Level

244LD LevelStar Intelligent Buoyancy Transmitter for Level, Interface and Density – HART® and FOUNDATION Fieldbus, SIL Safety Information

MI EML0710S

Instruction

Release date July 2024

https://www.se.com

Legal Information

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Table of Contents

Important Safety Instructions

Read these instructions carefully and look at the equipment to become familiar with it before trying to install, operate, service, or maintain it. The following safety messages might appear throughout this manual or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a “Danger” or “Warning” safety message indicates that an electrical hazard exists that results in personal injury if the instructions are not followed.

This safety alert symbol that lets you know about potential personal injury hazards. Obey all safety messages with this symbol to avoid possible injury or death.

⚠DANGER

DANGER indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

Failure to follow these instructions will result in death or serious injury.

⚠WARNING

WARNING indicates a hazardous situation that, if not avoided, **could result in** death or serious injury.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

⚠CAUTION

CAUTION indicates a hazardous situation that, if not avoided, **could result in** minor or moderate injury.

Failure to follow these instructions can result in injury or equipment damage.

NOTICE

NOTICE is used to address practices not related to physical injury.

Failure to follow these instructions can result in equipment damage.

Please Note

Electrical equipment should only be installed, operated, serviced, and maintained by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction, installation, and operation of electrical equipment and has received safety training to recognize and avoid the hazards involved.

Scope of Application

The intelligent transmitter 244LD LevelStar measures the level, interface and density of liquids continuously in processes of all industrial applications which meet the particular demands on safety equipment required according to IEC 61508 / IEC 61511-1.

Features

- Functional safety in compliance with IEC 61508 / IEC 61511-1
- Suitable for use up to SIL 2, independently assessed by exida.com
- Explosion protection (depending on the version)
- Electromagnetic compatibility to EN 61326 and NAMUR recommendation NE21

General

The scope of application encompasses the intelligent transmitters for level, interface and density of type 244LD LevelStar (HART and 4-20 mA without communications) for continuous measurement.

The measurement is based on the Archimedes buoyancy principle. The devices can be accessed and adjusted remotely using a PC or hand terminal but can also be adjusted by conventional means with local pushbuttons. The transmitters are suitable for use in explosion hazard zones.

Other features:

- Continuous self-diagnosis
- Configurable safety level
- Software locking for pushbuttons and reconfiguration
- Simple commissioning
- Measurements virtually independent of the product properties

The intelligent transmitters for level, interface, and density 244LD LevelStar can be employed in applications with low or high demand rates. For more technical information, see *244LD LevelStar Intelligent Buoyancy Transmitter for Level, Interface and Density – HART® and FOUNDATION Fieldbus, (PSS EML0710)* and *244LD LevelStar Intelligent Buoyancy Transmitter for Level, Interface and Density – HART® and FOUNDATION Fieldbus, (MI EML0710)*.

Identification

This safety manual is valid for all devices 244LD LevelStar:

- Model Code: 244LD-xxxxxxNxxxxx-Q
- Revision: 6.2.x with Software 8.29.x (Communication HART 5)
- Revision: 7.0.x with Software 9.29.x (Communication HART 7)
- DMU DTM Version 3.5.1 or higher (Communication HART 5)
- LevelStar DTM Version 1.1.0 or higher (Communication HART 7)

Requirements

Requirements for applications under the specific demands on safety equipment according to IEC 61508/IEC 61511-1.

Project Planning

The technical data specified in *244LD LevelStar Intelligent Buoyancy Transmitter for Level, Interface and Density – HART® and FOUNDATION Fieldbus, (PSS EML0710)*, particularly with regard to the application and ambient conditions, are fulfilled by the transmitters. The average operating temperature for the amplifier over longer periods is not higher than 40°C.

HART Communication

In case of using a DCS for HART configuration it is necessary to ensure using the correct HART communication link, for example, by checking the tag number and write protection status.

Commissioning

Conduct function test on the transmitters after project planning. The necessary tests must be specified in the safety manual of the system. The tests include:

- Zero point verification
- Measured value verification
- Simulation of various measured values
- Verification of the preset safety values

NOTE: Conduct function test for remote adjustment of the parameters relevant to measurements.

Entering Safety Mode

Before the safety mode is put into operation, a verification of all parameters must be performed. Steps to follow:

1. Restart the device via DTM or power cycle.
2. Upload all data within DTM.
3. Verify and confirm the configuration of all parameters by using the confirmation screen within the DTM.
4. Lock the HART communications and local operation by activating the write protection/entering the safety mode.

Regular Function Tests

Regular function tests (see Recurring Tests of the Transmitter for Level, Interface and Density, page 12) must be conducted.

Other Requirements

The infrared service interface is intended for special authorized Schneider Electric personnel for debug purposes only.

Relevant Standards

- DIN EN 61508 Parts 1 to 7: Functional safety-related electric/electronic/ programmable electronic systems
- DIN IEC 61511 Parts 1 to 3: Functional safety – Safety instrumented systems for industrial processes

Terms

The terms listed are defined according to DIN EN 61508 Teil 1-7 Beuth-Verlag, Berlin, Part 4 and DIN IEC 61511 Teil 1-3 Beuth-Verlag, Berlin, Part 1.

Term	Description
Actor	Component of a safety instrumented system which executes actions in the process to achieve a safe situation.
Failure	Loss of the ability of a functional unit to execute the required function.
Diagnostic coverage	Ratio of the failure rate of the faults detected by diagnostic tests to the overall failure rate of the components or subsystem. The diagnostic rate does not include faults detected by recurring tests.
Fault	Abnormal situation which can cause an impairment or loss of the ability of a functional unit to execute a required function.
Functional safety	Part of overall safety relating to the process and BPCS and dependent on the intended function of the SIS and other safety levels.
Functional unit	Unit consisting of hardware or software or both which is suitable to execute a defined task.
Dangerous failure	Failure with the potential of putting the safety instrumented system in a hazardous or dysfunctional condition.
Safety	Freedom of disproportionate risks.
Safety function	Function executed by an SIS, a safety-related system of other equipment or external facilities to reduce risks with the objective of achieving or upholding the safe conditions of a process, taking account of a defined, detected dangerous event.
Safety integrity	Mean probability that a safety instrumented system will execute the required safety functions under all defined conditions within a defined period.
Safety integrity level (SIL)	One of four discreet stages to specify the requirements for the safety integrity of the safety functions assigned to the safety instrumented system, in which safety integrity level 4 represents the highest degree of safety integrity and safety integrity 1 represents the lowest.
Safety instrumented system (SIS)	Safety instrumented system to execute one or more safety functions. An SIS consists of one or more sensors, a logic system, and actor(s).
Non-dangerous failure	Failure without the potential of putting the safety instrumented system in a hazardous or dysfunctional condition.

Abbreviations

Abbreviation	Description
BPCS	Basic process control system
DC	Diagnostic coverage

Abbreviation	Description
HFT	Hardware fault tolerance
PFD	Probability of failure on demand
PFDAVG	Average probability of failure on demand
SFF	Safe failure fraction
SIL	Safety integrity level
SIS	Safety instrumented system

Design Tables

The tables below are used to determine the Safety Integrity Level (SIL).

Mean Probability of a Failure on Demand (PFD_{AVG})

This table reflects the achievable safety integrity level (SIL) in dependency on the mean probability of a failure on demand. The specified failure tolerances in this case apply to a safety function operated in the mode with low demand rate (see DIN EN 61508 Teil 1-7 Beuth-Verlag, Berlin Part 1, Chapter 7.6.2.9).

Safety integrity level (SIL)	PFD_{AVG} with low demand rate
4	10^{-5} to < 10^{-4}
3	10^{-4} to < 10^{-3}
2	10^{-3} to < 10^{-2}
1	10^{-2} to < 10^{-1}

Probability of a Dangerous Failure per Hour (PFH)

If the requirement rate is more than once per year or greater than twice the frequency of recurring tests, the measurement system must be employed in the mode with high demand rate (see DIN EN 61508 Teil 1-7 Beuth-Verlag, Berlin Part 1, Chapter 3.5.12).

Safety Integrity Level (SIL)	PFH with high demand rate Probability of a dangerous failure per hour
4	10^{-9} to < 10^{-8}
3	10^{-8} to < 10^{-7}
2	10^{-7} to < 10^{-6}
1	10^{-6} to < 10^{-5}

Safety Integrity of the Hardware

This table shows the achievable Safety Integrity Level (SIL) in dependency on the proportion of non-dangerous failures (SFF) and the fault tolerance of the hardware (HFT) for safety-related type B sub-systems (see DIN EN 61508 Teil 1-7 Beuth-Verlag, Berlin Part 2, Chapter 7.4.3.1.4).

Proportion of non-dangerous failures (SFF)	Fault tolerance of the hardware (HFT)		
	0	1(0) (a)	2
< 60%	Not permitted	SIL 1	SIL 2
60% - < 90%	SIL 1	SIL 2	SIL 3
90% - < 99%	SIL 2	SIL 3	SIL 4
≤ 99%	SIL 3	SIL 4	SIL 4

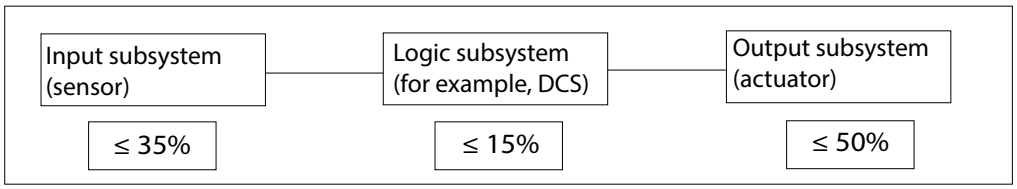
NOTE:

(a) According to DIN IEC 61511 Teil 1-3 Beuth-Verlag, Berlin Part 1, Chapter 11.4.4, the fault tolerance of the hardware (HFT) may be reduced by one (values in brackets) in subsystems such as sensors and actors if the employed device fulfills all of the following conditions:

- The device is validated in practice.
- Only process-relevant parameters can be changed at the device.
- Changes of the process-relevant parameters are protected (for example, password, jumpers and so on).
- The function has a required safety integrity level lower than 4.

Safety-related System

A safety-related system usually consists of the three subsystems input subsystem (sensor), logic sub-system (PLC or control system) and output subsystem (actuator). The Mean Probability of a Failure on Demand (PFD_{AVG}) is usually divided as follows:



Safety Function, Restrictions and Behavior

Safety Function

The safety related output signal is the 4-20 mA analog output signal. All safety measures refer to this output signal exclusively.

The logic subsystem (for example, DCS) must scan the field device with a scan rate of <500 ms for proper fault detection of the transmitter.

While running a safety application, the additional HART communication can be used to get additional diagnostic information.

Restrictions for Use in Safety Related Applications

The requirements described in Requirements, page 6 as well as all specifications for correct operation of the device must be fulfilled carefully for usage of the device within a safety related application.

The dangerous failure mode within the meaning of the safety characteristics given by Characteristics, page 13 is given by all detected failures leading to output accuracy worse than 2%.

Behavior during Operation and Malfunctions

For malfunctions the behavior of the output is defined according to NAMUR recommendation NE43:

- Up-scale the output current: ≥ 21 mA
- Down-scale the output current: ≤ 3.6 mA

Down Scaling is used in case of a detected fault, where the internal watchdog of the device is no longer triggered.

Up Scaling is used in case of a detected fault where the output can be controlled by the internal software.

Examples for these detections:

- Temperature out of range
- Internal Reference Voltages out of range
- Output Current not correct
- AD-Converter not working properly

Safety Relevant Configuration Parameters

Verify the following parameters before entering the safety mode using the confirmation screen as describe in Entering Safety Mode, page 6.

Table 1 - Safety Relevant Configuration Parameters

Name	Description
Smart Smoothing Damping	Integration Time of Smart Smoothing
Smart Smoothing Deadband	Deadband of Smart Smoothing
Zeropoint Mode	Mode of Zeropoint offset correction
Zeropoint Basic	Zeropoint of the sensor
Zeropoint Offset	Zeropoint Offset used in automode
Zeropoint Special Offset	Special zeropoint offset used in manual mode
Upper Range Value	Lower Range Value of measuring range (that is, weight of the displacer in case of an empty tank)
Lower Range Value	Upper Range Value of measuring range
Characterization	Characterization of the output
Output Damping	Damping of the output signal

Recurring Tests of the Transmitter for Level, Interface and Density

Safety Tests

According to IEC 61508/61511, the safety function of the entire safety loop must be tested regularly. The test intervals necessary for this purpose are defined in the calculation of the respective safety loop.

Function Test

The orderly function of the transmitter for level, interface and density must be tested regularly every 5 years. The test may be conducted by the manufacturer or an authorized workshop. The following work must be conducted:

1. Dismantle the sensor.
2. Examine the torsion tube to detect corrosion and leaks (replace if necessary).
3. Examine the sandwich housing support for dirt (clean or replace if necessary).
4. Examine the ball bearing in base plate for easy action.
5. Replace the sealing rings in the sensor (use Cu-based grease).
6. Examine the sealing rings in the amplifier and replace as necessary (apply grease).
7. Observe the tightening torques for the screws specified in the *244LD LevelStar Intelligent Buoyancy Transmitter for Level, Interface and Density – HART® and FOUNDATION Fieldbus,(MI EML0710)* when assembling.
8. Power on the device to initiate self test procedure.
9. Adjust the transmitter as described in *244LD LevelStar Intelligent Buoyancy Transmitter for Level, Interface and Density – HART® and FOUNDATION Fieldbus,(MI EML0710)*.
10. Adjust the safety range.
11. Verify all adjustments by setting to the zero point, the end value, a medium value (for example, 50% value) and the safety settings. In case of using a non-linear characterization curve the relevant points must be verified.
12. Verify the temperature measurement of the sensor and electronics.
13. Verify the alarm levels with the DTM-function “Error State Test”.
14. Lock the settings by entering the Safety Mode as described in Entering Safety Mode, page 6

The transmitter for level, interface and density of types 244LD LevelStar is subject to the pressure equipment directive (DGRL 97/23/EC). The intervals for recurring tests specified in the *244LD LevelStar, Safety Operating Instructions, (MI EML0010-Ex)* must therefore be observed (according to *German BertrSichV dated 27.09.2002). [Rev.6]*.

Repairs

Detected defective units are sent to the repair department of Schneider Electric with a precise description of the fault and the cause.

Safety Characteristics

Information not included in this summary is contained in Management Summary, page 17.

Assumptions

The specified characteristics are applicable under the following assumptions:

- The requirements stated in Requirements, page 6 are fulfilled.
- The repair time (MTTR) after a device has failed is 24 hours.
- Test interval: ≤ 5 years.
- Diagnostic time: < 5 min

Characteristics

Unit Type	HFT	SFF	PFD_{AVG}	PFH	λ_{DU}	λ_{DD}	λ_{SU}	λ_{SD}
B	0	92%	1.02E-03	< 0.42E-07	42 FIT	502FIT	0 FIT	0 FIT

The probability of a dangerous failure per hour (PFH) is based on an error response time < 5 min and a demand rate of > 500 min.

The failure rates are valid for the useful life of the instrument. According to section 7.4.7.4 note 3 of DIN EN 61508 part 2 DIN EN 61508 Teil 1-7 Beuth-Verlag, Berlin, the useful lifetime ranges between 8 to 12 years.

Declaration of Conformity

Figure 1 - Page 1 of EU/SIL Declaration of Conformity

EU/SIL DECLARATION OF CONFORMITY

We, Manufacturer:
Eckardt SAS
(Subsidiary of Schneider Electric Industries SAS
FR-93500 Rueil Malmaison)
20 rue de la Marne
FR-68360 Soultz

Hereby declare under our sole responsibility that the products:

Trademark	EcoStruxure™ Process Instrumentation
Product, Type	**244LD, Type AID421, AD931, AD432, AD432 A/B**
List of reference and options	See next pages

Are in conformity with the requirements of the following directives and conformity was checked in accordance with the following standards.

Directive	Harmonized Standard
PED Directive 2014/68/EU	**AD 2000-Code** resp. EN 13445 Applied conformity assessment procedures: Module H Module B For these products the following EU-Certificate exists: DGR-0036-QS-1308-19 Z-IS-AN3-STG-19-11-2974395-06143258 Z-IS-AN3-STG-19-11-2974395-06145525 Z-IS-AN3-STG-19-11-2974396-06151130 Z-IS-AN3-STG-19-11 -2974395-06152151 Z-IS-AN3-STG-19-11-297 4395-06153642 Z-IS-AN3-STG-19-11-2974395-06154417 Z-IS-AN3-STG-19-11-2974395-06160046 Z-IS-AN3-STG-19-11-2974395-06160954 Z-IS-AN3-STG-19-11-2974395-07080005 Z-IS-AN3-STG-19-11-2974395-07082801 Z-IS-AN3-STG-19-11-2974395-06133002 Z-IS-AN3-STG-19-11-2974395-06134621 Z-IS-AN3-STG-19-11-2974395-06142201 Z-IS-AN3-STG-19-11-2974395-06140955 Z-IS-AN3-STG-19-11-2974395-07085001 Z-IS-AN3-STG-19-11-2974395-07092548 Notified Body: TÜV SÜD Industrie Service GmbH, Westendstr. 199, D-80686 München Notified Body no.0036
EMC Directive 2014/30/EU	**EN 55011:2009+A1:2010** Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement **EN 61326:2013** Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements
ATEX Directive 2014/34/EU	**EN IEC 60079-0:2018** Explosive atmospheres - Part 0: Equipment - General requirements **EN 60079-1:2014** Equipment protection by flameproof enclosures “d” **EN 60079-11:2012** Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i" **EN 60079-26:2015** Explosive atmospheres - Part 26: Equipment with equipment protection level (EPL) Ga AID421 + AD432- Protection String(s): **II 2 G Ex db ib/ia IIB/IIC T4/T6 Gb** **-20°C≤Tamb≤+75°C…+80°C** AID421 + AD432 A/B- Protection String(s): **II 1/2 G Ex db ib/ia IIB/IIC T4/T6 Ga/Gb** **-20°C≤Tamb≤+75°C…+80°C** EU-Type examination certificate EPS 23 ATEX 1308 X and EU-Type examination certificate EPS 23 ATEX 1309 X

Figure 2 - Page 2 of EU/SIL Declaration of Conformity

EU/SIL DECLARATION OF CONFORMITY

	AD931 + AD432- Protection String(s): **Ⓔx II 2 G Ex db IIC T4/T6 Gb** **-20°C≤Tamb≤+75°C…+85°C** AD931 + AD432 A/B- Protection String(s): **Ⓔx II 1/2 G Ex db IIC T4/T6 Ga/Gb** **-20°C≤Tamb≤+75°C…+85°C** EU-Type examination certificate EPS 23 ATEX 1319 X and EU-Type examination certificate EPS 23 ATEX 1309 X
RoHS Directive 2011/65/EU (Inclusive of Directive (EU) 2015/863)	**EN IEC 63000:2018** Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Additionally, the devices complies with functional safety requirements according to **IEC 61508:2010 part 1 – 7** and are suitable for use in a safety related application according IEC 61511-1, if the safety instructions and the following parameters are observed:

Product	244LD LevelStar
Device Revision	6.2.x Software 8.29, 7.0.x Software 9.29
SIL	2
Proof test interval	≤ 5 Jahre / Years
Device Type	B
HFT	0 [1] (Single channel using)
SFF	92%
PFD_{avg}	$1{,}02 \times 10^{-3}$
PFH [2]	$< 0{,}42 \times 10^{-7}$
λ_{du}	42 FIT
λ_{dd}	502 FIT
λ_{su}	0 FIT
λ_{sd}	0 FIT
MTTF [3]	210 Jahre / Years
DC_D	92%

[1] According to chapter 11.4.4 of IEC 61511-1
[2] Error response time < 5min
[3] For MTTR = 8h

Subject to correct installation, maintenance and use conforming to its intended purpose, to the applicable regulations and standards, to the supplier's instructions and to accepted rules of the art.
This declaration becomes invalid in the case of any modification to the products not authorized by us.

Steve CONLON
Director of Compliance Engineering
Process Automation R&D
Industrial Automation Business
Schneider Electric
July, 2024

Issued at Foxboro Massachusetts, USA

PID 250401 ORIGINAL DECLARATION, NO TRANSLATION WITHOUT WRITTEN AUTHORISATION Page 2 of 3

Figure 3 - Page 3 of EU/SIL Declaration of Conformity

Schneider Electric

EU/SIL DECLARATION OF CONFORMITY

List of reference and options:

Product	Description
244LD-xxxxxxxxxD0C(1)	Buoyancy transmitter, flameproof, zone 0, T6
244LD-xxxxxxxxxD1C(1)	Buoyancy transmitter, flameproof, zone 1, T6
244LD-xxxxxxxxx0C4(1)	Buoyancy transmitter, Intrinsic-safe, zone 0, T4
244LD-xxxxxxxxx0C6(1)	Buoyancy transmitter, Intrinsic-safe, zone 0, T6
244LD-xxxxxxxxx1C4(1)	Buoyancy transmitter, Intrinsic-safe, zone 1, T4
244LD-xxxxxxxxx1C6(1)	Buoyancy transmitter, Intrinsic-safe, zone 1, T6
244LD-xxxxxxxxxZZZ(1)	Buoyancy transmitter, without certification
244LD-xxxxxxxxxxxx-Q(1)	Buoyancy transmitter, SIL

(1) "xxx" represent variations of the product.

If the DoC is intended to NOT be included in the User Information Documents, include an image or images, as appropriate:

244LD(2)

(2) Model shown for reference only

If appropriate, additional considerations / limitations of use:

AD931:

- AD432 A: For all flammable liquids, except carbon disulfide
- AD432 B: For all flammable liquids
- Repairs on flameproof joints may only be performed in accordance with the manufacturer´s design specifications.
- Repair on the basis of the values in tables of EN 60079-1 is not permitted.
- The measuring amplifier, type AD 931, shall be connected by means of suitable cable entries or conduit systems, which meet the requirements of EN 60079-1
- Cable entries (conduit threads) and sealing plugs of simple designs must not be used. Should the measuring amplifier, type AD 931, be connected by means of a conduit entry which has been approved for this purpose, the required sealing device has to be provided immediately at the terminal box.
- Openings not used shall be closed in a way that meets the requirements of EN 60079-1, section 13.
- The connecting lead of the measuring amplifier, type AD 931, shall be installed so as to provide for permanent wiring and adequate protection against damage.

AID421:

- The impact test of the glass window in the cover of the electronic compartment has been met with the low impact energy of 2 J.

Management Summary

Figure 4 - SIL 2 Capable Certificate Page 1

exida

The manufacturer may use the mark:

exida • CERTIFIED • IEC 61508 • SIL 2 CAPABLE •

Revision 2.0 July 03, 2024
Surveillance Audit Due
July 1, 2027

ANAB
ANSI National Accreditation Board
ACCREDITED
ISO/IEC 17065
PRODUCT CERTIFICATION BODY
#1004

Certificate / Certificat
Zertifikat / 合格証

FOX 1012062 P0009 C004

exida hereby confirms that the:

244LD LevelStar

Eckardt S.A.S.
A company in the Schneider Electric Group
Soultz, France

Has been assessed per the relevant requirements of:

IEC 61508 : 2010 Parts 1-3

and meets requirements providing a level of integrity to:

Systematic Capability: SC 2 (SIL 2 Capable)

Random Capability: Type B Element

SIL 2 @ HFT = 0; Route 1_H

PFH / PFD_{AVG} and Architecture Constraints must be verified for each application

Safety Function:
The 244LD LevelStar will measure Level, Interface and Density within the stated safety accuracy.

Application Restrictions:
The unit must be properly designed into a Safety Instrumented Function per the Safety Manual requirements.

exida Certification

Evaluating Assessor

Certifying Assessor

Page 1 of 2

Figure 5 - SIL 2 Capable Certificate Page 2

244LD LevelStar

Certificate / Certificat / Zertifikat / 合格証

FOX 1012062 P0009 C004

Systematic Capability: SC 2 (SIL 2 Capable)

Random Capability: Type B Element

SIL 2 @ HFT=0; Route 1_H

PFH / PFD_{AVG} and Architecture Constraints must be verified for each application

Systematic Capability:

The Product has met manufacturer design process requirements of Safety Integrity Level (SIL) 2. These are intended to achieve sufficient integrity against systematic errors of design by the manufacturer.
A Safety Instrumented Function (SIF) designed with this product must not be used at a SIL level higher than stated.

Random Capability:

The SIL limit imposed by the Architectural Constraints must be met for each element.

IEC 61508 Failure Rates in FIT*

	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF
244LD LevelStar	0	0	502	42	92%

* FIT = 1 failure / 10^9 hours

SIL Verification:

The Safety Integrity Level (SIL) of an entire Safety Instrumented Function (SIF) must be verified via a calculation of PFH / PFD_{AVG} considering redundant architectures, proof test interval, proof test effectiveness, any automatic diagnostics, average repair time and the specific failure rates of all products included in the SIF. Each element must be checked to assure compliance with minimum hardware fault tolerance (HFT) requirements.

The following documents are a mandatory part of certification:

Assessment Report: Foxboro 1012-062-C R004 V2R0

Safety Manual: 244LD: SIL Safety Information TI EML0710 S (en)

exida®

64 N Main St
Sellersville, PA 18960

T-062, V5R3

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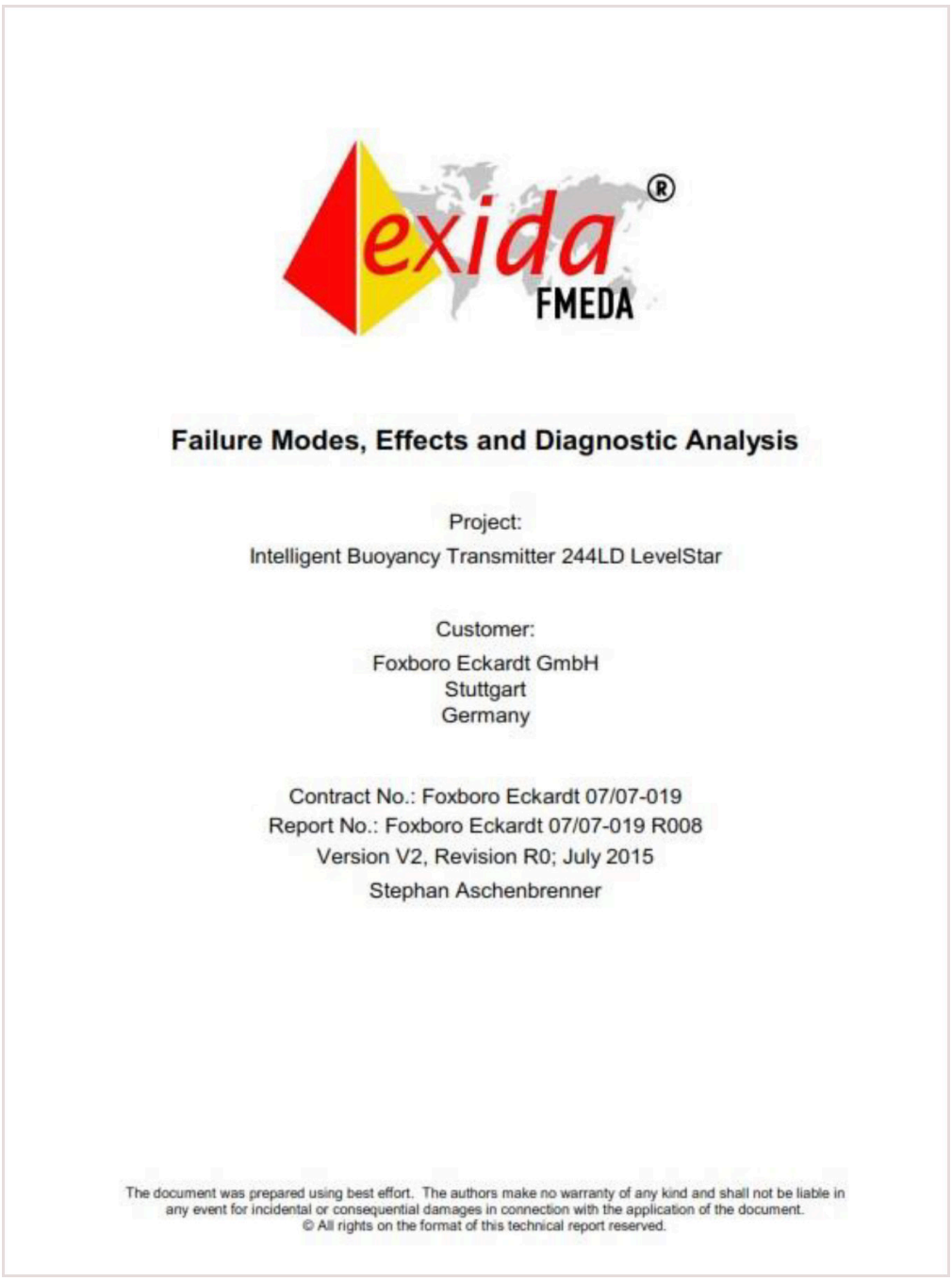
Figure 6 - Report No.: Foxboro Eckardt 07/07-019 R008 Version V2, Revision R0; July 2015



exida® FMEDA

Failure Modes, Effects and Diagnostic Analysis

Project:
Intelligent Buoyancy Transmitter 244LD LevelStar

Customer:
Foxboro Eckardt GmbH
Stuttgart
Germany

Contract No.: Foxboro Eckardt 07/07-019
Report No.: Foxboro Eckardt 07/07-019 R008
Version V2, Revision R0; July 2015
Stephan Aschenbrenner

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Figure 7 - Management Summary Page 2

Management summary

This report summarizes the results of the hardware assessment carried out on the Intelligent Buoyancy Transmitter 244LD LevelStar with software version V8.29 and hardware versions as listed in the circuit diagrams referenced in section 2.4.1.

The hardware assessment consists of a Failure Modes, Effects and Diagnostics Analysis (FMEDA). A FMEDA is one of the steps taken to achieve functional safety assessment of a device per IEC 61508. From the FMEDA, failure rates are determined and consequently the Safe Failure Fraction (SFF) is calculated for the device. For full assessment purposes all requirements of IEC 61508 must be considered.

For safety applications only the described configurations of the device were considered. All other possible output variants or electronics are not covered by this report.

Failure rates used in this analysis are basic failure rates from the Siemens standard SN 29500. For mechanical components experience-based *exida* data and field failure evaluations from Foxboro Eckardt GmbH were used.

Foxboro Eckardt GmbH and *exida* did a qualitative analysis (see [R1]) of the (electro-)mechanical components of the Intelligent Buoyancy Transmitter 244LD LevelStar. This analysis was used to calculate the failure rates of the (electro-)mechanical components of the Intelligent Buoyancy Transmitter 244LD LevelStar using experience-based *exida* data and field failure evaluations from Foxboro Eckardt GmbH.

A user of the Intelligent Buoyancy Transmitter 244LD LevelStar can utilize these failure rates in a probabilistic model of a safety instrumented function (SIF) to determine suitability in part for safety instrumented system (SIS) usage in a particular safety integrity level (SIL). A full table of failure rates is presented in section 4.3.1 along with all assumptions.

The Intelligent Buoyancy Transmitter 244LD LevelStar is considered to be a Type B[1] element with a hardware fault tolerance of 0.

[1] Type B element: "Complex" element (using micro controllers or programmable logic); for details see 7.4.4.1.3 of IEC 61508-2.

Figure 8 - Management Summary Page 3

Table 1 Summary – IEC 61508 failure rates

Failure category	SN29500 [FIT]
Fail Safe Detected (λ_{SD})	**0**
Fail Safe Undetected (λ_{SU})	**0**
Fail Dangerous Detected (λ_{DD})	**502**
Fail Dangerous Detected (λ_{dd}), detected by internal diagnostics	332
Fail Annunciation Detected (λ_{AD}) , detected by internal diagnostics	24
Fail High (λ_{H}), detected by safety logic solver	10
Fail Low (λ_{L}), detected by safety logic solver)	136
Fail Dangerous Undetected (λ_{DU})	**42**
Fail Annunciation Undetected (λ_{AU})	0
No effect	154
No part	277
Total failure rate of the safety function (λ_{Total})	**544**
Safe failure fraction (SFF) [2]	**92%**
DC_D	**92%**
SIL AC [3]	**SIL 2**

The failure rates are valid for the useful life of the Intelligent Buoyancy Transmitter 244LD LevelStar (see Appendix 2).

[2] The complete sensor subsystem will need to be evaluated to determine the overall Safe Failure Fraction. The number listed is for reference only.

[3] SIL AC (architectural constraints) will need to be evaluated on sensor subsystem level. The indicated value if is for reference only and means that the calculated values are within the range for hardware architectural constraints for the corresponding SIL but does not imply all related IEC 61508 requirements are fulfilled.

Figure 9 - PFD_{AVG} Calculation

5 Using the FMEDA results

The following section describes how to apply the results of the FMEDA.

It is the responsibility of the Safety Instrumented Function designer to do calculations for the entire SIF. *exida* recommends the accurate Markov based exSILentia tool for this purpose.

The following results must be considered in combination with PFD_{AVG} values of other devices of a Safety Instrumented Function (SIF) in order to determine suitability for a specific Safety Integrity Level (SIL).

5.1 Example PFD_{AVG} calculation

An average Probability of Failure on Demand (PFD_{AVG}) calculation is performed for the Intelligent Buoyancy Transmitter 244LD LevelStar considering a proof test coverage of 95% (see Appendix 1.1) and a mission time of 10 years. The failure rate data used in this calculation are displayed in sections 0.

For SIL2 applications, the PFD_{AVG} value needs to be < 1.00E-02.

Table 2: Intelligent Buoyancy Transmitter 244LD LevelStar

T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 5 years
PFD_{AVG} = 2.92E-04	PFD_{AVG} =4.75E-04	PFD_{AVG} =1.02E-03

Figure 6 shows the time dependent curve of PFD_{AVG} for the Intelligent Buoyancy Transmitter 244LD LevelStar.

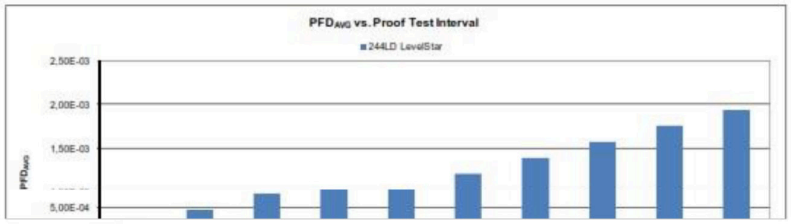

Figure 3: $PFD_{AVG}(t)$

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As standards, specifications, and design change from time to time,
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