



Certification

SITRANS P310, P DS III, P410

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Contents

1	Introduction	5
1.1	Objective and Scope	5
1.2	Product Description	5
1.3	Functional Safety Properties	7
2	Proven In Use Demonstration	8
2.1	Restricted Functionality	8
2.2	Conditions Of Use	8
2.3	Field Data	8
2.4	Modifications	8
2.5	Reliability analysis (FMEDA)	9
2.6	PFDG for 1oo1 configuration	10
2.7	PFDG for 1oo2 configuration	11
2.8	EMC, Basic Safety and Environmental Testing	11
3	User Documentation	12
4	Conclusions	12
5	Standards	13
6	References	13

List of Tables

1	Field Data	8
2	Failure rates from field data for SITRANS P310, P DS III, P410, 1oo1	9
3	Functional safety data for SITRANS P310, P DS III, P410, 1oo1	9
4	Functional safety data for SITRANS P310, P DS III, P410, 1oo2	10

Parties

About Siemens

Siemens offers a comprehensive range of products and systems for process instrumentation and process analytics for non safety and safety related applications. The process instrumentation portfolio covers positioners, process instruments for pressure, temperature, flow and level measurements. The products for process analytics include continuous gas analysers for stand-alone and system solutions as well as process gas chromatographs.

About Risknowlogy

Risknowlogy was founded in 2002 and is an employee owned business. We offer products, services, engineering, consulting, certification and training in the field of risk, reliability and safety. Our offices are located in Argentina, Colombia, Germany, France, India, The Netherlands, Switzerland (HQ), the United Arab Emirates and the United Kingdom.

1 Introduction

1.1 Objective and Scope

The objective of this report is to document the proven in use study carried out for the Siemens SITRANS P310, P DS III, P410 pressure transmitters. The purpose of the proven in use study is to demonstrate that the transmitters are suitable to be used in safety instrumented functions up to SIL 2 (1oo1) or SIL 3 (1oo2) according to IEC 61511 [1, 2].

1.2 Product Description

The products subject to the proven in use analyses are the SITRANS P310, P DS III, P410 pressure transmitters. The pressure transmitters are available for different measurement tasks including

- Gauge pressure measurement,
- Absolute pressure measurement,
- Differential pressure measurement,
- Flow measurement,
- Level measurement.

SITRANS P310, P DS III, P410 is available with different linearities of the characteristics.

Overview of SITRANS P310, P DS III, P410 versions

	P310	P DS III	P410
Linearity	≤ 0.075%	≤ 0.065%	≤ 0.04%
Order number	7MF2*33...-Z C23	7MF4*33...-Z C23	7MF4*33-...-Z C23 C41

Linearity values are typical values, detailed information is provided by the manual.

Pressure measurement SITRANS, Series P310 HART

Order number 7MF2a33-*b***-****-Z C23, valid combinations¹:

a	b	Function
0	B...G, J	Gauge pressure
4	C...H	Differential pressure and flow, PN 32/160

¹Overview of order numbers and valid combinations, see latest product catalogue Siemens FI 01.

Pressure measurement SITRANS, Series P DS III HART

Order number 7MF4a33-*b***-****-Z C23, valid combinations²:

a	b	Function
0	A...G, J	Gauge pressure
1	B...E, S, T, U	Gauge and absolute pressure, front-flush diaphragm
2	D, F, G, H	Absolute pressure from gauge pressure series
3	D, F, G, H, K	Absolute pressure from differential pressure series
4	B...H	Differential pressure and flow, PN 32/160
5	D...H	Differential pressure and flow, PN 420
6	D...G	Level

Pressure measurement SITRANS, Series P410 HART

Order Number 7MF4a33-*b***-****-Z C23 C41, valid combinations²:

a	b	Function
0	B...F	Gauge pressure
4	D...H	Differential pressure and flow, PN 32/160
5	D...H	Differential pressure and flow, PN 420

In the following data shown for Z C23 types are also valid for Z C23 C41.

The product is shown in Figure 1.



Figure 1: SITRANS P310, P DS III, P410

²Overview of order numbers and valid combinations, see latest product catalogue Siemens FI 01.

1.3 Functional Safety Properties

The functional safety properties according to IEC 61511 are:

- Safety function: Measure the pressure and convert actual value into a 4-20mA output signal with an accuracy of 2% of full span;
- This is a type B device with hardware fault tolerance 0.

Note: The HART communication is interference free for the safety function and not safety related.

2 Proven In Use Demonstration

2.1 Restricted Functionality

The purpose of the transmitter is to measure the pressure and to transmit this pressure as a 4-20mA signal. The functionality is restricted to pressure measurements. Possible configurations are related to process parameters. Access to the configuration is protected by administrative measures.

2.2 Conditions Of Use

The transmitters considered for proven in use have been used in similar operating environments [4]. These include more than 10 typical process industry environments.

2.3 Field Data

The hard- and firmware of the product was introduced 2003 and is unmodified [5]. The hardware version is 02.07.01 or 02.07.02, the firmware version 11.03.06 or 09.01.06. Siemens collected 6 years of field data for the transmitters [6]. From the field data 25% of the operating hours has been excluded take into account non-operating hours (e.g. from storage times, non-operation, etc). The typical operating time in the process industry is 24 hours per day. Siemens has compiled customer feedback and repair data [7]. The data demonstrates that during the time under consideration 1982 failures have occurred, see Table 1. 924 failures of the reported failures were classified as dangerous failures related to the safety function. None of the failures are related to systematic failures of software.

Table 1: Field Data

Product	Operating hours	Safe Failures	Dangerous Failures
SITRANS P310, P DS III, P410	6.15E9 h	1058	924

2.4 Modifications

The hardware and software has not been changed during the evaluated time [5, 8]. The systematic capability of the device is compliant to route 2H, 2S according to IEC 61508-2, SC 3.

2.5 Reliability analysis (FMEDA)

A qualitative and quantitative reliability study has been carried out in line with the requirements of the IEC 61508 standard. The reliability study consists of a failure modes and effects analyses (FMEDA) [9], [3].

Table 4 presents a summary of the reliability data derived from the FMEDA. Table 3 shows failure rates for use of the instrument in 1oo1 configuration (Fault Tolerance 0) and Table 4 in 1oo2 configuration (Fault Tolerance 1).

For the 1oo2 failure rates it is assumed that the safety related control system performs a compare of the output values of the sensors and performs safety function in case of divergence of the measured values. This improves the rate of dangerous detected failures compared to 1oo1 configuration.

The FMEDA analysis, which represents design expectations, corresponds with the data from the proven in use data, which represents operational experience.

Table 2: Failure rates from field data for SITRANS P310, P DS III, P410, 1oo1

Properties	Proven In Use	90% Confidence
Safe Failure Rate	172	181
Dangerous Failure Rate	150	159

Notes:

Failure rates are in FIT $10^{-9}1/h$.

Confidence interval according to IEC 61508 route 2H.

IEC 61508 requires a minimum DC of 60% for Type B products for route 2h, 2s.

Table 3: Functional safety data for SITRANS P310, P DS III, P410, 1oo1

Properties	7MF[2,4]033...-Z C23 span ≤ 63 bar 7MF[2,4]133...-Z C23	7MF[2,4]033...-Z C23 span ≥ 160 bar 7MF[2,4]233...-Z C23	7MF[2,4]333...-Z C23 7MF[2,4]433...-Z C23 7MF[2,4]533...-Z C23 7MF[2,4]633...-Z C23
Type	B	B	B
Safe failure rate	151	142	200
Safe detected failure rate	0	0	0
Safe undetected failure rate	151	142	200
Dangerous failure rate	513	486	535
Dangerous detected failure rate	381	356	407
Dangerous undetected failure rate	132	130	128
Safe Failure Fraction	80%	79%	82%
Diagnostic Coverage	74.3%	73.2%	76.1%

The DC values for the 1oo2 configuration in the table above are assuming that instrument values (4-20mA) are compared by the process control system. In case of deviation the safety function shall be executed.

Table 4: Functional safety data for SITRANS P310, P DS III, P410, 1oo2

Properties	7MF[2,4]033...-Z C23 span ≤ 63 bar 7MF[2,4]133...-Z C23	7MF[2,4]033...-Z C23 span ≥ 160 bar 7MF[2,4]233...-Z C23	7MF[2,4]333...-Z C23 7MF[2,4]433...-Z C23 7MF[2,4]533...-Z C23 7MF[2,4]633...-Z C23
Type	B	B	B
Safe failure rate	153	169	200
Safe detected failure rate	0	0	0
Safe undetected failure rate	153	169	200
Dangerous failure rate	512	486	534
Dangerous detected failure rate	486	462	509
Dangerous undetected failure rate	26	24	25
Safe Failure Fraction	96%	96%	96%

2.6 PFDG for 1oo1 configuration

7MF[2,4]033...-Z C23, span ≤ 63 bar, 7MF[2,4]133...-Z C23

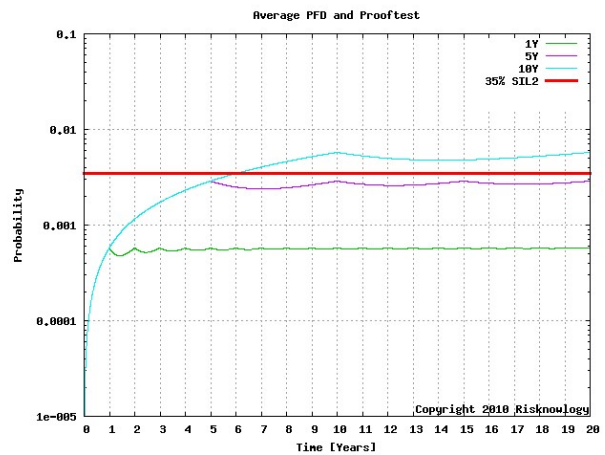
Years	1	5	10
PFDG	6.16E-4	2.93E-3	5.82E-3
%SIL 2	6.16%	29.3%	58.2%
PFSavg	3.78E-5		

7MF[2,4]033...-Z C23, span ≥ 160 bar, 7MF[2,4]233...-Z C23

Years	1	5	10
PFDG	6.05E-4	2.89E-3	5.74E-3
%SIL 2	6.05%	28.9%	57.4%
PFSavg	3.54E-5		

7MF[2,4]333...-Z C23, 7MF[2,4]433...-Z C23
7MF[2,4]533...-Z C23, 7MF[2,4]633...-Z C23

Years	1	5	10
PFDG	5.98E-4	2.83E-3	5.63E-3
%SIL 2	5.98%	28.4%	56.3%
PFSavg	4.31E-5		



2.7 PFDG for 1oo2 configuration

7MF[2,4]033...-Z C23, span ≤ 63 bar, 7MF[2,4]133...-Z C23

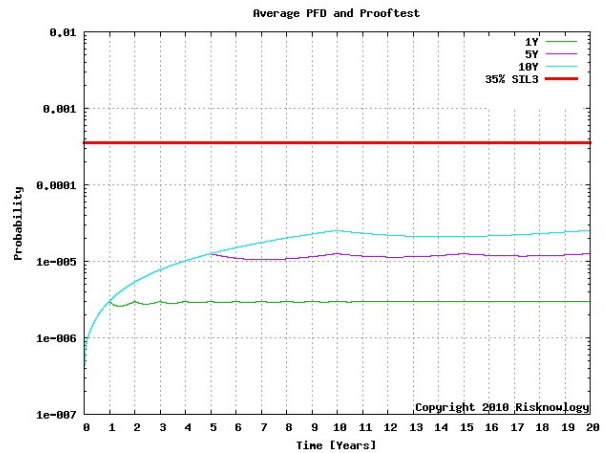
Years	1	5	10
PFDG, $\beta = 2\%$	3.06E-6	1.26E-5	2.54E-5
%SIL 2	0.3%	1.26%	2.54%
PFDG, $\beta = 5\%$	7.59E-6	3.09E-5	6.07E-5
%SIL 2	0.76%	3.09%	6.07%
PFSavg	9.12E-05		

7MF[2,4]033...-Z C23, span ≥ 160 bar, 7MF[2,4]233...-Z C23

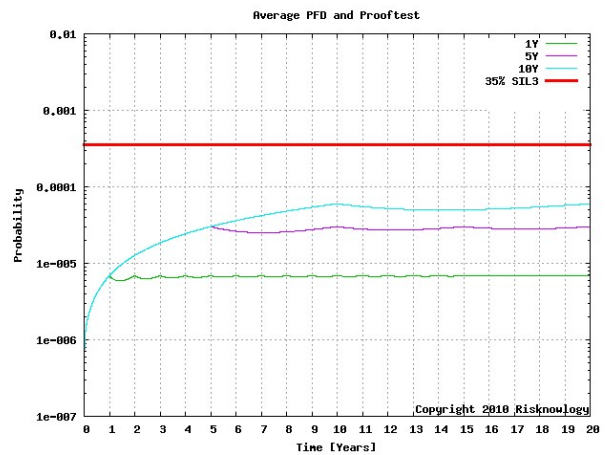
Years	1	5	10
PFDG, $\beta = 2\%$	2.84E-6	1.17E-5	2.34E-5
%SIL 2	0.28%	1.17%	2.34%
PFDG, $\beta = 5\%$	7.06E-6	2.86E-5	5.6E-5
%SIL 2	0.71%	2.86%	5.6%
PFSavg	8.99E-05		

7MF[2,4]333...-Z C23, 7MF[2,4]433...-Z C23
7MF[2,4]533...-Z C23, 7MF[2,4]633...-Z C23

Years	1	5	10
PFDG, $\beta = 2\%$	3.01E-6	1.23E-5	2.46E-5
%SIL 2	0.3%	1.23%	2.46%
PFDG, $\beta = 5\%$	7.48E-6	3.00E-5	5.88E-5
%SIL 2	0.75%	3.00%	5.88%
PFSavg	1.01E-04		



Beta 2%



Beta 5%

2.8 EMC, Basic Safety and Environmental Testing

The product complies [10] with

- EMC directive 2004/108/EC
- ATEX directive 94/9/EC
- LVD directive 2006/95/EC

3 User Documentation

The safety manual [11] provided by Siemens provides all necessary information for use of the product. The manual was reviewed without any objections.

4 Conclusions

The proven in use analysis demonstrates that the hardware and software of the transmitters correspond with SIL 2 safety properties according to IEC 61511 in 1oo1 configuration of the device. SITRANS P310, P DS III, P410 transmitters can be used in homogeneous redundant 1oo2 (Hardware Fault Tolerance 1) configurations for applications up to SIL 3.

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Verifier

5 Standards

- [1] IEC 61508: 2010
Functional safety of electrical/electronic/programmable electronic safety related systems.
- [2] IEC 61511: 2003
Functional safety: Safety instrumented systems for the process industry sector.
- [3] SN29000: 1996
Failure Rates of Components.

6 References

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- [6] D101_Stückzahlentwicklung_DSIII_2003_2009.
- [7] D102_Feldstatistik_DSIII_100326.
- [8] 1601_RD1066 Alina Impact Analyse prel 250mbar_M230_02_Rel.
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1502_A5E00047090-10_Rel_de_DS3_P410_HART_OI.
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