The Tilt Sensor Becomes More Ubiquitous

Here's Why?

Trend Paper

Over the past few years, tilt sensor technology has grown in usage and popularity. Tilt sensors have evolved from simple mechanical pendulum-type devices to fluid-filled electrolytic types to MEMS-based digital sensors. And as the technology has evolved and moved from analog to digital, and regulations have ensured safe operation, so have the number of ways that engineers are integrating tilt sensors in their applications. Once used primarily to measure safety parameters like vehicle reaction and boom angles, the tilt sensor is now being used to drive improvements in areas such as driver comfort as well.

In agricultural and construction industries, safety continues to be paramount. Safe vehicle/equipment operation is absolutely essential in these areas: off-road vehicles working at a construction site; tractors/other agricultural equipment; and in man lifts, lift platforms and on cranes. This is where sensors with a focus on platform leveling, tip-over protection and tilt alarms have become indispensable. In these industries, autonomous control functions have also become more pervasive, increasing the need for safety, efficiency and operator comfort.

As tilt sensors evolve and become more ubiquitous, we see three primary drivers having an impact on this trend:

Driver #1

More Stringent Regulatory Requirements

U.S. and European safety regulations are becoming ever-more stringent. Likewise, in Asia and other fast-growing regions with a huge amount of construction projects underway, safety is a key issue. To meet these safety requirements, manufacturers of lift platforms, cranes, and agricultural equipment have incorporated sensors to help ensure safe operation.

In addition to these safety requirements, government regulations related to Electro Magnetic Compatibility (EMC) must also be considered. EMC compatibility is needed to prevent radio frequency interferences. The more precise the measurements required in an application, the more significant an issue electromagnetic disturbance becomes.

For design engineers, these requirements place an increasing burden on them to include the latest technological advantages while also ensuring compliance with new regulations.

Driver #2

The Impact of the Digital Revolution—Advantages and Considerations

In addition to increasing safety regulations, technological evolution has been a key development driver for OEMs of these large machines and equipment. As technology has advanced, OEMs have in turn offered more features and options, many requiring more reliable, accurate sensors. With the increase in the number of sensors, as well as the complexity of the systems, the industry has quickly made the transition from analog to digital-based control systems, with the clear majority using the Controller Area Network (CAN) protocol.

Digital sensors and systems have many advantages over their analog counterparts. Information transferred digitally is typically much more immune to interference than analog signals. The likelihood of crosstalk corrupting the content of information transferred is also significantly lower. In addition, CAN interfaces also offer the ability to incorporate enhanced diagnostic features. While analog interfaces sometimes make use of “deadbands” for signaling fault conditions, the number of classifications is typically restricted to two, giving only a rough indication. With CAN differentiated information about the “health” condition of the sensor can be sent either automatically or on request.

While the switch from analog to digital sensors is happening everywhere—it is taking place faster in certain countries including Singapore, Finland, Sweden, Norway, the U.S., the Netherlands, Switzerland, and Japan, to name a few.[1] Digital sensors have developed sensitivity cancellation and are more precise in data conversion adaptable to CAN or BUS outputs.

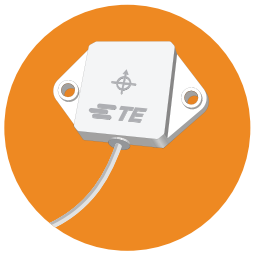
For design engineers, this means that adding technology innovations can have a big impact on the marketability and success of product designs.

Driver #3

New Applications and the Need for More Ergonomic, Comfort Advantages

Beyond current safety regulations and technical requirements, manufacturers are seeing another advantage to integrating tilt sensors in their development, such as different applications related to driver's comfort. In addition, they are using sensors to keep the tool area and seat level when the machine is operating on steep grades. With the increasing trend toward more autonomous control functions, they are finding their way into these applications as well. For applications that are related to significant vibration and shocks, a gyroscope can be added to improve stability of the tilt sensor's output.

For design engineers, new applications translate into more opportunities.



TE Connectivity's DOG2 MEMS CAN J1939 Inclinometers:

Superior Performance and Ease of Application

For design and procurement engineers looking to build tip-over protection in construction, agricultural, and many other off-road type vehicles, DOG2 MEMS CAN J1939 inclinometers from TE Connectivity may be the perfect solution for automatic tip-over protection. They can be used for off-road vehicles, man lifts, and lift platforms, cranes, and a range of agricultural equipment and have already been deployed by customers for depth control in trencher applications, backhoe bucket angle and excavator dig depth and for man lifts or cranes for chassis tilt and boom angle.

Inclinometers were designed from the beginning with a focus on platform leveling, tip-over protection, and tilt alarm markets. TE's inclinometers offer superior performance with high accuracy and rugged packaging for harsh environments—those capabilities provide the added value design engineers need. They also provide ease of application with CAN digital interface,

Source [1]https://www.weforum.org/agenda/2016/07/countries-best-prepared-for-the-new-digital-economy/

easy mechanical and electrical installation. In addition, because they are lightweight and compact, they help reduce overall weight, an increasing requirement today in all applications.

Here are some specifics on performance and ease of application, important to design and procurement engineers:

Superior Performance

The TE DOG2 MEMS CAN J1939 offers these performance advantages:

- Dual-axis inclinometers that simultaneously measure pitch and roll angles of up to 90 degrees with <0.5% cross-axis sensitivity (vs. the industry standard of 1-2%)
- On-board linearization and temperature compensation
- Integrated digital filtering algorithms that limit effects of vibrations and/or shock
- High-impact plastic housing and IP67 rating provide excellent protection in harsh environments

Ease of Application

The TE inclinometer offers these ease-of-use advantages:

- Communicates through industry-standard CAN interfaces, making system integration simple
- Compression limiting bushings ease mechanical installation concerns
- AMP SUPERSEAL 1.5 SERIES connector makes electrical connection easy and secure
- Compact and lightweight—perfect for space-restrictive applications

TE Connectivity (TE) is now one of the largest sensor companies in the world, with innovative sensor solutions that help customers transform concepts into smart, connected creations.

Our **tilt sensors** offer accurate measurement of inclination, in various applications. TE offers capacitive, conductive electrolytic and MEMS tilt sensing technologies in rugged die-cast aluminum, ceramic, or plastic packages.

Learn more today at **www.te.com.**