PEPPERL+FUCHS

SIL Declaration of Conformity

Functional safety of an inductive proximity sensor according to IEC 61508

Pepperl+Fuchs GmbH, Lilienthalstr. 200, 68307 Mannheim

declares as manufacturer, that for the inductive proximity sensors type

NCN3-F31-N4-V1 part no: 130428

the calculated PFD_{avg} values are within the allowed range for SIL 1 according to IEC 61508-1 table 2 and do fulfil the requirement to not claim more than 10 % of this range, i.e. to be better than or equal to 10^{-2}.

General

The failure rates are based on the Siemens standard SN 29500. According to IEC 61508-1 table 2 the average PFD for systems operating in low demand mode has to be lower than 10^{-1} for SIL 1 safety functions. However, as the module under consideration is only one part of an entire safety function it should not claim more than 10 % of this range, i.e. it should be better than or equal to 10^{-2}.
The sensor is considered to be Type B component. Therefore the SFF has to be 60 % to 90 % according to IEC 61508-2 table 3 for SIL 1 (sub-) systems with a hardware fault tolerance of 0.

Characteristics (valid for one sensor circuit)

Parameter	Symbol	Value	Unit
Type		B	
Hardware Fault Tolerance	*HFT*	0	
Safe Failure Rate	λ_{safe}	3.64E-08	1 / h
No Effect Failure Rate	$\lambda_{no\ effect}$	2.99E-08	1 / h
Dangerous Failure Rate	$\lambda_{dangerous}$	3.77E-08	1 / h
Total Failure Rate	λ_{total}	1.04E-07	1 / h
Total Safe Failure Rate	λ_S	6.63E-08	1 / h
Total Dangerous Failure Rate	λ_D	3.77E-08	1 / h
Safe Failure Fraction	*SFF*	63.77	%
Mean Time to Failure	*MTTF*	9.62E+06	h
Average Probability of Failure on Demand	PFD_{avg} (T_{proof} = 1 year) [1)]	1.65E-04	
Average Probability of Failure on Demand	PFD_{avg} (T_{proof} = 2 years) [1)]	3.30E-04	
Average Probability of Failure on Demand	PFD_{avg} (T_{proof} = 5 years) [1)]	8.24E-04	
Probability of Dangerous Failure per Hour	*PFH* [1)]	3.77E-08	1 / h
Safety Integrity Level	*SIL*	1	

[1)] 1oo1 structure

Assumptions

The following assumptions have been made during the Failure Mode Effect and Diagnostic Analysis:

- Failure rates are constant, wear out mechanisms are not included.
- Propagation of failures is not relevant.
- The repair time after a safe failure is 8 hours.
- The average temperature over a long period of time is 40 °C.
- The stress levels are average for an industrial environment and can be compared to the Ground Fixed classification of MIL-HDBK-217F. Alternatively, the assumed environment is similar to IEC 60645-1, Class C (sheltered location) with an average temperature over a long period of time of 40 °C.
- The sensor is operated in the low demand mode of operation.
- For the high impedance state the object is within the assured release distance ($s < s_{ar} = 0.7 \cdot s_n = 2.1$ mm).

Definitions

The following definitions for the failure of the product were considered.

Application according to EN 60947-5-6 (DC interface for proximity sensors and switching amplifiers (NAMUR)):

Fail-Safe State	The fail-safe state is defined as the output being below 1.2 mA (high impedance). Failure that causes the module / (sub)system to go to the defined fail-safe state without a demand from the process.
Fail Safe	Failure that causes the module / (sub)sysem to go to the defined fail-safe state without a demand from the process.
Fail Dangerous	Failure leading to an output current above 1.2 mA (i.e. being unable to go to the defined fail-safe state).
Fail No Effect	Failure of a component that is part of the safety function but that has no effect on the safety function. For the calculation of the SFF it is treated like a safe undetected failure.

For the calculation of the Safe Failure Fraction (SFF) the following has to be noted:

$\lambda_{total} = \lambda_{safe} + \lambda_{dangerous} + \lambda_{no\ effect}$

$SFF = 1 - \lambda_{dangerous} / \lambda_{total} = (\lambda_{safe} + \lambda_{no\ effect}) / \lambda_{total}$

The failure categories listed above expand on the categories listed in IEC 61508 which are only safe and dangerous. It is important to realize that the „no effect" failures are included in the „safe" failure category according to IEC 61508. Note that these failures on its own will not affect system reliability or safety, and should not be included in spurious trip calculations.

For the calculation of the accumulated Failure Rates (λ_S and λ_D) the following has to be noted:

$\lambda_S = \lambda_{safe} + \lambda_{no\ effect}$

$\lambda_D = \lambda_{dangerous}$

Summary

The calculated PFD_{avg} values are within the allowed range for SIL 1 according to of IEC 61508-1 table 2 and do fulfil the requirement to not claim more than 10 % of this range, i.e. to be better than or equal to 10^{-2}.

ZERTIFIZIERTES DIN EN ISO 9001 QUALITÄTSMANAGEMENTSYSTEM
Reg. Nr. 14 760-02

Hersteller-Unterschrift: Signature of manufacturer	ppa. Helm	i. A. Schober
Funktion des Unterzeichners: Function of the signer	Leiter GF Sensoren Fabrikautomation	Referent Qualitätsmanagement
Datum: Oktober 2008		