LEVERAGING CONNECTIVITY

Smart Sensor for hazardous areas

Launched in 2016, the ABB Ability™ Smart Sensor today operates in thousands of customer applications worldwide. ABB has now launched a new Smart Sensor that is suitable for hazardous environments.

Over the past ten years, ABB has released several integrated, intelligent sensors, such as WiMon100, the ABB Ability Smart Sensor for motors, the ABB Ability Smart Sensor for pumps and the ABB Ability Smart Sensor for mounted bearings and gearing.

Launched in 2016, the ABB Ability Smart Sensor family is now found in thousands of customer applications worldwide; however, a cost-efficient version of the product for rotating machines operating in hazardous areas was absent. To fill this gap, ABB has designed a new generation of ABB Ability Smart Sensors that can be used on equipment operating in explosive atmospheres.

Challenges:

### Challenge 1: Measuring Vibration

Whereas most equivalent sensors on the market measure only vibrations and temperature, the ABB Ability Smart Sensor measures vibrations, magnetic field, temperature and acoustics. Consequently, the sensor can measure the speed of rotation of motors with a very high accuracy.

Vibration sensors are becoming commonplace in consumer electronics and industrial automation – but creating a high-quality vibration sensor is no easy task. For example, it is essential to stop...
This first version of the metal plate delivered a poor performance with respect to self-resonance: Resonance forces from the body of the sensor propagated to the pressed metal base and were picked up by the vibration transducers. By using a fine-grained model of the sensor and metal plate, however, many alternatives were simulated, resulting in a metal plate that not only sticks completely to the machine without propagating vibration forces from the body of the sensor to the location of the vibration transducers, but also maintains cost targets →04.

**Challenge 2: building a sensor for hazardous areas**

Hazardous-area-certified sensors available on a global scale must comply with a large range of detailed requirements set out in several standards. Some essential conditions are:

- An internal short circuit in the battery shall not cause heating that can ignite gas.
- Internal hardware shall not cause heat or a spark that can ignite gas.

ABB’s first approach to the new sensor used a large pressed-steel plate at the bottom of the sensor to transmit the vibrations of the monitored asset in as direct a manner as possible. The sensor had two electronic boards: one glued to the metal plate (itself screwed to the asset) and another connected to the plate and that board using only a flexible cable →03.

The metal plate sticks to the machine without propagating vibration from the body of the sensor to the vibration transducers.
If the enclosure is compromised, and the sensor is filled with conductive material, no heating or sparks shall occur that may ignite gas.

The sensor must sustain stresses arising from its environment.

The first condition is typically taken care of by checking the temperature that can be reached under the most extreme conditions. In the case of a battery-powered sensor, such conditions are checked by having the batteries short-circuited and the resulting temperatures remaining below the maximum limit defined by the standard.

The Smart Sensor has a battery life up to three times longer than most competing designs.

135 °C (temperature class T4). In the design of the Smart Sensor for hazardous areas, this temperature criterion is met. Heat is also routed to the rest of the mechanical structure and absorbed by the plastics in the casing.

The last condition in the list above is to make sure that the sensor can survive even the most extreme environmental conditions. For the smart sensor, the target operating range was -40 to +85 °C – typical for most industrial electronic components. Highly accelerated life tests (HALTs) were performed to test the sturdiness of the sensor outside of the nominal operational window – through cycles of high and low temperatures and through a combination of high vibrations and extreme temperatures. The results of the HALT tests showed that the sensor survives ranges of temperatures from -70 to 130 °C, which is well beyond the original target.

Challenge 3: Building a battery-powered wireless sensor with a long lifetime

The ABB Ability Smart Sensor for hazardous areas has a battery life up to three times longer than most competing designs, and can match the lifetime of the monitored equipment. It also benefits from added range from the Bluetooth 5 protocol. The main battery cannot be replaced or recharged. Replaceable or rechargeable batteries are undesirable because:

- Replaceable batteries can increase the cost of the sensor to the point where it makes more sense to simply change the entire sensor – and get new electronic components with higher performance into the bargain.
- There is a risk that the user would compromise the hazardous area protection status by inserting new batteries incorrectly.
- Ingress protection against dust and water could also be compromised if the batteries are not replaced correctly.
The combined goal of designing an embedded system with a design life of up to 15 years as well as providing a reliable indication of remaining battery life is difficult, for at least three reasons:

- To limit battery internal leakage current, the temperature experienced by the battery must be moderate.
- To prevent the soldered pads from breaking, vibration forces from the battery and the sensor must not propagate to the interface between the two.
- The sensor’s power consumption must be kept low, even with a large battery installed.

In the new smart sensor, the battery and its soldered pads are enclosed in a battery holder that is separated from the primary heat sources by an air gap, which protects it from the heat coming from the monitored asset. To evaluate the temperature-dependent leakage current of the battery, the sensor measures battery temperature during operation and estimates the corresponding leakage current based on a proven battery model.

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In a further battery charge measurement tactic, the firmware uses a points system to calculate the charge consumed by normal sensor operations. Most of the time, the sensor is in a deep sleep and consumes very little power, but when the sensor wakes up, its power consumption ramps up. The sensor records how much time each battery-consuming operation takes – for example, the duration of a Bluetooth chip activity. From the durations and power curves of the operations, the consumed charge is calculated and subtracted from initial battery capacity. Based on a rolling average value of the consumption, remaining lifetime is estimated and published. This approach captures actual battery usage rather than relying on a predefined battery lifetime and assumed power consumption levels, which are often inaccurate.
gathering works as expected, any bugs introduced by reconfigurations or firmware changes are caught, algorithm upgrades are rigorously tested, and the firmware meets the requirements regarding low power consumption.

Based on increasing awareness of data protection, ABB has also been developing comprehensive cybersecurity features to satisfy customer requirements. These include secure key exchange for Bluetooth communication with out-of-band pairing, Bluetooth encryption, user authentication, role-based access control, and secure firmware update.

**Smart for the future**

The new Smart Sensor is a technological success that measures vibrations with an accuracy higher than that of all previous smart sensors. Hazardous-area certification (ATEX and IECEx: Zone 0, Zone 20, Class I Division I and Class 2 Division I) for this extremely sturdy sensor has been granted. Also, the sensor has benefitted from a design effort that introduces some features that significantly improve the operator’s experience: easy-to-use sensor commissioning through NFC (near-field communication) activation, improved antenna design for optimal wireless communication, and extended battery lifetime.

In summary, the latest sensor offers comprehensive cybersecurity features, flexible firmware platform, optimized performance, and real-world control and evaluation of power consumption. These enhancements bring even more value to customers and make the new ABB Ability Smart Sensor for hazardous environments the de facto standard for condition monitoring of rotating equipment.