Jørgen Langfelt, Nick Smith, and Svein Vetti

TI TechNotes

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

TEXAS INSTRUMENTS

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.

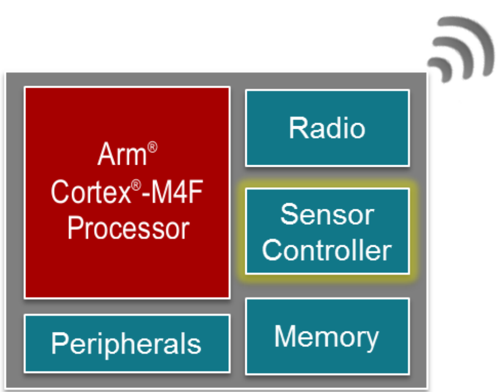

Figure 1. CC13x2 and CC26x2 Block Diagram

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.

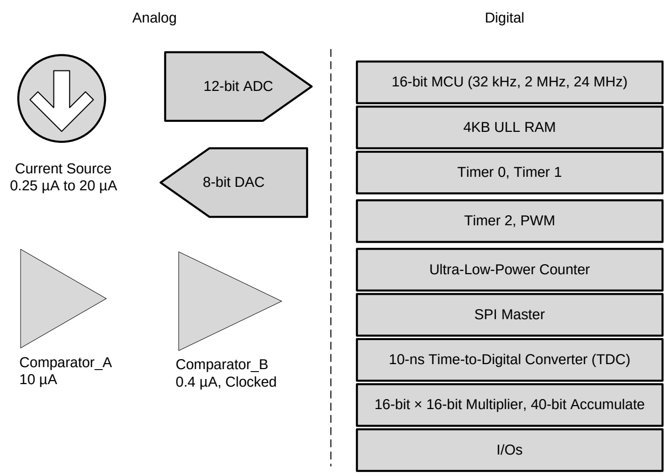

Figure 2. Sensor Controller Block Diagram

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 µA. Much lower current consumption is possible if less noise immunity and slower sampling is acceptable for the application.

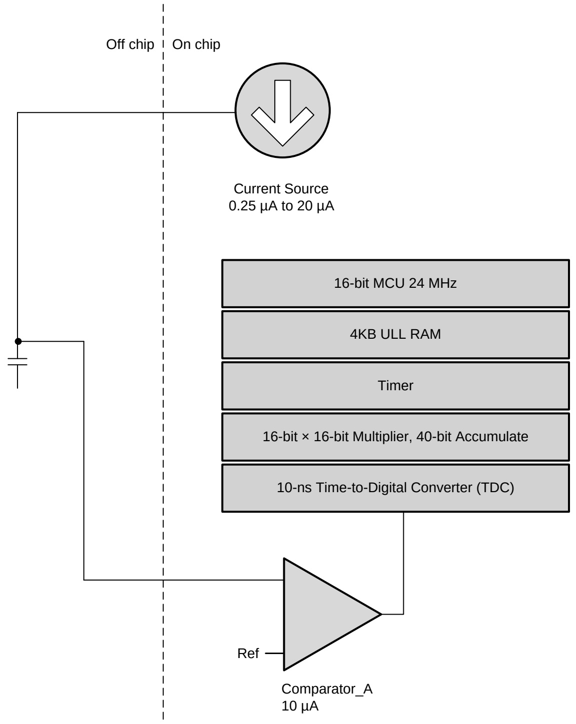

Figure 3. Capacitive Touch Principle (Simplified)

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 µA for a 16-Hz sampling rate (including external circuitry).

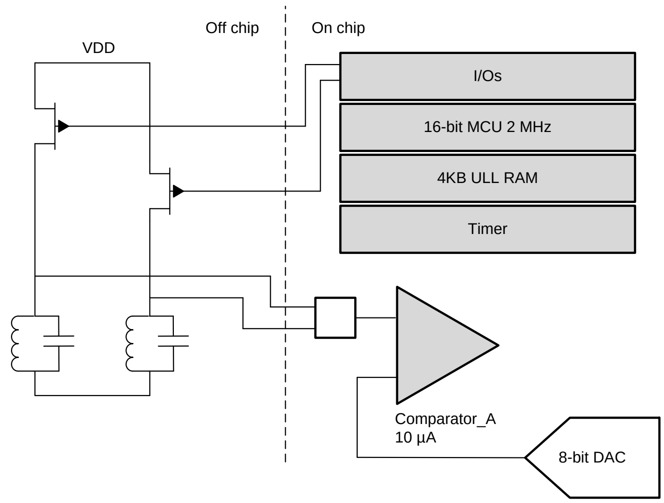

Figure 4. Inductive Sensing Principle (Simplified)

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 µA for 20 reads per second and 3.0 µA 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*

1.1 Trademarks

SimpleLink, Texas Instruments are trademarks of Texas Instruments.
Arm, Cortex are registered trademarks of Arm Limited (or its subsidiaries).
All other trademarks are the property of their respective owners.

IMPORTANT NOTICE FOR TI DESIGN INFORMATION AND RESOURCES

Texas Instruments Incorporated ('TI") technical, application or other design advice, services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using any particular TI Resource in any way, you (individually or, if you are acting on behalf of a company, your company) agree to use it solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources.

You understand and agree that you remain responsible for using your independent analysis, evaluation and judgment in designing your applications and that you have full and exclusive responsibility to assure the safety of your applications and compliance of your applications (and of all TI products used in or for your applications) with all applicable regulations, laws and other applicable requirements. You represent that, with respect to your applications, you have all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. You agree that prior to using or distributing any applications that include TI products, you will thoroughly test such applications and the functionality of such TI products as used in such applications. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

You are authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING TI RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY YOU AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

You agree to fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of your non-compliance with the terms and provisions of this Notice.

This Notice applies to TI Resources. Additional terms apply to the use and purchase of certain types of materials, TI products and services. These include; without limitation, TI's standard terms for semiconductor products http://www.ti.com/sc/docs/stdterms.htm), evaluation modules, and samples (http://www.ti.com/sc/docs/sampterms.htm).

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