Less Power, More Powerful: Sensors for Condition Monitoring

Energy-efficient sensors drive innovation for machine maintenance.

By Matthew Negaard, IMI Sensors

In the rapidly evolving Industrial Internet of Things (IIoT) landscape of industrial condition monitoring, the shift from reactive to predictive maintenance strategies has significantly changed the approach to machine health, operational efficiency, and equipment lifecycle management. Engineers and system designers prioritize efficiency and scalability, choosing monitoring solutions that balance convenience and ease of use with uncompromised data integrity. Gone are the days of traditional route-based (read: labor-intensive) condition monitoring, or even online, single-point analog systems, which can prove costly and challenging to implement.

Next-generation tools

In their place is a generation of sophisticated wireless maintenance tools that extend monitoring capabilities to areas that were once thought inaccessible, or too critical for novel, battery-powered devices. As the adoption of wireless monitoring grows, deploying a greater number of nodes across factory floors, so does the requirement for the embeddable accelerometers in these systems to produce data of increasingly higher fidelity. This surge in data generation is instrumental in providing the detailed insights necessary for smarter predictive maintenance strategies, but it also brings to the forefront the critical need for wireless accelerometers that can sustain prolonged operation without frequent battery replacements.

The key factors influencing battery consumption are the current draw and the time it takes for a sensor to "wake up" from a dormant state to an active one.

Piezoelectric accelerometers have long been recognized for their exceptional ability to provide high-fidelity readings and detect the high-frequency vibrations that signify the earliest fault stages but have only recently solidified their value for wireless condition monitoring through the development of new, ultra-low-power variants. Compared to their micro-electromechanical systems (MEMS) counterparts, these piezoelectric accelerometers offer significant advantages in terms of energy efficiency and battery life extension, while remaining on par in terms of affordability and ease of implementation.

The key factors influencing battery consumption in both sensor types are the current draw and the time it takes for a sensor to "wake up" from a dormant state to an active one. Innovations in amplifier and circuitry design in piezoelectric devices are continually improving upon these aspects, significantly reducing both the energy draw during operation and the wake-up time. Modern designs boast a substantially reduced current draw of 60 µA when active and almost instantaneous startup time of 350 µs.

Given the market trend toward more frequent data readings for continuous asset monitoring, these developments prove to extend the life of monitoring systems in the field by months to even years (depending on the frequency of measurements) before battery replacements are needed. The combination of lower current draw and faster startup times allows users to benefit from significantly reduced energy consumption, whether sensors are kept in a low-power standby mode or powered down entirely between readings. This distinct advantage positions piezoelectric sensors favorably against MEMS sensors, which tend to consume more power even in standby modes than piezoelectric sensors during active measurement periods and require a constant current draw to mitigate startup delays.

As predictive maintenance culture continues to embrace wireless condition monitoring, ultra-low-power piezoelectric sensors provide a promising path toward achieving smarter operations in industrial plants. The design not only aims to prevent equipment failure, but also contributes to the overarching goal of enhancing plant efficiency, reflecting a significant shift toward more sustainable industrial practices.

ABOUT THE AUTHOR

Matthew Negaard is business development manager, Industrial and Digital Sensors at IMI Sensors, PCB Piezotronics Inc.