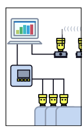
Safety Manual

VEGAMET 381 Ex

4 … 20 mA signal conditioning instruments

Document ID:
39686

Signal
conditioning instruments
and communication



Contents

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DE EN FR ES	Das vorliegende *Safety Manual* für Funktionale Sicherheit ist verfügbar in den Sprachen Deutsch, Englisch, Französisch und Spanisch. The current *Safety Manual* for Functional Safety is available in German, English, French and Spanish language. Le présent *Safety Manual* de sécurité fonctionnelle est disponible dans les langues suivantes: allemand, anglais, français et espagnol. El presente *Safety Manual* para seguridad funcional está disponible en los idiomas alemán, inglés, francés y español.
CZ	Pokud nastanou potíže při čtení bezpečnostních upozornění v otištěných jazycích, poskytneme. Vám na základě žádosti k dispozici kopii v jazyce Vaší země.
DA	Hvis De har svært ved at forstå sikkerhedsforskrifterne på de trykte sprog, kan. De få en kopi på Deres sprog, hvis De ønsker det.
EL	Εάν δυσκολεύεστε να διαβάσετε τις υποδείξεις ασφαλείας στις γλώσσες που ήδη έχουν τυπωθεί, τότε σε περίπτωση ζήτησης μπορούμε να θέσουμε στη διάθεσή σας ένα αντίγραφο αυτών στη γλώσσα της χώρας σας.
ET	Kui teil on raskusi trükitud keeltes ohutusnõuete lugemisega, siis saadame me teie järelepärimise peale nende koopia teie riigi keeles.
FI	Laitteen mukana on erikielisiä turvallisuusohjeita. Voit tilata meiltä äidinkieliset turvallisuusohjeet, jos et selviä mukana olevilla kielillä.
HU	Ha a biztonági előírásokat a kinyomtatott nyelveken nem tudja megfelelően elolvasni, akkor lépjen velünk kapcsolatba: azonnal a rendelkezésére bocsátunk egy példányt az Ön országában használt nyelven.
IT	Se le Normative di sicurezza sono stampate in una lingua di difficile comprensione, potete richiederne una copia nella lingua del vostro paese.
LT	Jei Jums sunku suprasti saugos nuorodų tekstą pateiktomis kalbomis, kreipkitės į mus ir mes Jums duosime kopiją Jūsų šalies kalba.
LV	Ja Jums ir problēmas drošības noteikumus lasīt nodrukātajās valodās, tad mēs Jums sniegsim pēc pieprasījuma kopiju Jūsu valsts valodā.
MT	F'kaz li jkollok xi diffikulta` biex tifhem listruzzjonijiet ta' sigurta`kif ipprovduti, infurmana u ahna nibghatulek kopja billingwa tieghek.
NL	Als u moeilijkheden mocht hebben met het lezen van de veiligheidsinstructies in de afgedrukte talen, sturen wij u op aanvraag graag een kopie toe in uw eigen taal.
PL	W przypadku trudności odczytania przepisów bezpieczeństwa pracy w wydrukowanych językach, chętnie udostępnimy Państwu kopię w języku obowiązującym w danym kraju.
PT	Caso tenha dificuldade de ler as instruções de segurança no idioma, no elas foram impressas, poderá solicitar junto a nós uma cópia em seu idioma.
SK	Pokiaľ nastanú problémy pri čítaní bezpečnostných pokynov vo vydaných jazykoch, poskytneme Vám na základe žiadosti k dispozícii kópiu v jazyku Vašej krajiny.
SL	Kadar se pojavijo težave pri branju varnostnih navodil v izdanih jezikih, vam bomo na osnovi zahtevka dali na razpolago kopijo v jeziku vaše države.
SV	Om du har problem att läsa säkerhetsanvisningarna på de här tryckta språken, ställer vi gärna på begäran en kopia på ditt språk till förfogande.

1 Scope

1.1 Instrument version

This safety manual applies to the signal conditioning instrument **VEGAMET 381 Ex** in SIL version.

Valid version:

- Instrument serial number >19992538
- Instrument software from Rev. 1.20.0

1.2 Application area

In combination with a 4 … 20 mA transmitter, the signal conditioning instrument can be used as measuring system for measurement of level, limit level and other process variables meeting the special requirements of safety technology.

Due to the service proven reliability according to IEC 61511-1, section 11.4.4, this is possible in a protective function up to SIL2.

The following interfaces can be used:

- 4 … 20 mA sensor input with transmitter power supply
- Two relay outputs for limit value monitoring
- 4 … 20 mA current output

Note:
For the sensor input, only the mode *Sensor Input 4 … 20 mA active* is permitted!

For the current output, only the characteristics *4 … 20 mA* is permitted!

1.3 SIL conformity

The SIL conformity is confirmed by the verification documents in the appendix.

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2 Planning

2.1 Safety function

The transmitter powered by the signal conditioning instrument generates a signal between 3.8 and 20.5 mA which is proportional to the process variable.

Safety function relay output
Dependent on this analogue signal and the adjusted switching points, one or two relays for limit value monitoring will be switched.

Safety function current output
This analogue signal can be also fed to a connected processing unit (e.g. safety-oriented PLC). The set switching points can be used for limit value monitoring.

Safety accuracy

The safety accouracy of the output signals is ±2 % relating to the complete value range of 16.7 mA (3.8 … 20.5 mA).

2.2 Safe state

Safe condition relay output
The safe condition on the relay output is the opened closing contact. For the sagety function only the closing contact (NO contact) must be used (closed circuit principle).

Safe condition current output
The safe state of the current output depends on the mode and the characteristics adjusted on the sensor.

	Monitoring upper limit value	**Monitoring lower limit value**
Rising characteristics: 4 mA = 0 %; 20 mA = 100 %	Output current > Switching point -334 µA	Output current < Switching point +334 µA
Falling characteristics: 20 mA = 0 %; 4 mA = 100 %	Output current < Switching point +334 µA	Output current > Switching point -334 µA

Output signals in failure mode

Relay output

- Closing contact is open

Current output

- "fail low" ≤ 3.6 mA
- "fail high" > 21 mA

2.3 Prerequisites for operation

General 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 of the output circuits, must be kept within the specified limits
- Existing communication interfaces (e. g. HART, USB) are not used for transmission of the safety-relevant measured value
- The instructions in chapter "*Safety-technical characteristics*", paragraph "*Supplementary information*" must be noted
- All parts of the measuring chain must correspond to the planned "*Safety Integrity Level (SIL)*"

3 Safety-related characteristics

3.1 General figures for all applications

Parameter according to IEC 61508	**Value**
Safety Integrity Level	SIL2
Hardware frequency tolerance	HFT = 0
Instrument type	Type B
Mode	Low demand mode/High demand mode
MTTR	8 h
MTBF = MTTF + MTTR[1)]	1.05 x 10^{6} h (120 years)

3.2 Specific figures for application 1

One relay output

One relay to control an actor for monitoring a limits value (e.g. overfill or dry run protection)

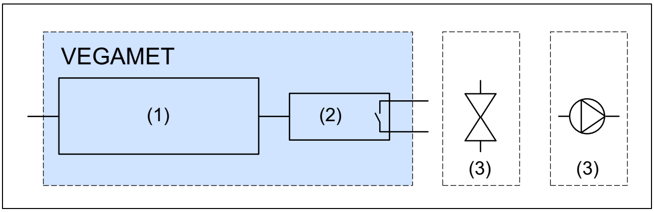

Fig. 1: Structure of application 1

1 Current input and processing electronics
2 Relay 1 or relay 2
3 Actor

λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	DC_S	DC_D
0 FIT	280 FIT	131 FIT	79 FIT	84 %	0 %	63 %

PFD_{AVG} (T1 = 1 year)	0.034 x 10^{-2}
PFD_{AVG} (T1 = 5 years)	0.172 x 10^{-2}
PFD_{AVG} (T1 = 10 years)	0.344 x 10^{-2}
PFH [h-1]	0.079 x 10^{-6}
Diagnosis test period	< 4 s

1) MTBF: Including errors outside the safety function

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3.3 Specific figures for application 2

Two relay outputs

Two relays for control of two actors for monitoring two limit values (e.g. range monitoring).

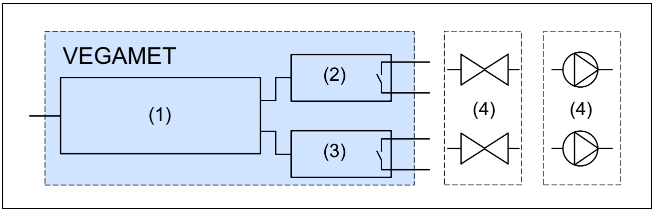

Fig. 2: Structure of application 2

1 Current input and processing electronics
2 Relay 1
3 Relay 2
4 Actors

λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	DC_S	DC_D
0 FIT	309 FIT	131 FIT	106 FIT	81 %	0 %	55 %

PFD_{AVG} (T1 = 1 year)	0.046×10^{-2}
PFD_{AVG} (T1 = 5 years)	0.231×10^{-2}
PFD_{AVG} (T1 = 10 years)	0.463×10^{-2}
PFH [h-1]	0.106×10^{-6}
Diagnosis test period	< 4 s

3.4 Specific figures for application 3

Two relay outputs, redundantly connected

Two redundantly connected relays for control of an actor for monitoring a limit value.

Note: The closing contacts of the two relays are connected in series. Both relay switching points have the same setting.

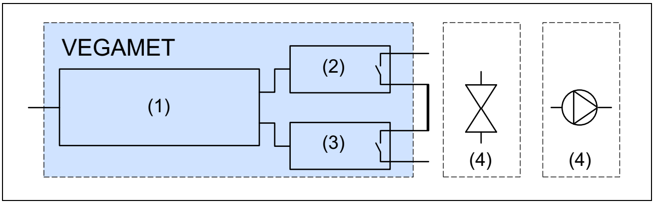

Fig. 3: Structure of application 3

1 Current input and processing electronics
2 Relay 1
3 Relay 2
4 Actors (redundant)

λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	DC_S	DC_D
0 FIT	334 FIT	156 FIT	55 FIT	90 %	0 %	74 %

PFD_{AVG} (T1 = 1 year)	0.024 x 10^{-2}
PFD_{AVG} (T1 = 5 years)	0.120 x 10^{-2}
PFD_{AVG} (T1 = 10 years)	0.240 x 10^{-2}
PFH [h-1]	0.055 x 10^{-6}
Diagnosis test period	< 4 s

3.5 Specific figures for application 4

Current output

One current output for control of a connected processing units (e.g. a SPLC).

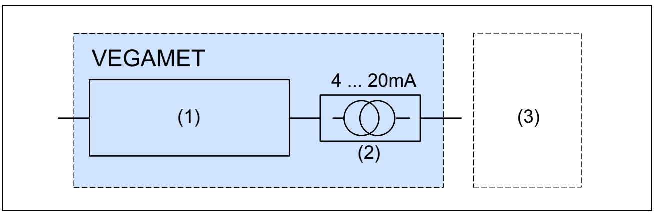

Fig. 4: Structure of application 4

1 Current input and processing electronics
2 Current output
3 Connected processing unit

λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	DC_S	DC_D
0 FIT	11 FIT	386 FIT	54 FIT	88 %	0 %	88 %

PFD_{AVG} (T1 = 1 year)	0.024 x 10^{-2}
PFD_{AVG} (T1 = 5 years)	0.118 x 10^{-2}
PFD_{AVG} (T1 = 10 years)	0.237 x 10^{-2}
PFH [h-1]	0.054 x 10^{-6}
Diagnosis test period	< 4 s

3.6 Supplementary information

Time-dependent process of PFD_{AVG}

The chronological sequence of PFD_{AVG} is nearly linear to the operating time over a period up to 10 years. The above values apply only to the T1 interval after which a recurring function test must be carried out.

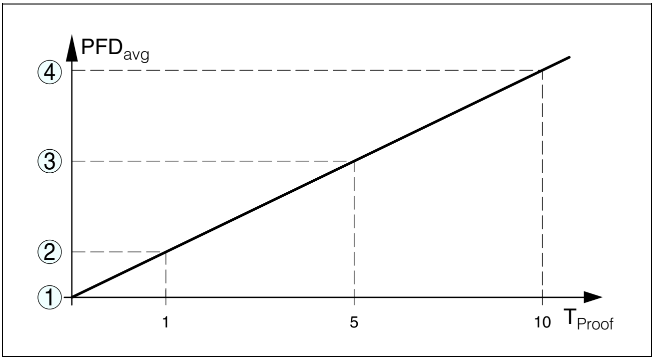

Fig. 5: Time-dependent process of PFD_{AVG}

1 $PFD_{AVG} = 0$
2 PFD_{AVG} after 1 year
3 PFD_{AVG} after 5 years
4 PFD_{AVG} after 10 years
(for values see the charts shown above)

Determination of the failure rates

The failure rates of the instrument were determined by an FMEDA according to IEC 61508. Basis for the calculations are the component failure rates according to SN 29500.

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

- Permanent application temperature > 50 °C (122 °F) by factor 1.3
- Permanent 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 life of the components according to IEC 61508-2.

- Multiple errors are not taken into account
- Wear of mechanical not taken into account
- Failure rates of external power supplies are not taken into account
- The environmental conditions correspond to an average industrial environment
- The repair time (exchange of the measuring system) after a non-dangerous malfunction is 8 hours (MTTR = 8 h)
- To avoid fusing of the contacts, the outputs of the safety relays are protected with a fuse, trigerring at 60 % of the max. contact current load.

Boundary conditions relating to transmitters

The powered transmitter must output an error current if it is powered by a voltage outside the voltage range specified for the sensor input in the operating instructions manual of VEGAMET 381.

Boundary conditions relating to the configuration of the processing unit

A connected control and processing unit offers the following properties:

- The output circuit of the measuring system is judged according to the quiescent current principle
- "*fail low*" and "*fail high*" signals are interpreted as failure and a failure message is triggered

If this is not the case, the respective shares of the failure rates must be assigned to the dangerous failures and the values stated in chapter "*Safety-technical figure*“ must be determined again!

Multiple channel architecture

In multiple channel systems for SIL3 applications, this measuring system must only be used with diversitary redundancy.

The dafety-related characteristics must be calculated especially for the selected structure of the measuring chain by means of the stated failure rates. For this purpose, a suitable common cause factor must be taken into account.

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4 Set up

4.1 Instrument parameter adjustment

Since plant conditions influence the functional safety of the measuring system, the instrument parameters must be set in compliance with the application.

Operation and parameter adjustment

The following adjustment elements or tools are permitted for adjustment of the instruments parameters for the safety function:

- The integrated indicating and adjustment unit for on-site adjustment

The parameter adjustment is described in the operating instructions manual.

It is recommended to document the parameter settings of the measurement loop.

To prevent inadvertent or unauthorized modification, the set parameters must be protected against unintentional access (e.g. by sealing the protective cover).

Dangerous device status

Warning:
During the instrument parameter adjustment, the safety function must be considered as unreliable. This applies until the parameter adjustment is finished.

If necessary, other measures must be taken to maintain the safety function.

Instrument reset

Warning:
With a reset, all values set by the user will be lost and are reset to factory settings.

4.2 Mounting and installation

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

During setup, it is recommended to check the safety function, e.g. by means of a first filling or simulation of the input signal. The procedure described in chapter "*Recurring function test*" can be used.

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5 Reaction during operation and in case of failure

5.1 General information

Device behaviour during operation or in case of malfunction as well as the respective fault messages are described in the operating instructions manual.

The manufacturer must be informed on the occurence of a dangerous, undetected error (incl. fault description).

5.2 Temporal behaviour in case of failure

Internal diagnosis

The instrument is permanently monitored by an internal diagnosis system. If an error is detected, the respective output signals go into the failure mode (see section "*Safe status*").

The diagnosis test period is specified in chapter "*Safety-relevant characteristics*".

Fault reaction time safety-relevant fault messages

Dependent on the fault, a respective fault message is triggered with the following reaction time:

Failure messages during operation	Reaction time
E014 (line short-circuit, sensor current > 21 mA)	< 5 s
E015 (line break, sensor current < 3.6 mA)	< 5 s

Failure messages during parameter adjustment	Reaction time
E003 (CRC error when storing into the EEPROM)	< 1 s
E016 (empty/full adjustment reversed)	< 1 s
E017 (adjustment span too small)	< 1 s
E021 (scaling span too small)	< 1 s
E110 (relay switching points too close together)	< 1 s

6 Recurring function test

6.1 General information

The recurring function test (*Proof Test*) serves to test the safety function and to find out possible undetected, dangerous failures. The functional capability of the measuring system has to be tested in adequate time intervals. It is the user's responsibility to choose the type of testing. The time intervals are subject to the PFD_{AVG} in chapter "*Safety-relevant characteristics*".

With high demand rate, a recurring function test is not requested in IEC 61508. The functional efficiency of the measuring system is demonstrated by the frequent use of the system. In double channel architectures it is a good idea to verify the effect of the redundancy through recurring function tests at appropriate intervals.

For documentation of the function tests, the test protocol in the annex can be used.

If the function test 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.

Tools

- Suitable calibrated ammeter (accuracy better than ±0.1 mA)
- Suitable calibrated resistance measuring instrument
- If necessary, simulator for sensor current (passive current source)

Preparation

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

Note:
The relay switching points and the output current depend on the *Offset correction* and the set *adjustment*!

Calculation see section *Calculation relay switching points and output current*.

Dangerous device status

Warning:
During the function test, the safety function must be treated as unsafe. It must be noted that the function test influences the connected instruments.

If necessary, other measures must be taken to maintain the safety function.

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

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6.2 Test application 1 - One relay output

Procedure for mode overfill protection

1 Set the simulated sensor current directly (max. 2 %) below the relay switching point "on".

2 Set the simulated sensor current directly (max. 2 %) above the relay switching point "off".

Procedure for mode dry run protection

1 Set the simulated sensor current directly (max. 2 %) above the relay switching point "on"

2 Set the simulated sensor current directly (max. 2 %) below the relay switching point "off"

Expected result

Used SIL relay contact must be closed with point 1 and opend with point 2.

Coverage of the test

PTC = 97 %

6.3 Test application 2 - Two relay outputs for range monitoring

Procedure

1 Set simulated sensor current directly (max. 2 %) below the relay switching point "on" for the upper range limit

2 Set simulated sensor current directly (max. 2 %) above the relay switching point "on" for the upper range limit

3 Set simulated sensor current directly (max. 2 %) above the relay switching point "off" for the upper range limit.

4 Set simulated sensor current directly (max. 2 %) below the relay switching point "off" for the lower range limit.

Expected result

Point 1 and 2: Both SIL relay contacts must be closed.

Point 3: The SIL relay contact for monitoring the upper range limit must be open.

Point 4: The SIL relay contact for monitoring the lower range limit must be open.

Coverage of the test PTC = 97 %

6.4 Test application 3 - Two redundant relay outputs

Procedure See section "*Test application 1*"

Coverage of the test PTC = 95 %

6.5 Test application 4 - Current output

Procedure Adjust at least five values of the simulated sensor current within the measuring range.

Expected result All measured current output values deviate by less than 2 % from the expected output current.

Coverage of the test PTC = 96 %

6.6 Calculation realy switching points and output current

Relay switching points

SwitchPoint_mA
By means of the following formula, the sensor current values of the relay switch points can be calculated in mA:

$$\text{SwitchPoint\_mA} = \frac{(\text{Adj\_max\_mA} - \text{Adj\_min\_mA})}{(\text{Adj\_max\_\%} - \text{Adj\_min\_\%})} \times \text{SwitchPoint\_\%} + \text{Adj\_min\_mA} + \text{Offset\_mA}$$

Output current

OutputValue_mA
The output current in mA can be calculated by means of the following formula:

$$\text{OutputValue\_mA} = \frac{\text{Value\_\%}}{100\%} \times 16\text{mA} + 4\text{mA}$$

$$\text{with Value\_\%} = (\text{InputValue\_mA} - \text{Adj\_min\_mA} - \text{Offset\_mA}) \times \frac{(\text{Adj\_max\_\%} - \text{Adj\_min\_\%})}{(\text{Adj\_max\_mA} - \text{Adj\_min\_mA})}$$

Abbreviations

Abbreviation	Unit	Term
InputValue_mA	[mA]	Sensor current

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Abbreviation	Unit	Term
Adj_max_mA	[mA]	Adjustment max.
Adj_min_mA	[mA]	Adjustment min.
Adj_max_%	[%]	Adjustment max.
Adj_min_%	[%]	Adjustment min.
Offset_mA	[mA]	Offset correction
SwitchPoint_mA	[mA]	Relay switching point
SwitchPoint_%	[%]	Relay switching point
Value_mA	[%]	Percentage value
OutputValue_mA	[mA]	Output current

7 Supplement A - Test protocol function test

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

Set parameters		
Used safety-relevant outputs	**O** Relay 1 **O** Relay 2 **O** Current output	
Offset correction	mA	
Adjustment min.	mA entspricht	% (percentage value)
Adjustment max.	mA entspricht	% (percentage value)
Set switching point "on" relay 1	% entspricht	mA sensor current
Set switching point "off" relay 1	% entspricht	mA sensor current
Set switching point "on" relay 2	% entspricht	mA sensor current
Set switching point "off" relay 2	% entspricht	mA sensor current

Test result 1 **Relay outputs**

	Relay output 1			**Relay output 2**		
Switching point	**Measured sensor current**	**Condition Relay 1**	**Test result**	**Measured sensor current**	**Condition Relay 2**	**Test result**
"on"	mA			mA		
"on"	mA			mA		
"on"	mA			mA		
"off"	mA			mA		
"off"	mA			mA		
"off"	mA			mA		

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Test result 2 **Current output**

Simulated sensor current		**Expected Output current**	**Measured Output current**	**Test result**
Sensor current 1	mA	mA	mA	
Sensor current 2	mA	mA	mA	
Sensor current 3	mA	mA	mA	
Sensor current 4	mA	mA	mA	
Sensor current 5	mA	mA	mA	

Confirmation

Date: Signature:

8 Supplement B - Explanations of terms

Abbreviations

SIL	Safety Integrity Level
HFT	Hardware Fault Tolerance
SFF	Safe Failure Fraction
PFD_{AVG}	Average Probability of dangerous Failure on Demand
PFH	Probability of a dangerous Failure per Hour
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_{DD}	Rate for dangerous detected failure
λ_{DU}	Rate for dangerous undetected failure
DC	Diagnostic Coverage
PTC	Proof Test Coverage
T1	Proof Test Interval
LT	Life Time
MTBF	Mean Time Between Failure
MTTF	Mean Time To Failure
MTTR	Mean Time To Repair
$MTTF_d$	Mean Time To dangerous Failure
PL	Performance Level (ISO 13849-1)

Failure limit values for a safety function

	Low demand mode	**High demand mode**
SIL	**PFD_{AVG}**	**PFH [1/h]**
4	$\geq 10^{-5} \ldots < 10^{-4}$	$\geq 10^{-9} \ldots < 10^{-8}$
3	$\geq 10^{-4} \ldots < 10^{-3}$	$\geq 10^{-8} \ldots < 10^{-7}$
2	$\geq 10^{-3} \ldots < 10^{-2}$	$\geq 10^{-7} \ldots < 10^{-6}$
1	$\geq 10^{-2} \ldots < 10^{-1}$	$\geq 10^{-6} \ldots < 10^{-5}$

Safety integrity for subsystems of type A

Max. permitted safety integrity level for a safety function, executed by a safety-related element or subsystem of **Type A**:

	Hardware Fault Tolerance		
SFF	**HFT = 0**	**HFT = 1**	**HFT = 2**

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	Hardware Fault Tolerance		
< 60 %	SIL1	SIL2	SIL3
60 % – < 90 %	SIL2	SIL3	SIL4
90 % – < 99 %	SIL3	SIL4	SIL4
≥ 99 %	SIL3	SIL4	SIL4

Safety integrity for sub-systems of type B

Max. permitted safety integrity level for a safety function, executed by a safety-related element or subsystem of **Type B**:

	Hardware Fault Tolerance		
SFF	**HFT = 0**	**HFT = 1**	**HFT = 2**
< 60 %	Not allowed	SIL1	SIL2
60 % – < 90 %	SIL1	SIL2	SIL3
90 % – < 99 %	SIL2	SIL3	SIL4
≥ 99 %	SIL3	SIL4	SIL4

9 Supplement C - SIL conformity

Konformitätserklärung

Declaration of conformity

Déclaration de conformité

IEC 61508 / IEC 61511

VEGA Grieshaber KG,
Am Hohenstein 113,
77761 Schiltach / Germany

erklärt als Hersteller, dass das Auswertgerät

declares as manufacturer, that the signal conditioning instrument

déclare en tant que fabricant que le transmetteur et indicateur de niveau

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entsprechend der IEC 61511-1, Abschnitt 11.4.4 („Betriebsbewährtheit") für den Einsatz in sicherheitsinstrumentierten Systemen (SIS) als Untersystem bis **SIL2** geeignet ist. Die Sicherheitstechnischen Kennzahlen sowie die Sicherheitshinweise im *Safety Manual* sind zu beachten. Die Beurteilung des Änderungswesens war Bestandteil des Nachweises der Betriebsbewährtheit.

according to IEC 61511-1, section 11.4.4 ("proven in use") is suitable as a subsystem until **SIL2** in safety instrumented systems (SIS). The safety related characteristics as well as the safety instructions in the *Safety Manual* must be considered. The assessment of the modification management was part of the proof for "proven in use".

convient à une utilisation dans les systèmes instrumentés de sécurité (SIS) comme sous-système jusqu'à **SIL2** suivant la norme IEC 61511-1, paragraphe 11.4.4 ("validé en utilisation"). Les caractéristiques techniques relatives à la sécurité ainsi que les consignes de sécurité stipulées dans le *Safety Manual* sont à respecter. L'évaluation du service de modifications a fait partie de la preuve de la validité en utilisation.

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J. Fehrenbach

Josef Fehrenbach
R&D Director

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VEGA Grieshaber KG
Am Hohenstein 113
77761 Schiltach
Germany
Phone +49 7836 50-0
Fax +49 7836 50-201
E-mail: info.de@vega.com
www.vega.com

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