Temperature sensors themselves are not covered by SIL.
The IEC 61508-1:2010 Edition 2.0 standard, Chapter 1, "Scope" states:

> *1.2 In particular, this standard*
> *a) applies to safety-related systems when one or more of such systems incorporates electrical/electronic/programmable electronic elements;*

This means that temperature sensors cannot be independently certified according to SIL (Safety Integrity Level).

An assessment of the SIL level is only possible if the temperature sensor is connected to a transmitter. The assessment is based on safety documentation about the transmitter in combination with the probability of various error outcomes in the sensor.

Possible errors in temperature sensors – seven examples
Two different types of errors relevant to a SIL assessment can be distinguished.

Error types		
Designation	**Meaning**	**Explanation**
s	Safe	Has no direct influence on the measurement result
d	Dangerous	Dangerous errors disrupt the measurement result or lead to immediate errors
The error types above are divided into two subcategories		
d	Detectable	Detectable errors can be discovered via the connected transmitter
u	Undetectable	Undetectable errors cannot be discovered at all or can only be discovered with the help of external tools

The error probability is often expressed as λ, which is the probability of one error occurring during one operating hour.

Example 1. An overload can lead to a break in the sensor or its connecting wires. An overload can easily be discovered via the connected transmitter. A sensor break is therefore a dangerous but detectable error and is designated as λ_{dd}.

Example 2. The gradual drift that occurs in a temperature sensor due to errors such as mechanical or thermal overload or chemical agents cannot be distinguished by a transmitter from the normal temperatures it is designed to measure. Drift is therefore a dangerous and undetectable error that is designated as λ_{du}.

The errors can be detected by calibration and it is possible to correct for drift that has occurred.

Special error risks for resistance thermometers (Pt100/Pt1000)

Example 3. A short circuit in the resistor, extension cable or plug can easily be detected by the transmitter. Such an error is dangerous but detectable, i.e. λ_{dd}.

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Example 4. Connection terminals, extension cables and plugs are the most common sources of error for resistance thermometers. The connection method, 2, 3 or 4 connecting wires, can directly influence the measurement result. With 2 connecting wires, the measurement result increases with plug and cable resistances. With 3 connecting wires, the measurement result increases or decreases if the resistance via one wire deviates from the others. These errors are designated as λ_{du}.

Example 5. For true 4-wire connections, the error risks in example 4 do not exist. All measurement results are considered to be safe but with undetectable errors, and are designated as λ_{su}. For a SIL assessment, this connection type is the safest.

Special error risks for thermocouples

Example 6. A short circuit in the extension cable or plug cannot be distinguished from "process turned off" and "internal and external temperatures equal". This is a particularly dangerous and undetectable situation, which is designated as λ_{du}.

Example 7. In the thermocouple, all influence is eliminated because the connection terminals, extension cables and plugs are made of compensated material. No resistance changes influence the measurement result, which is therefore designated as safe and undetectable λ_{su}.

Estimated values for expected error frequencies

Pt100, 4-wire	λ_{dd}	λ_{du}
Pt100 4-wire - Low vibration – Mounted directly	$4.80 \cdot 10^{-8}$	$3.00 \cdot 10^{-9}$
Pt100 4-wire - Low vibration - Extension cable	$4.95 \cdot 10^{-7}$	$5.00 \cdot 10^{-9}$
Pt100 4-wire - High vibration - Mounted directly	$9.50 \cdot 10^{-7}$	$5.00 \cdot 10^{-8}$
Pt100 4-wire - High vibration - Extension cable	$9.90 \cdot 10^{-6}$	$1.00 \cdot 10^{-7}$

Pt100. 3- wire	λ_{dd}	λ_{du}
Pt100 2/3-wire - Low vibration - Mounted directly	$3.90 \cdot 10^{-8}$	$9.00 \cdot 10^{-9}$
Pt100 2/3-wire - Low vibration - Extension cable	$3.80 \cdot 10^{-7}$	$9.50 \cdot 10^{-8}$
Pt100 2/3-wire - High vibration - Mounted directly	$7.87 \cdot 10^{-7}$	$1.73 \cdot 10^{-7}$
Pt100 2/3-wire - High vibration - Extension cable	$7.60 \cdot 10^{-6}$	$1.90 \cdot 10^{-6}$

Thermocouple (TC)	λ_{dd}	λ_{du}
TC - Low vibration - Mounted directly	$9.50 \cdot 10^{-8}$	$5.00 \cdot 10^{-9}$
TC - Low vibration - Extension cable	$9.00 \cdot 10^{-7}$	$1.00 \cdot 10^{-7}$
TC - High vibration - Mounted directly	$1.90 \cdot 10^{-6}$	$1.00 \cdot 10^{-7}$
TC - High vibration - Extension cable	$1.80 \cdot 10^{-5}$	$2.00 \cdot 10^{-6}$

- High vibration means vibration > 0.1 g.
- Low vibration means vibration < 0.1 g.
- Mounted directly refers to an extension cable shorter than 30 cm AND fully sheathed
- Extension cable refers to a cable longer than 30 cm OR not fully sheathed

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