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Advanced sensing solutions for cost-effective machine building

How the right sensors can cut machine building costs, improve flexibility and boost customer satisfaction

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Introduction

Sensing technology has a major presence in manufacturing machinery. It provides the foundation for maintaining consistent quality and detecting any variations in machine performance. If subtle changes in the physical properties of a machine can cause it to fail, then the sensors responsible for detecting those changes can save manufacturers lengthy downtime and repair costs.

In addition to helping cut costs of machine maintenance, the sensors also present an opportunity to make the machines more cost-efficient. Whether through their resistance to harsh chemicals or their ability to reduce the overall machine footprint, the right sensors can make a big difference.

This white paper will provide an overview of the following ways that intelligently designed sensors can make machine design more cost-effective:

- Reduction of machine footprint through reduced wiring
- Resistance to typical causes of sensor breakdown
- Improvements in predictive maintenance
- Additional benefits of IIoT-ready sensors

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Eliminating wires and reducing machine complexity with remote I/O blocks

To collect as much data as possible on the quality of works-in-progress and the level of machine performance, it helps to include a variety sensors on the machines. This poses a new challenge, however, since more sensors leads to more wires – and more wires leads to more expensive machine design. Excess wires also add complexity, meaning it will take longer to commission a new machine and troubleshoot any downtime-causing issues that may arise.

Customers expect machines to offer greater performance in a more compact design, and they want those machines to be delivered more quickly at attractive prices. Finding a way to reduce the wiring and shrink the control cabinet size goes a long way towards reducing the overall machine footprint.

Using sensors with built-in networks or remote I/O blocks instead of traditional sensors controls cabinet size and makes machines less complex thanks to the resulting reduction in wiring. With conventional

sensors, it would be necessary to run the wires all the way back to the PLC. With remote I/O or smart sensors that have built-in networks, it's possible to just run the wires over to a locally-placed remote I/O block and then have a single cable going from the I/O block to the PLC. Some sensors actually have the network built in – a solution that enables the least amount of wiring.

By reducing unnecessary and cumbersome wires, sensors with remote I/O can make machines much easier for customers to use and give machine builders the necessary flexibility to meet customer demands more effectively.

Using IP-rated sensors for greater longevity in challenging environments

In industries like automotive manufacturing and food and beverage production, sensors face all sorts of potentially destructive chemicals and processes. Dairy production, poultry processing, beef processing and similar applications use intense washdown treatments to eliminate the growth of bacteria and fungi. These washdowns incorporate harsh chemicals, high heat and high-pressure sprays.

Sensors used in these industries need to be washdown-resistant, both for the sake of overall longevity and cost-effectiveness and because they – like everything else on the production line – need to be cleaned. If sensors are too delicate to be washed down, then they could begin supporting dangerous levels of bacterial growth. They could also cause expensive downtime if they fail prematurely.

Omron has developed a number of sensing solutions that ensure longevity and cleanability in the harshest of environments. The IP69K-rated products can withstand both high and low ambient operating conditions and maintain integrity during washdowns in extreme environments. Their rounded and sealed construction allows for high washdown pressures at any angle and ensures resistance to aggressive cleaning solutions.

In automotive applications and metal cutting, a common cause of sensor breakdown is cutting oil. Omron's oil-resistant IP67G sensors provide rugged durability for harsh environments so that manufacturers who use cutting oil can eliminate oil ingress by any path, minimize unexpected machine downtime and lower the overall cost of ownership of their equipment. These sensors successfully keep oil out thanks to fluororesin cable sheaths that provide extra-strong resistance to deterioration as well as extra protection at joints and moving sections.

Although robust sensors might be slightly more expensive to purchase, the acquisition cost is small in comparison to extra maintenance, replacement and unplanned downtime. In some industries, downtime can cost several thousand – or even tens of thousands – of dollars per minute, easily outweighing the cost of IP-rated sensors.
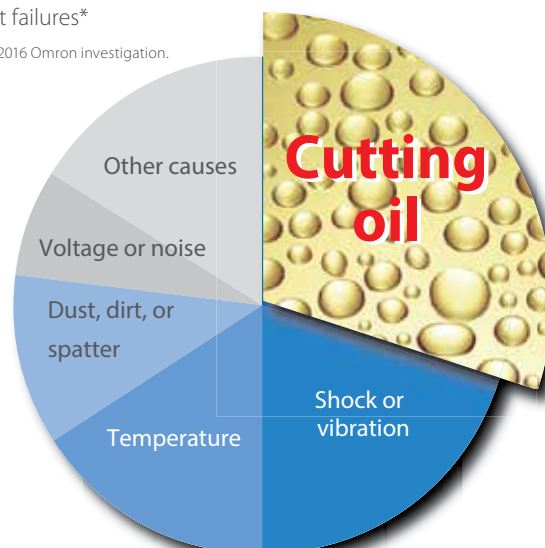
What is an IP rating?

Short for "ingress protection rating," an IP rating refers to a technology's level of protection against the entry of water, oil, dust and other potentially destructive substances.

Here are a few common examples:

- **IP65** – Protected from total dust ingress and low-pressure water jets from any direction.
- **IP67** – Protected from total dust ingress and waterproof when immersed in 15cm to 1m of water.
- **IP69K** – Protected from total dust ingress and steam-jet cleaning.

Environmental causes of component failures*

*Based on June 2016 Omron investigation.

Cutting oil

Other causes

Voltage or noise

Dust, dirt, or spatter

Temperature

Shock or vibration

Using smart sensors to improve predictive maintenance and minimize downtime

If a machine is starting to have problems functioning, the sensors will be the first to know it. That is, they'll be the first to gather any abnormal data that could point to machine trouble. However, if this data isn't properly communicated and analyzed, the deteriorating machine function could easily go unnoticed.

Smart sensors, considered to be a major component of the Industrial Internet of Things (IIoT) or Industry 4.0, can help end users monitor machine performance in real time. Because they don't need to send data through an I/O point like conventional sensors do, smart sensors can communicate more complex data than just whether they are on or off. They can return information such as how many times they've switched between on and off, and this data can offer insight into whether a part of the machine might fail in the near future. In addition, smart sensors can monitor their own functionality in real time.

By giving clearer, more detailed insight into how the system is working, smart sensors can make predictive maintenance much easier and much more effective. Manufacturers can catch problems while they're still relatively easy to fix, and they can avoid long periods of downtime. In industries like automotive manufacturing where downtime can cost $10,000-$12,000 per minute, smart sensors can be an extremely cost-effective solution.

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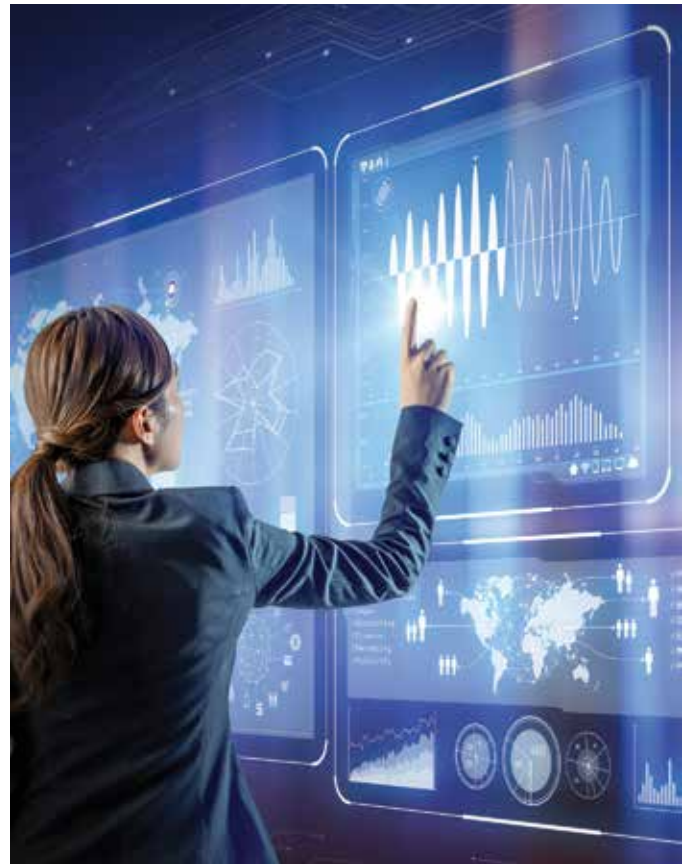
Harnessing IIoT-ready sensors to improve machine-to-machine communication

The benefits of smart sensors go beyond predictive maintenance. With the adoption of IIoT technologies increasing worldwide, machine data requires greater bandwidth and Ethernet is the new standard for machine-to-machine communication due to its numerous advantages such as easy scalability, faster speeds and network simplification.

The foundation of IIoT is data – specifically, machine-level data that is collected at the sensor level. The higher-level analytics and benefits of an IIoT solution depend upon the quality and variety of the data that is collected at the machine level. Smart sensors can help manufacturers reap the benefits of an IIoT solution, including lower costs and reduced downtime, because they provide more data overall to the manufacturing execution system (MES).

Omron offers several sensing technologies that can improve machine-to-machine communication, including a sensor-level communication module known as N Smart that communicate directly to EtherCAT, a real-time industrial Ethernet technology. Omron offers sensors with other communication options like IO-Link, plus a large variety of distributed I/O connection options.

What types of information do smart sensors provide?

IO-Link, a standard specified by IEC 61131-9, helps smart sensors communicate more detailed information about equipment, including the following:

- **Process data** – input or output data that shows the sensor's most recent state

- **Service data** – detailed information about the device in question, from basic info like version and serial number to advanced configuration and diagnostics data

- **Events** – unusual occurrences that happen too infrequently to be included in the process data but that could indicate a problem with the machine

Summary

Efforts to make machine building more cost-effective should always include the sensors. When machine builders choose the right sensors for the needs of their customers, they can ensure that those machines will have greater longevity, a smaller footprint and more effective predictive maintenance. Sensors play a significant role in every aspect of machine functionality and avoiding costly downtime.

In summary, machine builders can employ the following strategies to keep their machines cost-effective:

1. Use smart sensors or sensors with remote I/O blocks to eliminate wires and reduce machine complexity while collecting as much data as possible on machine function and work-in-progress status.

2. Select the right sensor for the environment to prevent premature machine failure and unplanned downtime. Choosing the wrong sensor upfront can cost a lot in the long run.

3. Improve predictive maintenance by employing smart sensors to give the system the vast amount and variety data that it needs for analytics.

4. Make connected choices – the future of manufacturing is in data, so it's important to select sensors that will provide the data that customers may need in the future.

Machine builders who take advantage of the above strategies and consider sensing technology as an important focus for long-term cost-effectiveness will receive much greater customer satisfaction thanks to dramatic improvements in ease of use, flexibility and overall productivity.

Omron oil-resistant IP67G sensors with rugged durability for harsh environments.

Omron's IO-Link sensors monitor error detection; reducing downtime, aiding in predictive maintenance and decreasing commissioning time.

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