Safety Manual

VEGATRENN 151, 152

With SIL qualification

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Contents

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51105-EN-200730

1 Document language

DE	Das vorliegende *Safety Manual* für Funktionale Sicherheit ist verfügbar in den Sprachen Deutsch, Englisch, Französisch und Russisch.
EN	The current *Safety Manual* for Functional Safety is available in German, English, French and Russian language.
FR	Le présent *Safety Manual* de sécurité fonctionnelle est disponible dans les langues suivantes: allemand, anglais, français et russe.
RU	Данное руководство по функциональной безопасности *Safety Manual* имеется на немецком, английском, французском и русском языках.

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2 Scope

2.1 Instrument version

This safety manual applies to separators

VEGATRENN 151, 152

Valid versions:

- from HW Ver 1.0.0

2.2 Application area

The instruments can be used for glavanic separation of 4 … 20 mA circuits and with a suitable transducer for level detection or range monitoring in a safety-related system in accordance with IEC 61508 in the *low demand mode* or *high demand mode*.

Due to the systematic capability SC3 this is possible up to:

- SIL2 in single-channel architecture
- SIL3 in multiple channel architecture

SIL The HART interface must not be used to output the measured value.

2.3 SIL conformity

The SIL conformity was independently judged and certified by the *TÜV Rheinland* according to IEC 61508:2010 (Ed.2). [1)]

SIL The certificate is valid for the entire service life of all instruments that were sold before the certificate expired!

[1)] Verification documents see appendix

3 Planning

3.1 Safety function

Safety function

The intrinsically safe current of the transmitters in Ex areas is detected and provided on the non-intrinsically safe output for further processing.

Safety tolerance

For the design of the safety function, the following aspect must be taken into account with regard to the tolerances:

Due to undetected failures in the range between 3.8 mA and 20.5 mA, an incorrect output signal can be generated which deviates from the real measured value by up to 2 %

3.2 Safe state

Safe state

The safe state of the current output depends on the safety function perceived by the connected transmitter.

Fault signal in case of malfunction

Possible fault currents:

- ≤ 3,6 mA ("fail low")
- > 21 mA ("fail high")

3.3 Prerequisites for operation

Instructions and restrictions

- The measuring system should suit the application. The application-specific limits must be maintained
- The specifications according to the operating instructions manual, particularly the current load on the output circuits, must be kept within the specified limits
- The instructions in chapter "*Safety-related characteristics*", paragraph "*Supplementary information*" must be noted
- All parts of the measuring chain must correspond to the planned "*Safety Integrity Level (SIL)*"

4 Safety-related characteristics

4.1 Characteristics acc. to IEC 61508

VEGATRENN 151 or one channel of VEGATRENN 152

Parameter	Value
Safety Integrity Level	SIL2 in single-channel architecture SIL3 in multiple channel architecture [2]
Hardware fault tolerance	HFT = 0
Instrument type	Type A
Mode	Low demand mode, High demand mode
SFF	> 60 %
MTBF [3]	5.59 x 10^6 h (638 years)

Failure rates

λ_S	λ_{DD}	λ_{DU}	λ_H	λ_L	λ_{AD}
9 FIT	0 FIT	9 FIT	31 FIT	29 FIT	0 FIT

PFD_{AVG}	0.004 x 10^{-2}	(T1 = 1 year)
PFD_{AVG}	0.008 x 10^{-2}	(T1 = 2 years)
PFD_{AVG}	0.020 x 10^{-2}	(T1 = 5 years)
PFH	0.009 x 10^{-6} 1/h	

Proof Test Coverag (PTC)

Test type [4]	Remaining failure rate of dangerous undetected failures	PTC
Test 1	0 FIT	99 %

4.2 Characteristics acc. to ISO 13849-1

The transmitter has been manufactured and verified using principles that demonstrate its suitability and reliability for safety-related applications. It can therefore be considered a " *proven component*" according to DIN EN ISO 13849-1.

VEGATRENN 151 or one channel of VEGATRENN 152

Derived from the safety-related characteristics, the following figures result according to ISO 13849-1 machine safety): [5]

Parameter	Value
MTTFd	1668 years
DC	87 %

[2] Homogeneous redundancy possible, because systematic capability SC3.
[3] Including errors outside the safety function.
[4] See section "Proof test".
[5] ISO 13849-1 was not part of the certification of the instrument.

Parameter	Value
Performance Level	8.85 x 10^{-9} 1/h

4.3 Supplementary information

Determination of the failure rates

The failure rates of the instruments were determined by an FMEDA according to IEC 61508. The calculations are based on failure rates of the components according to **SN 29500**:

All figures refer to an average ambient temperature of 40 °C (104 °F) during the operating time. For higher temperatures, the values should be corrected:

- Continuous application temperature > 50 °C (122 °F) by factor 1.3
- Continuous application temperature > 60 °C (140 °F) by factor 2.5

Similar factors apply if frequent temperature fluctations are expected.

Assumptions of the FMEDA

- The failure rates are constant. Take note of the useful service life of the components according to IEC 61508-2.
- Multiple failures are not taken into account
- Wear on mechanical parts is not taken into account
- Failure rates of external power supplies are not taken into account
- The environmental conditions correspond to an average industrial environment

Calculation of PFD_{AVG}

The values for PFD_{AVG} specified above were calculated as follows for a 1oo1 architecture:

$$PFD_{AVG} = \frac{PTC \times \lambda_{DU} \times T1}{2} + \lambda_{DD} \times MTTR + \frac{(1 - PTC) \times \lambda_{DU} \times LT}{2}$$

Parameters used:

- T1 = Proof Test Interval
- PTC = 99 %
- LT = 10 years
- MTTR = 8 h

Boundary conditions relating to transmitters

The transmitter used, must output an error current if it is powered by a voltage outside its voltage range.

Boundary conditions relating to the configuration of the processing unit

A connected control and processing unit must have the following properties:

- The failure signals of the measuring system are judged according to the idle current principle
- " *fail low*" and " *fail high*" signals are interpreted as a failure, whereupon the safe state must be taken on

If this is not the case, the respective percentages of the failure rates must be assigned to the dangerous failures and the values stated in chapter *Safety-related characteristics*“ redetermined!

Multiple channel architecture

Due to the systematic capability SC3, this instrument can also be used in multiple channel systems up to SIL3, also with a homogeneously redundant configuration.

The safety-related characteristics must be calculated especially for the selected structure of the measuring chain using the stated failure rates. In doing this, a suitable Common Cause Factor (CCF) must be considered (see IEC 61508-6, appendix D).

5 Setup

5.1 General information

Mounting and installation

Take note of the mounting and installation instructions in the operating instructions manual.

Setup must be carried out under process conditions.

5.2 Adjustment instructions

Adjustment elements

There are no adjustment elements available.

6 Diagnostics and servicing

6.1 Behaviour in case of failure

When a malfunction was detected, a fault signal is output on the current output (see section " *Safe state*").

SIL If failures are detected, the entire measuring system must be shut down and the process held in a safe state by other measures.

The manufacturer must be informed of the occurrence of a dangerous undetected failure (incl. fault description).

6.2 Repair

Defective instruments can only be repaired by the manufacturer.

7 Proof test

7.1 General information

Objective

To identify possible dangerous, undetected failures, the safety function must be checked by a proof test at adequate intervals. It is the user's responsibility to choose the type of testing. The time intervals are determined by the selected PFD_{AVG} (see chapter " *Safety-related characteristics*").

For documentation of these tests, the test protocol in the appendix can be used.

If one of the tests proves negative, the entire measuring system must be switched out of service and the process held in a safe state by means of other measures.

In a multiple channel architecture this applies separately to each channel.

Preparation

- Determine safety function (mode, switching points)
- If necessary, remove the instruments from the safety chain and maintain the safety function by other means

Unsafe device status

Warning:
During the function test, the safety function must be treated as unreliable. Take into account that the function test influences downstream connected devices.

If necessary, you must take other measures to maintain the safety function.

After the function test, the status specified for the safety function must be restored.

7.2 Test 1 - with input current simulation

Conditions

- Possibility of sensor current simulation exists
- Output signals correspond to the current process variable

Procedure

1. Simulate the currents ≤ 3.6 mA, 4 mA, 12 mA, 20 mA, > 21 mA on the sensor input
2. Check output current

Expected result

The output current corresponds to the simulated input currents (tolerances see operating instructions)

Proof Test Coverage

See *Safety-related characteristics*

8 Appendix A - Test report

Identification	
Company/Tester	
Plant/Instrument TAG	
Meas. loop TAG	
Instrument type/Order code	
Instrument serial number	
Date, setup	
Date, last function test	

Test reason	
(…)	Setup
(…)	Proof test

Operating mode channel 1		**Operating mode channel 2**	
(…)	Max.	(…)	Max.
(…)	Min.	(…)	Min.
(…)	Range monitoring	(…)	Range monitoring

Test result				
Test point	**Real value channel 1**	**Test result**	**Real value channel 2**	**Test result**
≤ 3.6 mA				
4 mA				
12 mA				
20 mA				
> 21 mA				

Confirmation	
Date:	Signature:

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9 Appendix B - Term definitions

Abbreviations

SIL	Safety Integrity Level (SIL1, SIL2, SIL3, SIL4)
SC	Systematic Capability (SC1, SC2, SC3, SC4)
HFT	Hardware Fault Tolerance
SFF	Safe Failure Fraction
PFD_{AVG}	Average Probability of dangerous Failure on Demand
PFH	Average frequency of a dangerous failure per hour (Ed.2)
FMEDA	Failure Mode, Effects and Diagnostics Analysis
FIT	Failure In Time (1 FIT = 1 failure/10^9 h)
λ_{SD}	Rate for safe detected failure
λ_{SU}	Rate for safe undetected failure
λ_S	$\lambda_S = \lambda_{SD} + \lambda_{SU}$
λ_{DD}	Rate for dangerous detected failure
λ_{DU}	Rate for dangerous undetected failure
λ_H	Rate for failure, who causes a high output current (> 21 mA)
λ_L	Rate for failure, who causes a low output current (≤ 3.6 mA)
λ_{AD}	Rate for diagnostic failure (detected)
λ_{AU}	Rate for diagnostic failure (undetected)
DC	Diagnostic Coverage
PTC	Proof Test Coverage (Diagnostic coverage for manual proof tests)
T1	Proof Test Interval
LT	Useful Life Time
MTBF	Mean Time Between Failure = MTTF + MTTR
MTTF	Mean Time To Failure
MTTR	IEC 61508, Ed1: Mean Time To Repair IEC 61508, Ed2: Mean Time To Restoration
$MTTF_d$	Mean Time To dangerous Failure (ISO 13849-1)
PL	Performance Level (ISO 13849-1)

10 Supplement C - SIL conformity

Certificate

Nr./No.: 968/FSP 1088.01/20

Prüfgegenstand **Product tested**	Trennübertrager Separator	**Zertifikats-inhaber** **Certificate holder**	VEGA Grieshaber KG Am Hohenstein 113 77761 Schiltach Germany
Typbezeichnung **Type designation**	VEGATRENN 151, VEGATRENN 152		
Prüfgrundlagen **Codes and standards**	IEC 61508 Parts 1-7:2010	IEC 61326-3-2:2017	
Bestimmungsgemäße Verwendung **Intended application**	Trennübertrager für 4..20mA Sensoren. Die Trennübertrager VEGATRENN 151/152 erfüllen die Anforderungen der genannten Prüfgrundlagen und können in einem sicherheitsbezogenen System gemäß IEC 61508 eingesetzt werden, in HFT=0 Struktur bis SIL 2 und redundant (HFT=1) bis SIL 3 (systematische Eignung SC 3). Ausgangsströme <3,6mA und >21mA müssen von dem nachgeschalteten Sicherheitsgerät als Fehler behandelt werden. Die Produkte wurden auch in Bezug auf die anwendaren Anforderungen der IEC 61511-1:2017 überprüft und können im Anwendungsbereich der IEC 61511-1:2017 verwendet werden Separator for 4..20mA sensors. The Separators VEGATRENN 151/152 comply with the requirements of the stated standards and can be used in a safety-related system acc. IEC 61508, in HFT=0 configuration up to SIL 2 and redundant (HFT=1) up to SIL 3 (systematic capability SC 3). Output currents <3.6mA and >21mA have to be considered by the downstream safety device as failure condition. The products were also reviewed in reference to the requirements of IEC 61511-1:2017 applicable during a type examination and can be used in application as such.		
Besondere Bedingungen **Specific requirements**	Die zugehörigen Betriebsanleitungen und das Safety Manual sind zu beachten. The operating instructions and the safety manual shall be considered.		

Gültig bis / Valid until 2025-07-01

Der Ausstellung dieses Zertifikates liegt eine Prüfung zugrunde, deren Ergebnisse im Bericht Nr. 968/FSP 1088.01/20 vom 01.07.2020 dokumentiert sind.
Dieses Zertifikat ist nur gültig für Erzeugnisse, die mit dem Prüfgegenstand übereinstimmen.
The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/FSP 1088.01/20 dated 2020-07-01.
This certificate is valid only for products which are identical with the product tested.

Köln, 2020-07-01

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