Technical Article Designing Wireless Motion-detector Systems with Sub-1 GHz



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Widely deployed in households, commercial buildings and other facilities, motion detectors issue notifications when they sense the presence of people in designated areas. The detector shares these notifications through sound, light, or wired and wireless transmissions to other units like control panels, alarms or cloud applications.

Systems based on wireless motion detectors are easier to install and scale, since the hassle of wiring through walls is eliminated. Some typical sensing methods include passive infrared (PIR), ultrasonic emitter and microwave emitter. Installed indoors or outdoors and used mainly as intrusion-detection systems, wireless motion-detector systems commonly use Sub-1 GHz wireless technology because of its excellent radio-frequency (RF) performance, low power and low cost.

Designing with the SimpleLink Sub-1 GHz wireless MCU

As part of the SimpleLink[™] microcontroller (MCU) platform, TI's system-on-chip (SoC) Sub-1 GHz solutions (CC13x0 wireless MCUs) provide a low-power and peripheral-rich MCU with an integrated RF solution on a single chip. In a sensor system (as seen in Figure 1 below), the low-power wireless MCU operates as the main MCU for the system, either interfacing directly with the sensors or through an amplifier, filter or comparator. The CC1350 and CC1310 wireless MCUs also have Inter-Integrated Circuit (I²C), universal synchronous receiver/ transmitter (UART) or Serial Peripheral Interface (SPI) for controlling peripherals and a 12-bit analog-to-digital converter (ADC) for analog signal sampling.

By choosing a SoC wireless MCU instead of a chipset solution (a separate MCU and RF transceiver), you can achieve better integration, size and cost. The primary MCU is based on the ARM® Cortex®-M3 architecture, which contains enough flash and RAM for your application and protocols.





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Low power

Extremely low shutdown or standby current modes (0.185µA and 0.7µA, respectively), 51µA/MHz millioninstruction-per-second (MIPS) consumption, and receiver (5.4mA) and transmitter (13.4mA at 10dBm) currents establish the foundation for low-power design. Additionally, a novel low-power execution unit known as sensorcontroller module monitors sensors while the rest of the system (the main MCU) remains asleep. This enables the system to consume as little as 0.95µA with an ADC reading every second.

In a typical motion-detector system, the sensor controller monitors sensors continuously. As can be seen in the below figure, once triggered, the controller wakes up the main MCU, which then transmits a notification to a central unit.



Figure 2. Typical Use Case Profile

Software

The SimpleLink Sub-1 GHz CC13x0 software development kit (SDK) provides two easy options for RF communication. The first option is called Easylink, which is a proprietary RF interface using one of many supported modulations and a standards-based 802.15.4g stack for a star topology. With Easylink, you can use your own protocol and add motion detectors to existing wireless systems.. If you don't have a proprietary protocol the TI 15.4 stack is probably the better fit for you. Its standard access mechanism includes acknowledgment, security features and a frequency-hopping option – tools that can help you protect against RF jamming, cyberattacks and noisy environments. TI also provides an end-to-end sensor-to-cloud solution that enables two-way communication between the sensor nodes, and a cloud provider for monitoring and control.

Dual-mode systems

The CC1350 wireless MCU supports both Sub-1 GHz and *Bluetooth*® low energy connectivity. The addition of Bluetooth low energy connectivity opens up options for new and advanced applications. Bluetooth low energy technology adds a native user interface to the motion detector system (at minimal cost), so end users can communicate with each smart device directly to set configurations and pull information from throughout the system. Figure 3 illustrates a house with several motion detectors. These sensors are all forming a Sub-1 GHz network to connect to both each other and the alarm siren. But because these devices also have Bluetooth low energy connectivity, they are accessible with a smartphone or tablet.







System management using Bluetooth low energy

To set up this system, a phone or tablet connects to the motion detector via Bluetooth low energy and transmits network properties and security credentials for the Sub-1 GHz network. Once the network configuration is complete, the motion detector switches to Sub-1 GHz mode and connects to the Sub-1 GHz network. You can use the phone or tablet interface to configure many other aspects of the motion sensor such as detection modes, sensitivity, day-specific modes and more. You can also easily test the system by checking the network status on your phone without waiting for the alarm to sound.

Connecting to mobile applications via Bluetooth low energy also makes it easy to push software updates to any part of the system, keeping it up to date and bug-free. Just release an update, push it to your mobile app users and they will get a notification to upgrade their system.

Lastly, Bluetooth low energy supports the advertisement feature. With advertisement, the motion detector can transmit notifications to a nearby phone in a connectionless mode, pushing notifications like battery status or network issues to the end user automatically.

Resources

You can learn more in-depth information and use-case analysis for wireless motion detectors in a new application note: Wireless Motion Detector with Sub-1 GHz SimpleLink Wireless MCU.

To learn more about TI's Sub-1 GHz and dual band solutions, see these resources for additional information:

- Low Power Wireless PIR Motion Detector Reference Design Enabling 10 Year Coin Cell Battery Life.
- Sub-1 GHz Sensor to Cloud Industrial IoT Gateway Reference Design.
- "How to build a fully managed and scalable long-range network with low-power nodes."
- "Bringing wireless scalability to intelligent sensing applications."
- Software development kit with 15.4 and Easylink support.

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