FUNCTIONAL SAFETY ASSESSMENT

This certifies, that the company

Sensitron S.r.l.
Via della Repubblica, 48
20010 Cornaredo (MI) - ITALY

Manufacturing plant: **Sensitron S.r.l.**
Via della Repubblica, 48
20010 Cornaredo (MI) - ITALY

Is authorized to provide the product mentioned below with the mark as illustrated

Description of product:
(Details see Annex 1)

Detector SMART S–SS EC with Electrochemical Sensor
Detector SMART S–SS IR with intelligent Infrared Sensor
Detector SMART S–SS Pell with Pellistor Sensor
Detector SMART S-MS
Detector SMART S–IS EC with Electrochemical Sensor
Detector SMART S–IR with intelligent Infrared and Pellistor Sensor
Detector SMART S–DS Pell with dual sensor

Detector SMART3G with Electrochemical Sensor
Detector SMART3G with intelligent Infrared Sensor
Detector SMART3G with Pellistor Sensor
Detector SMART3G-Gr1
Detector SMART3G-D2
Detector SMART3G-C2
Detector SMART3G-D3
Detector SMART3G-C3

Detector SMART3-R with Electrochemical Sensor
Detector SMART3-R with intelligent Infrared Sensor
Detector SMART3-R with Pellistor Sensor
Detector SMART3-H

Detector CYBER-OTH with Electrochemical Sensor
Detector CYBER-OTH with intelligent Infrared Sensor
Detector CYBER-OTH with Pellistor Sensor

Tested in accordance with: **EN 61508 : 2010 Parts 1, 2, 3, 4, 5, 6, 7**
EN 50402 : 2017

Registration No. 18 17025 01
Test Report No. PS-21963-21-L-01 Rev.2
File reference 17025-01

Validity	
from	2021-05-29
until	2024-05-29
First issue:	2018-05-28

TÜV NORD Italia S.r.l. (TÜV NORD Group)
Via Turati, 70 20023 Cerro Maggiore (MI) www.tuev-nord.it

Cerro Maggiore, 2021-07-01
prodotto@tuev-nord.it

Please also pay attention to the information stated overleaf

ANNEX

Annex 1, Page 1 of 26

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Product description

Detector SMART S–SS EC with Electrochemical Sensor

The SMART S–SS detector is consisting of an EC sensing element operated in diffusion mode and protected by a membrane against dust. The signal of the sensing element will be amplified, processed and normalized in relation to the measuring range of 0 – 25(30) %Vol. oxygen or 0 – 300(500) ppm CO. The measuring range and the target gas are depending on the type of sensing element. The signal output is linear and will be made alternatively by an analogue 4 – 20 mA signal or a digital output.

Detector SMART S–SS IR with intelligent Infrared Sensor

The SMART S–SS IR detector is consisting of an intelligent IR sensor (with microprocessor) operated in diffusion model. The signal of the sensing element will be amplified and linearized in the intelligent sensor, processed and normalized in relation to the measuring range of 0 – 100 % of the LEL. The signal output is linear and will be made alternatively by an analogue 4 – 20 mA signal or a digital output.

Detector SMART S–SS Pell with Pellistor Sensor

The SMART S–SS detector is consisting of a Pellistor sensing element operated in diffusion mode and protected by a sintered metal. The signal of the sensing element will be amplified, processed and normalized in relation to the measuring range of 0 – 100 % of the LEL. The signal output is linear and will be made alternatively by an analogue 4 – 20 mA signal or a digital output.

Detector SMART S-MS

SMART S-SS detector without display.

Detector SMART S–IS EC with Electrochemical Sensor

The SMART S–IS detector is consisting of an EC sensing element operated in diffusion mode and protected by a membrane against dust. The signal of the sensing element will be amplified, processed and normalized in relation to the measuring range of 0 – 25(30) %Vol. oxygen or 0 – 300(500) ppm CO. The measuring range and the target gas are depending on the type of sensing element. The signal output is linear and will be made alternatively by an analogue 4 – 20 mA signal or a digital output.
The SMART S–IS detector provides a galvanic isolation between the sensing element amplified signal and the base board electronics.

Detector SMART S–IR with intelligent Infrared and Pellistor Sensor

The SMART S-IR detector is consisting of an intelligent IR sensor (with microprocessor) and a Pellistor sensor operated in diffusion model. The signal of the sensing elements will be amplified and linearized in the intelligent sensor, processed and normalized in relation to the measuring range of 0 – 100 % of the LEL. The single signal output, which is obtained from the two sensors signals, is linear and will be realised alternatively by an analogue 4 – 20 mA signal or a digital output.

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Detector SMART S–DS Pell with dual sensor

The SMART S-DS detector is consisting of two different sensing element operated in diffusion mode. The signal of each sensing element will be amplified, processed and normalized in relation to the measuring range of 0 – 100 % of the LEL , or 0 – 25(30) %Vol. oxygen or 0 – 300(500) ppm CO. The signal output is linear and will be realised alternatively by an analogue 4 – 20 mA signal or a digital output. With two sensors implemented there are two different safety functions.

Detector SMART3G with Electrochemical Sensor

The SMART3G detector is consisting of an EC sensing element operated in diffusion mode and protected by a membrane against dust. The signal of the sensing element will be amplified, processed and normalized in relation to the measuring range of 0 – 25(30) %Vol. oxygen or 0 – 300(500) ppm CO. The measuring range and the target gas are depending on the type of sensing element. The signal output is linear and will be realised alternatively by an analogue 4 – 20 mA signal or a digital output.

Detector SMART3G with intelligent Infrared Sensor

The SMART3G detector is consisting of an intelligent IR sensor (with microprocessor) operated in diffusion mode. The signal of the sensing element will be amplified and linearized in the intelligent sensor, processed and normalized in relation to the measuring range of 0 – 100 % of the LEL. The signal output is linear and will be made alternatively by an analogue 4 – 20 mA signal or a digital output.

Detector SMART3G with Pellistor Sensor

The SMART3G detector is consisting of a Pellistor sensing element operated in diffusion mode and protected by a sintered metal. The signal of the sensing element will be amplified, processed and normalized in relation to the measuring range of 0 – 100 % of the LEL. The signal output is linear and will be made alternatively by an analogue 4 – 20 mA signal or a digital output.

Detector SMART3G-Gr1

SMART3G detector fitted into Group I Mines and Tunnels suitable housings.

Detector SMART3G-D2

SMART3G detector fitted into Zone 1 Category 2 areas suitable housings. The detector comes with a display

Detector SMART3G-C2

SMART3G detector fitted into Zone 1 Category 2 areas suitable housings. Without display

Detector SMART3G-D3

SMART3G detector fitted into Zone 2 Category 3 areas suitable housings. The detector comes with a display

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Detector SMART3G-C3

SMART3G detector fitted into Zone 2 Category 3 areas suitable housings. Without display

Detector SMART3-R with Electrochemical Sensor

The SMART3-R detector is consisting of an EC sensing element operated in diffusion mode and protected by a membrane against dust. The signal of the sensing element will be amplified, processed and normalized in relation to the measuring range of 0 – 25(30) %Vol. oxygen or 0 – 300(500) ppm CO. The measuring range and the target gas are depending on the type of sensing element. The signal output is linear and will be realized alternatively by an analogue 4 – 20 mA signal or a digital output.

Detector SMART3-R with intelligent Infrared Sensor

The SMART3-R detector is consisting of an intelligent IR sensor (with microprocessor) operated in diffusion mode. The signal of the sensing element will be amplified and linearized in the intelligent sensor, processed and normalized in relation to the measuring range of 0 – 100 % of the LEL. The signal output is linear and will be realised alternatively by an analogue 4 – 20 mA signal or a digital output.

Detector SMART3-R with Pellistor Sensor

The SMART3-R detector is consisting of a Pellistor sensing element operated in diffusion mode and protected by a sintered metal. The signal of the sensing element will be amplified, processed and normalized in relation to the measuring range of 0 – 100 % of the LEL. The signal output is linear and will be realised alternatively by an analogue 4 – 20 mA signal or a digital output.

Detector SMART3-H

SMART3-R detector fitted into hotel rooms and buildings suitable housings.

Detector CYBER-OTH with Electrochemical Sensor

The CYBER-OTH EC sensor is consisting of a main board (CSSE3959), an EC sensor board (CSSE3964) and the output board (CSSE3957). The boards are placed in an EX “d” housing. The sensor will be operated in diffusion mode with a sintered filter in front. The gas signal is processed, temperature compensated and normalized in relation to the measuring of 0 – xx % Vol. oxygen or 0 – xxx ppm of a toxic gas or hydrogen. The output board contains 3 different safety functions, a linear analogue 4 – 20 mA output signal, a digital RS485 output signal and the digital switching outputs (alarm + fault signals).

Inspection & Certification Services TÜV NORD Italia S.r.l.

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Detector CYBER-OTH with intelligent Infrared Sensor

The CYBER-OTH IR sensor is consisting of a main board (CSSE3959), an IR sensor board (CSSE3962), the output board (CSSE3957) and the intelligent Infrared (IR) sensor IRNET (type IRNET–P–32 or IRNET–P–20). The boards are placed in an EX “d” housing. The sensor will be operated in diffusion mode with a sintered filter in front. The gas signal is processed, temperature compensated and normalized in relation to the measuring range 0 – 100 % of the LEL for combustible gases. The output board contains 3 different safety functions, a linear analogue 4 – 20 mA output signal, a digital RS485 output signal and the digital switching outputs (alarm + fault signals).

Detector CYBER-OTH with Pellistor Sensor

The CYBER-OTH Pell sensor is consisting of a main board (CSSE3959), an Pellistor sensor board (CSSE3966) and the output board (CSSE3957). The boards are placed in an EX “d” housing. The sensor will be operated in diffusion mode with a sintered filter in front. The gas signal is processed, temperature compensated and normalized in relation to the measuring range 0 – 100 % of the LEL for combustible gases. The output board contains 3 different safety functions, a linear analogue 4 – 20 mA output signal, a digital RS485 output signal and the digital switching outputs (alarm + fault signals).

Operating temperature range
-20 to +60 °C with IR sensor and Pellistors
-20 to +50 °C with cells

Storage temperature range
-20 to +60 °C

Operating humidity range
5-95% non-condensing

Type designation:

Detector SMART S–SS EC with Electrochemical Sensor

FW Version: 04.03.37
HW Version: 5

Detector SMART S–SS IR with intelligent Infrared Sensor

FW Version: 04.03.37
HW Version: 5

Detector SMART S–SS Pell with Pellistor Sensor

FW Version: 04.03.37
HW Version: 5

Detector SMART S–IS Pell with Pellistor Sensor

FW Version: 04.03.37
HW Version: 5

Detector SMART S–IR Pell with Pellistor Sensor

FW Version: 04.03.37

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

HW Version: 5

Detector SMART S–DS Pell with Dual Head and Dual Sensor

FW Version: 04.03.37
HW Version: 5

Detector SMART3G with Electrochemical Sensor

FW Version: 04.03.37
HW Version: 1

Detector SMART3G with intelligent Infrared Sensor

FW Version: 04.03.37
HW Version: 1

Detector SMART3G with Pellistor Sensor

FW Version: 04.03.37
HW Version: 1

Detector SMART3-R with Electrochemical Sensor

FW Version: 04.03.37
HW Version: 1

Detector SMART3-R with intelligent Infrared Sensor

FW Version: 04.03.37
HW Version: 1

Detector SMART3-R with Pellistor Sensor

FW Version: 04.03.37
HW Version: 1

Detector CYBER-OTH with Electrochemical Sensor

FW Version: 04.03.37
HW Version: 1

Detector CYBER-OTH with intelligent Infrared Sensor

FW Version: 04.03.37
HW Version: 1

Detector CYBER-OTH with Pellistor Sensor

FW Version: 04.03.37
HW Version: 1

Refer to the internal document DN 1.8

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Safety related data:

Single channel use of SMART S–SS detector with EC sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. Implementing the assumed values for the sensing element to the PFD calculation leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	1,36E-08	1,16E-06	3,60E-07	1,18E-07	92,83%	5,29E-04	16,90%
Digital output RS 485	1.35E-08	1,16E-06	3,31E-07	1,18E-07	92,66%	5,28E-04	15,08%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate ($3,5 \times 10^{-3}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 16,9% and 15,08% of this sensor subsystem of a SIL 2 overall safety system. In both cases the SFF is well above the required 90%.

Redundant use of SMART S–SS detector with EC sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete detector including sensing element a β-factor of 10 % will be assumed as conservative approach. This leads to the following results:

Safety Function	PFD	% of SIL 3
4 – 20 mA output	5,32E-05	15,2%
Digital output RS 485	5,32E-05	15,2%

The column "% of SIL 3" considers the percentage of that rate ($3,5 \times 10^{-4}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 15,2% and 15,2% of this m sensor subsystem of a SIL 3 overall safety system.

Because the software of the detector is compliant with SIL 3 the redundant use of two detectors in a 1oo2 a full compliance with SIL 3 in combination with a Galileo central unit.

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Single channel use of SMART S–SS IR detector with intelligent IR sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. Implementing the assumed values for the sensing element to the PFD calculation leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	1,50E-08	2,10E-07	5,93E-07	3,27E-08	96,16%	1,58E-04	4,51%
Digital output RS 485	1,48E-08	2,02E-07	5,64E-07	3,27E-08	95,99%	1,57E-04	4,48%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate ($3,5 \times 10^{-3}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 4,51% and 4,48% of this sensor subsystem of a SIL 2 overall safety system.

In both cases the SFF is well above the required 90%.

Redundant use of SMART S–SS IR detector with intelligent IR sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete detector including sensing element a β-factor of 10 % will be assumed as conservative approach. This leads to the following results:

Safety Function	PFD	% of SIL 3
4 – 20 mA output	7,94E-06	2,26%
Digital output RS 485	7,90E-06	2,25%

The column "% of SIL 3" considers the percentage of that rate ($3,5 \times 10^{-4}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 2,26% and 2,25% of this sensor subsystem of a SIL 3 overall safety system.

Because the software of the detector is compliant with SIL 3 the redundant use of two detectors in a 1oo2 a full compliance with SIL 3 in combination with a Galileo central unit.

Single channel use of SMART S–SS detector with Pellistor sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. Implementing the assumed values for the sensing element to the PFD calculation leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	1,50E-08	1,01E-06	3,23E-07	1,05E-07	92,76%	4,71E-04	13,45%

ANNEX

Digital output RS 485	1,48E-08	9,72E-07	2,65E-07	1,05E-07	92,25%	4,69E-04	13,4%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate (3,5 × 10^{-3}) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 13,45% and 13,4% of this sensor subsystem of a SIL 2 overall safety system. In both cases the SFF is well above the required 90%.

Redundant use of SMART S–SS detector with Pellistor sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete detector including sensing element a β-factor of 10 % will be assumed as conservative approach. This leads to the following results:

Safety Function	PFD	% of SIL 3
4 – 20 mA output	4,73E-05	13,51%
Digital output RS 485	4,72E-05	13,48%

Single channel use of SMART S–IS detector with EC sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. Implementing the assumed values for the sensing element to the PFD calculation leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	2,95E-08	1,29E-06	6,97E-07	1,20E-07	94,39%	5,44E-04	15,54%
Digital output RS 485	2.94E-08	1,28E-06	6,67E-07	1,20E-07	94,29%	5,43E-04	15,51%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate (3,5 × 10^{-3}) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 15,54% and 15,51% of this sensor subsystem of a SIL 2 overall safety system. In both cases the SFF is well above the required 90%.

Redundant use of SMART S–IS detector with EC sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete detector including sensing element a β-factor of 10 % will be assumed as conservative approach. This leads to the following results:

Inspection & Certification Services TÜV NORD Italia S.r.l.

ANNEX

Annex 1, Page 9 of 26

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Safety Function	PFD	% of SIL 3
4 – 20 mA output	5,47E-05	15,63%
Digital output RS 485	5,46E-05	15,60%

The column "% of SIL 3" considers the percentage of that rate ($3,5 \times 10^{-4}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 15,63% and 15,60% of this m sensor subsystem of a SIL 3 overall safety system.

Because the software of the detector is compliant with SIL 3 the redundant use of two detectors in a 1oo2 a full compliance with SIL 3 in combination with a Galileo central unit.

Single channel use of SMART S–IR detector with intelligent IR and Pellistor sensors

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours with 24 hours. Adding the values for the intelligent IR sensor to the PFD calculation leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	1,80E-08	1,15E-06	7,52E-07	1,38E-07	93,28%	6,27E-04	17,91%
Digital output RS 485	1,80E-08	1,14E-07	6,08E-07	1,32E-08	93,01%	5,98E-04	17,08%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate ($3,5 \times 10^{-3}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 17,91% and 17,08% of this sensor subsystem of a SIL 2 overall safety system.

In both cases the SFF is well above the required 90%.

Redundant use of SMART S–IR detector with intelligent IR and Pellistor sensors

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete detector including sensing element a β-factor of 10 % will be assumed as conservative approach. This leads to the following results:

Safety Function	PFD	% of SIL 3
4 – 20 mA output	6,31E-05	18,03%
Digital output RS 485	6,01E-05	17,07%

The column "% of SIL 3" considers the percentage of that rate ($3,5 \times 10^{-4}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 18,03% and 17,07% of this sensor subsystem of a SIL 3 overall safety system.

Because the software of the detector is compliant with SIL 3 the redundant use of two detectors in a 1oo2 a full compliance with SIL 3 in combination with a Galileo central unit.

Single channel use of SMART S–DS detector with two different sensors

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. Implementing the assumed values for the sensing element to the PFD calculation leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
IR 4 – 20 mA	1,80E-08	2,46E-07	7,91E-07	5,05E-08	95,43%	2,41E-04	6,9%
Pell 4 – 20 mA	1,80E-08	1,05E-06	5,26E-07	1,22E-07	92,88%	5,50E-04	15,7%
EC 4 – 20 mA	1,80E-08	1,18E-06	5,26E-07	1,35E-07	92,73%	6,07E-04	17,3%
IR Digital RS 485	1,80E-08	2,26E-07	6,08E-07	4,14E-08	95,37%	1,97E-04	5,6%
Pell Digital RS 485	1,80E-08	1,03E-06	3,43E-07	1,13E-07	92,48%	5,06E-04	14,5%
EC Digital RS 485	1,80E-08	1,16E-06	3,43E-07	1,26E-07	92,34%	5,62E-04	16,1%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate ($3,5 \times 10^{-3}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 5,6% and 17,3% of this sensor subsystem of a SIL 2 overall safety system. In all cases the SFF is well above the required 90%.

Redundant use of SMART S–DS detector both with the same type of sensors

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete detector including sensing element a β-factor of 10 % will be assumed as conservative approach. This leads to the following results:

	Infrared	**Pellistor**	**Electro-chemical**			
Safety Function	**PFD IR**	**% of SIL 3**	**PFD Pell**	**% of SIL 3**	**PFD EC**	**% of SIL 3**
4 – 20 mA output	1,21E-05	3,5%	5,53E-05	15,8%	6,11E-05	17,5%

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Digital output RS 485	9,89E-06	2,8%	5,08E-05	14,5%	5,66E-05	16,2%

The column "% of SIL 3" considers the percentage of that rate (3,5 × 10^{-4}) which is commonly accepted as maximum value for the sensor subsystem (= detector). The values achieved for the different safety functions are between 2,8% and 17,5% of this maximum value for the sensor subsystem of a SIL 3 overall safety system.

Because the software of the detector is compliant with SIL 3 the redundant use of two detectors in a 1oo2 combination leads to a full compliance with SIL 3 in combination with a Galileo central unit.

Single channel use of SMART3G detector with EC sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. Implementing the assumed values for the sensing element to the PFD calculation leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	1,39E-07	1,13E-06	3,06E-07	1,20E-07	92,91%	5,38E-04	15,37%
Digital output RS 485	1,36E-07	1,13E-06	3,03E-07	1,17E-07	93,05%	5,24E-04	14,97%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate (3,5 × 10^{-3}) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 15,37% and 14,97% of the sensor subsystem of a SIL 2 overall safety system. In both cases the SFF is well above the required 90%.

Redundant use of SMART3G detector with EC sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete detector including sensing element a β-factor of 10 % will be assumed as conservative approach. This leads to the following results:

Safety Function	PFD	% of SIL 3
4 – 20 mA output	5,41E-05	15,45%
Digital output RS 485	5,27E-05	15,06%

The column "% of SIL 3" considers the percentage of that rate (3,5 × 10^{-4}) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 15,45% and 15,06% of the sensor subsystem of a SIL 3 overall safety system.

ANNEX

Annex 1, Page 12 of 26

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Because the software of the detector is compliant with SIL 3 the redundant use of two detectors in a 1oo2 a full compliance with SIL 3 in combination with a Galileo central unit.

Single channel use of SMART3G detector with intelligent IR sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) with 24 hours. Implementing the assumed values for the sensing element to the PFD calculation leads to

Safety Fun	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA	1,40E-07	1,12E-06	2,78E-07	1,19E-07	92,81%	5,32E-04	15,2%
Digital output	1,37E-07	1,99E-07	5,34E-07	3,17E-08	96,47%	1,53E-04	4,37%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate ($3,5 \times 10^{-3}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 15,2% and 4,37% of this m sensor subsystem of a SIL 2 overall safety system. In both cases the SFF is well above the required 90%.

Redundant use of SMART3G detector with intelligent IR sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete detector including sensing element a β-factor of 10 % will be assumed as conservative approach. This leads to the following results:

Safety Function	PFD	% of SIL 3
4 – 20 mA output	5,35E-05	15,2%
Digital output RS 485	7,69E-06	2,20%

The column "% of SIL 3" considers the percentage of that rate ($3,5 \times 10^{-4}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 15,2% and 2,2% of this m sensor subsystem of a SIL 3 overall safety system.

Because the software of the detector is compliant with SIL 3 the redundant use of two detectors in a 1oo2 a full compliance with SIL 3 in combination with a Galileo central unit.

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Single channel use of SMART3G detector with Pellistor sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. Implementing the assumed values for the sensing element to the PFD calculation leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	1,40E-07	9,84E-07	2,70E-07	1,07E-07	92,85%	4,79E-04	13,68%
Digital output RS 485	1,37E-07	9,94E-07	2,61E-07	1,05E-07	92,99%	4,68E-04	13,37%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate ($3,5 \times 10^{-3}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 13,68% and 13,37% of the sensor subsystem of a SIL 2 overall safety system.

In both cases the SFF is well above the required 90%.

Redundant use of SMART3G detector with Pellistor sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete detector including sensing element a β-factor of 10 % will be assumed as conservative approach. This leads to the following results:

Safety Function	PFD	% of SIL 3
4 – 20 mA output	4,82E-05	13,77%
Digital output RS 485	4,71E-05	13,46%

The column "% of SIL 3" considers the percentage of that rate ($3,5 \times 10^{-4}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 13,77% and 13,46% of the sensor subsystem of a SIL 3 overall safety system.

Because the software of the detector is compliant with SIL 3 the redundant use of two detectors in a 1oo2 combination leads to a full compliance with SIL 3 in combination with a Galileo central unit.

Single channel use of SMART3-R detector with EC sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. Implementing the assumed values for the sensing element to the PFD calculation leads to the following results:

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	1,25E-07	1,10E-06	2,13E-07	1,15E-07	92,60%	5,11E-04	14,60%
Digital output RS 485	1,22E-07	1,10E-06	2,19E-07	1,16E-07	92,56%	5,16E-04	14,74%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate ($3,5 \times 10^{-3}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 14,60% and 14,74% of the sensor subsystem of a SIL 2 overall safety system. In both cases the SFF is well above the required 90%.

Redundant use of SMART3-R detector with EC sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete detector including sensing element a β-factor of 10 % will be assumed as conservative approach. This leads to the following results:

Safety Function	PFD	% of SIL 3
4 – 20 mA output	5,14E-05	14,69%
Digital output RS 485	5,19E-05	14,83%

The column "% of SIL 3" considers the percentage of that rate ($3,5 \times 10^{-4}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 14,69% and 14,83% of the sensor subsystem of a SIL 3 overall safety system.

Because the software of the detector is compliant with SIL 3 the redundant use of two detectors in a 1oo2 a full compliance with SIL 3 in combination with a Galileo central unit.

Single channel use of SMART3-R detector with intelligent IR sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. Implementing the assumed values for the sensing element to the PFD calculation leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	1,25E-07	6,07E-08	2,08E-07	1,09E-08	92,57%	5,11E-04	14,6%
Digital output RS 485	2,46E-09	1,69E-07	4,61E-07	3,09E-08	95,35%	1,47E-04	4,20%

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate ($3{,}5 \times 10^{-3}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 14,6% and 4,20% of this sensor subsystem of a SIL 2 overall safety system. In both cases the SFF is well above the required 90%.

Redundant use of SMART3-R detector with intelligent IR sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete detector including sensing element a β-factor of 10 % will be assumed as conservative approach. This leads to the following results:

Safety Function	PFD	% of SIL 3
4 – 20 mA output	5,13E-05	14,65%
Digital output RS 485	7,38E-06	2,11%

The column "% of SIL 3" considers the percentage of that rate ($3{,}5 \times 10^{-4}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 14,65% and 2,11% of this m sensor subsystem of a SIL 3 overall safety system.

Because the software of the detector is compliant with SIL 3 the redundant use of two detectors in a 1oo2 a full compliance with SIL 3 in combination with a Galileo central unit.

Single channel use of SMART3-R detector with Pellistor sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. Implementing the assumed values for the sensing element to the PFD calculation leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	1,25E-07	9,71E-07	2,09E-07	1,02E-07	92,76%	4,54E-04	12,97%
Digital output RS 485	1,22E-07	9,70E-07	2,00E-07	1,02E-07	92,66%	4,56E-04	13,03%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate ($3{,}5 \times 10^{-3}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 12,97% and 13,03% of the sensor subsystem of a SIL 2 overall safety system.

In both cases the SFF is well above the required 90%.

TÜV NORD

ANNEX

Annex 1, Page 16 of 26

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Redundant use of SMART3-R detector with Pellistor sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete detector including sensing element a β-factor of 10 % will be assumed as conservative approach. This leads to the following results:

Safety Function	PFD	% of SIL 3
4 – 20 mA output	4,56E-05	13,02%
Digital output RS 485	4,58E-05	13,08%

The column "% of SIL 3" considers the percentage of that rate ($3{,}5 \times 10^{-4}$) which is commonly accepted as maxim subsystem (= detector). The values achieved for the two different safety functions are 13,02% and 13,08% of the sensor subsystem of a SIL 3 overall safety system.

Because the software of the detector is compliant with SIL 3 the redundant use of two detectors in a 1oo2 combination leads to a full compliance with SIL 3 in combination with a Galileo central unit

Single channel use of CYBER-OTH detector with EC sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. This leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	6,92E-09	1,10E-06	2,93E-07	1,18E-07	92,24%	5,27E-04	15,1%
Digital output RS485	6,92E-09	1,11E-06	3,14E-07	1,18E-07	92,37%	5,27E-04	15,1%
Switching output	6,92E-09	1,11E-06	2,86E-07	1,18E-07	92,20%	5,29E-04	15,1%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate ($3{,}5 \times 10^{-3}$) which is commonly accepted as maximum value for the sensor subsystem (= sensor + detector electronic). The values achieved for the different safety functions are equivalent to 15,1% of this maximum value for the sensor subsystem of a SIL 2 overall safety system. The SFF is well above the required 90%.

Redundant use of CYBER-OTH detector with EC sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete Cyber-OTH EC sensor including the output board a β-factor of 10 % (for chemical sensor principles according to the EN 50402:2017) is considered. This leads to the following results:

Inspection & Certification Services TÜV NORD Italia S.r.l.

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Safety Function	PFD	% of SIL 3
4 – 20 mA output	5,30E-05	15,1%
Digital output RS 485	5,31E-05	15,2%
Digital switching output (2 signals)	5,32E-05	15,2%

The column "% of SIL 3" considers the percentage of that rate ($3,5 \times 10^{-4}$) which is commonly accepted as maximum value for the sensor subsystem (= sensor + detector electronic). The values achieved for the different safety functions are around 15,2% of this maximum value for the sensor subsystem of a SIL 3 overall safety system.

Because the software of the sensor is compliant with SIL 3 the redundant use of two sensors in a 1oo2 combination leads to a full compliance with SIL 3 in combination with a SIL 3 compliant control unit carrying out the comparison between both redundant channels.

Single channel use of CYBER-OTH detector with IR sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. This leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	1,60E-08	1,41E-07	6,15E-07	2,53E-08	96,83%	1,26E-04	3,6%
Digital output RS485	1,60E-08	1,45E-07	6,37E-07	2,54E-08	96,92%	1,27E-04	3,6%
Switching output	1,60E-08	1,45E-07	6,09E-07	2,58E-08	96,76%	1,28E-04	3,7%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate ($3,5 \times 10^{-3}$) which is commonly accepted as maximum value for the sensor subsystem (= sensor + detector electronic). The values achieved for the different safety functions are around 3.7% of this maximum value for the sensor subsystem of a SIL 2 overall safety system. The SFF is well above the required 90%.

Redundant use of CYBER-OTH detector with IR sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete Cyber-OTH IR sensor including the output board a β-factor of 5 % (for physical sensor principles according to the EN 50402:2017) is considered. This leads to the following results:

ANNEX

Annex 1, Page 18 of 26

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Safety Function	PFD	% of SIL 3
4 – 20 mA output	6,33E-06	1,8%
Digital output RS 485	6,37E-06	1,8%
Digital switching output (2 signals)	6,43E-06	1,8%

The column "% of SIL 3" considers the percentage of that rate ($3,5 \times 10^{-4}$) which is commonly accepted as maximum value for the sensor subsystem (= sensor + detector electronic). The values achieved for the different safety functions are equivalent to 1,8% of this maximum value for the sensor subsystem of a SIL 3 overall safety system.

Because the software of the sensor is compliant with SIL 3 the redundant use of two sensors in a 1oo2 combination leads to a full compliance with SIL 3 in combination with a SIL 3 compliant control unit carrying out the comparison between both redundant channels.

Single channel use of CYBER-OTH detector with Pellistor sensor

For the calculation of PFD the proof test interval T1 is specified with 1 year and the average time for repair (MTTR) is specified with 24 hours. This leads to the following results:

Safety Function	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	PFD	% of SIL 2
4 – 20 mA output	1,10E-08	9,76E-07	3,46E-07	1,03E-07	92,79%	4,64E-04	13,3%
Digital output RS485	1,10E-08	9,80E-07	3,67E-07	1,04E-07	92,92%	4,65E-04	13,3%
Switching output	1,10E-08	9,80E-07	3,39E-07	1,04E-07	92,75%	4,66E-04	13,3%

Failure rates for λ are given per hour.

The column "% of SIL 2" considers the percentage of that rate ($3,5 \times 10^{-3}$) which is commonly accepted as maximum value for the sensor subsystem (= sensor + detector electronic). The values achieved for the different safety functions are equivalent to 13,3% of this maximum value for the sensor subsystem of a SIL 2 overall safety system. The SFF is well above the required 90%.

Redundant use of CYBER-OTH detector with Pellistor sensor

For redundant use the probability of common failures which would occur in both channels at the same time has to be considered. The formulas for the PFD calculation for a 1 out of 2 (1oo2) are specifying a "β-factor" for the rate of common failures within the total rate of dangerous undetected failures. For the complete Cyber-OTH EC sensor including the output board a β-factor of 10 % (for chemical sensor principles according to the EN 50402:2017) is considered. This leads to the following results:

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Safety Function	PFD	% of SIL 3
4 – 20 mA output	4,66E-05	13,3%
Digital output RS 485	4,67E-05	13,3%
Digital switching output (2 signals)	4,68E-05	13,4%

The column “% of SIL 3” considers the percentage of that rate (3,5 × 10^{-4}) which is commonly accepted as maximum value for the sensor subsystem (= sensor + detector electronic). The values achieved for the different safety functions are around 13,4% of this maximum value for the sensor subsystem of a SIL 3 overall safety system.

Because the software of the sensor is compliant with SIL 3 the redundant use of two sensors in a 1oo2 combination leads to a full compliance with SIL 3 in combination with a SIL 3 compliant control unit carrying out the comparison between both redundant channels.

Conditions for safe use:

Detector SMART S–SS EC with Electrochemical Sensor

The values for the SIL-Capability of the SMART S–SS detector and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).

The detector has to be placed at a position suitable for the measuring application, to be connected correctly to the central unit and to be put into operation by Sensitron or an authorized installer company.
Output signals of the detector of <3 mA (fail low) and >21 mA (fail high) have to be recognized by the central unit as detector failure. If a central unit from Sensitron is used this is ensured automatically.
The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user manual have to be observed and followed.
The SMART S–SS detector has to be maintained regularly following the instructions and to be calibrated using certified calibration gas mixture.
The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out without additional requirements.

Detector SMART S–SS IR with intelligent Infrared Sensor

The values for the SIL-Capability of the SMART S–SS IR detector and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).

The detector has to be placed at a position suitable for the measuring application, to be connected correctly to the central unit and to be put into operation by Sensitron or an authorized installer company.
Output signals of the detector of <3 mA (fail low) and >21 mA (fail high) have to be recognized by the central unit as detector failure. If a central unit from Sensitron is used this is ensured automatically.
The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user manual have to be observed and followed.
The SMART S–SS IR has to be maintained regularly following the instructions and to be calibrated using certified calibration gas mixture.

ANNEX

The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out without additional requirements.

Detector SMART S–SS Pell with Pellistor Sensor

The values for the SIL-Capability of the SMART S–SS detector and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).

The detector has to be placed at a position suitable for the measuring application, to be connected correctly to the central unit and to be put into operation by Sensitron or an authorized installer company.
Output signals of the detector of <3 mA (fail low) and >21 mA (fail high) have to be recognized by the central unit as detector failure. If a central unit from Sensitron is used this is ensured automatically.
The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user manual have to be observed and followed.
The SMART S–SS detector has to be maintained regularly following the instructions and to be calibrated using certified calibration gas mixture.
It has to be ensured that the SMART S–SS detector with Pellistor sensor has no contact with traces of one of the following poisoning agents which may destroy the catalyst of the sensing element:

- Silicone vapours (e.g. in polishes, waterproof agents, silicone grease or plasticizer)
- Organic phosphorous compounds (e.g. herbicide or insecticide)
- Halogen compounds (e.g. inorganic or organic chlorine or fluorine compounds)
- Sulphur compounds (e.g. hydrogen sulphide or sulphur organic compounds)

If the presence of one of the mentioned poisons for the catalytic sensor will be expected an IR sensor e.g. SMART S-SS or SMART S–IR (OEM) should be used instead of the pellistor sensor.
If none of the mentioned poisons is expected but the presence cannot be excluded short calibration intervals are recommended which may be enlarged if no negative effect will be recognized during normal operation.
The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out without additional requirements.

Detector SMART S–IS EC with Electrochemical Sensor

The values for the SIL-Capability of the Smart S–IS detector and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).
The detector has to be placed at a position suitable for the measuring application, to be connected correctly to the central unit and to be put into operation by Sensitron or an authorized installer company.
Output signals of the detector of <3 mA (fail low) and >21 mA (fail high) have to be recognized by the central unit as detector failure. If a central unit from Sensitron is used this is ensured automatically.
The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user manual have to be observed and followed.
The Smart S–IS detector has to be maintained regularly following the instructions and to be calibrated using a certified calibration gas mixture.
The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out without additional requirements.

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Detector SMART S–IR EC with Dual Sensor

The values for the SIL-Capability of the Smart S-IR detector and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).
The detector has to be placed at a position suitable for the measuring application, to be connected correctly to the central unit and to be put into operation by Sensitron or an authorized installer company.
Output signals of the detector of <3 mA (fail low) and >21 mA (fail high) have to be recognized by the central unit as detector failure. If a central unit from Sensitron is used this is ensured automatically.
The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user manual have to be observed and followed.
The Smart S-IR detector has to be maintained regularly following the instructions and to be calibrated using a certified calibration gas mixture.
The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out without additional requirements.

Detector SMART S–DS with Dual Head and Dual Sensor

The values for the SIL-Capability of the Smart S-DS detector and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).
The detector has to be placed at a position suitable for the measuring application, to be connected correctly to the central unit and to be put into operation by Sensitron or an authorized installer company.
Output signals of the detector of <3 mA (fail low) and >21 mA (fail high) have to be recognized by the central unit as detector failure. If a central unit from Sensitron is used this is ensured automatically.
The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user manual have to be observed and followed.
The Smart S-DS detector has to be maintained regularly following the instructions and to be calibrated using a certified calibration gas mixture.
If a Pellistor sensor is implemented it has to be ensured that the SMART S-DS detector has no contact with traces of one of the following poisoning agents which may destroy the catalyst of the sensing element:

- Silicone vapours (e.g. in polishes, waterproof agents, silicone grease or plasticizer)
- Organic phosphorous compounds (e.g. herbicide or insecticide)
- Halogen compounds (e.g. inorganic or organic chlorine or fluorine compounds)
- Sulphur compounds (e.g. hydrogen sulphide or sulphur organic compounds)

If the presence of one of the mentioned poisons for the catalytic sensor will be expected an IR sensor (intelligent IR sensor implemented into SMART S-DS) should be used instead of the Pellistor sensing element.
If none of the mentioned poisons is expected but the presence cannot be excluded short calibration intervals are recommended which may be enlarged if no negative effect will be recognized during normal operation.
The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out without additional requirements.

Inspection & Certification Services TÜV NORD Italia S.r.l.

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Detector SMART3G with Electrochemical Sensor

The values for the SIL-Capability of the SMART3G detector and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).
The detector has to be placed at a position suitable for the measuring application, to be connected correctly to the central unit and to be put into operation by Sensitron or an authorized installer company.
Analogue output: A signal of 3mA is under scale condition; from 20 to 21.6 will be indicated as concentration above 100% LEL. Signals < 2 mA (fail low) and > 22 mA (fail high) have to be recognized by the central unit as detector fault. If a central unit from Sensitron is used this is ensured automatically.
Digital output: The detector has to be connected to a central unit from Sensitron, which will send and receive the high safety data protocol for the communication with the detector.
The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user manual have to be observed and followed.
The SMART3G detector has to be maintained regularly following the instructions and to be calibrated using a certified calibration gas mixture.
The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out without additional requirements.

Detector SMART3G with Intelligent Infrared Sensor

The values for the SIL-Capability of the SMART3G detector and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).
The detector has to be placed at a position suitable for the measuring application, to be connected correctly to the central unit and to be put into operation by Sensitron or an authorized installer company.
Analogue output: A signal of 3mA is under scale condition; from 20 to 21.6 will be indicated as concentration above 100% LEL. Signals < 2 mA (fail low) and > 22 mA (fail high) have to be recognized by the central unit as detector fault. If a central unit from Sensitron is used this is ensured automatically.
Digital output: The detector has to be connected to a central unit from Sensitron, which will send and receive the high safety data protocol for the communication with the detector.
The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user manual have to be observed and followed.
The SMART3G detector has to be maintained regularly following the instructions and to be calibrated using a certified calibration gas mixture.
The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out without additional requirements.

Detector SMART3G with Pellistor Sensor

The values for the SIL-Capability of the SMART3G detector and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).
The detector has to be placed at a position suitable for the measuring application, to be connected correctly to the central unit and to be put into operation by Sensitron or an authorized installer company.
Analogue output: A signal of 3mA is under scale condition; from 20 to 21.6 will be indicated as concentration above 100% LEL. Signals < 2 mA (fail low) and > 22 mA (fail high) have to be recognized by the central unit as detector fault. If a central unit from Sensitron is used this is ensured automatically.

Inspection & Certification Services TÜV NORD Italia S.r.l.

ANNEX

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Digital output: The detector has to be connected to a central unit from Sensitron, which will send and receive the high safety data protocol for the communication with the detector.
The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user manual have to be observed and followed.
The SMART3G detector has to be maintained regularly following the instructions and to be calibrated using a certified calibration gas mixture.
It has to be ensured that the SMART3G detector with Pellistor sensor has no contact with traces of one of the following poisoning agents which may destroy the catalyst of the sensing element:

- Silicone vapours (e.g. in polishes, waterproof agents, silicone grease or plasticizer)
- Organic phosphorous compounds (e.g. herbicide or insecticide)
- Halogen compounds (e.g. inorganic or organic chlorine or fluorine compounds)
- Sulphur compounds (e.g. hydrogen sulphide or sulphur organic compounds)

If the presence of one of the mentioned poisons for the catalytic sensor will be expected an IR sensor e.g. SMART3G IR or should be used instead of the Pellistor sensor.
If none of the mentioned poisons is expected but the presence cannot be excluded short calibration intervals are recommended which may be enlarged if no negative effect will be recognized during normal operation.
The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out without additional requirements.

Detector SMART3-R with Electrochemical Sensor

The values for the SIL-Capability of the SMART3G detector and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).
The detector has to be placed at a position suitable for the measuring application, to be connected correctly to the central unit and to be put into operation by Sensitron or an authorized installer company.
Analogue output: A signal of 3mA is under scale condition; from 20 to 21.6 will be indicated as concentration above 100% LEL. Signals < 2 mA (fail low) and > 22 mA (fail high) have to be recognized by the central unit as detector fault. If a central unit from Sensitron is used this is ensured automatically.
Digital output: The detector has to be connected to a central unit from Sensitron, which will send and receive the high safety data protocol for the communication with the detector.
The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user manual have to be observed and followed.
The SMART3G detector has to be maintained regularly following the instructions and to be calibrated using a certified calibration gas mixture.
The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out without additional requirements.

Detector SMART3-R with Intelligent Infrared Sensor

The values for the SIL-Capability of the SMART3-R detector and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).
The detector has to be placed at a position suitable for the measuring application, to be connected correctly to the central unit and to be put into operation by Sensitron or an authorized installer company.
Analogue output: A signal of 3mA is under scale condition; from 20 to 21.6 will be indicated as concentration above 100% LEL. Signals < 2 mA (fail low) and > 22 mA (fail high) have to be recognized by the central unit as detector fault. If a central unit from Sensitron is used this is ensured

automatically.
Digital output: The detector has to be connected to a central unit from Sensitron, which will send and receive the high safety data protocol for the communication with the detector.
The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user manual have to be observed and followed.
The SMART3-R detector has to be maintained regularly following the instructions and to be calibrated using a certified calibration gas mixture.
The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out without additional requirements.

Detector SMART3-R with Pellistor Sensor

The values for the SIL-Capability of the SMART3G detector and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).
The detector has to be placed at a position suitable for the measuring application, to be connected correctly to the central unit and to be put into operation by Sensitron or an authorized installer company.
Analogue output: A signal of 3mA is under scale condition; from 20 to 21.6 will be indicated as concentration above 100% LEL. Signals < 2 mA (fail low) and > 22 mA (fail high) have to be recognized by the central unit as detector fault. If a central unit from Sensitron is used this is ensured automatically.
Digital output: The detector has to be connected to a central unit from Sensitron, which will send and receive the high safety data protocol for the communication with the detector.
The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user manual have to be observed and followed.
The SMART3G detector has to be maintained regularly following the instructions and to be calibrated using a certified calibration gas mixture.
It has to be ensured that the SMART3G detector with Pellistor sensor has no contact with traces of one of the following poisoning agents which may destroy the catalyst of the sensing element:

- Silicone vapours (e.g. in polishes, waterproof agents, silicone grease or plasticizer)
- Organic phosphorous compounds (e.g. herbicide or insecticide)
- Halogen compounds (e.g. inorganic or organic chlorine or fluorine compounds)
- Sulphur compounds (e.g. hydrogen sulphide or sulphur organic compounds)

If the presence of one of the mentioned poisons for the catalytic sensor will be expected an IR sensor e.g. SMART3G IR or should be used instead of the Pellistor sensor.
If none of the mentioned poisons is expected but the presence cannot be excluded short calibration intervals are recommended which may be enlarged if no negative effect will be recognized during normal operation.
The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out without additional requirements.

Detector CYBER-OTH with Electrochemical Sensor

The values for the SIL-Capability of Cyber-OTH EC sensor with output board and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).
The Cyber-OTH EC sensor with output board connected to a detector has to be placed at a position suitable for the measuring application, to be connected correctly to a central unit and to be put into operation by an authorized installer company.
For sensors using the analogue output as safety function
Output signals of the sensor of <3 mA (fault low) and >21 mA (fault high) have to be recognized by an

Inspection & Certification Services TÜV NORD Italia S.r.l.

external detector electronic or by the central unit as sensor / detector failure.

For sensors using the digital RS 485 output as safety function
The Cyber-OTH EC sensor has to be connected to a detector electronic, which will send and receive the high safety data protocol or MODBUS protocol data for the communication with the Cyber-OTH EC sensor.

For sensors using the digital switching output as safety function
The alarm signal and the fault signal of the Cyber-OTH EC sensor have to be connected to actors to carry out automatic action to achieve a safe state and/or to optical and audible alarm indicators.

The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user's manual have to be observed and followed.
The sensor / detector has to be maintained regularly following the instructions and to be calibrated using a certified calibration gas mixture.

The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out.
The relays connected to the switching output signals have to be switched during proof test to recognize eventually welded contacts of the relays.
The relays are not part of the Cyber-OTH EC-sensor.

Detector CYBER-OTH with Intelligent Infrared Sensor

The values for the SIL-Capability of Cyber-OTH IR sensor with output board and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).
The Cyber-OTH IR sensor with output board connected to a detector has to be placed at a position suitable for the measuring application, to be connected correctly to a central unit and to be put into operation by an authorized installer company.
For sensors using the analogue output as safety function
Output signals of the sensor of <3 mA (fault low) and >21 mA (fault high) have to be recognized by an external detector electronic or by the central unit as sensor / detector failure.

For sensors using the digital RS 485 output as safety function
The Cyber-OTH IR sensor has to be connected to a detector electronic from Sensitron, which will send and receive the high safety data protocol for the communication with the Cyber-OTH IR sensor.

For sensors using the digital switching output as safety function
The alarm signal and the fault signal of the Cyber-OTH IR sensor have to be connected to actors to carry out automatic action to achieve a safe state and/or to optical and audible alarm indicators.

The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user's manual have to be observed and followed.
The sensor / detector has to be maintained regularly following the instructions and to be calibrated using a certified calibration gas mixture.
The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out.
The relays connected to the switching output signals have to be switched during proof test to recognize eventually welded contacts of the relays.
The relays are not part of the Cyber-OTH IR-sensor.

Inspection & Certification Services TÜV NORD Italia S.r.l.

ANNEX

Annex 1, Page 26 of 26

To Functional Safety Assessment report-No. PS-21963-21-L-01 Rev.2

Detector CYBER-OTH with Pellistor Sensor

The values for the SIL-Capability of Cyber-OTH Pell sensor with output board and the determined failure rates are valid only if the following conditions for use will be obeyed (responsibility of the user).
The Cyber-OTH Pell sensor with output board connected to a detector has to be placed at a position suitable for the measuring application, to be connected correctly to a central unit and to be put into operation by an authorized installer company.
For sensors using the analogue output as safety function
Output signals of the sensor of <3 mA (fault low) and >21 mA (fault high) have to be recognized by an external detector electronic or by the central unit as sensor / detector failure.

For sensors using the digital RS 485 output as safety function
The Cyber-OTH Pell sensor has to be connected to a detector electronic, which will send and receive the high safety data protocol or MODBUS protocol data for the communication with the Cyber-OTH Pell sensor.

For sensors using the digital switching output as safety function
The alarm signal and the fault signal of the Cyber-OTH Pell sensor have to be connected to actors to carry out automatic action to achieve a safe state and/or to optical and audible alarm indicators.

The environmental parameters (e.g. the ranges for temperature, humidity and pressure) specified in the user's manual have to be observed and followed.
The sensor / detector has to be maintained regularly following the instructions and to be calibrated using a certified calibration gas mixture.

It has to be ensured that the Cyber-OTH Pell sensor has no contact with traces of one of the following poisoning agents which may destroy the catalyst of the sensing element:
Silicone vapours (e.g. in polishes, waterproof agents, silicone grease or plasticizer)
Organic phosphorous compounds (e.g. herbicide or insecticide)
Halogen compounds (e.g. inorganic or organic chlorine or fluorine compounds)
Sulphur compounds (e.g. hydrogen sulphide or sulphur organic compounds)
If the presence of one of the mentioned poisons for the catalytic sensor will be expected an IR sensor e.g. Cyber-OTH IR or should be used instead of the Pellistor sensor.
If none of the mentioned poisons is expected but the presence cannot be excluded short calibration intervals are recommended which may be enlarged if no negative effect will be recognized during normal operation.

The proof test has to be carried out minimum once per year. As proof test a regular calibration using a certified calibration gas mixture has to be carried out.
The relays connected to the switching output signals have to be switched during proof test to recognize eventually welded contacts of the relays.
The relays are not part of the Cyber-OTH Pell-sensor.

TÜV NORD Italia S.r.l. (TÜV NORD Group) Cerro Maggiore, 2021-07-01
Via Turati 70 20023 Cerro Maggiore (MI) www.tuev-nord.it prodotto@tuev-nord.it