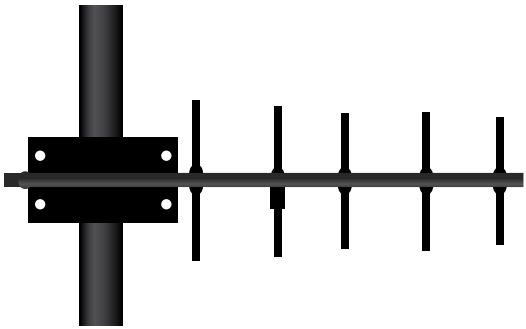
Wireless Antenna Installation Guide

10 Tips for Making Your Wireless Installation a Success



Making Wireless Easy

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Europe, Africa, Middle East
10 Westlink Commercial Park
Oranmore, Co. Galway, Ireland
Phone: +353.91.792444 • Fax: +353.91.792445
In the U.K. call +44.01926.851500
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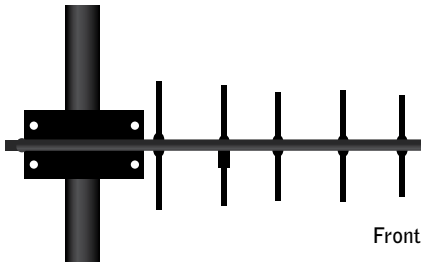
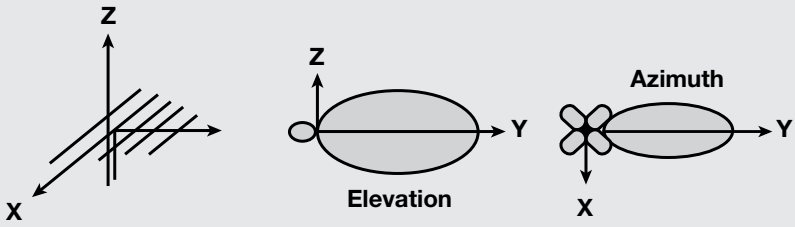
Yagi Antenna

A directional antenna. Focuses energy to one particular direction. In a point-to-point application, it is ideal to use Yagi antennas at both locations for extended range and better signal strength. Yagi antennas generate best results in point-to-multipoint applications when used with remote slave radios.



High Gain Yagi Antenna

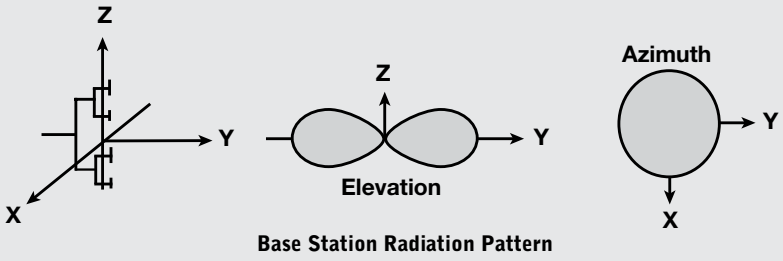


Yagi Radiating Pattern

Omni Antenna

Omni-directional antennas focus their energy equally in all directions. They typically have lesser range than a Yagi antenna of similar gain. Omni antennas are used in point-to-multipoint applications for the central master unit.

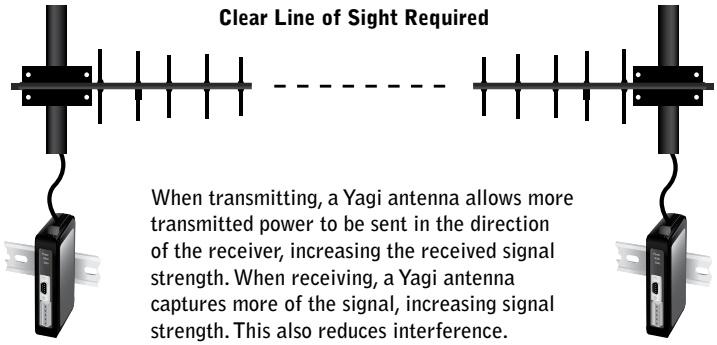
Omni-Directional Antenna



Base Station Radiation Pattern

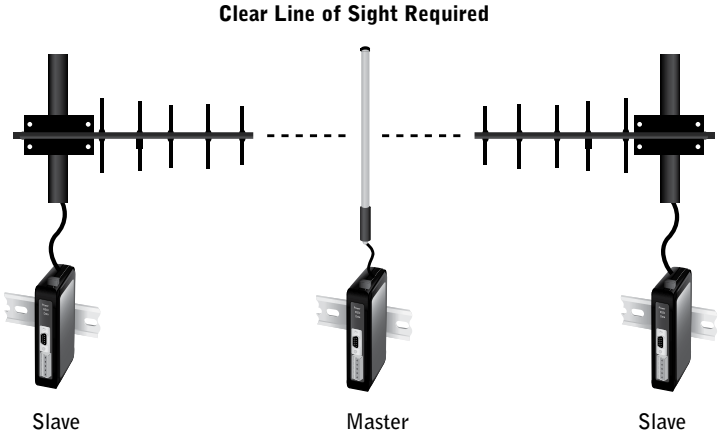
Point-to-Point

In this configuration, two radios will be talking to one another. Typical examples are serial-to-serial communication or peer-to-peer I/O wire replacement systems. Yagi antennas at both ends increase signal strength, range and reduce interference.



Point-to-Multipoint

In a multipoint system, an Omni antenna is typically used as the master with individual Yagi antennas as "slaves" pointing to the "master" antenna for the best range and signal strength. A typical example is Modbus I/O configuration with a Radio Modem connected to an RTU master with several I/O nodes as slaves.



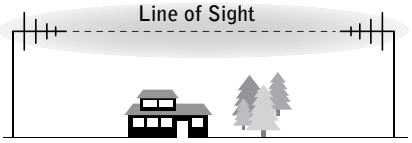
2 Wireless Antenna Installation Tips

RF Range is influenced by several factors. Proper consideration during installation will help enhance the signal strength and range ensuring reliable operation.

Tip 1 - Clear RF Path of Obstructions

Make sure the RF path is clear of obstructions. Antennas should be installed where they can "see" each other as much as possible. Make sure the antennas are high enough above any obstructions in the RF path.

CORRECT



WRONG

Obstructions in the lobe of the radio signal

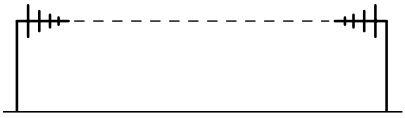
SUGGESTED HEIGHT CLEAR OF OBSTRUCTIONS

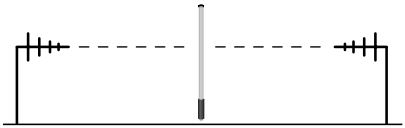
Range	2.4 GHz	900 MHz	868 MHz
1000 ft (300 m)	5.5 ft (1.7 m)	8 ft (2.5 m)	8.5 ft (2.6 m)
1 mi (1.6 km)	10.5 ft (3.2 m)	16 ft (5 m)	19.4 ft (5.9 m)
5 mi (8 km)	—	34 ft (10.5 m)	46.6 ft (14.2 m)
10 mi (16 km)	—	47.5 ft (14.5 m)	61 ft (18.6 m)

Tip 2 - Pay Attention to Antenna Alignment

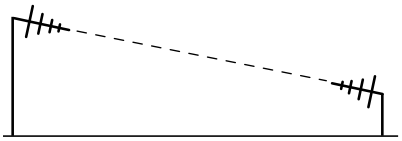
Make sure the antennas are aligned to center of the signal path and angle, and on the same level plane.

CORRECT

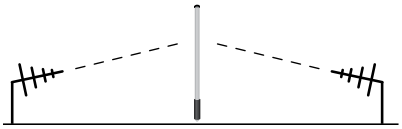




ACCEPTABLE

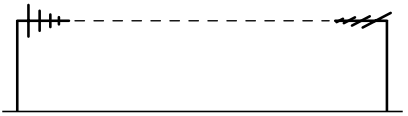


Antennas not on the same level plane

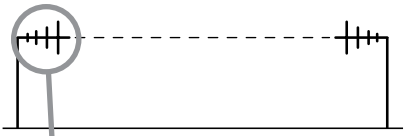


Antennas not on the same level plane

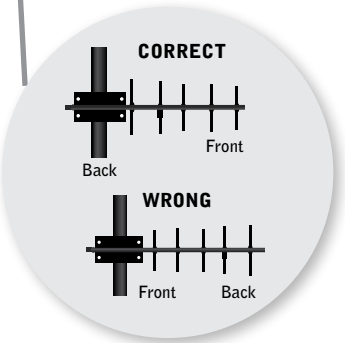
WRONG

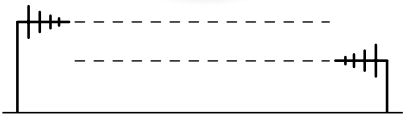


1 Parallel, 1 Perpendicular to the ground



Antennas are backwards





Antennas not aligned

Tip 3 - Know Your Overall System Gain Required to Meet the Distance

The more the distance between the radios, the more the overall system gain needs to be. A quick rule of thumb for the overall system gains vs. distance is as below:

Radio Frequency & Wattage	300 ft (100 m)	1000 ft (300 m)	1 mile (1.6 km)	5 miles (8 km)	10 miles (16 km)
2.4 GHz, 60mW	2.1 dB	>6 dB	>10 dB	—	—
900 MHz, 1W	2.1 dB	2.1 dB	>3 dB	>6 dB	>10 dB

Note: RF signal is lost across cables and connections. Refer to Tip 4 to know the impact of cable lengths and connections and how to select the antenna gain to compensate for the signal loss.

Tip 4 - Know Your Signal Losses and the Required Antenna Gain

Signal is lost across cables and connectors. The longer the antenna cable and the more the number of connections, the more the signal loss. A larger antenna gain is necessary to compensate for these losses and to meet the required distance. **As a rule of thumb, the RF range will be reduced by half for every 6 dB signal loss.**

The lost signal has to be compensated by choosing a proper antenna gain. B&B's 900 MHz Zlinx and Zlinx Xtreme radios come standard with a 3 dBi Omni antenna and the 2.4 GHz radios come with a 2.1 dBi gain Omni antenna. If more gain is necessary, choose a higher gain antenna depending on your system requirement.

The table below shows the signal loss across cables and connections.

SIGNAL LOSS ACROSS COMPONENTS

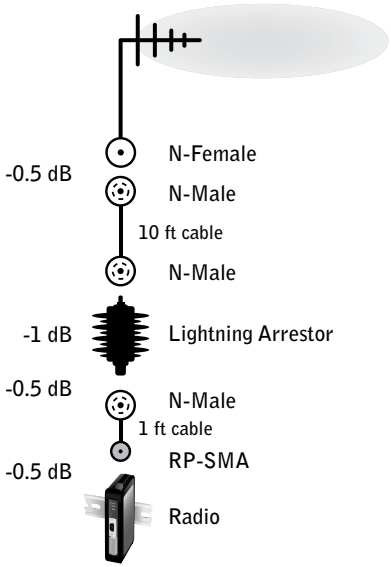
	Signal Loss	
	868/900 MHz	2.4 GHz
Antenna Cable (LMR400)	-3.9 dB/100 ft	-6.8 dB/100 ft
Connectors (RP-SMA/N-Type)	-0.5 dB	-0.5 dB
Lightning Arrestors	-1 dB	-1 dB

How Too Many Connectors Affect dB Loss

LOWER LOSS, LONGER RANGE

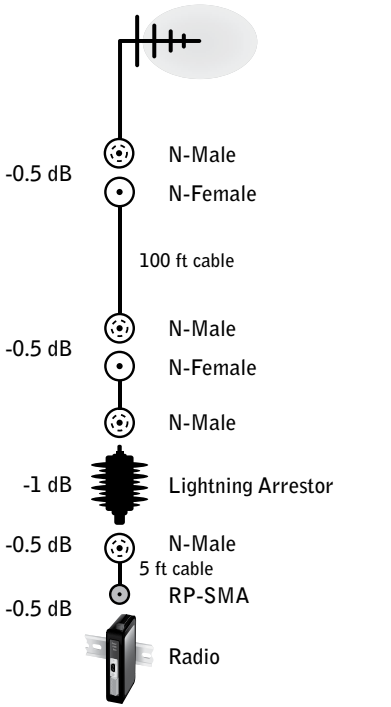
Total Signal Loss Calculation	
Connectors (3) =	-1.5 dB
Lightning Arrestor =	-1.0 dB
Cable (11 ft) =	-0.429 dB
Total =	**-2.929 dB**

Note: A Lightning Arrestor is strongly recommended for outdoor applications.



HIGHER LOSS, SHORTER RANGE

Total Signal Loss Calculation	
Connectors (4) =	-2.0 dB
Lightning Arrestor =	-1.0 dB
Cable (105 ft) =	-4.095 dB
Total =	**-7.095 dB**



Example Antenna Gain Calculation

For a 900 MHz, 1W radio to achieve a 5 mile distance: Overall gain required = >6 dB (see Tip 3).

Signal lost across a 11 ft antenna cable (LMR400) and a lightning arrestor = -2.929 (approximately -3 dB).

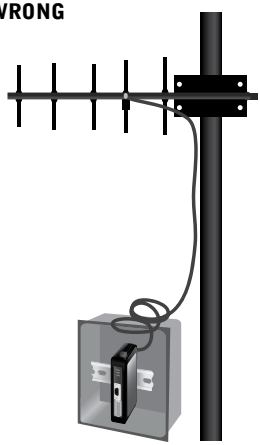
Antenna gain required = 6 dB + 3 dB = 9 dB

Tip 5 - Use the Minimum Cable Length Required

Use the minimum cable length required. Do not run more cable than needed.

CORRECT

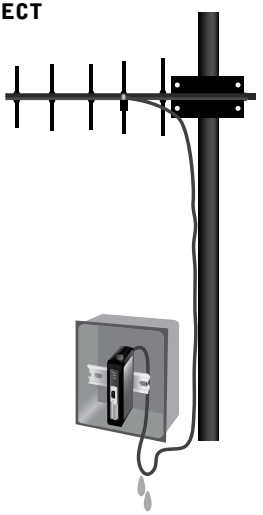
WRONG



Tip 6 - Do Not Wrap the Cables

Do not wrap or coil the cables around anything.

CORRECT



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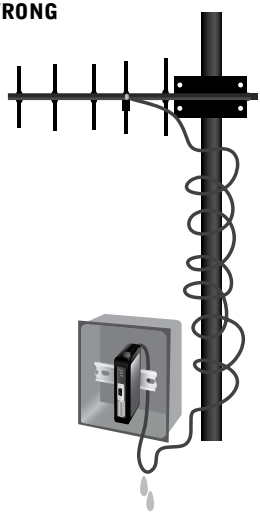
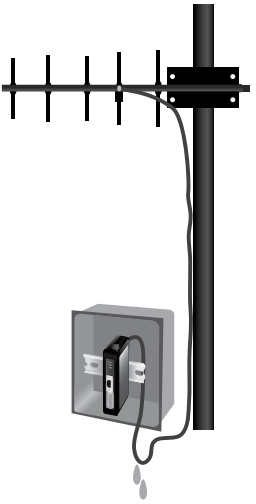


Tip 7 - Use Drip Loops

Use drip loops at the cabinet. This keeps moisture from collecting between the connection joints and in the cabinet itself. When using cabinets, bottom cable entry is recommended versus side entry. Never run the cable in through the top of your cabinet.

CORRECT



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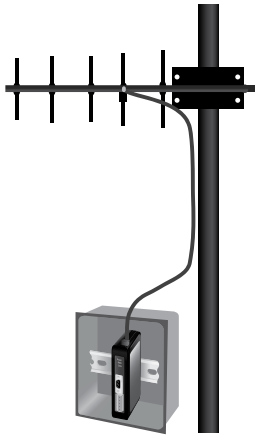

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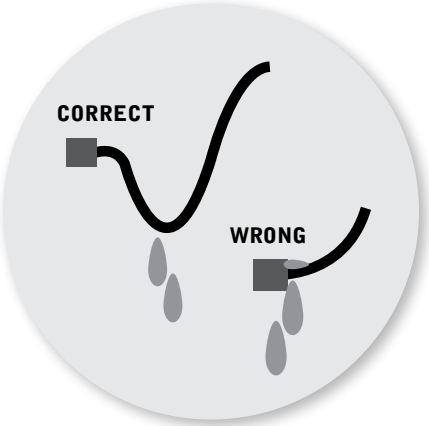
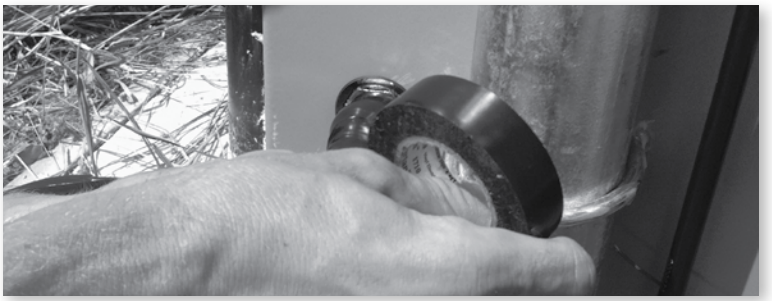


Tip 8 - Protect the Antenna Connection

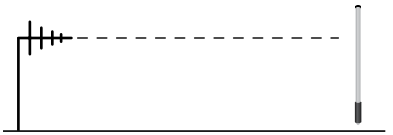
Protect the antenna connection with the correct vulcanizing rubberized tape.



Tip 9 - Correctly Phase the Yagi with Respect to the Omni Base Antenna

Make sure Yagis are phased (oriented) correctly with respect to the Omni base antenna.

CORRECT



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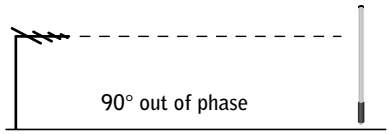
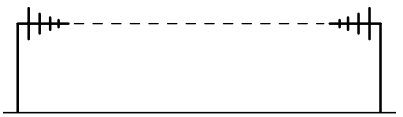


Tip 10 - Correctly Phase Yagis with Respect to Each Other

Make sure Yagis are phased (oriented) correctly with respect to each other.

CORRECT



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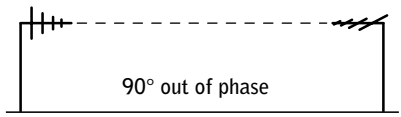

3 Additional Resources

RANGE VARIABLES AND THEIR IMPACT

Range Variable	RF Range Reducer	RF Range Enhancer
Transmitter Power	Less	More
Receiver Sensitivity	More	Less
Antenna Gain	Less	More
Antenna Cable Length	More	Less
Number of Connectors	More	Less
Physical Obstructions	More	Less
Radio Frequency Interference	More	Less
Data Rate	More	Less

The table below shows the maximum distance for different antenna and cable combinations at different terrains. Impact of weather is not factored in.

HOW WILL ENVIRONMENTAL CONDITIONS AFFECT MY ANTENNA CHOICE?

	2.4 GHz Models	868/900 MHz Models
Indoor: No line of sight, limited number of frame-construction walls, multiple reflective surfaces		
500 ft (150 m)	Supplied antenna	Supplied antenna
500-2600 ft (150-750 m)	—	Supplied antenna
Outdoor Unobstructed: Perfect RF conditions: Tower to Tower		
Up to 1.4 mi (2.25 km)	Supplied antenna (no cable)	Supplied antenna (no cable)
5 mi (8 km)	Omni (10 ft / 3 m cable) Yagi (20 ft / 6 m cable)	Supplied antenna (no cable)
7 mi (11.2 km)	Yagi (50 ft / 15 m cable)	Supplied antenna (no cable)
10 mi (16 km)	Yagi (20 ft / 6 m cable)	Supplied antenna (no cable)
14 mi (22.5 km)	—	Omni (50 ft / 15 m cable) Yagi (50 ft / 15 m cable)
40 mi (64 km)	—	Yagi (50 ft cable)
Outdoor Rural: Clear line of sight with elevated antennas and no obstructions		
Up to 2900 ft (870 m)	Supplied antenna (no cable)	Supplied antenna (no cable)
1 mi (1.6 km)	Omni (20 ft / 6 m cable) Yagi (50 ft / 15 m cable)	Supplied antenna (no cable)
1.5 mi (2.4 km)	Omni (10 ft / 3 m cable) Yagi (50 ft / 15 m cable)	Supplied antenna (no cable)
3 mi (4.8 km)	Yagi (20 ft / 6 m cable)	Supplied antenna (no cable)
7 mi (11.2 km)	—	Omni (10 ft / 3 m cable) Yagi (50 ft / 15 m cable)
10 mi (16 km)	—	Yagi (50 ft / 15 m cable)
20 mi (32 km)	—	Yagi (10 ft / 3 m cable)

TABLE CONTINUED FROM PAGE 12

	2.4 GHz Models	868/900 MHz Models
Outdoor Suburban: Line of sight but with some obstructions		
Up to 1100 ft (330 m)	Supplied antenna (no cable)	Supplied antenna (no cable)
2900 ft (870 m)	Omni (10 ft / 3 m cable)	Supplied antenna (no cable)
1 mi (1.6 km)	Yagi (20 ft / 6 m cable)	Supplied antenna (no cable)
1.5 mi (2.4 km)	—	Supplied antenna (no cable)
2 mi (3.2 km)	—	Omni (20 ft / 6 m cable) Yagi (50 ft / 15 m cable)
6 mi (9.6 km)	—	Yagi (10 ft / 6 m cable)
7 mi (11.2 km)	—	Yagi (2 ft / 0.6 m cable)
Outdoor Urban: No clear line of sight, multiple reflective surfaces		
Up to 500 ft (150 m)	Supplied antenna (no cable)	Supplied antenna (no cable)
2700 ft (810 m)	Omni (10 ft / 3 m cable) Yagi (10 ft / 3 m cable)	Supplied antenna (no cable)
3900 ft (1.2 km)	—	Supplied antenna (no cable)
1 mi (1.6 km)	—	Omni (10 ft / 3 m cable) Yagi (10 ft / 3 m cable)
2.5 mi (4 km)	—	Yagi (10 ft / 3 m cable)

Additional Online Resources

For more information, visit B&B Electronics Technical Library, Wireless section at www.bb-elec.com/techpapers.

- 10 Commandments of Wireless Communication
  www.bb-elec.com/10WirelessCommandments
- Wireless Range Estimator
  www.bb-elec.com/WirelessRangeEstimator
- Making Wireless Work: Antenna and Cable Selection
  www.bb-elec.com/Antennas

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International Headquarters
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Ottawa, IL 61350 USA
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www.bb-elec.com

Europe, Africa, Middle East
10 Westlink Commercial Park
Oranmore, Co. Galway, Ireland
Phone: +353.91.792444 • Fax: +353.91.792445
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