Safety Manual
Probes VA40 and VA40 Ex-d
Measuring tubes VA Di and VA Di Ex-d

höntzsch
flow measuring technology

ATEX

SIL 2
Safety Integrity Level
IEC 61508

zertifiziert nach
ISO 9001
certified quality

Safety Manual

- Probes VA40 ... ZG7 with integrated transducer UVA in AS80 housing
- Measuring tubes VA Di ... ZG1 with integrated transducer UVA in AS80 or AS102 housing

- Probes VA40 ... ZG8 Ex-d with integrated transducer UVA-Ex-d in Ex-d flameproof housing
- Measuring tubes VA Di ... ZG1 Ex-d with integrated transducer UVA-Ex-d in Ex-d flameproof housing

VA40 ... ZG7

VA40 ... ZG8 Ex-d

VA DI ... ZG1

VA DI ... ZG1 Ex-d

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Contents

1 Safety Symbols

Warning! Failure to observe the instructions can result in serious injury and damage to property!

Important notice! Non-observance can result in serious damage to the equipment or performance restriction!

2 Operating Safety

All steps described below must be carried out by qualified personnel only!

Please read the Operating Instructions carefully before unpacking the equipment!

Safety can only be guaranteed if the equipment is operated in accordance with the regulations. Improper handling can result in serious injury and damage to property.

The Safety Manual is only effective in connection with the relevant Operating Instructions or Instruction Manual for Ex-instruments.

3 Planning / Layout

3.1 Ex-application

Approved appliances only are to be used for applications in potentially explosive atmospheres. Special attention should be paid to Instruction Manual UVA-Ex-d.

3.2 Choice of Installation Location

The place of installation must be chosen with care to optimise measurement accuracy. For tips refer to the Operating Instructions.

3.3 Safe Applications (SIL 1 and SIL 2)

Requirements:
- Operation in Low Demand Mode
- The analog output values 0...4 mA and above 20 mA are diagnosed as faults by the subsequent control unit; the process goes into safe mode.
- Safety functions cannot be implemented with the digital output, as no fault tracking can be effected via this output.
- A measurement error of less than 10 % of the measured value has no impact on the safety function.
- The efficiency of the equipment must be checked at regular intervals by repeated inspection.

4 Scope of Delivery

Please check that everything listed in the Technical Data Sheet is included in the delivery.
Also look out for potential small parts such as screw sets, seals, etc.

For use in 'Safe Applications (SIL 1 and SIL 2)' the device must have a SIL logo on the electronics housing and the SIL conformity must be confirmed in the Technical Data Sheet.

5 Conformity with Standards

In addition, the following standards apply for the functional safety (SIL 1 and SIL 2):

DIN EN 61508 Part 1 to Part 7:
Functional safety of electrical/electronic/programmable electronic safety-related systems

DIN EN 61511 Part 1 to Part 3:
Functional safety - Safety instrumented systems for the process industry sector

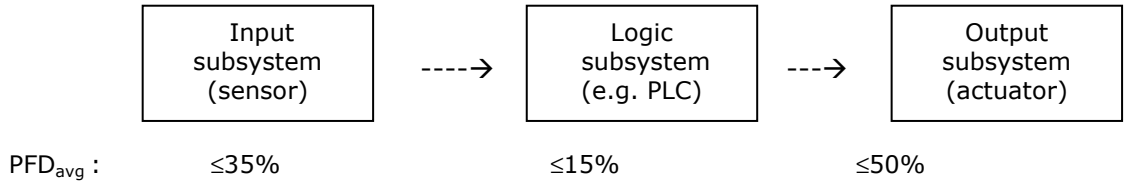
The flow measuring equipment complies with DIN EN 61508 Part 1 to Part 7 and may be used in safety instrumented systems according to DIN EN 61511 Part 1 to Part 3.

6 Abbreviations and Definitions

Abbreviation	Designation	Definition
	Functional Safety	Describes the part of the safety of a system that depends on the correct function of the safety-related (sub-)systems and external equipment for risk minimisation.
SIL	**S**afety **I**ntegrity **L**evel	To assess electrical / electronic / programmable electronic (E/E/PE) systems relating to the reliability of the safety functions. From the target level arises the safety-directed design principle, which must be observed to reduce the risk of failure. SIL 4 = highest level, SIL 1 = lowest level.
SIS	**S**afety **I**nstrumented **S**ystem	Safety instrumented system for carrying out one or more safety instrumented functions. A SIS consists of sensor(s), logic system and actuator(s).
	Mission Time	Mission time of the failure mode and effects analysis
PFD_{avg}	**Av**era**g**e **P**robability of **F**ailure on **D**emand	Averaged probability of failure on demand of the safety function
PFS_{avg}	**Av**era**g**e **P**robability of **F**ail **S**afe	Averaged probability of causing a spurious trip of the process
OK		Probability product is running without any failures
FMEA	**F**ailure **M**ode and **E**ffects **A**nalysis	Failure mode and effects analysis
	Mode of operation	- operation in low demand mode, whereby the demand on the safety-related system is no more than once a year and not greater than the double frequency of the repeat test - operation in high demand or continuous mode, whereby the demand on the safety-related system is more than once a year or greater than the double frequency for the repeat test
SFF	**S**afe **F**ailure **F**raction	Fraction of safe failures relating to the total average failure rate
HFT	**H**ardware **F**ault **T**olerance	The capability of a functional unit to continue the execution of a demanded function in case of faults or deviations
FIT	**F**ailure **I**n **T**ime	1 FIT = 1 failure per 10^9 hours
λ	Failure rate	sd =safe detected su =safe undetected dd =dangerous detected du =danger undetected
MTTF	**M**ean **T**ime **T**o **F**ailure	s = safe d = dangerous
DC	**D**iagnostic **C**overage	s = safe d = dangerous

7 Safety Instrumented System (SIS)

A safety instrumented system generally consists of the three subsystems – input subsystem (sensor), logic subsystem (PLC) and output subsystem (actuator).
The average probability of failure on demand PFD_{avg} is usually distributed over the subsystems as follows:



8 Average Probability of Failure on Demand (PFDavg)

This table indicates the attainable Safety Integrity Level (SIL) subject to average probability of failure on demand. The specified failure boundaries here are effective for a safety function in low demand mode.

Safety Integrity Level (SIL)	PFD_{avg} (low demand mode)
4	$\geq 10^{-5}$ to $< 10^{-4}$
3	$\geq 10^{-4}$ to $< 10^{-3}$
2	$\geq 10^{-3}$ to $< 10^{-2}$
1	$\geq 10^{-2}$ to $< 10^{-1}$

9 Safety Integrity of the Hardware

This table indicates the attainable Safety Integrity Level (SIL) for Type B devices (according to IEC61508-2) subject to Safe Failure Fraction (SFF) and the Hardware Fault Tolerance (HFT):

Safe Failure Fraction (SFF)	Hardware Fault Tolerance (HFT)		
	0	1 (0)*	2
< 60%	not allowed	SIL 1	SIL 2
60% to < 90%	SIL 1	SIL 2	SIL 3
90% to < 99%	SIL 2	SIL 3	SIL 4
≥ 99%	SIL 3	SIL 4	SIL 4

* According to IEC 61511-1 Section 11.4.4 the hardware fault tolerance (HFT) for sensors may be reduced by one if the devices used comply with certain conditions.
This possibility was introduced to enable sensors which only reach SIL 1 requirements according to IEC 61508-2 (SFF 60% to < 90%), to advance to SIL 2.

This does not apply to the Höntzsch sensors described here as these meet the SIL 2 requirements (SFF 90% to < 99%) according to IEC 61508-2.

10 Initial Operation

Initial operation is described in the respective Operating Instructions. For Ex-applications the respective Instruction Manual must also be observed.

11 Behaviour during Operation and in case of Failure

Behaviour during operation and in case of failure is described in the respective Operating Instructions.

12 Periodic Testing

12.1 Safety Checks

The safety function of the entire safety loop must be checked regularly in accordance with IEC 61508/61511. Check intervals are determined when calculating the individual safety loop.

12.2 Performance Check

The proper functional operability of the flow measuring device must be checked regularly at least every 5 years. This can only be carried out by the manufacturer.
In the case of unfavourable operating conditions shorter proof test intervals may be determined by the user.

13 Repairs

Defective devices should be returned to Höntzsch service and repairs department, preferably with a detailed breakdown of type of failure and possible reasons.

14 Safety-related Characteristics

Extract from Reliability Study No. 193.101.3-0 Vortex Sensors

Properties:

Device Type: B
Mode of operation: low demand mode
Hardware fault tolerance: 0

Table 1 - Results FMEA at +55 °C and +85 °C

Properties	VA40 ... ZG7 VA Di ... ZG1		VA40 ... ZG8 Ex-d VA40 ... ZG1 Ex-d	
Temperature	+55 °C	+85 °C	+55 °C	+85 °C
Safe failure fraction SFF	90.6%	91.5%	91.3%	92.0%
Safe detected failure rate λ_{sd} [1/h]	$0.00*10^{-9}$	$0.00*10^{-9}$	$0.00*10^{-9}$	$0.00*10^{-9}$
Safe undetected failure rate λ_{su} [1/h]	$322.92*10^{-9}$	$352.42*10^{-9}$	$1011.53*10^{-9}$	$1080.73*10^{-9}$
Dangerous detected failure rate λ_{dd} [1/h]	$6.60*10^{-9}$	$6.60*10^{-9}$	$17.40*10^{-9}$	$17.40*10^{-9}$
Dangerous undetected failure rate λ_{du} [1/h]	$56.91*10^{-9}$	$58.43*10^{-9}$	$158.51*10^{-9}$	$163.15*10^{-9}$
No effect failure rate [1/h]	$218.88*10^{-9}$	$269.26*10^{-9}$	$642.77*10^{-9}$	$773.33*10^{-9}$
Diagnostic Coverage for dangerous failures DC_d	10.4%	10.1%	9.9%	9.6%
$MTTF_d$ [years]	1797	1755	649	632
$MTTF_s$ [years]	211	184	69	62

Table 2 - Results Example Reliability Calculations

Properties	VA40 ... ZG7 VA Di ... ZG1		VA40 ... ZG8 Ex-d VA Di ... ZG1 Ex-d	
Temperature	+55 °C	+85 °C	+55 °C	+85 °C
Mission time	10 years	10 years	10 years	10 years
Periodic testing	1 year 5 years	1 year 5 years	1 year 5 years	1 year 5 years
PFD_{avg}	$2.58*10^{-4}$ $1.24*10^{-3}$	$6.89*10^{-4}$ $3.38*10^{-3}$	$2.55*10^{-4}$ $1.27*10^{-3}$	$7.08*10^{-4}$ $3.47*10^{-3}$
PFS_{avg}	$1.41*10^{-3}$ $7.03*10^{-3}$	$4.40*10^{-3}$ $2.18*10^{-2}$	$1.54*10^{-3}$ $7.67*10^{-3}$	$4.70*10^{-3}$ $2.32*10^{-2}$
OK	0.997 0.987	0.992 0.964	0.997 0.985	0.990 0.957

Table 3 - Summary Results

Properties	VA40 ... ZG7 VA Di ... ZG1		VA40 ... ZG8 Ex-d VA Di ... ZG1 Ex-d	
Temperature	+55 °C	+85 °C	+55 °C	+85 °C
Fit for use in safety integrity level	SIL 2	SIL 2	SIL 2	SIL 2
Fit for use in spurious trip level®	STL 2	STL 2	STL 2	STL 2
% SIL for 1Y proof test interval	2.58%	6.89%	2.55%	7.08%
% STL™ for 1Y proof test interval	14.1%	44%	15.4%	47.0%

15 Functional Safety Data Sheet

RISKNOWLOGY®

FUNCTIONAL SAFETY DATA SHEET®

Manufacturer	Höntzsch GmbH Gottlieb-Daimler-Str. 37 D-71334 Waiblingen Germany
Product(s)	Probes VA40 ... ZG7 and measuring tubes VA Di ... ZG1
Intended application	The above listed product(s) are used for flow rate or flow velocity measurement in gaseous environments including air
Basis of testing	IEC 61508:1999
Report	The test report 193.101.3 of 2008-07-21 is an integral part of this data sheet
Functional Safety Data	
Type	B
Hardware Fault Tolerance	0
Safe Failure Fraction	90.6 %
Safe Detected Failure Rate	0.00 /hour
Safe Undetected Failure Rate	322.92E-9 /hour
Dangerous Detected Failure Rate	6.60E-9 /hour
Dangerous Undetected Failure Rate	56.91E-9 /hour
No Effect Failure Rate	218.88E-9 /hour
MTTFd	1797 years
MTTFs	211 years
PFD	See report for sample calculations
PFS	See report for sample calculations
Fit for use in Safety Integrity Level	2
Fit for use in Spurious Trip Level™	2

2008-08-11
Date

Dr. M.J.M. Houtermans

RISKNOWLOGY®

FUNCTIONAL SAFETY DATA SHEET®

Manufacturer	Höntzsch GmbH Gottlieb-Daimler-Str. 37 D-71334 Waiblingen Germany
Product(s)	Probes VA40 ... ZG8 Ex-d and measuring tubes VA Di ... ZG1 Ex-d
Intended application	The above listed product(s) are used for flow rate or flow velocity measurement in gaseous environments including air
Basis of testing	IEC 61508:1999
Report	The test report 193.101.3 of 2008-07-21 is an integral part of this data sheet
Functional Safety Data	
Type	B
Hardware Fault Tolerance	0
Safe Failure Fraction	91.3 %
Safe Detected Failure Rate	0.00E- /hour
Safe Undetected Failure Rate	1011.53E-9 /hour
Dangerous Detected Failure Rate	17.40E-9 /hour
Dangerous Undetected Failure Rate	158.51E-9 /hour
No Effect Failure Rate	642.77E-9 /hour
MTTFd	649 years
MTTFs	69 years
PFD	See report for sample calculations
PFS	See report for sample calculations
Fit for use in Safety Integrity Level	2
Fit for use in Spurious Trip Level™	2

2008-08-11

Date

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