Technical Article

Smart Buildings Get Smarter with Ultra-low-power MCUs

Shailesh Thakurdesai

How did everything get so smart? Within building automation systems you'll find smart thermostats, smart light switches, smart light bulbs, smart refrigerators and heaters and appliances and all manner of smart devices. Add it all up and you've got a genius of a building automation system.

A new breed of highly integrated, ultra-low-power microcontrollers (MCUs) with completely configurable ferroelectric random access memory (FRAM) and a super-sensitive analog front-end for interfacing to advanced sensors is part of the shift in building automation that is pushing more and more intelligence out into every corner of office buildings, factories, apartment complexes or just about any building that's being automated.

These mighty mites of the MCU world give developers a flexible and reconfigurable base on which they can build a wide range of intelligent end nodes that team up with sensors, microprocessors, centralized control systems and other types of building automation system components.

Smart thermostats offer a good example of the design advantages of these new MCUs in building automation applications. The first smart thermostats were the next step up from programmable devices. Instead of requiring users to program in a schedule of temperature changes for a day or week, smart thermostats 'learn' from users as they change the temperature setting and then anticipate those changes automatically. In addition, many smart thermostats interface to wireless communications technologies like Wi-Fi® or *Bluetooth*® low energy so users can check the status of the thermostat, change its settings or monitor its operations from a smartphone or a centralized control system with wireless connectivity.

An extremely low power and flexible sensing subsystem capable of processing both temperature and humidity sensor signals is integral to many smart thermostats. Monitoring for both temperature and humidity means that the thermostat can ensure a certain comfort level to occupants of the space rather than simply maintaining a constant temperature. With high humidity, the people will feel less comfortable at a certain temperature than if the humidity were lower. Knowing temperature and humidity lets a smart thermostat adjust the temperature to achieve the right level of comfort, even though continuously monitoring two parameters could potentially consume significant power and deplete the device's batteries much faster. As a result, low-power consumption is a major requirement of smart thermostats.

Copyright © 2023 Texas Instruments Incorporated

Of course, the increased integration of these new MCUs helps reduce power consumption and some of these devices, like the MSP430FR2311 MCU, feature an analog front-end that includes standard op amps and a transimpedance amplifier (TIA) with the industry's lowest power leakage of just 50 picoAmps (pA) and a standby power rating of just one microAmp. A sensor subsystem based on such a MCU could run on a battery for as long as 10 years. If the MCU is integrated with a digitally controlled oscillator, it will be able to wake up from a low-power standby mode and move into an active mode in less than 10 microseconds. FRAM memory is also a low-power storage media. It is non-volatile like Flash, but features fast and low-power writes, write endurance of 1,015 cycles, enhanced security that makes it less vulnerable to attackers than Flash or EEPROM, and unmatched configuration flexibility.

The capabilities of the MSP430FR2311 MCU device make it appropriate for smart thermostat applications and other building automation devices like occupancy sensors, smoke or gas detectors, wireless power switches and others.

Additional Resources

- Get started developing with the MSP430FR2311 MCU LaunchPad™ development kit.
- TI Design reference design for single-chip, portable carbon monoxide (co) monitors with MSP430™ MCUs (TIDM-1CHP-DTECT-CO).
- Learn how to meet the low-power challenge for building automation applications in this white paper.
- Enjoyed this topic? Keep reading other related blog posts:
  - Reach new low-power levels for any sensor based design with new MSP430FR2311 MCU
  - IoT, wearables and other new applications create need for super-sensitive sensors
  - Air quality monitors and smoke detectors put on a new face
  - Design a battery-powered building automation system to last for decades
  - Trends in building automation: connected sensors for energy efficiency
  - When green meets the IoT
  - Value line MCUs bring more analog to personal electronic products

Copyright © 2023 Texas Instruments Incorporated

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2023, Texas Instruments Incorporated