



AHEAD OF WHAT'S POSSIBLE™

MORE INTELLIGENT SOLUTIONS. MORE IMPACTFUL, RELIABLE OUTCOMES.

Technologies and Applications for the Internet of Things



The Internet of Things Depends on the Intelligence of Things

Advances in connectivity and cloud computing are helping us realize greater value from the massive amounts of data collected in our world of ubiquitous sensing. However, we're quickly learning that the future of IoT will require a more holistic, system-level approach to extracting insights from data. Collecting raw, low quality data at the edge and relying solely on the cloud for analytics is far from optimal—the implications on accuracy, reliability, speed, and security can be extremely costly.

At Analog Devices, we're bringing intelligence to the edge by optimizing data quality and analytics within the *things* to ensure only the most relevant, accurate, and secure information is sent to the cloud. We do this

by taking a system-level approach, leveraging hardware and software throughout the system to ensure the right level of insight is developed at the optimal point. From human biometrics to machine vibration profiles, our technologies are seeing, hearing, and feeling things that couldn't be measured before, and our customers are realizing new possibilities, more reliable outcomes, and lower costs of development and ownership.

We invite you to explore some of our key technologies and applications to learn how the Internet of Things can transform your business and the outcomes you deliver to your customers and users.



Visit analog.com/IoT

Technologies

You wouldn't build a house on a weak foundation, so why build your IoT solution that way? Our technologies sense, measure, interpret, and connect in ways that add integrity and intelligence at the edge, improving the overall reliability, impact, and efficiency of the IoT solution.



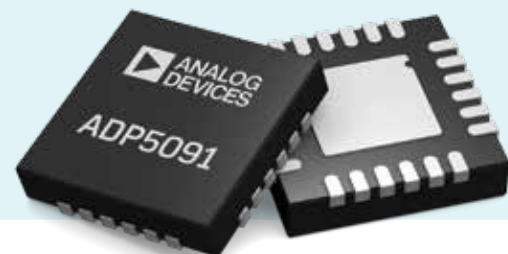
Power Management in IoT

Because many IoT applications require wireless, remote, or mobile solutions, power management can be a primary challenge in system design. Battery life can have significant implications on cost of ownership, and can sometimes be a barrier to viability. Analog Devices takes a system-level approach to power management. What does this mean?

- ▶ Energy harvesting technology to source power from the environment
- ▶ System-level power management functions built in at the component level
- ▶ Ultralow power products that often achieve best benchmark scores in class
- ▶ Unmatched design expertise around low power systems

Product Highlight

- ▶ ADP5091 energy harvesting PMU
- ▶ ULP boost with maximum power point tracking (MPPT) and charge management
- ▶ Supports PV harvester or TEG harvester
- ▶ Fast cold start with SISO regulated output



Sense

Sensing is the birthplace of data in the IoT. Our high performance sensing portfolio combines precision, power efficiency, and robustness to ensure the highest level of integrity right from the start.

- ▶ MEMS inertial
- ▶ Optical
- ▶ Biopotential
- ▶ Impedance
- ▶ Temperature

Product Highlight: ADXL362

- ▶ Ultralow power, 3-axis MEMS accelerometer consumes less than 2 μ A at a 100 Hz output data rate and 270 nA when in motion triggered wake-up mode.



Measure

Our robust signal conditioning technologies play a critical role in turning the most sensitive signals into useful data and solving the most challenging measurement problems faced by our customers.

- ▶ Integrated AFEs
- ▶ Converters
- ▶ Amplifiers
- ▶ References
- ▶ Switches/muxes
- ▶ Power management

Product Highlight: AD8233 Electrocardiogram (ECG) Integrated AFE

- ▶ Small size enables health devices that are smaller, lighter, and easier to wear.
- ▶ Microamp-range power requirements enable extended battery life and continuous monitoring.
- ▶ Low electrical noise enables precise signal measurement.
- ▶ On-chip integration including multiple filtering and amplifiers enables ease of use.



Interpret

The *brain* of the connected solution, our processors combine hardware and advanced algorithms to deliver intelligence, functionality, and localized decision making for IoT solutions.

- ▶ Ultralow power microcontrollers and processors
- ▶ Integrated precision microcontrollers and processors
- ▶ Blackfin[®] low power DSP

Product Highlight: ADuCM3027/ADuCM3029

- ▶ Ultralow power ARM[®] Cortex[®]-M3 MCU with integrated power management and 256 kB of embedded flash memory.
- ▶ High performance ULPBench[™] certified score of 245.5 points (Embedded Microprocessor Benchmark Consortium)
- ▶ Faster encryption enabled by a combination of hardware and software protection mechanisms providing read protection



Connect

Our IoT radio products ensure power efficiency, reliability, and flexibility across a number of wireless protocols and range requirements. They enable robust networks in applications where timeliness and reliability of information are critical.

- ▶ Long range radio transceivers
- ▶ High data rate radio transceivers
- ▶ Integrated radio/micros

Product Highlight: ADF7030-1

- ▶ Sub-GHz integrated radio transceiver. Supports narrow-band and wideband operation across sub-GHz ISM bands, with low power operation and data rates from 0.1 kbps to 300 kbps using 2GFSK modulation. Low power operation reduces battery cost and increases product lifetime.
- ▶ Faster encryption enabled by a combination of hardware and software protection mechanisms providing read protection.



Focus Applications

Health. Safety. Security. Economy. At Analog Devices we focus on applications where outcomes really matter. These are spaces where accuracy and reliability are mission-critical, and where the insights we harness from the physical world are used in powerful ways to make better decisions, work more productively, and lead healthier, safer lives.

Smart Buildings and City

We help customers build smart building and city solutions delivering secure and intelligent sensing, localized decision making, and power efficiency. Our advanced imaging and sensing platforms combine hardware, software, and connectivity, enabling users to realize the full benefits of real-time monitoring in applications such as building security, asset tracking, parking space occupancy detection, object and gesture recognition, and many more.

Smart Infrastructure

Highly integrated sensing and connectivity solutions enable our customers to monitor their critical assets at the edge—whether in industrial environments, remote field locations, or in transit. From structural health and conditions monitoring to location and movement tracking, our high performance and low power solutions deliver the most accurate, reliable information at the lowest cost of maintenance.

Smart Health

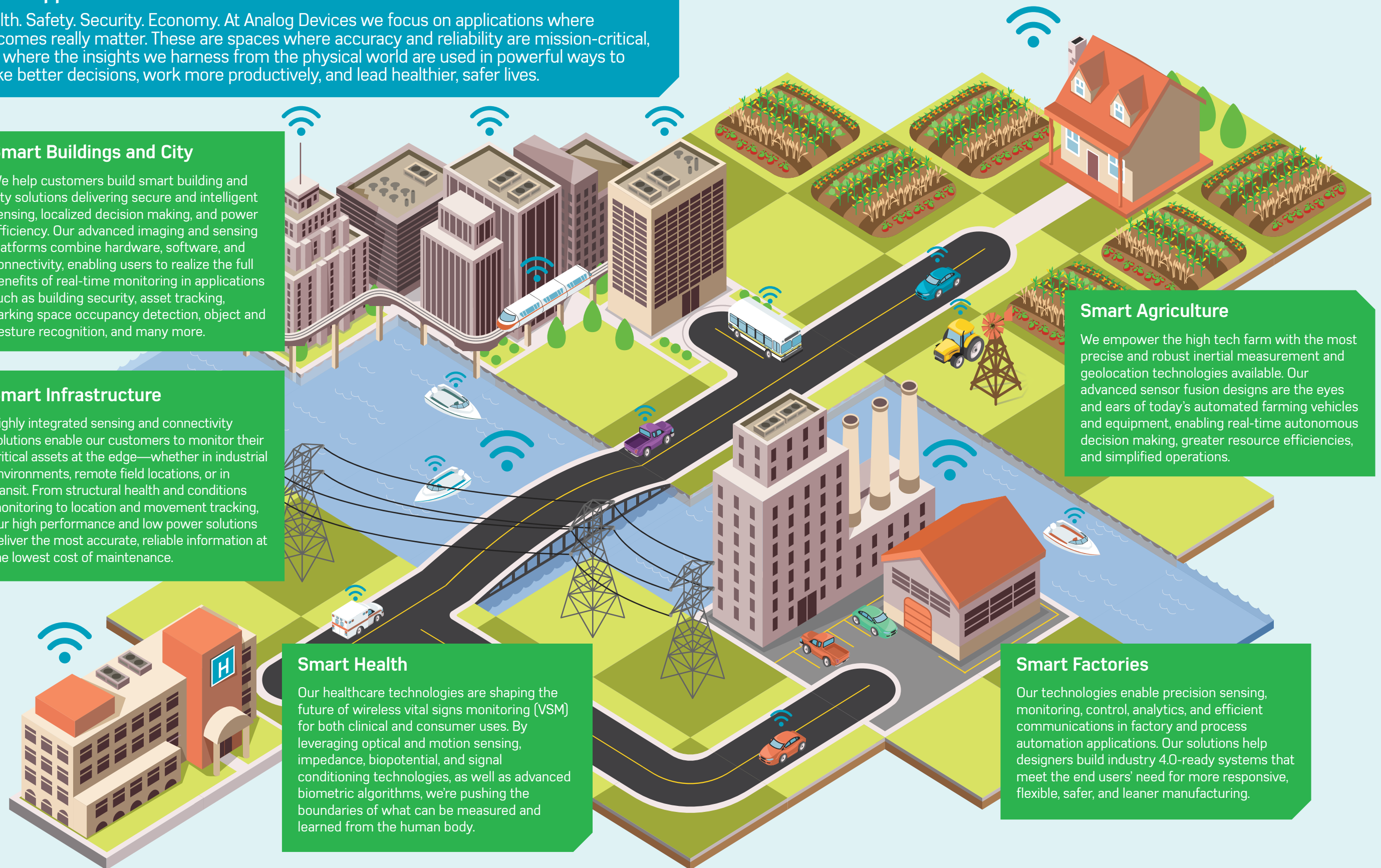
Our healthcare technologies are shaping the future of wireless vital signs monitoring (VSM) for both clinical and consumer uses. By leveraging optical and motion sensing, impedance, biopotential, and signal conditioning technologies, as well as advanced biometric algorithms, we're pushing the boundaries of what can be measured and learned from the human body.

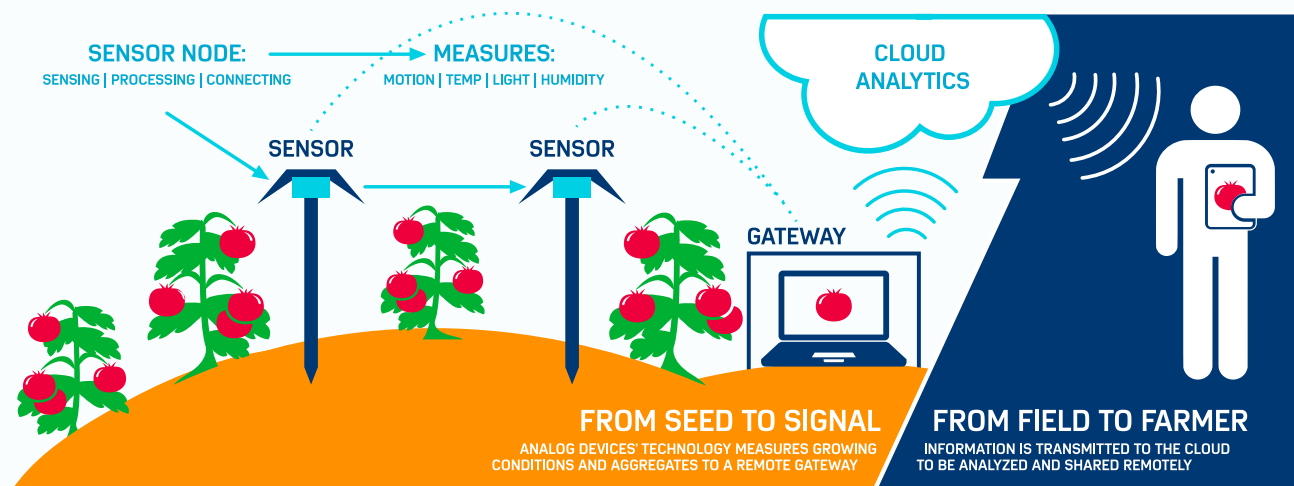
Smart Agriculture

We empower the high tech farm with the most precise and robust inertial measurement and geolocation technologies available. Our advanced sensor fusion designs are the eyes and ears of today's automated farming vehicles and equipment, enabling real-time autonomous decision making, greater resource efficiencies, and simplified operations.

Smart Factories

Our technologies enable precision sensing, monitoring, control, analytics, and efficient communications in factory and process automation applications. Our solutions help designers build industry 4.0-ready systems that meet the end users' need for more responsive, flexible, safer, and leaner manufacturing.





THE INTERNET OF TOMATOES: PUTTING IoT INTO ACTION

How do you grow a great tomato? Start with great technology.

A Fresher Look at the IoT.

New England is home to scenic coastlines, vibrant foliage, thousands of small farms, and (someday) the ultimate tomato.

That's because Analog Devices, Inc. (ADI), is partnering with New England tomato farmers to develop technology that will help them harvest tastier, more abundant, and more sustainably grown tomatoes than ever before.

By leveraging our technical expertise in sensing, measuring, and interpreting the world around us, and our deep knowledge of the IoT ecosystem, Analog Devices is building a complete sensor-to-cloud solution that will empower farmers to make better decisions throughout the growing cycle, ultimately improving quality, economic, and environmental outcomes.

Welcome to the Internet of Tomatoes—and a deliciously powerful example of what smart agriculture can mean to products, people, and the future.

Red. Ripe. Revolutionary.

The process started with collaboration, as ADI engineers met with local farmers to better understand the art of tomato growing; discuss a tomato's ideal flavor profile, shape, aroma, sugar, acid, and lycopene content; and listen to the challenges farmers face in making the most of their harvest.

Based on those insights, we developed a platform-based sensing, processing, and communications solution that can precisely measure environmental data—humidity, temperature, and ambient sunlight—that contribute to growing a delicious tomato. Placed among the tomato plants at various locations throughout the farm, this solution will monitor the growing environment and keep tomato farmers apprised of real-time conditions and trends (taking sensory information from the field, relaying that content to a cloud application, and providing rich information back to farmers on handheld devices).

All told, this will provide a precise, always-on look at conditions that affect tomato quality, flavor, yield, potential for disease, and

more—fresh from the vine, sent through the air, stored in the cloud. It will allow farmers to make interventions to improve outcomes and optimize flavors (that is, to water more or less, make amendments to soil, and even determine the ideal time to harvest).

Moving forward, this aggregated information will also build a shareable database of insight that can help other farmers with their future harvests, and further the cause of delivering the perfect tomato.

From Seed to Signal. From Sensor to Cloud.

By integrating the hardware solution with a cloud-based IoT application from ThingWorx,[™] Analog Devices is developing a complete solution that will be accessible and easy to use from end to end.

This solution delivers reliable and precise information to farmers, while withstanding long-term exposure to the environment (thanks to highly rugged and accurate sensors); lasts several seasons without battery replacement (owing to its highly reliable, low power processing); and will give farmers anytime, anywhere access to their crops (through cloud-integrated communications). In addition, apps and dashboards built on ThingWorx (armed with data from ADI's precision sensing) can help farmers better understand and implement improvements.

The result: a healthier, fresher, tastier tomato. Farmed with care and skill. Supported with technology. But the benefits go—and grow—far beyond.

Better Tomatoes. A Better Tomorrow.

Smart agriculture can positively impact the planet in immeasurable ways: improving yields of crops of all kinds, decreasing dependence on pesticides, reducing operational costs, optimizing water usage, and ensuring better land management and crop rotation.

Analog Devices' ability to deliver complete sensing solutions to customers—from small New England farms to growers in the developing world—means extending the value and possibilities of IoT in truly transformative ways.

In short, the more sensory information we are able to extract, analyze, and share from our world, the more we will be able to feed our world.



Ahead of What's Possible

At Analog Devices, our technologies play a critical role in bridging the physical and digital worlds, enabling the Internet of Things, and empowering smarter cities, factories, energy grids, agricultural practices, healthcare systems, and more.

Working together with customers, we continue to apply our knowledge of the signal chain and IoT ecosystem to create solutions, at the system level, that solve the toughest challenges.

Our innovations, expertise, and drive to always be Ahead of What's Possible mean Analog Devices can implement—not just theorize—greater possibilities for today's interconnected world. We consider problems at a big picture level, and implement holistic, system-level technologies to address them. And the more we learn, unlock opportunities, and apply these solutions, the more our customers—and their customers—succeed.

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