

# DIGITAL SENSORS: Meeting OEM Needs, Addressing Market Demands

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Trend Paper

We increasingly live in a digital world. While it wasn't all that long ago that analog was the technology through which all data was transmitted, in today's market – from Silicon Valley innovators to Main Street consumers – there is widespread acknowledgement that digital technologies are increasingly dominating how we operate in a smart world.

This evolution from analog to digital also has been quietly taking shape in the world of industrial manufacturing and in turn, the world of sensing. In particular, the shift from analog to digital sensors is of major relevance to producers of applications for the IOT (Internet of Things), or what it is often referred to as Industry 4.0. That's because digital sensors offer a host of features that more effectively meet critical product requirements for operating in a wireless world.

## When the Shift Began

Sensing all started in the analog world where the desired information came from a continuously variable value or parameter. Traditionally, the sensor element output has been amplified, compensated, and linearized to suit the system to which a transducer is attached, all within the analog domain.

Starting in the mid-1990s, sensors and transducers started to move from purely analog operation to digital protocols, signal processing, and interfaces. Today that migration is in full force. In the digital version of the transducer, the data is manipulated by a digital signal processing core where various compensations and corrections are applied and the processed digital data is then stored in registers to be transmitted to the system later.

The rate at which products cross the analog/digital line varies by industry, but digital now prevails in many IOT applications across a wide spectrum of industries – from medical and mobile products to household appliances and smart home and factory devices. Overall, the catalyst behind this shift from analog to digital sensors reflects key performance criteria: delivering rapid response, using limited space, consuming low power and producing more precise readings – all critical components for today’s wireless applications.

In addition, digital sensors can help address the go-to-market challenges IOT product manufacturers face in what is a rapidly evolving environment. By their very construction and functionality, digital sensors offer a plug-and-play capability that can help manufacturers bring a product to market more quickly – an issue of paramount significance since any delays in product introduction can result in businesses losses or the product failing to go to market at all.

## The Case for Digital Sensors

Looking at the features and functionalities of a digital sensor is an effective way to illustrate its benefits. It also makes sense to focus on temperature measurement since many digital sensors offer some sort of critical temperature reading – either to directly measure the temperature of a liquid or gas or to compensate for pressure signals in providing more accurate readings.

The Thermopile Sensor Digital (TSD)\* contactless temperature measurement system is just that – a high-precision, thermostatic or pyrometric solution – and it is an ideal example of a sensor that is usable and fundamental to a wide variety of IOT applications. It offers the type of design and functionality features that are critical to addressing key trends in sensor creation today. This includes:

- **Miniaturization and packaging:** A major trend in the sensors industry is miniaturization, an effort to limit a sensor’s required ‘real estate’ within a particular product. The TSD example offers just that – a small footprint to support flexible design. Developed in a stainless steel, hermetically sealed TO5 package, it includes an infrared sensor (a digital thermopile component) and a sensor signal conditioner to not only improve EMI resistance but also allow for reduced PCB space requirements.
- **Digital precision:** Greater accuracy is a key objective in choosing a sensor, making digital sensors a more desirable option in light of their more precise outputs. For example, TSD delivers high accuracy  $\pm 1^{\circ}\text{C}$  readings of temperature ranges from  $0^{\circ}$  to  $100^{\circ}\text{C}$ , and when customized to accommodate a wider range of applications for intensely harsh environments, TSD can deliver high accuracy of  $\pm 4.5^{\circ}\text{C}$  at  $300^{\circ}\text{C}$ .
- **Interconnectivity speed with ease of integration:** Precision results require fast interconnectivity speeds between product components. This is another advantage that digital sensors provide. For example, TSD offers an Inter-Integrated Circuit (I2C) Interface, the most common digital communication protocol used by sensors and transducers, which gets attached to high speed (micro) processors and microcontrollers in short-distance, intra-board communications. This interconnectivity not only delivers fast results, but with its streamlined integration, helps to facilitate more rapid product development with a plug-and-play solution.

- **Low power consumption:** The way in which a digital sensor operates limits its power consumption. Typically, a digital sensor will not take a pressure reading or report it until there is a master controller request for the data. This not only lowers the system's power requirement but because readings are intermittent, the sensors can go into "sleep mode" during the slowdowns. In the case of TSD, the system operates on voltage of 1.68 to 3.6V, and in "sleep mode" at 20nA. This has a dramatic impact on the battery by increasing its lifetime and reducing its charge/change frequency rate – a feature that is particularly relevant to wireless applications.
- **Cost-Effectiveness:** Digital sensors address another key market need – cost-effectiveness. While analog products, in and of themselves, are often less expensive, digital sensors by virtue of their design and configuration, do not require the purchase of additional electrical components such as low offset/low noise amplifier and associated filters (which analog products do require). This presents a tangible cost savings issue. In addition, because digital sensors avoid the need for additional testing, e.g. calibration and inter-operability on the PCB, (which again, analog products require), another cost savings results. Together, these two savings not only mitigate the cost differential with analog products but at the same time facilitate product development by helping to positively impact time-to-market schedules.

## Looking ahead

In looking ahead, the shift to digital sensors is expected to clearly dominate the future of industrial manufacturing but this does not mean that the analog transducer industry will shrink and die. There are still many application areas — such as high EMI/RFI environments or legacy analog systems — where the benefits of an analog transducer will always surpass a digital approach.

However, as we increasingly work in a smart world where IOT applications become that much more pervasive, digital sensors answer the clarion call for speedy, highly effective, plug-and-play, ease-to-market solutions. The time to consider digital sensors is now.

## About the Authors

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