

### Overview

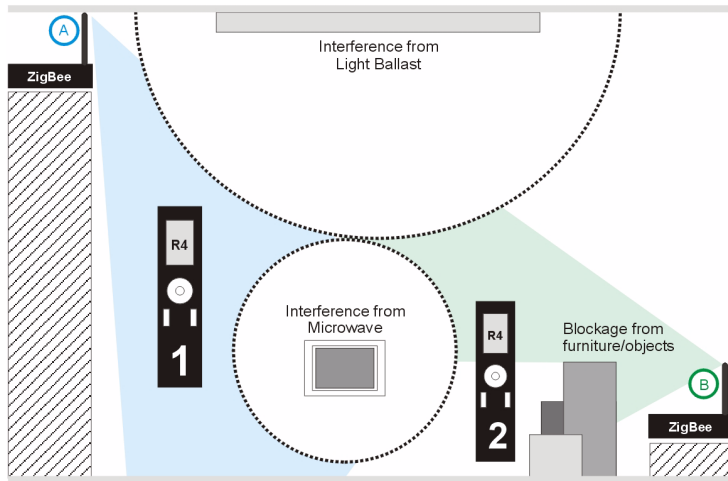
The ZigBee protocol provides a standards-based wireless network solution that is simple to develop and deploy, and affords robust security, high data reliability, and product interoperability. When properly deployed, a ZigBee network will provide "Wireless Control that Simply Works".

For a successful ZigBee installation, it is critical to understand that the ZigBee wireless protocol is influenced by the same environmental factors that affect other wireless systems. Interference from radio emitters, various electronic devices, and blockage due to solid objects may slow or stop communication between devices on the ZigBee network.

This paper is intended to assist with setting up a wireless network with the best possible communication between ZigBee devices (such as the Mio R-4) and ZigBee access points (APs) - ZXR-ZGW Gateways and ZXR-ZRP Repeaters.

As shown in FIG. 1 below, the Mio Modero® R-4 #1 (on the left) has clear access to the ZigBee Repeater "A" in the high elevation, but may have problems with connection to the Repeater "B" in the low elevation.

The R-4 #2 faces potential signal blockage from furniture in the way of the Repeater "B". The R-4 #2 will only send an unimpeded signal to Repeater "B" if it is elevated above the furniture.



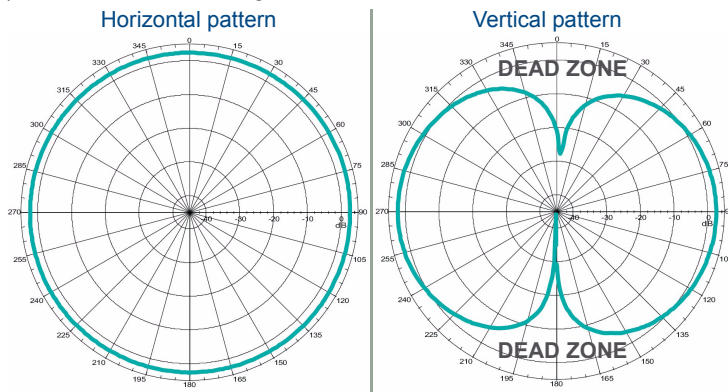
**FIG. 1** RECOMMENDED PLACEMENT OF ZIGBEE GATEWAYS/REPEATERS.

- Mio R-4 #1 may have problems with connection if the user moves closer to the microwave or the light ballast.
- Both Mio R-4s face interference when reaching a Repeater on the opposite side of the room due to microwave oven and light ballast in the center.

Although these are examples of sources of potential interference and signal blockage, the presence of these factors may or may not result in noticeable performance degradation. Environmental issues must be faced with every ZigBee network installation.

### Wireless Antenna Radiation Patterns

The antennas used for both the Gateways and Repeaters provide a uniform, 360-degree radiation pattern (FIG. 2). This radiation pattern should be taken into account when designing a ZigBee wireless network, in order to assure that a Gateway or Repeater in a particular location has coverage in both the vertical and horizontal axes.



**FIG. 2** WIRELESS ANTENNA RADIATION PATTERNS - HORIZONTAL AND VERTICAL POSITIONS

- The Horizontal pattern indicates the shape and range of coverage of the ZigBee signal, as it radiates from the antenna horizontally. Use this chart to understand what the area of coverage will be, around the ZigBee AP.

- The Vertical pattern indicates the shape and range of coverage of the ZigBee signal, as it radiates from the antenna vertically. Use this chart to understand what the area of coverage will be above and below the ZigBee AP. This chart is particularly useful in multi-story installations where you need an AP to span floors.
- Note that the Vertical pattern indicates two dead zones around the 0° and 180° positions.

*Note: The radiation patterns may vary slightly depending upon the channel being used.*

### Performing a Full Site Survey

For the best possible results, you should always start by performing a full site survey to fully understand the wireless network and RF environment in which your ZigBee network will operate.

#### Site Survey Tools

A site survey is typically performed using a laptop PC equipped with a wireless adapter card and mapping software. A laptop PC allows you to move around within the installation area to scan for access points and possible "dead spots" in the RF environment.

There are many free wireless network mapping software applications available, including "NetStumbler" and "Chanalyzer". These tools provide a visual overview of the local wireless network, and indicate the number of wireless access points in the area as well as the amount of wireless network traffic on any given RF channel or frequency. This is the most basic information that you'll need to optimize access point (AP) placement.

#### Performing the Site Survey

To perform an effective site survey for AMX ZigBee devices, consider placing ZigBee Gateways/Repeaters in various locations in the installation area that represent the overall area of the installation environment.

If possible, run the site survey with all other electronic devices in the general area (plasma screens, DVD players, microwave ovens, lighting ballasts, cordless phones, non-ZigBee access points, etc.) turned ON to determine possible interference when these devices are operating. Many of these devices may produce interference as far away as 10 feet (3.4 m) away during operation.

When performing the site survey, note the following:

- The number of wireless access points (WAPs) in the area, and the location of each.
- The signal strength for each WAP.
- The channels/frequencies that are already being used.
- Dead-spots in the area (weak or no RF signals detected)

This information enables you to determine the best placement and configuration of your ZigBee network:

- Avoid placing ZigBee Gateways/Repeaters in close proximity (< 5 feet / 1.52 m) to other WAPs.
- Avoid using heavily trafficked channels.
- Avoid dead spots created by interference, reflection or blockage.

#### Target RSSI and SNR values

Two key values presented by mapping software are RSSI (Received Signal Strength Indication) and SNR (Signal to Noise Ratio). The RSSI and SNR reported for each AP in the wireless network tell you how strong the signal from each AP is, usually updated in real-time.

As a general rule, good target values to have for reliable wireless connections used in a NetLinx control system are:

- An RSSI value between -55 and -78 dBm
- An SNR value greater than or equal to 18 dBm

*Note: "RSSI" and "SNR" are terms that technically are associated with the 802.11G wireless protocol (as opposed to ZigBee). However, most mapping software applications (including NetStumbler) use these terms generically across all protocols, including ZigBee.*

If the site survey indicates that your ZigBee devices are communicating outside of these guidelines, consider relocating one or more ZigBee APs to improve signal quality.

When installing a Gateway or Repeater, do not deviate from the site survey unless absolutely necessary.

If you have no choice but to install a Gateway or Repeater in a place other than the most optimal location, resurvey the site again and note any dead spots in the coverage area.

- Bluetooth-enabled devices, such as laptop computers and PDAs, may cause issues with performance if operating in close proximity to ZigBee Gateways or Repeaters. This issue is particularly severe if the ZigBee device is relatively distant from the ZigBee AP with which it is communicating.
- 2.4 GHz wireless telephones have also been noted to cause similar interference.

#### Site Survey Tools - More Information

Free mapping software applications (particularly NetStumbler) are supported via an extensive online community. There are many FAQs and user forums to help you get started. The better you understand these tools, the more successful your ZigBee installation is likely to be. Keep in mind that these tools are also valuable for troubleshooting wireless networks.

## Temperature and Humidity

When conducting the site survey, consider the maximum and minimum temperature and humidity under which the device(s) will function.

Installing ZigBee APs in areas subject to heat buildup in excess of specifications (for instance, in attics or eaves) is not recommended.

Materials tending to absorb moisture from the air (**wood, concrete, and heavy cardboard**, among others) may also tend to block wireless transmissions.

Test for signal blockage during particularly humid conditions if possible.

## Avoid Potential Sources of Signal Blockage

Don't place ZigBee Gateways or Repeaters behind metallized or metal-bracketed objects, such as mirrors, windows, or equipment racks. Check the wall and ceiling composition for possible range fall off.

### Materials That May Affect Signals

Metal, walls, and floors can affect wireless signals. The closer your Gateway or Repeater is to these obstructions, the more severe the potential for blockage and/or reflection becomes, very likely resulting in some degree of signal degradation.

*Note: The depth or thickness of the blocking material may also affect wireless connections.*

While not all-inclusive, a list of common construction and fabrication materials and their potential for adversely affecting wireless signals is provided in the following table:

<b>Low potential:</b>	Wood
	Plaster
	Synthetic materials (plastic, Lucite, fabric, composites)
	Glass (window or other clear glass)
<b>Medium potential:</b>	Water
	Brick or cinder block
	Marble or other soft stone
<b>High potential:</b>	Paper rolls and heavy corrugated cardboard
	Concrete
	Granite or other hard stone
	Bulletproof glass
	Mirrors and smoked or tinted glass
	Ferrous and nonferrous metal

For instance, installing a ZigBee Gateway within an equipment rack may produce a multipath signal as a result of signal reflections as well as blockage. Multipath signals result in poor connectivity and slower reaction times. For this reason, make sure to install the Gateway in as accessible a location as possible to prevent or at least minimize multipath signals.

## Place Gateways and Repeaters as High as Possible

All ZigBee APs should be placed as high as possible, according to the location that offers the greatest amount of coverage, within a room to guarantee maximum connectivity.

Placing a ZigBee AP close to the ground increases the likelihood of interference from furnishings, support structures, and other objects within an area.

ZigBee APs are best placed five feet (1.52 m) above the ground or floor for maximum coverage.

*Note: Locales containing large groups of people should have all ZigBee APs well above the average height of the people inside.*

## Don't Saturate the RF Environment

Too many Gateways and receivers, whether ZigBee or WiFi, are worse than not enough. Always be careful not to saturate the local RF environment.

## Don't Place Gateways and Repeaters Within 5' of Each Other

Don't put receivers of any type within five feet (1.52 m) of each other. This includes not only ZigBee Gateways and Repeaters, but also any other RF transmitting devices such as WiFi access points and wireless phone base stations.



FIG. 3 PROPER PLACEMENT OF ZIGBEE APS

## Proper Channel Selection

When reserving channels to be used for a particular ZigBee PAN ID, use ones that are not already in use by other ZigBee or WiFi devices. This includes specifying channels that may overlap channels already in use. For instance, if channel 21 is already taken for a WiFi network ID, try not to use channels 20 or 22 for a ZigBee PAN ID.

For best results, do not use the same channel for different ZigBee PANs.

## Don't Use Gateways as Repeaters

Since each wireless Gateway has a unique PAN ID, devices cannot roam between Gateways. If you need to extend coverage over a large area, always use Repeaters to expand that coverage.

Setting up multiple Gateways within an area will NOT expand a particular ZigBee network, even if the Gateways are all connected to the same master.

## Additional Sources of Information

- For more information on the ZigBee wireless protocol, please refer to the ZigBee Alliance site at [www.zigbee.org](http://www.zigbee.org).
- To download the latest (free) version of NetStumbler software for performing site surveys, go to [www.netstumbler.com](http://www.netstumbler.com). Additional information on using NetStumbler is available at NetStumbler.org Forums (<http://www.netstumbler.org/>).
- To download the latest (free) version of Chanalyzer spectrum analyzer software for performing site surveys, go to <http://www.metageek.net/products/chanalyzer>.