Using Sure Cross Wireless Products in a 802.11 (Wi-Fi) Environment

Will Banner's wireless systems work with your existing 802.11 (Wi-Fi) network? Yes, it will work exceptionally well.

History of the 2.4 GHz band

The 2.4 to 2.5 GHz frequency range was originally reserved internationally for devices that generate radio noise but are not radios. These devices included radio-frequency process heaters, microwave ovens, and medical diathermy machines. The powerful radio emissions of these devices can create electromagnetic interference and disrupt radio communication using the same frequency, limiting the devices to certain bands of frequencies. This band was named the industrial, scientific, and medical band, or ISM Band.

It is interesting to note that this band was originally set aside as a noisy area that communication devices should avoid. As communication technology has advanced, many methods have been developed to reliably communicate even with significant background noise. Many different noise tolerant networks are now in widespread use in the 2.4 GHz band. These include 802.11 (Wi-Fi), Bluetooth, and ZigBee, to name a few.

How do these networks work together?

It is surprising that different networks can share the same frequency and work together reliably. Today's wireless systems use very sophisticated communication technologies. Networks use multiple frequency channels, coding algorithms, timing, and signal transformation algorithms to provide reliable wireless connections even in noisy environments. In fact, common fault tolerant networks are based on military developments that resist jamming and interception. The exact details are complex, but radios now contain very good technology to sift out the signal from the noise.

Secondly, all products used in the 2.4 GHz band need to be certified. The certification process provides a level of assurance that the devices "play nice together." The certification places strict limits on transmission power, transmit duration, and communication methods used. In the US, certification is handled by the Federal Communications Commission (FCC). So, at the most basic level, all 2.4 GHz devices are designed to work together and reliably communicate in the presence of other devices.

A word of caution: simply saying all wireless products must have the FCC or local agency approval is a good foundation. Relying on agency approvals alone is sufficient for most commercial or residential applications. But in time-critical applications, it is important to look a little deeper at the details. Some 2.4 GHz products are bandwidth "hogs" while others consume almost nothing. In industry, it is important to consider the underlying details and choose the wireless technology that best fits the application.

All 2.4 GHz radios expect a noisy environment, so, they will automatically work well together.

To ensure a given level of bandwidth, range, and response time, it is critical to do some research and planning.

- Remove or isolate very noisy devices
- Use devices that use the shared frequency very efficiently.

Minimizing Interference

Which network technology minimizes the interference with existing wireless infrastructure? How much interference can we expect?

We first consider and analyze an 802.11b (Wi-Fi) based design. Then, we consider a Banner wireless system for the same application and compare the results. Minimizing bandwidth consumed has two main parts:

1. Minimizing the amount of time a radio is transmitting
2. Minimizing the power that is transmitted.

To start the analysis, some key characteristics of each network are given below:

	Banner's Wireless System	802.11b/g
Power	100 mW EIRP	100 mW EIRP
Range	1000 ft	50 to 200 ft
Sensitivity	–100 dB	–91 dBm, –74 dBm
Data Rate	250 Kbit/s	1 Mbit/s to 54 Mbit/s
Type	FHSS	DSSS, OFDM
Channels	27	13
Frequency	2.424 to 2.478 GHz, 2 MHz spacing	2.400 to 2.483 GHz, 22 MHz wide

This table provides insight to system performance. Banner's wireless systems have the advantage in receive sensitivity and range whereas 802.11 has a clear advantages in the data rate. From this you can expect 802.11 to perform better when transferring larger amounts of data over shorter distances. Banner's wireless systems will perform better with small amounts of data over large distances.

Network characteristics imply that Wi-Fi will work much better for high data throughput while Banner's wireless systems will have much greater range.

Typical Factory Application

To determine which system affects the existing 802.11 infrastructure the most, let's consider a hypothetical system of 20 control panels evenly placed in a 1000 foot radius from a central access point. This is typical of a large industrial facility application.

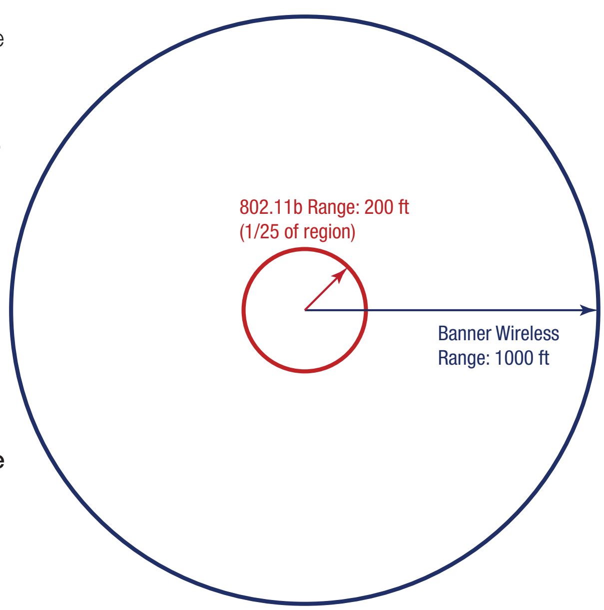
Range and Access Points

First, let's imagine how this would be physically arranged using both the Banner DX80 wireless system and using 802.11b. We selected 802.11b because it has the longest range of the commonly used Wi-Fi networks. The 802.11g network would not work because of the limited range of about 50 feet.

The Banner DX80 2.4 GHz wireless system has a range of 1000 feet inside a plant. The 802.11b system has a maximum range of about 200 feet in a plant. To cover a 1000 foot radius with Banner's wireless system requires only a single central access point (also called a Gateway).

For the 802.11b system, the 200 foot maximum range becomes problematic. The 20 control panels that need to be connected are more than 200 feet apart on average, making the Wi-Fi range insufficient for the application. The 802.11b system will require roughly 25 times more access point than the Banner wireless system. Installing a grid of 25 wireless access points comes with significant interference, cost, and installation issues.

Banner's wireless systems have five times the range as 802.11b and therefore requires 25 times fewer access points in large plants. This is a definite advantage for Banner wireless systems when covering larger areas.



Banner Engineering Corp. • Minneapolis, MN U.S.A
www.bannerengineering.com • Tel: 763.544.3164

Percentage of Time Transmitting

When determining how much bandwidth a particular system will consume, the first step is to consider what percent of time the system is transmitting. A radio can only interfere when it is transmitting.

First, determine how much time is consumed using 802.11b radios to exchange data. The 802.11b radio can send its data in about 0.3 ms. For this application, the radio needs to transmit twice a second, resulting in a total transmission time of 0.6 ms every second.

Fundamentally, the Banner wireless system operates very differently from a 802.11b radio. In the Banner wireless system there are two types of devices: a central point called a Gateway (similar to the access point in Wi-Fi) and remote points called Nodes.

The Banner wireless system operates by having the Gateway transmit for 0.9ms every second for every Node connected to the Gateway. In this example, there will be 20 messages, for 20 × 0.9 = 18 ms per second. The Nodes only respond with a message when their data changes value or every 16 seconds. This feature conserves a considerable amount of bandwidth. The Nodes are essentially silent by wirelessly transmitting only 0.9 ms every 16 seconds.

Device	Average Transmit time per second
802.11b (Wi-Fi)	0.6 ms
Banner Gateway	18 ms
Banner Node	0.056 ms

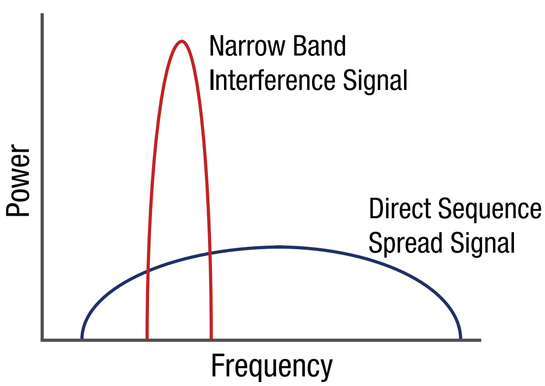
When using the Banner wireless system, the Nodes located in the 20 remote panels are almost silent, transmitting very infrequently.

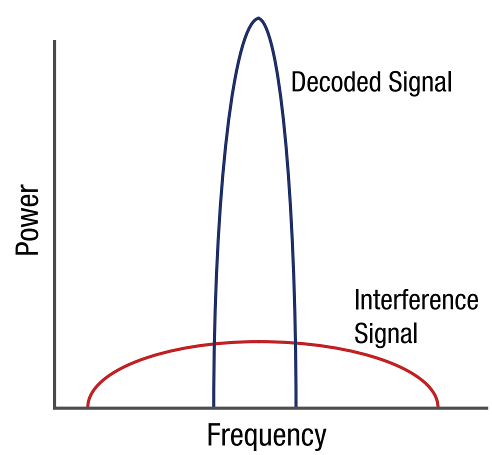
Signal to Noise Ratio

When considering how much the Banner wireless system interferes with the existing 802.11b infrastructure, it is important to understand how the two technologies interact. The 802.11b standard uses a 22 MHz wide Direct Sequence Spread Spectrum technology (DSSS). Banner's wireless system uses a narrow 2 MHz wide Frequency Hopping Spread Spectrum system.

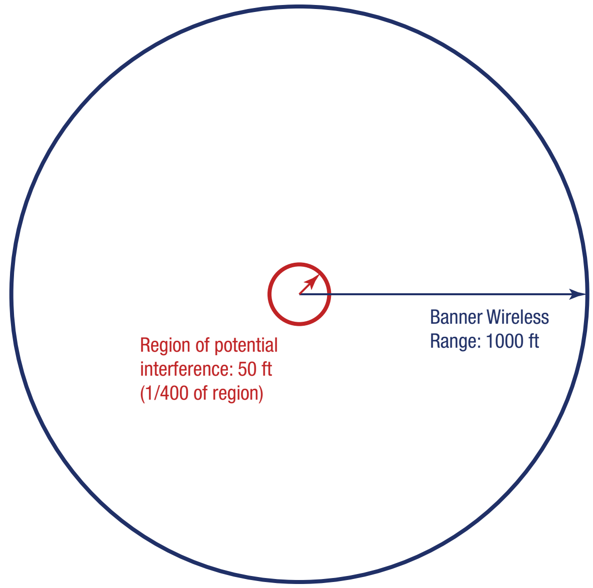
As the term "Spread Spectrum" implies, DSSS spreads its signal across a wide spectrum. This has two main effects: it allows the system to transfer greater amounts of data more quickly by using a larger frequency range, and it averages out any noise at a fixed frequency. This effectively reduces the apparent signal power seen from a collocated frequency hopping radio system.

These figures show how the DSSS 802.11b systems filter out noise from a narrow frequency. Because of the signal processing, the Banner wireless system appears 10 dB quieter than a 802.11b radio of the same power. This means that the Banner wireless system can only interfere with 802.11b systems up to about 50 feet. Beyond 50 feet, Banner's signal is simply too low to interfere with the 802.11b system.





Although the Banner access point (Gateway) can communicate with other Banner Nodes up to 1000 feet away, it cannot interfere at all with 802.11b devices more than 50 feet away.



Interference in Time and Region

As previously discussed, wireless devices interfere for a specific period of time and over a specific region. Now we will consider both aspects together. To determine the total bandwidth effect we need to take into account that the existing 802.11b infrastructure can operate in three non-overlapping channels. This increases total available bandwidth by a factor of three. Also, the Banner wireless system will interfere with a much smaller area because of its narrow band transmission that is very effectively filtered out by the existing DSSS 802.11b system.

Total bandwidth consumed by the 802.11b system is given by the average transmit time of 0.6ms per second in one of the three channels, or 0.02% of the total bandwidth. This interference exists over the entire 1000 foot radius area.

Total bandwidth consumed by the Banner wireless Gateway is given by an average transmit time of 18ms/second in one of three channels or 0.6% of the total bandwidth. This interference only exists over a 50 foot radius or 1/400 of the entire area.

Total bandwidth consumed by the Banner wireless remote Nodes is given by 0.9 ms per 16 seconds divided by three channels or 0.0019% of the total bandwidth. This interference exists in a 50 foot radius around each Node or 20/400 of the entire area.

If you multiply the affected area by the bandwidth consumption you have:

- Banner Wireless System: 1/400 × 0.6% + 20/400 × 0.0019% or 0.0016%
- 802.11b system: 0.02%

The 802.11b system consumes more than 10 times more bandwidth than the Banner wireless system.

The Banner wireless system can be installed within any existing 802.11b environment. The low data rates and narrow frequency band of the Banner wireless system make it almost silent to the existing 802.11b infrastructure. The long-range characteristics of the Banner wireless system offer significant advantages in system layout over 802.11b.

more sensors, more solutions

P/N b_3090135 Rev. A

Banner Engineering Corp., 9714 Tenth Ave. No., Minneapolis, MN USA 55441 • Phone: 763.544.3164 • www.bannerengineering.com • Email: sensors@bannerengineering.com