

# Ultra-Low Power Designs With the CC13x2 and CC26x2 Sensor Controller



A key factor in the rise of connected devices and the widespread adoption of networked sensors in our homes, buildings, and cities is the ability to operate at ultra-low power for extended battery and product lifetime. Many wireless microcontrollers (MCUs) available in the market today boast ultra-low power in standby, shutdown, and sleep modes; however in this state, the MCU cannot monitor sensor data or actuate devices. With the ultra-low power sensor controller on the SimpleLink™ CC13x2 and CC26x2 device platform from Texas Instruments™, designers can achieve low power while also handling sensors.

### Ultra-Low Power Sensor Controller—What is It?

TI's SimpleLink low-power RF wireless MCU products, the CC13x2 and CC26x2 device platform, are designed toward low power and high flexibility (see [Figure 1](#)). The sensor controller is a dedicated, 16-bit CPU core that is designed with very low power in mind—with respect to active mode, standby mode, and start-up energy. The sensor controller executes code from a dedicated ultra-low-leakage (ULL) RAM memory and can run independent from the main Arm® Cortex®-M4F application processor. Therefore, the main processor can sleep as long as possible and only wakes up to perform more compute-intensive tasks for which it is optimized.

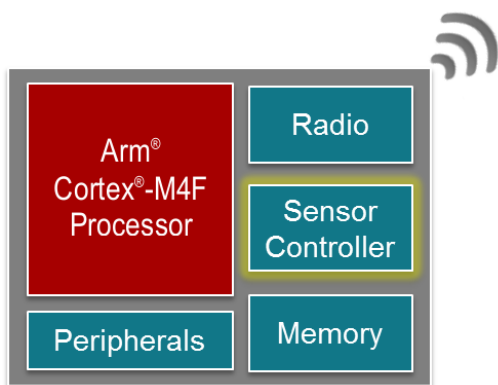


Figure 1. CC13x2 and CC26x2 Block Diagram

**Sensor Controller—System Block Diagram:** The sensor controller is part of a system with analog and digital peripherals that are all tuned toward ultra-low power (see [Figure 2](#)). The analog peripherals include a 12-bit ADC, two comparators, a programmable current

source, and an 8-bit DAC (voltage reference). The digital peripherals include three timers, an ultra-low power counter, a 10-ns time-to-digital converter (TDC), SPI interface, and a hardware multiplier. These peripherals can be combined with the sensor controller in numerous ways to handle both analog and digital sensors with very low power consumption—several examples follow.

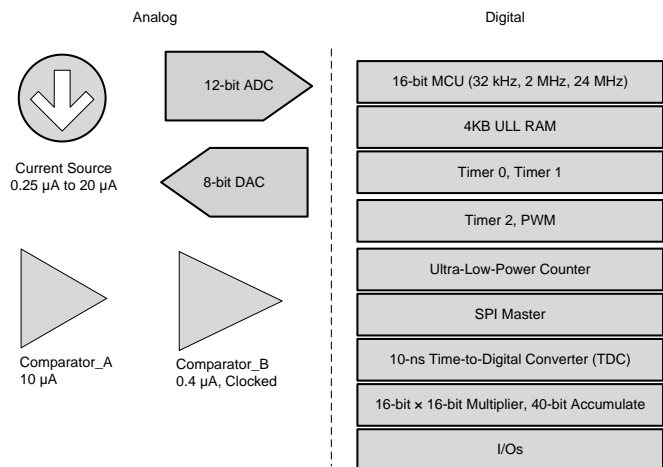
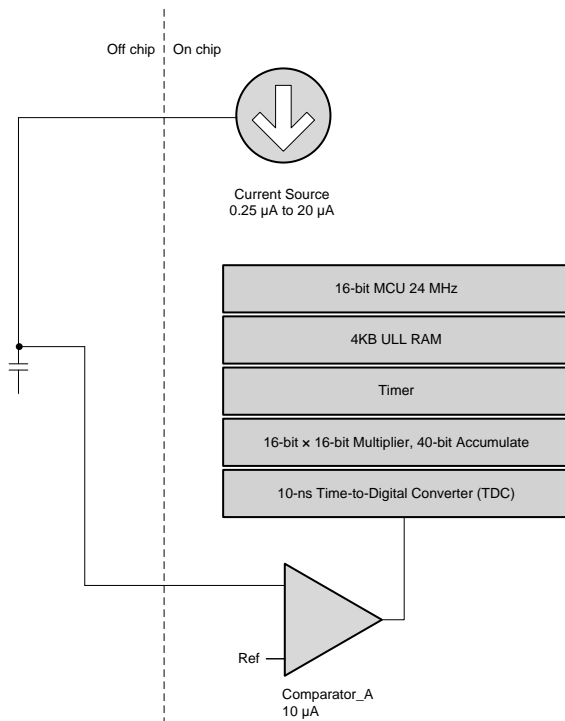


Figure 2. Sensor Controller Block Diagram

### Application Example Building Security—Motion Detector (PIR):

A motion detector, passive infrared (PIR) sensor, is very common in building application solutions. There are many ways to implement a PIR sensor. One common way is to use a window comparator, which will detect if an analog signal is above or below a predefined voltage level. Using the sensor controller in the CC13x2 and CC26x2 device platform, the window comparator can be implemented with Comparator A and the 8-bit DAC. The sensor controller can then be programmed to select different DAC levels as reference for the comparator and can verify if the signal swing is large enough to trigger the *people detect* signal. Excluding the external circuits, the PIR element and the amplifier, the sensor controller can check the incoming signal 100 times per second while consuming an average current consumption of less than 1.9 µA. This enables PIR sensors to run on small CR2032 coin-cell batteries for multiple years.

**Capacitive Touch:** The sensor controller can also perform more advanced tasks (for example, a complete capacitive touch button solution), which enables low-cost and low-power user interfaces. [Figure 3](#) shows the main components in this solution, the programmable current source and the time-to-digital converter (TDC). The multiplier is used in digital filtering for improved operation in noisy environments. A complete solution with a 33-Hz sampling of two buttons is only drawing 9  $\mu\text{A}$ . Much lower current consumption is possible if less noise immunity and slower sampling is acceptable for the application.

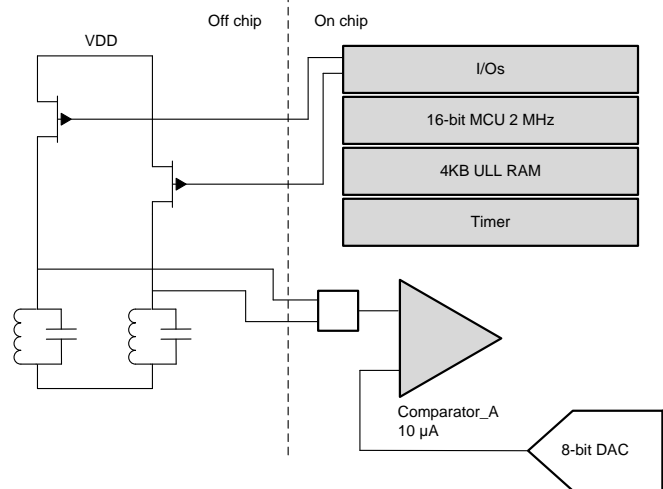


**Figure 3. Capacitive Touch Principle (Simplified)**

**Mechanical Flow Meter:** Electronic add-on modules for mechanical flow meters often use an inductive measurement principle to count rotations because it is a more tamper-proof than many other solutions. Such a system can also be implemented with the sensor controller using very low current consumption. [Figure 4](#) shows a block diagram for the solution. More information can be found in the [Low-Power Water Flow Measurement With Inductive Sensing Reference Design](#). Measurements on the CC13x2 and CC26x2 device platform show that a robust solution can be implemented with an average current consumption of 1.6  $\mu\text{A}$  for a 16-Hz sampling rate (including external circuitry).

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**Figure 4. Inductive Sensing Principle (Simplified)**

**Digital Sensors:** Today many sensors are implemented with a fully digital interface. The sensor controller is designed to handle digital sensors with very low power. For example, when using the serial peripheral interface (SPI), the sensor controller can read 18 bytes from a digital sensor with an average current consumption of 1.4  $\mu\text{A}$  for 20 reads per second and 3.0  $\mu\text{A}$  for 100 reads per second (excluding the sensor). The user can read and process data from a digital sensor in a very low power manner. This is very useful for applications that require fast response time and low power (for example: fall detector sensors, fitness trackers, and in general battery-powered sensors).

## 1 Related Documentation

- [Sensor Controller Studio product page](#)
- [SimpleLink™ Academy: Introduction to Sensor Controller training video](#)

### Application Reports:

- [Getting Started With the CC13xx and CC26xx Sensor Controller](#)
- [Integrating Sensor Controller Studio Examples Into ProjectZero](#)
- [Wireless Motion Detector With SimpleLink™ Sub-1 GHz Wireless MCU](#)

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
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