

SIL Declaration of Conformity

Temperature sensors for use in safety-relevant systems in accordance with IEC 61508 and IEC 61511

RECKMANN GMBH, as a manufacturing plant of resistance thermometers (RT) and thermocouples / sheathed thermocouples (TC/STC), hereby confirms that the following designs are suitable for use in safety systems according to IEC 61508 / IEC 61211.

Designs / sensor type:

Resistance thermometers (RT) with sensor type PT100, PT1000, Ni100, Ni1000 according to IEC / EN 60751:

RT blanks type 1R14-R

RT measuring inserts type 1R14-B, 1R14-C, 1R14-D, 1R14-E, 1R14-F, 1R14-G, 1R14-H, 1R14-Q, 1R14-J.

RT with cable and/or plug connector type 1R14-O, 1R14-P, 1R14-M, RKW-1 - 11.

RT with protection fitting and measuring insert type 1R15-A0, 1R15-B0 - B3, 1R15-C0 - C3, 1R15-D0 - D1.

Thermocouples (TC) with sensor type T, E, J, K, N, R, S, B according to IEC / EN 60584-1:

TC with metal protection tube type 1R7-A, 1R7-B, 1R8-A, 1R8-B.

TC with ceramic protection tube type 1R7-C, 1R7-D, 1R8-C, 1R8-D.

TC with ceramic protection tube and platinum sleeve type 1R7-E, 1R7-F, 1R7-G, 1R7-H, 1R7-J.

Sheathed thermocouples (STC) with sensor type T, E, J, K, N, R, S to IEC / EN 60584-1:

STC blanks type 1R9-E0.

STC measuring inserts type 1R9-F0 - F1, 1R9-G0 - G1, 1R9-H0 - H1.

STC with cable and/or connector type 1R-I0 - I4, 1R9-J0 - J1, 1R9-K0, 1R9-L0, RKT-1 - 11.

STC with protective fitting and measuring insert type 1R9-A0, 1R9-B0 - B3, 1R9-C0 - C3, 1R9-D0 - D1.

Thermocouples as cable sensors (TC) with sensor type T, E, J, K, N according to IEC / EN 60584-1:

Thermo-cable with "welding bead" type 1R17-I0 - I4.

Introduction / normative foundations / assessment and necessity

Extract from the definition of SIL pursuant to IEC/EN 61508 Part 4:

"Safety integrity level" SIL

One of four discrete levels corresponding to a range of safety integrity values, with Safety Integrity Level 4 representing the highest level of safety integrity and Level 1 the lowest. A Safety Integrity Level (SIL) is not a characteristic of a system, subsystem, element or component. The correct interpretation of the phrase "safety-related system with SIL "n" (where n represents 1, 2, 3 or 4) is that the system may be capable of supporting safety functions with a safety integrity level up to "n".

Assessment

Due to constantly increasing global expectations in terms of the safety of technical systems, standards and guidelines have been developed to support the system operator in achieving the highest possible safety level as early as during the project planning stage. There are application-specific standards such as IEC EN 61511 (Functional safety - Safety instrumented systems for the process industry) and EN 62061 (Machine safety) for the planning and operation of safety systems. To avoid dangerous system failures, electrical / electronic / programmable electronic systems (E/E/PE systems), so-called SIS systems (Safety Instrumental System), consisting of sensor, controller and actuator are utilized.

Requirement

A special aspect is that, similar to explosion-proof areas, electrical temperature sensors such as resistance thermometers (RT) / thermocouples / sheathed thermocouples (TC/STC) are also considered "simple electrical components" and are not covered by IEC 61508, as these thermometers are not capable of performing self-diagnosis with regard to fault analysis. For electrical temperature sensors, without a connected temperature transmitter certified according to IEC 61508, only the failure rates can be indicated. Sensor and transmitter are evaluated as a sensor subsystem, whereby the temperature sensor is classified as a type A component (elementary component) and the temperature transmitter as a type B component (complex component).

Extract from "The 61508 Association" (www.61508.org)

- *The 61508 series of standards does not require certificates for components!*
- *A certificate is not sufficient proof of reliability and suitability for an application!*
- *The SIL classification does not refer to the individual component, but to the evaluation of the entire application!*
- *It is not uncommon for an application built with SIL2 or SIL3 devices to achieve only one SIL1 rating!*

Typical failure rates of our thermocouples / sheathed thermocouples

Table 1 TC / STC with connecting cable

Fault type	Low load	High load	Fault classification
Cable break (open)	898 FIT	18010 Fit	λ_{DD}
Short circuit	48 FIT	1010 FIT	λ_{DU}
Drift	48 FIT	1010 FIT	λ_{DU}

Table 2 TC / STC directly connected

Fault type	Low load	High load	Fault classification
Cable break (open)	93 FIT	1905 Fit	λ_{DD}
Short circuit	3.5 FIT	83 FIT	λ_{DU}
Drift	1 FIT	23 FIT	λ_{DU}

Types for table 1 + 2:

TC type 1R7-A, 1R7-B, 1R8-A, 1R8-B, 1R7-C, 1R7-D, 1R8-C, 1R8-D, 1R7-E, 1R7-F, 1R7-G, 1R7-H, 1R7-J.
STC type 1R9-A0, 1R9-B0 – B3, 1R9-C0 – C3, 1R9-D0 – D1, 1R9-E0, 1R9-F0 – F1, 1R9-G0 – G1, 1R9-H0 – H1, 1R9-I0 – I4, 1R9-J0 – J1, 1R9-K0, 1R9-L0, RKT-1 – 11.

Typical failure rates of our resistance thermometers

Table 3 RT in 4-wire circuit with connecting cable

Fault type	Low load	High load	Fault classification
Cable break (open)	408 FIT	8205 Fit	λ_{DD}
Short circuit	18 FIT	405 FIT	λ_{DD}
Drift	68 FIT	1405 FIT	λ_{DU}

Table 4 RT in 4-wire circuit directly connected

Fault type	Low load	High load	Fault classification
Cable break (open)	41 FIT	835Fit	λ_{DD}
Short circuit	2.5 FIT	53 FIT	λ_{DD}
Drift	5.5 FIT	122 FIT	λ_{DU}

Table 5 STC in 2- or 3-wire circuit with connecting cable

Fault type	Low load	High load	Fault classification
Cable break (open)	369 FIT	7415 Fit	λ_{DD}
Short circuit	9 FIT	192 FIT	λ_{DD}
Drift	93 FIT	1905 FIT	λ_{DU}

Table 6 STC in 2- or 3-wire circuit directly connected

Fault type	Low load	High load	Fault classification
Cable break (open)	37 FIT	760 Fit	λ_{DD}
Short circuit	2 FIT	31 FIT	λ_{DD}
Drift	8 FIT	175 FIT	λ_{DU}

Types for table 3 + 6:

STC type 1R14-B, 1R14-C, 1R14-D, 1R14-E, 1R14-F, 1R14-G, 1R14-H, 1R14-Q, 1R14-J, type 1R14-O, 1R14-P, 1R14-M, 1R14-R, 1R15-A0, 1R15-B0 – B3, 1R15-C0 – C3, 1R15-D0 – D1, RKW-1 – 11.

Annex

A number of publications confirm that the dominant types of faults in temperature sensors are short-circuit (burn-out), "mechanical breakage" (open connection) and/or measurement errors in temperature measurement (drift); please refer to Tables 1 to 6 for the respective failure rates.

You can use any SIL-approved temperature transmitter for the application of our temperature sensors in electrical / electronic / programmable electronic systems (E/E/PE systems), so-called SIS systems (Safety Instrumental System). For the evaluation of the resulting measuring unit, the specifications of the transmitter manufacturer must be observed.

Bibliography and sources

- IEC 61508:2011
Funktionale Sicherheit sicherheitsbezogener elektrischer/elektronischer/
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- Exida:
Safety Equipment Reliability Handbook – 4th edition,
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- Extract from "The 61508 Association" (www.61508.org).


Heinz-Günter Appel
Product Management
Representative for Explosion Protection


Graduate Engineer (TH) Ulrich Born
Managing Partner