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SIL Declaration of Conformity

Functional safety of inductive proximity switches according to IEC 61508.

Pepperl+Fuchs GmbH, Lilienthalstr. 200, 68307 Mannheim

declares as manufacturer, that for the inductive proximity switches, types mentioned below, are suitable for SIL 2 applications.

Products

Inductive proximity switches with NAMUR interface in accordance with IEC 60947-5-6:1999 or EN 60947-5-6:2000, see product list.

Safety Function

The safety function is only given if the target is within the assured release distance.

Product List, Nominal Sensing Distance (s_n), Assured Release Distance (s_{ar}) and Targets

Part No.	Product Name	s_n	s_{ar}	Reference Target
106444	NJ 5-18GK-N *2*G***D	5.0 mm	3.50 mm	18 x 18 x 1 mm³, Fe 360
106445	NJ 5-18GK-N 10M *2*G***D	5.0 mm	3.50 mm	18 x 18 x 1 mm³, Fe 360
106446	NJ 5-18GK-N 5M *2*G***D	5.0 mm	3.50 mm	18 x 18 x 1 mm³, Fe 360
106450	NJ 5-18GM-N 12*G***D	5.0 mm	3.50 mm	18 x 18 x 1 mm³, Fe 360
106451	NJ 5-18GM-N 10M *2*G***D	5.0 mm	3.50 mm	18 x 18 x 1 mm³, Fe 360
106452	NJ 5-18GM-N 5M *2*G***D	5.0 mm	3.50 mm	18 x 18 x 1 mm³, Fe 360
106453	NJ 5-18GM-N-V1 12*G***D	5.0 mm	3.50 mm	18 x 18 x 1 mm³, Fe 360
106456	NJ 6-22-N *23G**3D	6.0 mm	4.20 mm	22 x 22 x 1 mm³, Fe 360
106457	NJ 6-22-N 10M *2*G***D	6.0 mm	4.20 mm	22 x 22 x 1 mm³, Fe 360
106458	NJ 6-22-N 5M *2*G***D	6.0 mm	4.20 mm	22 x 22 x 1 mm³, Fe 360
106459	NJ 6-22-N-G *2*G***D	6.0 mm	4.20 mm	22 x 22 x 1 mm³, Fe 360
106460	NJ 6-22-N-G 15M *2*G***D	6.0 mm	4.20 mm	22 x 22 x 1 mm³, Fe 360
106461	NJ 6-22-N-G 5M *23G**3D	6.0 mm	4.20 mm	22 x 22 x 1 mm³, Fe 360
106464	NJ 8-18GK-N *2*G***D	8.0 mm	5.60 mm	24 x 24 x 1 mm³, Fe 360
106465	NJ 8-18GK-N 10M *2*G***D	8.0 mm	5.60 mm	24 x 24 x 1 mm³, Fe 360
106470	NJ 8-18GM-N 12*G***D	8.0 mm	5.60 mm	24 x 24 x 1 mm³, Fe 360
106471	NJ 8-18GM-N 5M *2*G***D	8.0 mm	5.60 mm	24 x 24 x 1 mm³, Fe 360
106472	NJ 8-18GM-N-V1 12*G***D	8.0 mm	5.60 mm	24 x 24 x 1 mm³, Fe 360
106473	NJ 10-22-N-G *2*G***D	10.0 mm	7.00 mm	30 x 30 x 1 mm³, Fe 360
106474	NJ 10-22-N-G 5M *2*G***D	10.0 mm	7.00 mm	30 x 30 x 1 mm³, Fe 360
106475	NJ 10-30GKK-N *2*G***D	10.0 mm	7.00 mm	30 x 30 x 1 mm³, Fe 360
106476	NJ 10-30GK-N *2*G***D	10.0 mm	7.00 mm	30 x 30 x 1 mm³, Fe 360
106477	NJ 10-30GK-N 15M *2*G***D	10.0 mm	7.00 mm	30 x 30 x 1 mm³, Fe 360
106478	NJ 10-30GK-N 5M *2*G***D	10.0 mm	7.00 mm	30 x 30 x 1 mm³, Fe 360
106480	NJ 10-30GM-N 12*G***D	10.0 mm	7.00 mm	30 x 30 x 1 mm³, Fe 360
106481	NJ 10-30GM-N 10M *2*G***D	10.0 mm	7.00 mm	30 x 30 x 1 mm³, Fe 360
106482	NJ 10-30GM-N 5M *2*G***D	10.0 mm	7.00 mm	30 x 30 x 1 mm³, Fe 360
106483	NJ 10-30GM-N-V1 12*G***D	10.0 mm	7.00 mm	30 x 30 x 1 mm³, Fe 360
106485	NJ 15-30GKK-N *2*G***D	15.0 mm	10.50 mm	45 x 45 x 1 mm³, Fe 360
106486	NJ 15-30GK-N *2*G***D	15.0 mm	10.50 mm	45 x 45 x 1 mm³, Fe 360

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Part No.	Product Name	s_n	s_{ar}	Reference Target
106487	NJ 15-30GK-N 10M *2*G***D	15.0 mm	10.50 mm	45 x 45 x 1 mm³, Fe 360
106491	NJ 15-30GM-N 12*G***D	15.0 mm	10.50 mm	45 x 45 x 1 mm³, Fe 360
106492	NJ 15-30GM-N 10M *2*G***D	15.0 mm	10.50 mm	45 x 45 x 1 mm³, Fe 360
106494	NJ 15-30GM-N 2,5M *2*G***D	15.0 mm	10.50 mm	45 x 45 x 1 mm³, Fe 360

The nominal sensing distance s_n and therefore the assured release distance s_{ar} depends on the dimensions and the material of the target. **The safety characteristics are evaluated when the target is within the assured release distance s_{ar}. It is important that the distance between the damping material and the active faces of the sensor is closer than s_{ar}.**

If customized targets are used it must be guaranteed that the distance between the damping material and the active face of the sensor is closer than 0.7 times the individual measured real sensing distance or 0.6 times the real sensing distance measured at an even reference sensor.

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^{-2} for SIL 2 safety functions. However, as the sensor under consideration is only one part of an entire safety function it should not claim more than 25% of this range, i.e. it should be better than or equal to $2.5 \cdot 10^{-3}$.

The sensor is considered to be Type A component. Therefore the *SFF* has to be 60% to 90% according to IEC 61508-2 table 2 for SIL 2 (sub-) systems with a hardware fault tolerance of 0.

Characteristics

Parameter	Symbol	Condition [2)]	Value	Unit
Type			A	
Hardware Fault Tolerance	*HFT*		0	
Safe Failure Rate	λ_{safe}		1.49E-08	1 / h
No Effect Failure Rate	$\lambda_{no\ effect}$		7.55E-09	1 / h
Dangerous Failure Rate	$\lambda_{dangerous}$		9.60E-09	1 / h
Total Failure Rate	λ_{total}		3.20E-08	1 / h
Total Safe Failure Rate	λ_S		2.25E-08	1 / h
Total Dangerous Failure Rate	λ_D		9.60E-09	1 / h
Safe Failure Fraction	*SFF*		70.00	%
Mean Time to Failure	*MTTF*		3.13E+07	h
Average Probability of Failure on Demand	PFD_{avg} [1)]	T_{proof} = 1 year	4.21E-05	
Average Probability of Failure on Demand	PFD_{avg} [1)]	T_{proof} = 2 years	8.42E-05	
Average Probability of Failure on Demand	PFD_{avg} [1)]	T_{proof} = 5 years	2.10E-04	
Probability of Dangerous Failure per Hour	*PFH* [1)]		9.60E-09	1 / h
Safety Integrity Level	*SIL*		2	
Useful lifetime (Assumption)			8-12	years

[1)] 1oo1 structure

[2)] Conditions and 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.
- All component failure modes are known (Type A).
- The repair time after a safe failure is 8 hours.

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- 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 ($s < s_{ar} = 0.7 \cdot s_n$, see table "Product List, Nominal Sensing Distance (s_n), Assured Release Distance (s_{ar}) and Targets").
- The 2-wire connection cable between the sensor and the switching amplifier must meet the qualities as follows: Line resistance $R_{series} < 50\ \Omega$ (both leads in series); Insulation resistance $R_{insulation} > 1\ M\Omega$.
- *PFD* and *PFH* values are calculated when used in an 1oo1 structure.
- A useful lifetime of 8 to 12 years is assumed.

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).**
Fail Safe	Failure that causes the module / (sub)system 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.
Useful lifetime	According to section 7.4.7.4 note 3 of IEC 61508-2 experience has shown that the useful lifetime often lies within a range of 8 to 12 years.

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:

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

$\lambda_D = \lambda_{dangerous}$

Hersteller-Unterschrift/ Signature of manufacturer:	i. V. Ruppert	i. V. Aicher
Funktion des Unterzeichners/ Function of the signer:	Leiter Produkt-management EMS	Leiter Qualitätsmanagement
Datum/Date:	Mai 2010/May 2010	

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

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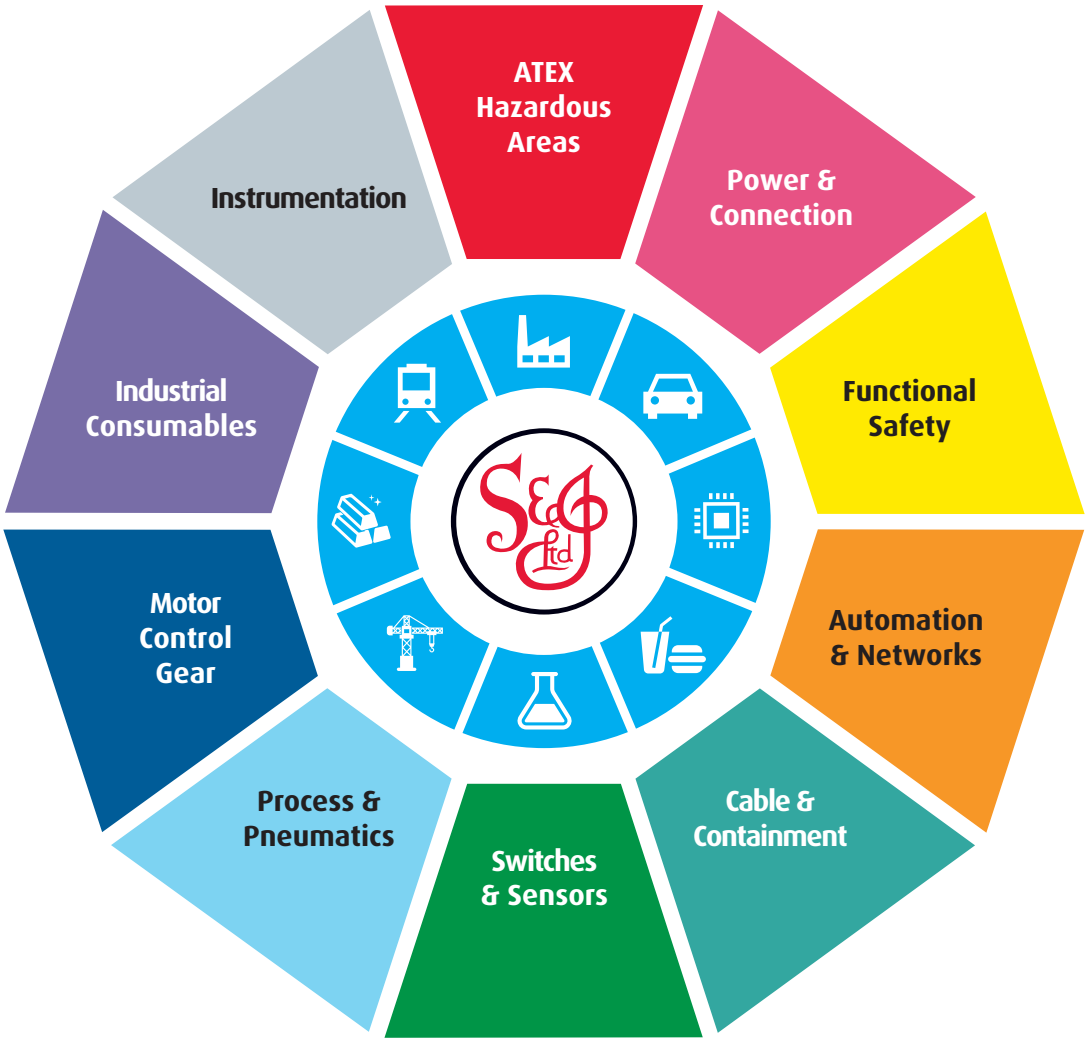

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