Accsense Wireless Coexistence Document

Quick Product Facts

- Wireless Standard: IEEE 802.15.4
- Frequency Band: 2.4GHz Industrial, Scientific, and Medical
- Frequencies Used: 2405 MHz - 2480 MHz, 16x 3MHz Channels Spaced 5MHz
- Transmit Power: 0 dBm (0.79mW)

Introduction & Purpose

This document contains a summary of the wireless technology employed by Accsense solutions and issues surrounding its coexistence with other wireless systems, particularly WiFi.

Accsense understands that customers considering the installation of a wireless monitoring system may have concerns with implementing multiple wireless technologies in their facility. Will the Accsense system work properly considering an already crowded wireless spectrum? Will the Accsense system interfere with existing wireless infrastructure such as 802.11 WiFi, Building Automation Systems, or wireless telephones? The quick answer is, “No”, the system will not interfere. Accsense communication protocols were specifically designed to co-exist with other wireless systems without interference. This “good neighbor” policy is an integral part of an Accsense Fast & Easy system deployment.

General Technical Information

Accsense products utilize the unlicensed and internationally recognized 2.4GHz global Industrial, Scientific, and Medical band. This is the same band that is utilized by WiFi systems. However, whereas WiFi systems employ the IEEE 802.11 communications standard, Accsense employs the IEEE 802.15.4 communications standard, which is the same standard that has become popularized by Zigbee. Figure 1 illustrates how 802.11 (WiFi) and 802.15.4 (Accsense) co-exist on the 2.4GHz band.

Duty cycle

Because Accsense is transmitting a very small amount of data and doing so very infrequently, transmissions have an extremely low duty cycle. In typical installations the duty cycle of Accsense hardware is about 0.001%, equivalent to a 3ms transmission during each 5 minute interval. The rest of the time the radio is completely powered off and no interference can result. This transmission is synchronized to reduce interference (see CCA below).

Low Transmit Power

Accsense products have an extremely low transmit power of 0dBm, equivalent to 0.79mW. Emitting less power than a typical Bluetooth headset, and significantly less power than the average WiFi node (usually 100-200mW), Accsense equipment will always lose in a "shouting match," and the amount of electromagnetic radiation is low enough to have an insignificant impact on existing equipment, particularly when coupled with proper frequency spacing. However, as discussed below the Accsense protocol is very robust and can withstand high noise environments with intelligent, built-in retry algorithms.

Clear Channel Assessment

Accsense products incorporate a Clear Channel Assessment (CCA) mechanism which forces the pod to wait to send data until the frequency is determined to be clear. By employing such carrier energy detection, the possibility for interference and collisions is significantly reduced. When coupled with low transmission duty cycles (discussed below), low power, and proper frequency spacing CCA makes a small problem even smaller. If CCA mechanisms fail, and a packet is dropped retries exist.

Channel spacing

Channel spacing is the single most effective way to passively mitigate interference between any wireless products, including an Accsense system and WiFi. There are sixteen 802.15.4 channels to choose from each having a bandwidth of 3MHz and a spacing of 5MHz. Figure 1 illustrates that even in a typical WiFi deployment utilizing channels 1, 6, and 11, there are four remaining clear channels that Accsense products may utilize, which are 15, 20, 25, and 26.

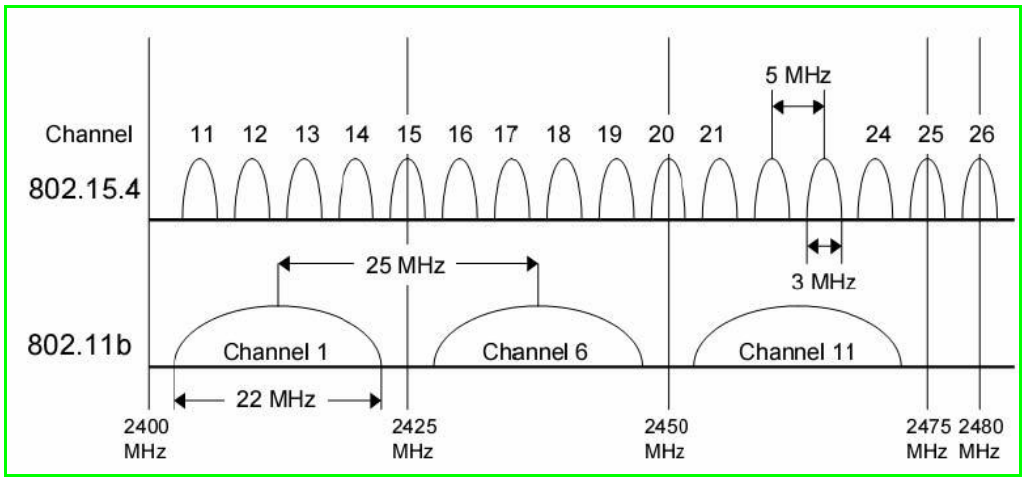

Figure 1→802.15.4 and 802.11 Frequency Comparisons

The first time an Accsense Gateway is powered on it will scan all available *channels and automatically detect and choose to use the one with the quietest* radio noise. Customers may verify the channel selected and re-assign the system to another channel using the supplied "Remote Gateway Configuration Utility."

Although the calculations are outside the scope of this document, the 802.15 Task Group 4 (designers of the IEEE 802.15.4 standard) simulated the importance of physical equipment spacing. With a 47+ MHz carrier offset the equipment must only be spaced apart by 0.8 meters to achieve frame error rates less than 10% WITHOUT the use of CCA algorithms (see below).

Modulation

Accsense products rely on a very robust modulation technique known as Phase-Shift Keying (PSK), instead of Frequency-Shift Keying (FSK) used in Bluetooth and other inexpensive two-way data solutions. 802.15.4's offset Quadrature-PSK offers extremely good low bit error rate (BER) performance at low Signal-to-Noise Ratios (SNR), especially valuable in noisy radio environments.

Figure 2 compares the performance of the 802.15.4 (depicted as Zigbee) **technique to Wi-Fi, Bluetooth, and other proprietary FSK modulation formats.**

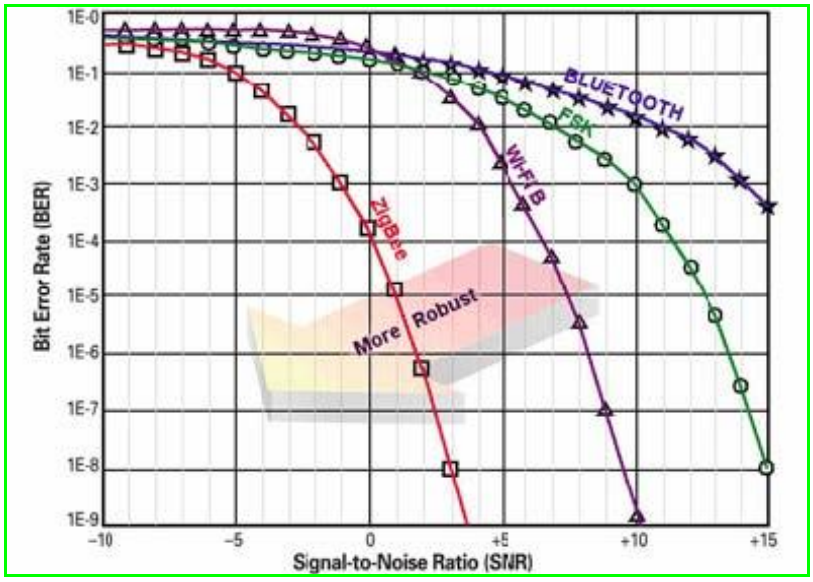

Figure 2→Modulation: ZigBee (PSK) More Robust than FSK

Conclusion

Accsense has systems deployed around the globe. Of all these systems, not a single customer ever reported interference trouble.

Proper frequency selection, the extremely low duty cycles, and transmit power coupled with the active coexistence CCA mechanisms and modulation make Accsense a "good neighbor" and allow it to thrive in high radio noise environments.

In addition to this document, the **Accsense Deployment Guide** is an excellent resource for trouble free deployment of Accsense wireless equipment.

Additional References

There are many valuable internet resources available discussing the coexistence of wireless networks including the following articles:

"Worry Free Wireless Networks" by Terry Hubler
http://www.us.sbt.siemens.com/bau/products/Wireless/HPACEprint.pdf

"IEEE Standard 802.15.4" by Jon Adams http://www.embedded-computing.com/departments/zigbee/fall_04/

Zigbee Alliance FAQ http://www.zigbee.org/en/about/faq.asp

Additionally, the book entitled "Wireless network Coexistence" by Robert Morrow and published by McGraw-Hill (ISBN 0-07-139915-1) contains a comprehensive and detailed look at the associated issues.