

VIP 110-24 Spread Spectrum Radio Co-Located Radios

INTRODUCTION

There are times when it is desirable to have more than one root or repeater radio sharing a single tower. However, without careful planning, it is possible to render all systems inoperable due to frequency cross over. This application note will discuss these issues and then give suggestions on mitigating interference.

BACKGROUND

It is assumed the user has a working knowledge of the VINE protocol and understands how to change the inbound and outbound channels of all RF systems. If the reader is not familiar with the VINE protocol, it is suggested that the VIP 110-24 manual be consulted for details on its operation. For information on interference issues specific to the VIP 110-24, consult Wi-LAN application note 139.

FREQUENCY PLANNING

The transmission of a spread spectrum radio using the 802.11b chipset follows a sinc/x pattern. This bandwidth is typically 20 to 25 MHz to the first null and 30 to 35 MHz to the first side lobes. For the VIP, the first node is 30 dB down from the peak value.

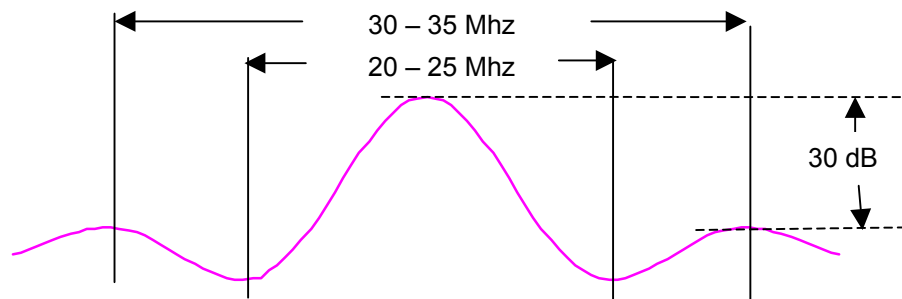


Figure 1

A typical 802.11b radio states that they can have three non-overlapping channels, or in other words, three channels that will not interfere with each other if placed in the same location. These channels are normally defined as channel 6 (2.412 GHz), channel 18 (2.437 GHz), and channel 31 (2.462 GHz) with frequency separation of 25 MHz each. The VIP has four non-overlapping channels in the ISM band being

defined as channel 5 (2.410 GHz), channel 15 (2.430 GHz), channel 25 (2.450 GHz), and channel 35 (2.470 GHz) with a frequency separation on 20 MHz. Note that since the VIP has a smaller transmit bandwidth, a VIP and an 802.11b system using the pre-defined non-overlapping channels will interfere with each other.

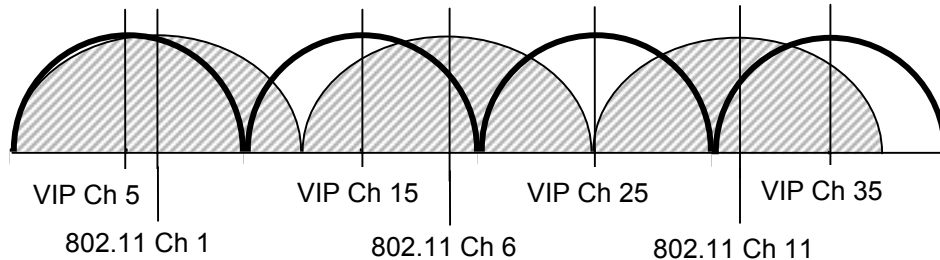


Fig 2

The default configuration of an 802.11b radio uses channel 1 as the initial transmit/receive frequency. If there is interference at that channel, then the radio will look at channel 6, then channel 11. The default channel plan for the VIP has the outbound channel set to 5 and the inbound channel set to 25. By observing figure 2, we can see that VIP channels 5 and 25 are within the transmit/receive bandwidth of all three default 802.11b channels. This means that if a user co-locates a VIP and 802.11b system using the default channel plan, they will cause interference with each other.

A simple fix to this is to use the VIP's capability to easily change the inbound and outbound channels. A possible solution is to send the following command to the root radio:

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Root> rf-nnp-2 enable=1
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and at the leaf send the command:

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Leaf> rf-from-parent channel=35
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What this will do is shift the VIP from using channel 5 to channel 35, giving you the following spectrum.

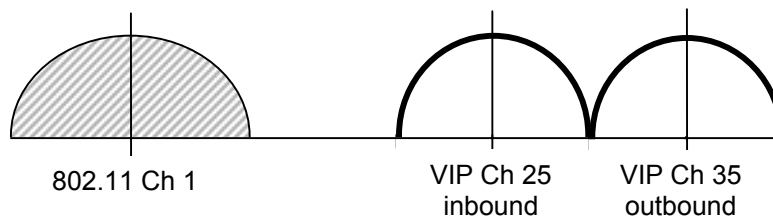


Fig. 3

Thus allowing you the maximum separation between two systems.

Does this mean that if you have sufficient frequency separation you can operate any combination of co-located systems? The answer is of course no. Other factors influence interference and frequency separation is just one aspect. The next section will discuss another source of potential interference.

VIP RADIO ARCHITECTURE

In order to understand this next section, a brief description of a typical ISM band receiver will be given, starting at the antenna:

1. First ISM band Filter - 100 MHz bandwidth, filters out signals outside the ISM band
- 2 Low Noise Amplifier (LNA) - this has moderate gain and amplifies all frequencies in the ISM band
3. Second ISM band Filter (same as 1 to further filter out of band signals)
4. Mixer – down converts the selected channel frequency to a fixed Intermediate Frequency (IF)
- 5 Channel filter - Bandwidth of around 17 MHz (for the 802.11b), filters out the adjacent channel signals.
6. Intermediate Frequency Amplifiers - Most of the receiver gain comes from this stage.

When radios are co-located, it is helpful to use widely separated frequencies. However, note that the transmit signal of one radio will pass directly through blocks 1 through 4 of the other radio's receiver. This undesired signal is finally filtered out when it reaches block 5. If the coupling between the two antennas is significant, this undesired signal is very strong and saturates either the Low Noise Amplifier or the Mixer. Once in saturation they distort all signals, including the desired receive signal. The radio will now make errors or not operate.

Note that the RSSI measurement measures only the desired signal, so even if the front end of the radio is in saturation you will not read this in the RSSI value. The VIP 110-24 can perform a spectrum analysis to find the signal strength of the undesired signal.

Designing the radio with LNA and mixers with high compression levels will help reduce the effect of the entire band passing through blocks 1 through 4. At installation time, the following techniques can also be used:

1. De-couple the antennas as much as possible. This can be achieved this by increasing physical separation (both vertical and horizontal), using a metal barrier, or

trying different polarizations (vertical and horizontal). In the near field (if the separation is only 2 or 3 meters) the polarization will not have a strong effect.

2. Reduce the transmit power level to the minimum required to reach the remote radio. For a point-to-point link increase the antenna gain as much as possible. This makes up for the lower power and decreases the coupling between antennas.

2. Use outside filters between the radio and the antenna that split the ISM band in the middle. Operate one radio at the lowest frequency channel and the other at the highest. If you are interested we could try to identify such filters for the 2.4 GHz ISM band.

CONCLUSION

Co-location of radio systems is possible when good RF design techniques are followed with appropriate frequency planning and antenna placement. By using the concepts above, any user can successfully deploy co-located systems while maintaining maximum performance.

If there are any questions in regard to this application note, contact your local sales distributor or Wi-LAN Technologies Inc.