Sensor Engines by Vectron International

Wireless SAW Temperature Sensing System for Switchgear
Power Transmission and Distribution

Key Features and Attributes:

- Enhanced Operator and Asset Safety
- SAW based Wireless Temperature Sensors
- Passive (No Batteries, No Energy Harvesting)
- Control Room Software with Alarm Capability
- Temperature Range: -20°C to 120°C
- RF Operating Range 428 MHz to 439 MHz
- System Accuracy: ±2°C
- Environmentally Friendly
- Real-Time Monitoring and Data Logging
- Monitor Inaccessible Locations

Issue: Continuous and Cost Effective Monitoring of Switchgear Temperature

Switchgear, which serve as important points of control within power distribution systems, transformers and other transmission and distribution (T&D) components, are susceptible to failure if not closely monitored and controlled. Increased loads can greatly stress switchgear. The resulting increases in temperature of critical switchgear components can cause significant degradation of metal contacts and insulation. In turn, this increases the probability of internal short-circuits or increases the contact resistance, which, if unchecked can lead to system failure and possibly cause personal harm to system operators. The problem is especially relevant in emerging economies where the burgeoning need for power greatly stresses outdated legacy electric power infrastructure. Conventional methods of monitoring switchgear temperature are expensive and not entirely effective. SenGenuity provides a solution based on Surface Acoustic Wave (SAW) technology which is ideally suited for passive (no battery or energy harvesting) wirelessly-interrogated temperature measurement.

Situation: Conventional Methods are Expensive and Provide Sporadic Coverage Only

“Hot Spots” within the switchgear are readily identified by taking thermal images of cable connections, insulators and bus bar connections. The non-contact testing afforded by Infrared (IR) cameras addresses a variety of safety concerns with respect to operating in a high voltage/high current environment.

However, thermal images also have distinct disadvantages associated with them:

- Spot Assessments
- High Recurring Cost
- Images Distorted by Dust
- Absence of Real-Time Data

Other traditional temperature measurement methods including battery powered sensors also have distinct disadvantages:

- Burden of Battery Replacement
- Restricted Access to Equipment Compounding Battery Replacement Burden
- Environmental Impact
- Time Consuming Installation
Solution: SAW Based Switchgear Temperature Sensing

A Surface Acoustic Wave (SAW) based temperature measurement solution for switchgear includes SAW Temperature sensors mounted at critical contact points within the switchgear box (shown in the Figure 1a and 1b) and a reader capable of interrogating multiple SAW temperature sensors in rapid sequence. The reader antenna is mounted within the box, offering good radio frequency shielding of the interrogation process by the box itself. The locally powered reader sends short RF pulses into the switchgear, if the pulses are at the frequency of the sensor, the sensor receives, modifies and passively returns the pulses. Returned pulses contain information related to sensor temperature.

SAW based temperature sensors take advantage of the controlled change in material properties of a crystal. The sensing mechanism involves electrically inducing a surface acoustic wave into a piezoelectric material and then reconverting the energy of the wave (influenced by the temperature to which the sensing element is exposed) back into an electrical signal for temperature measurement.

One significant advantage of a SAW based temperature sensor is their passive operation, which makes them very amenable to operation in harsh environments via wireless interrogation and inherently have low maintenance requirements. A wireless SAW based temperature sensing solution consists of a reader (RF Transceiver) electromagnetically linked to a SAW sensor element as shown in Figure 2.

Solution Differentiators

A SAW based temperature measurement system addresses many of the disadvantages associated with other means of temperature monitoring:

- **Continuous Monitoring and Data Logging**: A SAW based temperature measurement solution allows for the continuous monitoring of temperature and thereby provides for the ability to continually monitor the switchgear for adverse events or the prelude to adverse events.
- **Cost**: The cost of a SAW based temperature monitoring system is much lower than traditional methods of temperature monitoring including IR Thermography.
- **Environmentally Friendly**: SAW wireless sensors are passive (do not require batteries) and thereby provide for an environmentally friendly temperature measurement solution.
- **Passive Solution**: SAW based temperature sensors are powered by an EM wave (ElectroMagnetic Wave) generated by the reader.
- **Low Cost and Small Size**: The SAW sensor is suitable for many years of operation without maintenance.
Solution Differentiators continued....
The key solution differentiator of the TempTrackr™ system is that it measures temperature at the **source of expected failure**: the bus bar connection, the cable connection and the circuit breaker connection. Unlike other solutions which measure the ambient temperature of the air within the switchgear box, the TempTrackr™ system measures the temperature at the most vulnerable points within the switchgear. The core value of the system lies in its ability to provide **early warning signs** of expected failure by continuously monitoring the temperature of critical switchgear components.

**TempTrackr™ SAW Sensor System**
SenGenuity has developed a SAW based temperature sensing solution that fully addresses the unique needs of T&D infrastructure temperature monitoring. The TempTrackr™ SAW Sensor System is capable of wirelessly monitoring **multiple (up to twelve) passive SAW temperature sensors per breaker box**.

Figure 3 shows the different mounting schemes available to install the sensor on bus-bar and conductors. The wireless reader can generate temperature data on demand or on a continuous basis.
For Switchgear OEM's who are interested in integrating the TempTrackr™ system into the switchgear control architecture, SenGenuity can provide wireless readers capable of multi-communication protocols (RS485, RS232, CAN, 4/20mA Analog Output, USB, Modbus). For end-users of legacy switchgear or end-users who are interested in monitoring switchgear temperature remotely, SenGenuity can provide control room software, shown in Figure 4, with alarm capabilities.

![Control Room Software with Alarm Capability](image)

The various components of the TempTrackr™ system have undergone certification tests and are in compliance with CE and FCC requirements.

**Scalable System Configurations:**
- 6 Sensor System
- 12 Sensor System

**Contact Information**
Please contact our Application Engineering group at support@sengenuity.com for more information about the TempTrackr™ SAW Sensor System.

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