

WEIDMANN CERTIFIED Smart Spacer®

THERMAL MANAGEMENT SYSTEM

PURPOSE OF SYSTEM

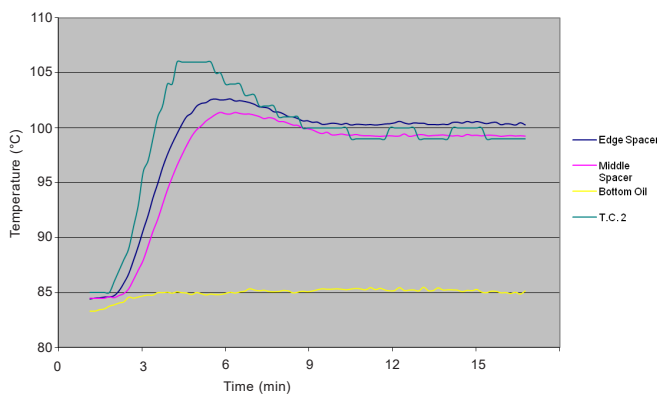
Governed by the IEEE/ANSI or the IEC Loading Guide, the transformer upper loading limit, for normal or emergency operation, is set by the winding hot spot and/or top oil temperature. The upper loading limit may also be defined as a function of the allowed percentage loss of insulation life per operating cycle. Users of power transformers therefore want to understand the actual operating temperatures as a function of load applied to the unit in real time as a way of maximizing the asset value in use and minimizing the risk of overheating, excessive loss of insulation life, and/or failure. The system is designed to monitor and acquire key operating temperatures of the apparatus.

The data can be used to control the apparatus cooling systems and unit loading levels. Weidmann's real time InsuLogix® T monitoring system can be connected to the operator's local computer network or SCADA system to provide necessary thermal management data to the load dispatch center.

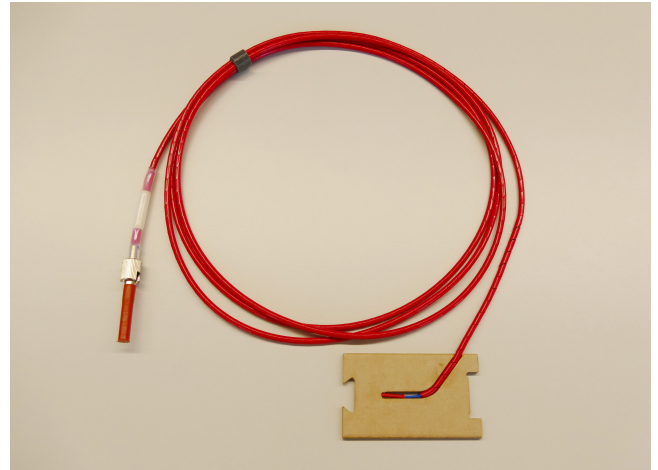
THERMAL REQUIREMENTS

The Smart Spacer® fiber optic probe assembly will read the winding hottest-spot temperature with a tolerance of ± 2 °C. Typical maximum operating hot spot temperature is 118 °C (IEC) / 120 °C (IEEE) maximum during normal operation and up to 140 °C during loading beyond transformer nameplate rating.

Maximum emergency or contingency loading temperature should not exceed 180 °C. Measured temperatures will track the actual temperature with a time constant of three minutes maximum.



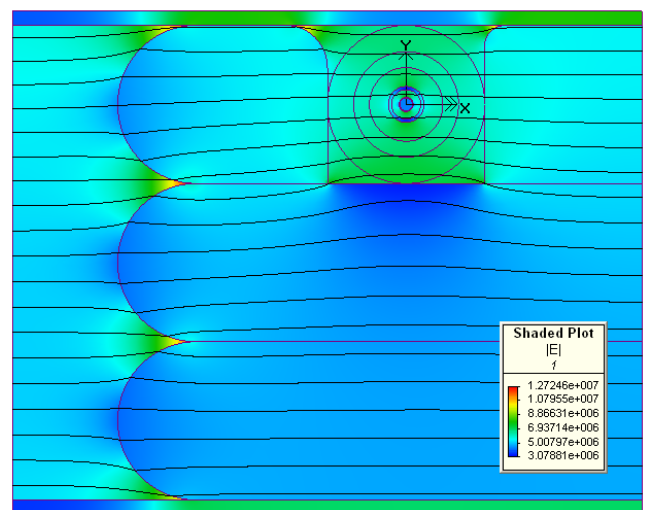
Sensor reading during hot spot temperature rise from 85 °C to 100 °C



Weidmann Certified Smart Spacer®

ELECTRIC AND DIELECTRIC REQUIREMENTS

Weidmann certification for Smart Spacer® products is integral to insulation systems in oil-filled transformers at all voltage classes through EHV and UHV levels. The assembly, along with the fiber cable leading in and out of the assembly, shall be free of any partial discharge in use and in no way contribute to increased electric field stress in adjacent insulation materials. The assembly must also be capable of withstanding all required dielectric tests that the apparatus may be subjected to during factory testing.



WEIDMANN

Smart Spacer® CERTIFICATION PROCESS

All Weidmann Smart Spacer® products are certified as individual components that are integral to the liquid-immersed HV insulation systems found in medium and large power transformers on the electric power grid. Smart Spacer® assemblies utilize embedded sensors capable of communicating the status or change in thermal properties that can indicate loss-of-life criteria and probability of failure of power transformers.

All Smart Spacer® products are shipped with a certificate of compliance outlining that the component has met the following five-part Weidmann certification process:

1. **Design:** The detailed design of the insulation component and embedded sensor are compatible with normal and emergency electrical stress limits typically found in liquid-immersed HV power transformer winding designs, as specified by the transformer manufacturer and operator.
2. **Dielectric Analysis:** The component, sensor, and connection system have been extensively modeled and analyzed using Finite Element Analysis (FEA) techniques to ensure that the Smart Spacer® is compatible with electric field stresses in the winding and support insulation system designs.
3. **Functional Testing:** Insulation components and embedded sensors are tested in the Weidmann or equivalent high-voltage laboratory to demonstrate the output metrics and applicable tolerances required for the sensor, and that both are suitable for use in the transformer internal environment, in both alternating voltage and impulse conditions, applicable to the BIL voltage class as specified by the power transformer operator. (See chart for applicable tests.)

4. **Manufacturing Processes:** All components meet strict manufacturing process controls in compliance with drawings and specifications that preclude the possibility of electric field stress concentration or negative impact on the transformer dielectric system or performance.
5. **Quality:** Strict conformance to written quality assurance system standards are met for components and matching sensors throughout the manufacturing, assembly, packaging, and shipping stages. The Weidmann Quality Management System is certified to the ISO 9001 Standard.

Qualification and Production Testing of Smart Spacer®

Verification Tests

Mechanical

Pull-out Force

Compression, including short-circuit force simulation

Thermal

Sensor Response Time

Sensor Accuracy

Dielectric

Power frequency withstand PD inception
ASTM D-149
≥ 6 kV/mm

Power frequency withstand breakdown
ASTM D-149
≥ 8 kV/mm

Production and Certification Tests

Incoming Sensors

Sensor Accuracy
± 2 °C

After Assembly of Button in Spacer

Sensor Accuracy
± 2 °C

X-ray
Final inspection & verification

Campaign Tests*

After Assembly of fiber optic in Spacer

Power frequency withstand PD inception
ASTM D-149
≥ 6 kV/mm

Power frequency withstand breakdown
ASTM D-149
≥ 8 kV/mm

Compression
35 N/mm² (5000 PSI)

* Once per year, in addition to Production Tests

Rev. 06.20