Our internal company quality management system ensures information on safety-related systematic faults which become evident in the future

[1)] Valid order codes and order code exclusions are maintained in the E+H ordering system
[2)] FIT = Failure In Time, number of failures per 10^9 h
[3)] Valid for average ambient temperature up to +40 °C (+104 °F)
For continuous operation at ambient temperature close to +60 °C (+140 °F), a factor of 2.1 should be applied
[4)] PTC = Proof Test Coverage
[5)] All diagnostic functions are performed at least once within the diagnostic test interval
[6)] Maximum time between error recognition and error response

A0052167

2 About this document

2.1 Document function

This supplementary Safety Manual applies in addition to the Operating Instructions, Technical Information and ATEX Safety Instructions. The supplementary device documentation must be observed during installation, commissioning and operation. The requirements specific to the protection function are described in this safety manual.

General information on functional safety (SIL) is available at:
www.endress.com/SIL

2.2 Symbols used

2.2.1 Safety symbols

DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

WARNING
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

CAUTION
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol contains information on procedures and other facts which do not result in personal injury.

2.2.2 Symbols for certain types of information and graphics

Tip
Indicates additional information

Reference to documentation

Reference to graphic

▶
Notice or individual step to be observed

1., 2., 3.
Series of steps

Result of a step

1, 2, 3, ...
Item numbers

A, B, C, ...
Views

2.3 Supplementary device documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

The following document types are available in the download area of the Endress+Hauser website (www.endress.com/downloads):

2.3.1 Further applicable documents

- TI00353F
- BA01972F, FTL325N 1-channel
- KA01433F, FTL325N 1-channel
- BA01973F, FTL325N 3-channel
- KA01434F, FTL325N 3-channel

2.3.2 Technical Information (TI)

Planning aid
The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.

2.3.3 Brief Operating Instructions (KA)

Guide that takes you quickly to the 1st measured value
The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.

2.3.4 Operating Instructions (BA)

Your reference guide
These Operating Instructions contain all the information that is required in various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.

2.3.5 Safety Instructions (XA)

Depending on the approval, the following Safety Instructions (XA) are supplied with the device. They are an integral part of the Operating Instructions.

The nameplate indicates the Safety Instructions (XA) that are relevant to the device.

3 Design

3.1 Permitted devices types

The details pertaining to functional safety in this manual relate to the device versions listed below and are valid as of the specified firmware and hardware versions.

Unless otherwise specified, all subsequent versions can also be used for safety functions.

A modification process according to IEC 61508 is applied for device changes.

Valid device versions for safety-related use:

3.1.1 Ordering features

FTL325N-

Feature: 010 "Approval"
Version: G, H, N, P, T, W, 2, 8

Feature: 020 "Housing"
Version: all

Feature: 030 "Power supply"
Version: all

Feature: 040 "Switch output"
Version: all

Feature: 995 "Marking"
Version: all

3.2 Identification marking

SIL-certified devices are marked with the SIL logo ㊎ on the nameplate.

3.3 Safety function

The device's safety functions are:

- Maximum level monitoring (overfill prevention, MAX detection)
- Minimum level monitoring (dry running protection, MIN detection)

A maximum of one safety function – either MAX detection or MIN detection of a level – may be performed with a 3-channel Nivotester unit.

A device combination with non-functional safety functions is only possible in accordance with version VI.

3.3.1 Other safety-related characteristic values

Please note the following in relation to the Declarations of Conformity with safety-related characteristic values.

- A common cause factor β = 10 % has been assumed in the calculations specified.
- For multi-channel systems, the PFD_{avg} values already contain common cause failures for the specific wiring scheme.
- The PFD_{avg} values only apply to the particular wiring scheme for which the values have been calculated. They are not a suitable basis for making calculations for other wiring schemes. The use of NC contacts instead of NO contacts, in particular, is not permitted for operation according to SIL specifications.
- The wiring scheme shows the number of devices and the switching of the contacts in the level relays (contact open in demand mode).
- If there are several devices in a wiring scheme, all the devices have the same settings shown.
- The Declarations of Conformity show safety-related values and wiring options for the measuring system.
- FIT = Failure in Time, 1 FIT = 10^{-9} 1/h

3.3.2 Common cause errors

Where HFT=1, the failure rates are based on an analysis in accordance with DIN EN 61508-6: 2011-02, Table D.4, "Using the β-factor to calculate the probability of failure in an E/E/PE safety-related system due to common cause failures".

The calculation gives a β-factor of 10 %.

This factor is based on the failure rates indicated above.

If additional measures are implemented during installation to prevent common cause errors as defined in Table D.1, the β-factor can possibly be reduced to 5 %.

Possible measures are:
- Sensors installed in a physically separate location
- Cable routed separately between the Liquiphant and Nivotester
- Separate protection from environmental influences:
  - Impact
  - Sunshine
  - EMC protection and/or overvoltage
- Use of different sensor materials
- Combination of high-temperature and normal version

3.4 Basic conditions for use in safety-related applications

The measuring system must be used correctly for the specific application, taking into account the medium properties and ambient conditions. Carefully follow instructions pertaining to critical process situations and installation conditions from the Operating Instructions. The application-specific limits must be observed. The specifications in the Operating Instructions and the Technical Information must not be exceeded.

3.4.1 EMC compatibility

The Nivotester is certified in accordance with IEC 61326-3-2 and is thus suitable for safety-related, industrial applications in a specified electromagnetic environment. If the specified electromagnetic ambient conditions are exceeded, the switch status might not be reliably detected. An unshielded cable can be used between the devices in these environmental conditions. Electromagnetic interference immunity can be further improved by using shielded cables.

3.5 Useful lifetime of electrical components

The established failure rates of electrical components apply within the useful lifetime as per IEC 61508-2:2010 section 7.4.9.5 note 3.

In accordance with DIN EN 61508-2:2011 section 7.4.9.5 (national footnote N3), appropriate measures taken by the manufacturer and operator can extend the useful lifetime.

4 Commissioning (installation and configuration)

4.1 Requirements for personnel

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:

- Trained, qualified specialists must have a relevant qualification for this specific function and task.
- Personnel must be authorized by the plant owner/operator.
- Be familiar with federal/national regulations.
- Before starting work: personnel must read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- Personnel must follow instructions and comply with general policies.

The operating personnel must fulfill the following requirements:

- Personnel are instructed and authorized according to the requirements of the task by the facility's owner-operator.
- Personnel follow the instructions in this manual.

4.2 Installation

The mounting and wiring of the device and the permitted orientations are described in the Operating Instructions pertaining to the device.

Correct installation is a prerequisite for safe operation of the device.

4.3 Commissioning

The commissioning of the device is described in the Operating Instructions pertaining to the device.

Prior to operating the device in a safety instrumented system, verification must be performed by carrying out a test sequence as described in **Section 6 Proof testing**.

4.4 Operation

The operation of the device is described in the Operating Instructions pertaining to the device.

4.5 Device configuration for safety-related applications

The device settings may not be changed if SIL operation is in progress.

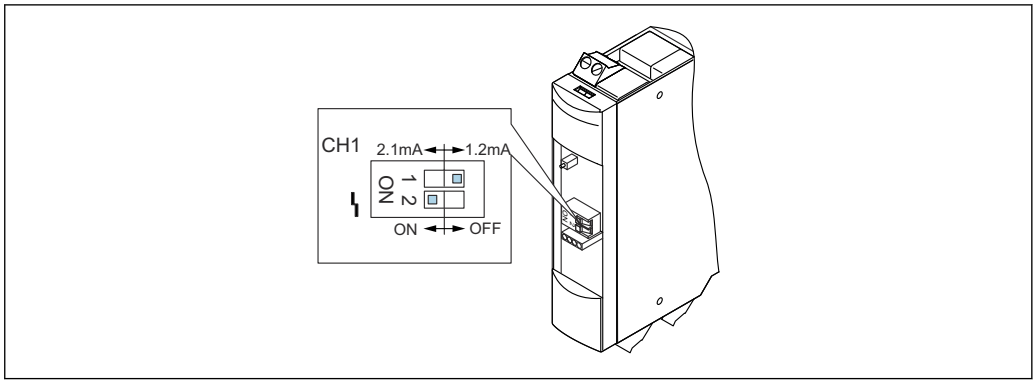
NOTICE

The protective function can be impaired

After commissioning the measuring system, changes to the settings can impact the protective function

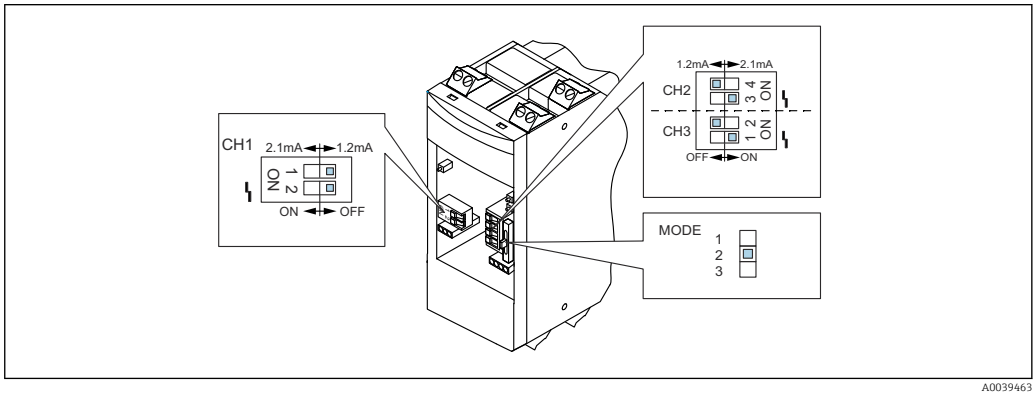
- After changing the settings, perform a proof test to ensure that the safety function is working correctly

4.5.1 Version II



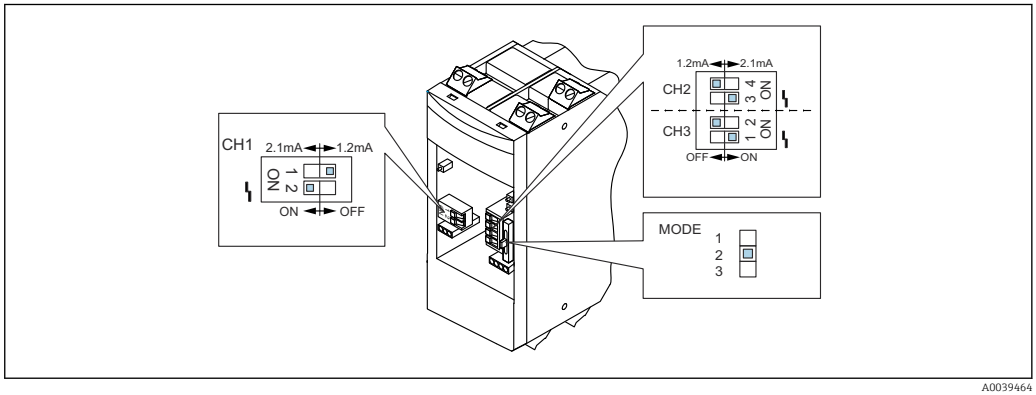
1 1-channel Nivotester, version II wiring scheme

4.5.2 Version III



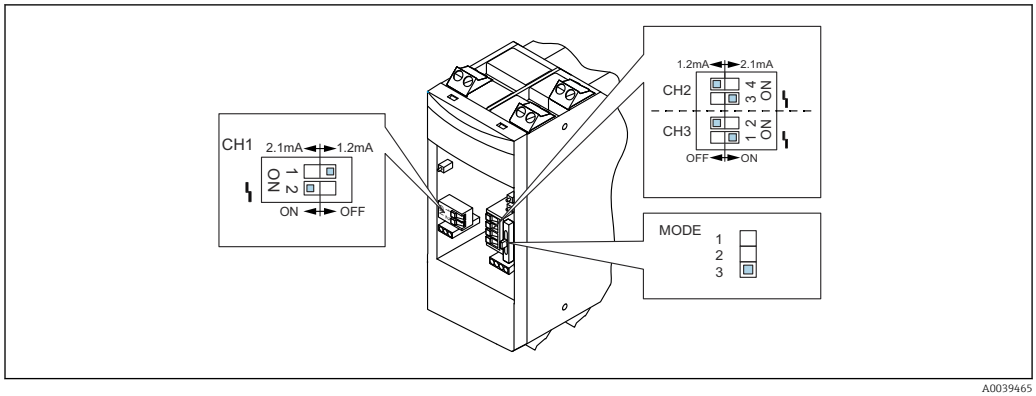
2 3-channel Nivotester, version III wiring scheme

4.5.3 Version IV



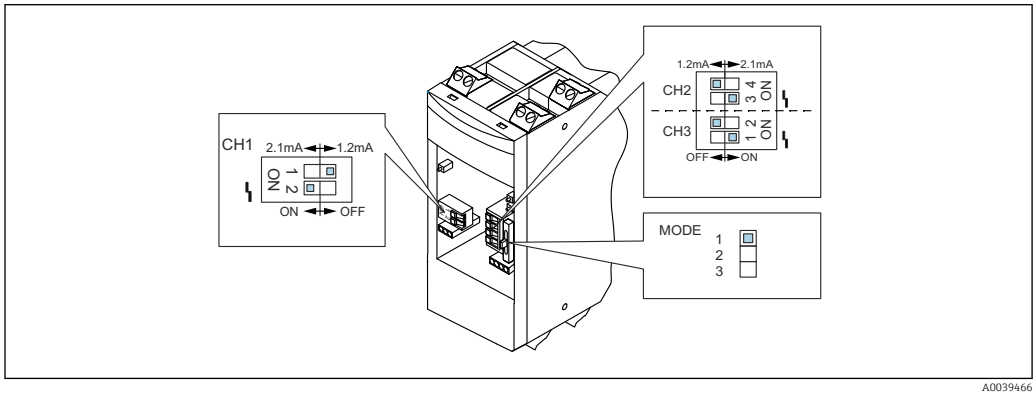
3 3-channel Nivotester, version IV wiring scheme

4.5.4 Version V



4 3-channel Nivotester, version V wiring scheme

4.5.5 Version VI



5 3-channel Nivotester, version VI wiring scheme

5 Operation

5.1 Device behavior when switched on

The behavior of the device when switched on is described in the relevant Operating Instructions.

5.2 Device behavior in safety function demand mode

The safety-related output signal consists of one switch contact per channel.

Version II and version VI:
Terminal 4 + 5

Version III:
- Terminal 22 + 23
- Terminal 26 + 27

Version IV and version V:
- Terminal 4 + 5
- Terminal 22 + 23
- Terminal 26 + 27

The switch contacts work with quiescent current safety; they are closed when the status is OK.

The switch contacts are de-energized in the following situations:
- Demand mode
- Fault detected
- If the supply voltage fails

5.3 Device behavior in the event of an alarm

The behavior of the device in the event of an alarm is described in the relevant Operating Instructions.

6 Proof testing

The safety-related functionality of the device in the SIL mode must be verified during commissioning, when changes are made to safety-related parameters, and also at appropriate time intervals. This enables this functionality to be verified within the entire safety instrumented system. The time intervals must be specified by the operator.

⚠ CAUTION

The safety function is not guaranteed during a proof test

Suitable measures must be taken to guarantee process safety during the test.
- ▶ The safety-related output signal 4 to 20 mA must not be used for the safety instrumented system during testing.
- ▶ A completed test must be documented; the reports provided in the Appendix can be used for this purpose (see Section 8.2).
- ▶ The operator specifies the test interval and this must be taken into account when determining the probability of failure PFD_{avg} of the sensor system.

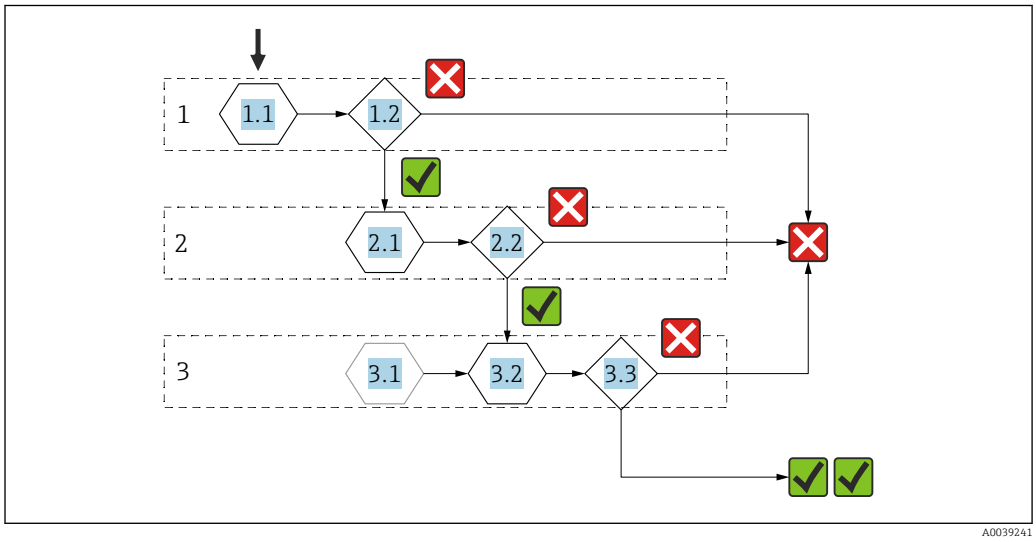
When using the proof-test wizard in the SmartBlue app, the correct version must be selected.

The proof tests for **version II** to **version VI** are described below.

Proof testing of the device can be performed as follows:
- Test sequence A:
  Approach the level, or remove and immerse in a medium of similar density and viscosity
  - Test sequence A, MIN detection
  - Test sequence A, MAX detection
- Test sequence B:
  Simulation using test button or test magnet
  - Test sequence B, simulation using test button or test magnet on Liquiphant
  - Test sequence B, simulation using test button on Nivotester

Note the following for the test sequences:
- A demand mode or a fault takes absolute precedence over the proof test and in the measuring system safety path. For this reason, the demand mode must first be ended or the fault rectified before the proof test can commence.
- The proof test can and may only be performed if the device status is OK.
- The status of the individual output signal is indicated by a measuring device or a downstream component of the safety path (e.g., PLC, actuator).
- The individual proof test coverages (PTC) that can be used for calculation are specified in the Declaration of Conformity.

6.1 Basic test sequence



6 *Basic test sequence*

1.1 Status OK
1.2 Output signal for status OK?
2.1 Establish demand mode
2.2 Output signal for demand mode?
3.1 Re-install the sensor that was removed (optional)
3.2 Establish status OK
3.3 Output signal for status OK?

The output signal can be evaluated based on the response of the following components of the safety function.

6.2 Test sequence A, MIN detection

- Approach the level or
- Remove and immerse in a medium of similar density and viscosity

The contacts to be checked depend on the version.

Version II and version VI:
Terminal 4 + 5

Version III:
- Terminal 22 + 23
- Terminal 26 + 27

Version IV and version V:
- Terminal 4 + 5
- Terminal 22 + 23
- Terminal 26 + 27

Step 1

1. Raise the level or immerse the tuning fork of the sensor that has been removed into the medium until the tuning fork is fully covered.
   ↳ If it is not possible to do this with the original medium, a medium of a similar density and viscosity must be used.
2. Check the status of the safety contacts.
   ↳ The contacts to be checked must be closed.

If one or more safety contacts are open, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Step 2

1. Lower the level or take the tuning fork of the sensor that has been removed out of the medium until the tuning fork is completely free.
   ↳ Wait for the switching delay to elapse (1 s, unless ordered otherwise)
2. Check the status of the safety contacts.
   ↳ The contacts to be checked must be open.

If one or more safety contacts are closed, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Step 3

1. Re-install the sensor that was removed (optional).
   ↳ Wait for power-up (10 s).
2. Restore the status OK by fully covering the tuning fork.
   ↳ Wait for the switching delay to elapse (1 s, unless ordered otherwise).
3. Check the status of the safety contacts.
   ↳ The contacts to be checked must be closed.

If one or more safety contacts are open, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

6.3 Test sequence A, MAX detection

- Approach the level or
- Remove and immerse in a medium of similar density and viscosity

The contacts to be checked depend on the version.

Version II and version VI:
Terminal 4 + 5

Version III:
- Terminal 22 + 23
- Terminal 26 + 27

Version IV and version V:
- Terminal 4 + 5
- Terminal 22 + 23
- Terminal 26 + 27

Step 1

1. Lower the level or take the tuning fork of the sensor that has been removed out of the medium until the tuning fork is completely free.
   ↳ If it is not possible to do this with the original medium, a medium of a similar density and viscosity must be used.
2. Check the status of the safety contacts.
   ↳ The contacts to be checked must be closed.

If one or more safety contacts are open, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Step 2

1. Raise the level or immerse the tuning fork of the sensor that has been removed into the medium until the tuning fork is fully covered.
   ↳ Wait for the switching delay to elapse (1 s, unless ordered otherwise)
2. Check the status of the safety contacts.
   ↳ The contacts to be checked must be open.

If one or more safety contacts are closed, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Step 3

1. Re-install the sensor that was removed (optional).
   ↳ Wait for power-up (10 s).
2. Restore the status OK by fully exposing the tuning fork.
   ↳ Wait for the switching delay to elapse (1 s, unless ordered otherwise).
3. Check the status of the safety contacts.
   ↳ The contacts to be checked must be closed.

If one or more safety contacts are open, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

6.4 Test sequence B, simulation using test button or test magnet on Liquiphant

No change of level in the tank is necessary for this sequence.

Note the following for the test sequences:
Test sequence B (simulation) is not permitted for a commissioning test.

The contacts to be checked depend on the version.

Version II and version VI:
Terminal 4 + 5

Version III:
- Terminal 22 + 23
- Terminal 26 + 27

Version IV and version V:
- Terminal 4 + 5
- Terminal 22 + 23
- Terminal 26 + 27

Step 1

▶ Check the status of the safety contacts.
↳ The contacts to be checked must be closed.

If one or more safety contacts are open, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Step 2

1. Press the test button or apply the test magnet.
   ↳ The device restarts (3 s).
   If the button is pressed (or magnet applied) for a short period, the demand mode is maintained for 7 s afterwards.
   If the button is pressed (or magnet applied) for a longer period, the demand mode is maintained as long as the button remains pressed or the test magnet is applied.
2. Check the status of the safety contacts.
   ↳ The contacts to be checked must be open.

If one or more safety contacts are closed, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Step 3

1. Release the test button or remove the test magnet.
   ↳ Wait for the switching delay to elapse (1 s, unless ordered otherwise)
2. Check the status of the safety contacts.
   ↳ The contacts to be checked must be closed.

If one or more safety contacts are open, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

6.5 Test sequence B, simulation with test button on Nivotester

No change of level in the tank is necessary for this sequence.

Note the following for the test sequences:
Test sequence B (simulation) is not permitted for a commissioning test.

The contacts to be checked depend on the version.

Version II and version VI:
Terminal 4 + 5

Version III:
- Terminal 22 + 23
- Terminal 26 + 27

Version IV and version V:
- Terminal 4 + 5
- Terminal 22 + 23
- Terminal 26 + 27

Step 1

▶ Check the status of the safety contacts.
↳ The contacts to be checked must be closed.

If one or more safety contacts are open, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Step 2

1. Press the test button and release.
   ↳ The device restarts (3 s), and the demand mode is then maintained for 7 s.
2. Check the status of the safety contacts.
   ↳ The contacts to be checked must be open.

If one or more safety contacts are closed, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Step 3

1. Wait for the demand mode to be finished
   ↳ The demand mode is finished 10 s after the test button is released.
2. Check the status of the safety contacts.
   ↳ The contacts to be checked must be closed.

If one or more safety contacts are open, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

6.6 Verification criterion

If one of the test criteria from the test sequences described above is not fulfilled, the device may no longer be used as part of a safety instrumented system.
- The purpose of proof-testing is to detect dangerous undetected device failures (λ_{DU}).
- This test does not cover the impact of systematic faults on the safety function, which must be assessed separately.
- Systematic faults can be caused, for example, by process material properties, operating conditions, build-up or corrosion.
- As part of the visual inspection, for example, ensure that all of the seals and cable entries provide adequate sealing and that the device is not visibly damaged.

7 Repair and error handling

7.1 Maintenance

Maintenance instructions and instructions regarding recalibration may be found in the Operating Instructions pertaining to the device.

Alternative monitoring measures must be taken to ensure process safety during configuration, proof-testing and maintenance work on the device.

7.2 Repair

Repair means restoring functional integrity by replacing defective components.

Components may be repaired/replaced by the customer's technical staff if **genuine spare parts** from Endress+Hauser are used (they can be ordered by the end user) and the appropriate installation instructions are followed.

A proof test must always be performed after every repair.

Spare parts are grouped into logical kits with the associated replacement instructions.

Document the repair with the following information:
- Serial number of the device
- Date of the repair
- Type of repair
- Person who performed the repair

Installation Instructions are supplied with the orginal spare part and can also be accessed in the Download Area at www.endress.com

Return the replaced component to Endress+Hauser for fault analysis.

When returning the defective component, always enclose the "Declaration of Hazardous Material and Decontamination" with the note "Used as SIL device in a safety instrumented system.

For information on device returns, please see:
http://www.endress.com/support/return-material

7.3 Modification

Modifications are changes to SIL devices that are already delivered or installed.
- Modifications to SIL devices are usually performed in the Endress+Hauser manufacturing center.
- Modifications to SIL devices onsite at the user's plant are possible following approval by the Endress+Hauser manufacturing center.
  In this case, the modifications must be performed and documented by an Endress+Hauser service technician.
- **Modifications to SIL devices by the user are not permitted.**

7.4 Decommissioning

When decommissioning, the requirements according to IEC 61508-1:2010 section 7.17 must be observed.

7.5 Disposal

If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to Endress+Hauser for disposal under the applicable conditions.

7.6 Battery disposal

- In some countries, the end user is legally obliged to return used batteries.
- The end user can return old batteries or electronic assemblies containing these batteries free of charge to Endress+Hauser.

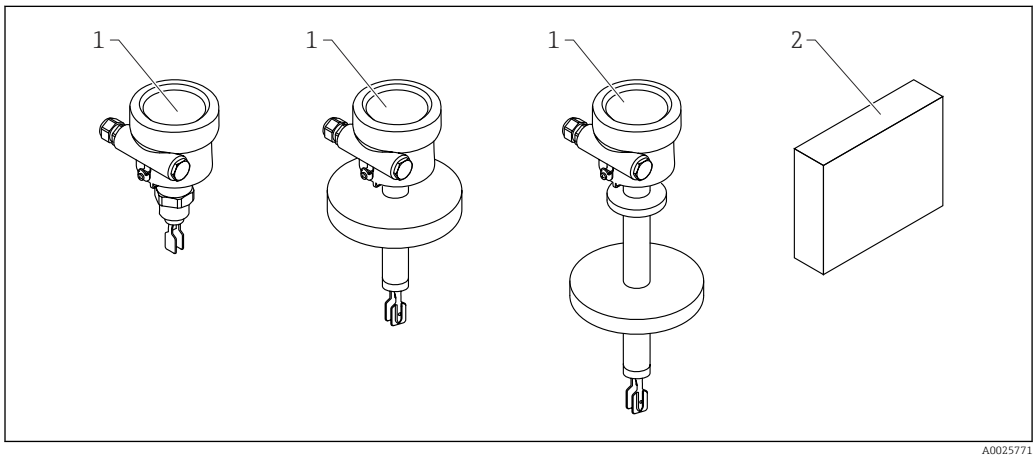
In accordance with German law regulating the use of batteries (BattG §17 Para Number 3), this symbol is used to denote electronic assemblies that must not be disposed of as municipal waste.

8 Appendix

8.1 Structure of the measuring system

8.1.1 System components

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



7 System components

1 Liquiphant
2 Nivotester

8.1.2 Description of application as a safety instrumented system

The sensor's tuning fork vibrates at its intrinsic frequency. The vibration frequency decreases as the density increases. This change in the frequency causes the current signal to change.

Correct installation is a prerequisite for safe operation of the device.

8.1.3 Measurement function

Choice of operating modes:

- MIN detection
  The measuring system is used to protect against a level that is too low (e.g., pump dry running protection, protection against emptying or protection against insufficient filling).
  In normal operation, the tuning fork is covered by liquid and the measuring system reports the OK status. If the tuning fork is free, the device assumes the safe state and signals the demand mode.
- MAX detection
  The measuring system is used to protect against a level that is too high (e.g., overfill prevention).
  In normal operation, the tuning fork is not covered by liquid and the measuring system reports the OK status. If the tuning fork is covered, the device assumes the safe state and signals the demand mode.

8.2 Commissioning or proof test report

The following device-specific test report acts as a print/master template and can be replaced or supplemented any time by the SmartBlue app or the customer's own SIL reporting and testing system.

8.2.1 Test Report - Page 1 -

Device information
System
Measuring points/TAG No.
Device type/order code
Serial number Liquiphant
Serial number Nivotester

Verification information
Date/time
Performed by

Verification result	
Overall result	
☐ Passed	☐ Failed

Comment

Company/contact person
Tester

Date Signature Signature of tester

8.2.2 Test Report Version II - Page 2 -

Device information
System
Measuring points/TAG No.
Serial number Liquiphant
Serial number Nivotester

Verification information
Date/time

Safety function - Set point monitoring	
☐ MIN	☐ MAX

Density range setting	
☐ >0.7	☐ >0.5

Commissioning test - Test sequence A	
☐ MIN detection	☐ MAX detection

Proof testing
☐ Test sequence A, MIN detection
☐ Test sequence A, MAX detection
☐ Test sequence B, simulation using test button or magnet on Liquiphant
☐ Test sequence B, simulation using test button on Nivotester

Safety contacts, check status				
Test step	**Target**	**Terminal actual value** **4 + 5**	**Verification result** ☑	☒
Step 1				
Step 2				
Step 3				

8.2.3 Test Report Version III - Page 2 -

Device information
System
Measuring points/TAG No.
Serial number Liquiphant
Serial number Nivotester

Verification information
Date/time

Safety function - Set point monitoring	
☐ MIN	☐ MAX

Density range setting	
☐ >0.7	☐ >0.5

Commissioning test - Test sequence A	
☐ MIN detection	☐ MAX detection

Proof testing
☐ Test sequence A, MIN detection
☐ Test sequence A, MAX detection
☐ Test sequence B, simulation using test button or magnet on Liquiphant
☐ Test sequence B, simulation using test button on Nivotester

Safety contacts, check status					
Test step	**Target**	**Terminal actual value**		**Verification result**	
		22 + 23	**26 + 27**	☑	☒
Step 1					
Step 2					
Step 3					

8.2.4 Test Report Version IV - Page 2 -

Device information
System
Measuring points/TAG No.
Serial number Liquiphant
Serial number Nivotester

Verification information
Date/time

Safety function - Set point monitoring	
☐ MIN	☐ MAX

Density range setting	
☐ >0.7	☐ >0.5

Commissioning test - Test sequence A	
☐ MIN detection	☐ MAX detection

Proof testing
☐ Test sequence A, MIN detection
☐ Test sequence A, MAX detection
☐ Test sequence B, simulation using test button or magnet on Liquiphant
☐ Test sequence B, simulation using test button on Nivotester

Safety contacts, check status						
Test step	Target	Terminal actual value			Verification result	
		4 + 5	22 + 23	26 + 27	☑	☒
Step 1						
Step 2						
Step 3						

8.2.5 Test Report Version V - Page 2 -

Device information
System
Measuring points/TAG No.
Serial number Liquiphant
Serial number Nivotester

Verification information
Date/time

Safety function - Set point monitoring	
☐ MIN	☐ MAX

Density range setting	
☐ >0.7	☐ >0.5

Commissioning test - Test sequence A	
☐ MIN detection	☐ MAX detection

Proof testing
☐ Test sequence A, MIN detection
☐ Test sequence A, MAX detection
☐ Test sequence B, simulation using test button or magnet on Liquiphant
☐ Test sequence B, simulation using test button on Nivotester

Safety contacts, check status						
Test step	Target	Terminal actual value			Verification result	
		4 + 5	22 + 23	26 + 27	☑	☒
Step 1						
Step 2						
Step 3						

8.2.6 Test Report Version VI - Page 2 -

Device information
System
Measuring points/TAG No.
Serial number Liquiphant
Serial number Nivotester

Verification information
Date/time

Safety function - Set point monitoring	
☐ MIN	☐ MAX

Density range setting	
☐ >0.7	☐ >0.5

Commissioning test - Test sequence A	
☐ MIN detection	☐ MAX detection

Proof testing
☐ Test sequence A, MIN detection
☐ Test sequence A, MAX detection
☐ Test sequence B, simulation using test button or magnet on Liquiphant
☐ Test sequence B, simulation using test button on Nivotester

Safety contacts, check status				
Test step	**Target**	**Terminal actual value** **4 + 5**	**Verification result** ☑	☒
Step 1				
Step 2				
Step 3				

8.3 Version history

FY01005F; Version: 03.23
- Valid as of hardware version: 02.00.zz
- Changes:
  Declarations of conformity adapted

FY01005F; Version: 02.20
- Valid as of hardware version: 02.00.zz
- Changes:
  Addition of FTL62 and FTL64

FY01005F; Version: 01.19
- Valid as of hardware version: 02.00.zz
- Changes:
  First version

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