

# Custom ASICs for Industrial Internet of Things (IIoT)

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## ***Abstract***

This white paper commences with an overview of the IIoT (Industrial Internet of Things) opportunity, the market drivers, and how the semiconductor industry is responding to this need. We then include an example of a customizable SoC intended for use in various industrial applications where low power consumption, remote deployment, reduced production costs and short time-to-market are vital.

## **Introduction**

In the industrial control and automation market, we are entering a fortuitous period where the Industry 4.0 needs can be readily met by access to practical integrated solutions from the semiconductor industry. The total engineering bill of materials can be vastly reduced through the use of customised mixed signal SoC's (system-on-chip). Why pay for highly margined discrete off-the shelf analog components, when an integrated SoC can save up to 90% off our BOM (Bill of materials). With custom integration, customer specified features can be incorporated, that can either differentiate the end solution further, or allow for entry into other lucrative application areas. Ownership of the entire solution is guaranteed, no distributors to deal with, no supply chain uncertainty.

## Market Overview

### The Market Numbers

Industry 4.0 (or the fourth industrial revolution) is a collective term embracing a number of contemporary automations, data exchange and manufacturing technologies. It facilitates the vision and execution of a modular 'smart factory' in which cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decentralised decisions. Over the IIoT, cyber-physical systems communicate and cooperate with each other and with humans in real time, and via the Internet of Services (Wikipedia).

In 2014 global sensors in the IIoT market generated revenue of \$3.77B. This is estimated to increase to \$11.23B in 2021, yielding a CAGR of 16.8% (Frost & Sullivan, 2015). Within this market, the largest share is attributed to industrial control applications which commands 38% of that share. Dissecting that data further, the 5 biggest sensor applications that dominate are temperature, pressure, flow, imaging and gas detection. Suffice to say that the IIoT market is in its very early life-cycle stage. It is a good time to be addressing this segment. Problem Setting and Solution

### The Market Drivers

Factory automation requires real-time data. Process monitoring reduces waste and improves efficiency. Being able to access this information remotely and in real-time, allows for the optimisation of resource, energy and manpower. In cases of variation in performance, operators can be warned in advance to mitigate against production down-time. Maintenance cost reduction and improved efficiencies should impact positively on the bottom-line. Acceptance of sensor solutions are predicated by the low cost of their implementation, their low power consumption, communications security and reliability. In addition, there is a growing need for precision, which in effect will define the differentiation points for the end product moving forward.

## Custom ASICs

Considering the relatively early stage of this IIoT market, the majority of these sensing solutions today, consist of large, heavily populated PCB boards, crammed with discrete data-converters, references, amplifiers and MCU's. Unfortunately, these solutions tend to be non-optimal in terms of cost, power, area/volume and reliability.

Leveraging from decades of expertise in developing SoC's for the connected consumer electronics segments, to provide optimised, lower-cost, lower power with differentiating features, the semiconductor industry is well poised to bring this integration to this emerging IIoT segment. Custom mixed-signal ASICs are now within the grasp of mid to lower volume market segments, by virtue of cheaper access to semiconductor foundry nodes from 0.18um down to 65nm, in addition to a slew of silicon proven IP. Currently the name of the game in the semiconductor industry is IoT, driven by the need to nurture new markets as the mobile consumer electronics market growth levels off. Mature process nodes are being aggressively pushed by all foundries, breathing new life into those geometries with ultra-low power derivatives and higher-voltage support. These are perfectly placed to support IIoT needs.

Within the current IoT market uncertainty, IIoT is the clear segment where the rubber has hit the road!

## Reference Design Example

We have developed, and continue to develop multiple SoCs, targeting multiple applications. Included here is an example of one such development which in effect is a customisable SoC intended for use in various industrial applications where low power consumption, remote deployment, reduced production costs and short time-to-market are important. The solution includes a low power implementation of an ARM™ Cortex-M4 & PIC microcontrollers, sensor interface AFE (analog-front end), memory and industrial communication interfaces such as FOUNDATION fieldbus, Profibus and HART.

Using a cost effective 180nm mixed-signal CMOS process from TSMC, the digital system is fully integrated with a customised analog front-end consisting of:

- 2 integrated 12-bit DACs for actuator control
- Integrated 14 bit low-power SAR ADCs, coupled to a switch that allows up to 16 separate sensors to be independently interrogated
- A variety of interfaces to on-board circuit elements (multiple SPI, UART, I<sup>2</sup>C and Parallel)
- Temperature sensor for measurement of on-chip temperature.
- Custom PWM
- 2 types of Timers
- High-performance Op amps, Analog switches/muxes
- Clock gating of logic and power gating of RAM and ROM
- Designed to run off 2.7 and operate from a 4-20mA control loop
- Low power design: 160 $\mu$ W/MHz



Significantly, the electronic bill of materials is reduced by up to 90% due to the level of integration onto the SoC of the discrete components that would otherwise have been used. In addition, with the incorporation of a customised SoC, it leads to an optimised total solution, whilst allowing for additional features that otherwise would not be possible with a discrete solution consisting of off the shelf components. Performance is enhanced due to better signal integrity at a chip level, without compromising on excess power or cost associated with equivalent discrettes. Due to the reduction in total bill of materials, overall system reliability and yield is hugely enhanced. Supply chain certainty is guaranteed as the customer owns their custom solution.

## Conclusion

In the industrial control and automation market, we are entering a fortuitous period where the Industry 4.0 needs can be readily met by access to practical and high-performance integrated solutions from the semiconductor industry. The total engineering bill of materials can be vastly reduced by customised mixed-signal SoC's. Why pay for highly margined discrete off the-shelf analog components when integration saves up to 90%. With custom integration, customer specified features can be incorporated, that can either differentiate their end solution further, or allow for entry into other lucrative application areas. Ownership of the entire solution is guaranteed, no distributors to deal with, no end of life concerns or other supply chain uncertainty. We have 3 decades of delivering highly integrated mixed-signal and RF SoC's. Together with our system and integration expertise, we have a rich portfolio of silicon proven IP, equivalent to high-performance analog components from analog semiconductor IDMs, which we can readily integrate with any processor and communication interface. If you are seeking an opportunity to reduce your electronic bill of materials, whilst adding custom features that you want, and to own your own solution, come talk to us.