# Living in the Real World: Position and Motion Sensors for Harsh Environments

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For many control systems, sensors are the vital components that link the external world of machinery and materials to the electronic world of programmable controllers. And, since the external world is often a world of dust and moisture, shock and vibration, selecting sensor devices that can stand up to harsh environmental conditions can be critical to the success of the system.

*OPTOCODE rotary encoders combine accuracy, durability (to IP67) and a wide range of output interfaces*

For motion control applications - which includes systems for manufacturing, transportation, construction and energy production - position sensors enable the control system to be 'aware' of the physical location of the mechanical components that it controls. Some of the most important sensors in this category include:

• Rotary encoders and potentiometers, which translate the motion of a shaft or wheel into an electronic signal;
• Linear encoders, which sense and digitize translational motion
• Inclinometers or tilt sensors, which monitor the orientation of an object with respect to the earth's gravitational field; and
• Limit switches, which transmit a signal to the control systems when motion (translational or rotational) exceeds a pre-set limit.

 *IP 69K-rated MAGNETOCODE encoders can survive the humidity, dust and lightning strikes encountered in wind turbines*

**Sensors in the Real World**
Selecting the right position/motion sensor requires careful consideration of the full requirements of the application. Accuracy and range are obvious performance requirements. So too is the availability of output interfaces that are supported by the control system hardware. Maintainability is another consideration - are there internal batteries that will need to be replaced?

Considering the environmental conditions under which each sensor must operate is also extremely important. Because position/motion sensors often operate in the middle of the working environment - which could include factory or mill settings or harsh outdoor environments - they must be able to withstand a wide variety of hazards.

 *ACCELENS inclinometer with a heavy-duty impact-resistant housing*

Dust and Water Sealing: One obvious hazard faced by electromechanical devices in a working environment is exposure to dust and various forms of moisture. Devices that are designed to survive under harsh conditions will typically carry a rating that describes the level of protection provided by their housings. One such rating system is the Ingress Protection or IP code, as defined in the international standard IEC 60529. An IP code has two digits. The first ranges from 0 (no protection) to 6 (complete dust protection). The second digit refers to protection from water or other

fluids. A device rated at IP56, for example, would be suitable for use in a moderately dusty environment and be capable of withstanding water splashes. A rating of IP67 means that the device must be completely sealed from dust and capable of surviving immersion in water to a depth of 1 meter for 30 minutes without damage. The highest rating normally encountered in industrial-grade equipment is IP69K. Devices that meet this standard can withstand high-pressure water or steam jets from pressure washing equipment.

A second rating system for environmental sealing is the NEMA scale, from the US National Electrical Manufacturers' Association. A NEMA Level 3 rating is broadly equivalent to IP56, while NEMA 6 aligns with IP67.

As a general rule of thumb, devices rated at IP56/NEMA 3 or above can be used in 'normal' factory or plant settings, while equipment rated at IP67/NEMA 6 would be a better choice for wet and dirty conditions. IP69K rated devices are indicated when the equipment is likely to be cleaned by pressure washers. This would include construction machinery and food-handling equipment.


*OPTIPACT optical sensor can measure motion of objects and materials with a wide variety of surface characteristics without direct contact*

Mechanical Hazards: Sensors installed in motion control systems may also be required to stand up to a variety of mechanical loads. Shock and vibration loads can be significant, especially for construction machinery, military vehicles or transportation equipment. There are several challenges here. High shock loading can damage delicate internal components, while persistent vibration can lead to failure due to fatigue damage to mechanical parts and connections.

Another problem associated with vibration is the potential impact on instrument accuracy. Some electromechanical sensors have measuring components such as fluid cells or spring-suspended masses that have relatively low natural frequencies of vibration. If the vibration frequency approaches or exceed the natural frequency of the measuring components, accuracy will be seriously degraded.

In order to avoid these problems, the design engineer must have a clear picture of the shock and vibration environment that the sensors will be working in and to carefully select instruments that can cope successfully with these loadings.

Another 'real life' mechanical hazard is accidental impact from a tool or heavy loose object. An example of a sensor designed to stand up to rough handling is the new heavy-duty model of the ACCELENS inclinometer from POSITAL. This version was introduced in response to requests from customers for a sensor that could operate in the most demanding construction, military or offshore applications.

**An Emerging Technology: Optical Sensors**
With more processing power available in small packages, it has become increasingly feasible to build sensors that make use of use optical image processing techniques. An example is FRABA's OPTIPACT motion sensor, which makes use of a specialized digital camera to measure movement of an object or surface. An advantage of these devices in harsh environments is that they don't require physical contact with the object that they are monitoring. This makes it easier to protect them from heat, moisture etc. (Of course it is necessary to ensure that the optical path isn't blocked by accumulations of dust or dirt.) These optical motion sensors have been used successfully in production processes, vehicle guidance systems and even speed monitoring in wind turbines.

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**Posted by Janine E. Mooney, Editor**

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