

## Introduction

When purchasing a CradlePoint router, the most difficult part is determining which antenna will meet your needs.

The Branch Market Segment and the IOT Market Segment come with Cellular antennas and WiFi antennas. Products ending in '50' do not have WiFi capabilities. So, the AER1650, the CBA850, the CBA550 and IBR650C routers do not come with WiFi antennas. In most cases, the antennas provided in the box will satisfy your needs. However, in circumstances where there is poor reception or a great deal of electromagnetic interference, an external antenna may be required. If this is so, follow along with the Mobile Market Segment.

The Mobil Market Segment does not come with any antennas and thus, you must determine which antenna will meet your needs. You can choose the CradlePoint Cellular antennas (paddle) and WiFi antennas similar to the ones provided in the Branch and IOT segment. But these antennas are not designed for vehicles and in most cases an external antenna will do a better job.

So, how do you determine which antenna will meet your needs.

## Leads

The first thing to determine is how many leads you need. The answer to this question depends on which router and modem you have purchased. You will need to determine how many cellular connections the modem has, how many WiFi connections the router has, and whether the router has GPS. Once you determine the # of leads, you will need to choose an antenna with the same number of leads. Obviously, if you don't intend to use GPS or you don't intend to use WiFi, then you can ignore those leads. Following is a table of CP mobile routers and the number of leads required:

### Mobile Segment

Model	Modem	LTE Connectors	WiFi Connectors	GPS Connector
IBR1700	600M	2	2 to 6	1
IBR1700	1200M-B	4	2 to 6	1
IBR900	All	2	2	1
	MA-MC400-1200M-B	4		1
	MC400-LP6	2		1

The IBR1700 has 6 WiFi connections with 3 radios. It isn't the most powerful WiFi as the E3000 series has WiFi 6. However, the 3 radios are a great asset. You can have 1 radio just for 5GHz, 1 radio for 2.4GHz/5GHz and 1 radio for WiFi as WAN or the ability to upload data to a central repository when returning to a depot. The configuration is controlled by a wizard. I have not tried, but I believe you can control how you want them set up, by configuring the parameters without the use of the wizard. There is an extensive (technical) explanation of how the radios work under the 1700 overview on this website. This explanation is theoretical as I have no confirmation from CradlePoint that this is exactly how the radios work. But, from a theoretical standpoint, it makes sense. So, if you intend to use the 1700,

# ANTENNA PRIMER

1200M-B CradlePoint using 2 WiFi radios, you would need 4 LTE leads, 4 WiFi leads and 1 GPS lead, or a 9-in-1 antenna (4+4+1). If you intend to use the 1700, 600M CradlePoint with 4 WiFi connections, you would need a 7-in-1 Antenna (2+4+1). The important part in choosing is to make sure you have an antenna with the correct number of LTE leads, the correct number of WiFi leads and the correct number of GPS leads.

The 900 is a different animal. In general, a 1200M-B modem requires 4 LTE leads. But the 900 only allows for 2 LTE leads. So, in general a 5-in 1 antenna will work for all configurations, 2 LTE, 2 WiFi and 1 GPS.

## **Branch Segment**

As previously stated, the Branch Segment comes with its own antennas. In general, these antennas will work and we always advise our users to try that configuration before expending money for another configuration. If there are problems with reception or transmission, then other options are necessary.

## **Branch Connectivity**

<b>Model</b>	<b>Modem</b>	<b>LTE Connectors</b>	<b>WiFi Connectors</b>	<b>GPS Connector</b>
E3000	All	4	4	1
E300	150M	2	Internal Antennas	1
E300	1200M-B	4	Internal Antennas	1
AER2200	1200M-B	4	2	1
AER2200	600M	2	2	1
AER1600	All	2	Internal Antennas	1
AER1650	All	2	0	1
	MC400LP6	2		1
	BF-MC400LP6	2		1
	BA-MC400-1200M-B	4		1

An E3000 configuration would require a 9-in-1 Antenna, 4 LTE, 4 WiFi and 1 GPS

# ANTENNA PRIMER

## LTE Adapters

Model	Modem	LTE Connectors	WiFi Connectors	GPS Connector
CBA850	1200M-B	4	0	1
CBA850	LP6	2	0	1
CBA550	All	2	0	0
	BB-MC400-1200M-B	4	0	1

The 850 LTE Adapter does not have an embedded modem. The LTE connectivity is provided by inserting an MC400 modem into the modem slot. The 1200M-B external modems would require 4 LTE leads and 1 GPS lead (there is no WiFi in the 850). The LP6 configuration would require 2 LTE leads and 1 GPS lead.

The 550 is not able to accept an MC400 modem.

The important thing to remember about using a CP router with 2 modems is that they require 2 separate antennas.

## IOT Market Segment

Model	Modem	LTE Connectors	WiFi Connectors	GPS Connectors
IBR900	All	2	2	1
IBR600C	All	2	2	1
IBR650C	All	2	0	1
IBR200	All	2	1	0

The IBR900 only has 2 LTE connectors. Even though the 900 with an embedded 1200M-B modem theoretically has 4 leads, only 2 LTE leads are used. So, for the most part, a 5-in-1 antenna will work as a solution for the IBR900 IOT router. The same applies for an IBR600C. A 5-in-1 antenna would be a potential solution. Since the IBR650C has no WiFi capabilities, a 3-in-1 antenna will work.

The IBR200 is a low end unit equipped with a CAT 1 modem, 10 Mbps download and 5 Mbps upload. It only has 1 WiFi Antenna and the GPS is muxed onto the aux LTE lead. For this solution, there are several alternatives. If you are not interested in WiFi, a 2-in-1 antenna with 2 LTE connectors would work. There is also a 3-in-1 antenna with 2 LTE leads and 1 WiFi Lead.

## Cable Length

In all cases, the cable length is important. You need to choose a cable length which does not have too much excess length. The cable length should be sufficient to connect the antenna to the CradlePoint unit without too much excess cable. The longer the cable the more signal attenuation will result. Thus, do not use a cable which is too long.

The typical cable length for an antenna is 5M (Panorama or TAOGLAS) or 15' (PARSEC). Shorter cable lengths are available. But this is typically a special order which takes additional time.

## Frequencies

In **5G** technology, two kinds of frequency bands are classified, those below 6 GHz and those above 6GHz. Frequencies below 6GHz are referred to as **Sub-6 GHz** bands. Frequencies above 6GHz are for future mobile communication and are referred to as mmWave bands. The **'Sub-6'** bands are very similar to 4G, where the frequencies transmitted from cell phone towers are below **6GHz**.

All of the 5G antennas certified by CradlePoint are able to handle all **'Sub-6'** frequencies used by CP routers. This includes the paddle LTE antennas and the dipole WiFi antennas provided by CP. The CradlePoint LTE and WiFi antennas which handle all of the **'Sub-6'** frequencies are:

## ANTENNA PRIMER

<b>LTE</b>	<b>Description</b>
170761-001	White, 600MHz-6GHz cellular 6" antenna with SMA connector (1x), used with CBA850-1200M-B
170801-000	Gray, 600MHz-6GHz cellular 6" antenna with SMA connector (1x), used with E300 and E3000 (all modems including MC400)
<b>WiFi</b>	<b>Description</b>
170836-000	Gray, Dual-band 2.4/5.0 GHz external WiFi antenna (single antenna), used with E3000

These antennas should be used in pairs. If you intend to replace/purchase antennas, they should all be the same. If you intend to purchase a single antenna which has been lost or broken, it is best to order the matching antenna.

CradlePoint recommends CradlePoint certified antennas manufactured by Panorama, Parsec or TAOGLAS. These antennas cover the full 'Sub 6' frequency range, 600MHz to 6000MHz. This is to future proof your installation. They work for all CradlePoint routers for all supported frequencies.

Prior to the certified 5G 'Sub-6' antennas, CradlePoint had certified antennas in the range of 600MHz to 3800MHz. These antennas are still available and will work for the CradlePoint routers which use modems certified for less than CAT 18.

# ANTENNA PRIMER

## Bands and their Frequencies

Band	To Tower (Upload)	From Tower (Download)	Duplex Mode	Carrier
2 (25)	1850-1910	1930-1990	FDD	Verizon, T-Mobile, ATT
4 (66)	1710-1755	2110-2155	FDD	Verizon, T-Mobile, ATT
5 (26)	824-849	869-894	FDD	Verizon, T-Mobile, ATT
12	698-716	728-746	FDD	T-Mobile, ATT
13	777-787	746-756	FDD	Verizon
14	788-798	758-768	FDD	ATT FirstNet
17	704-716	734-746	FDD	ATT
25	1850-1915	1930-1995	FDD	Sprint
26	814-849	859-894	FDD	Sprint
29		717-728	DownLink Only	ATT
30	2305-2315	2350-2360	FDD	ATT
41	2496-2690		TDD	Sprint
46	5150-5925		TDD	Verizon LAA
48	3550-3700		TDD	Verizon, T-Mobile, ATT
66	1710-1780	2110-2200	FDD	Verizon, T-Mobile, ATT
71	663-698	617-652	FDD	T-Mobile

All bands with 'FDD' Duplex Mode provide for Frequency Division Duplex. This means that transmit and receive can occur simultaneously on separate Transmit and Receive frequencies. 'TDD' means Time Division Duplex. This means that transmit and receive transmission occupies time slots. The data is divided into frames and the communication switches back and forth between transmit and receive. If you look at the chart, the TDD bands only have 1 set of frequencies which can be used to either transmit data to the tower or receive data from the tower.

So, when choosing an antenna, you will need to look at the bands supported in the CradlePoint modem/router for a given carrier. If your antenna handles those frequencies, you're good to go.

Again, CradlePoint recommends that you use the 5G certified Antennas to make sure your solution is future proof. However, when you are considering a lower end solution, you can choose one of the antennas that were previously certified.

## Lead Time

Perhaps the most frustrating issue is the issue of availability. The delay time is extraordinary and frustrating to TCI as the provider of antennas to our customers. CradlePoint has certified antennas from 3 manufacturers, TAOGLAS, Panorama and PARSEC. TAOGLAS headquarters is in Ireland with manufacturing facilities in China. Panorama headquarters is in England with manufacturing facilities in China. PARSEC is located in the United States with manufacturing facilities in the United States. All 3 companies have difficulty maintaining inventory. Delivery times can be very sporadic. And, to complicate matters, if you require a special order antenna, the lead time can be in the area of 6 weeks. The availability of the CradlePoint equipment is rarely a problem. The headquarters for CradlePoint is in Boise, Idaho and they generally have a good supply of equipment ready for immediate shipping. So, in general, when implementing a project, be prepared for longer than expected delivery of antennas.

## Summary

If you are unsure of which antenna you should choose, or you want confirmation that your choice will work for a specific application, please don't hesitate to call us. We're more than happy to assist you with the technical choice and will provide you with competitive pricing. Every customer, every order is important to us and we want to make sure all of your components for your project are suitable for your needs.