



# Antenna Reference Guide

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# Antenna Reference Guide

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## Introduction

This antenna reference guide provides best practices for selecting and installing antennas with Cradlepoint hardware, regulations for specific Cradlepoint products to ensure FCC compliance, and references to supporting resources.

## Best Practices for Selecting & Installing Antennas on Cradlepoint Hardware

Cradlepoint endpoints are unique in their form and function and therefore not all antennas will be the best fit for each device. Cradlepoint recommends considering the following as you determine which antenna(s) will best suite your needs.

### LTE, WiFi, and MIMO

LTE and WiFi are Multiple Input, Multiple Output (MIMO) technologies, which means that all LTE and WiFi antennas are sending and receiving data. For proper operation, all LTE and WiFi antenna ports on the Cradlepoint endpoint need an attached antenna.

Attaching only a portion of the LTE or WiFi antennas will impact the device's functionality, up to and including reduced throughput, signal drops, and instability. For example, attaching two antennas to a Cradlepoint endpoint with two LTE ports may provide 40 Mbps throughput while only attaching one antenna may provide 25 Mbps. The device modem will experience connectivity issues such as completely dropping the LTE signal for periods of time or dropping the signal as the modem is trying to cycle through available technologies (i.e. fallback to 3G), up to and including fully disconnecting.

For the 1200M modems (with four LTE antennas), we highly recommend all four LTE antennas be attached for the best performance. However, they can be used with only two antennas (either connected to main0/aux0 or main1/aux1) with reduced throughput, reduced band support, and the service connectivity is not guaranteed and is, therefore, not recommended.

### Cellular Reception

Without sufficient cellular reception, the router may behave as though there are no antennas attached. The following describe how reception may be impacted:

- A paddle (direct attach) antenna is attached to a router inside of a metal box (i.e. kiosk) with no cellular reception
- A paddle (direct attach) antenna is used inside a building behind metal walls and/or brick with no reception
- A long coax cable with insufficient shielding/rating is run too far from the router
  - Higher frequencies are more susceptible to signal loss when using longer cables
- The antenna does not support the frequency the device is trying to connect to
  - Most antennas made before 2H 2019 or 2020 do not provide adequate gain for LTE bands 71 (600Mhz), 48/CBRS (3.5GHz) and/or 46/LAA (5GHz)
  - NOTE: All of the antennas in the Cradlepoint Antenna Program are required to support all the frequencies of all our modems
- An antenna doesn't have proper separation from other radiation sources
  - Example: Antennas from 2 radios that are simultaneously transmitting and receiving are positioned too close to each other and are de-sensing
- Direct attach paddle antennas aren't positioned for optimal reception
  - Example: The antennas are laying on top of each other or not properly spaced
- An antenna has an insufficient ground plane to function properly
  - Example: Mobile antennas are meant to be mounted on top of a metal roof with a sufficient ground plane to function properly. If mounted on a non-metallic surface or on a metal surface that is too small, they may provide insufficient gain.

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- NOTE: Antenna spec sheets will call out if a ground plane is included or if needed and the minimum size.

Refer to <https://customer.cradlepoint.com/s/article/Modem-Signal-Strength-and-Signal-Quality> to determine if the signal strength is sufficient.

NOTE: Antenna types may be mixed and matched so long as they all have sufficient reception and do not exceed FCC regulations (i.e. remote/wired-out antennas for 2 LTE antenna ports on main/aux0 and GPS on the 1200M-B modem, and direct attached paddle antennas on main/aux1 of the 1200M-B modem and the WiFi RP-SMA ports of an AER2200). Refer to the FCC Regulations section of this guide for more information.

## Cables & Ports

The following are best practices for connecting antenna cables to the Cradlepoint ports:

- Ensure cable ends are connected to the correct ports.
- LTE and GPS ports use SMA connectors and WIFI ports use RP-SMA. Check cable ends to ensure they are the appropriate connection type for the port you're attaching them to.
- GPS/GNSS connectors can be either active or passive. An active antenna requires an active port with suitable ratings to work. A passive antenna may be used on a passive port and can often be used on an active port, as long as the antenna is not a DC short-circuit type (e.g., Loop and PIFA antennas are typically DC short circuit).
- Do not over-torque the SMA connector on the modem. Finger-tight is sufficient (maximum torque is 4 in-lbs).
- Plan cable runs to minimize signal loss.
- Coax cable has signal loss, especially for higher frequencies. For cable runs 15 feet or longer, use low loss LMR400. They generally connect using a larger, N-type connector, which requires a convertor to connect to the smaller SMA connectors on Cradlepoint endpoints.
- Use cable clamps or other cable-holding mechanisms to secure low-loss cables against a wall or pole.
- Use at least two clamps on the cable near the Cradlepoint endpoint. This construction helps reduce stress on the cable/modem connection and increases product reliability.
- Use lightning protection

## Positioning Antennas

To avoid signal loss, ensure the appropriate cables and direct attach antennas are connected to their applicable ports on the Cradlepoint endpoint.

### Antennas connected by cables:

Ensure the antennas are installed according to the manufacturer's installation requirements and that the power, gain, and other applicable signal settings are configured in compliance with the specifications dictated in the Antenna selection guide.

### Paddle and direct attach antennas:

Stagger the angles of the paddles so that they are not in alignment with each other. Use the antenna alignment tool with applicable endpoints. For positioning examples, refer to [How to Position 1200M Antennas](#).

## FCC Regulations

The FCC requires that antennas attached to Cradlepoint products meet certain standards. Using antennas not sold by Cradlepoint places the burden of confirming that the antenna meets FCC regulations on the customer. The following specifies the acceptable frequency ranges, antenna types, and gains to assist with identifying third party antennas to use with specific Cradlepoint products.

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## IBR1700-1200M-B Specific Regulations

Antennas connected to the MAIN and AUX ports on products that include 1200M-B modems must have a system gain (antenna gain minus cable loss) less than the following values:

Frequency	Maximum Gain
617-698 MHz	9 dBi
699-787 MHz	6 dBi
788-798 MHz	6.4 dBi
1710-1785 MHz	5.5 dBi
1850-1920 MHz	8.51 dBi
2000-2020 MHz	9 dBi
2300-2400 MHz*	1.08 dBi
2496-2690 MHz	5.5 dBi

*\*Operation in the 2300-2400 MHz band is allowed indoors only, and the antenna must be more than 50' from any roadway. If the antenna is installed outdoors, within 50' of any roadway, or if the antenna system gain is greater than 1.08 dBi in this band, the installer must disable LTE Band 30 in the Connection Manager>Modem properties>Modem tab.*

Antennas connected to the WiFi ports on IBR1700 series devices must have system gain (antenna gain minus cable loss) less than the following values:

Frequency	Dipole Antennas	Other Antennas
2402-2843.5 MHz	5 dBi	Not allowed
5150-5250 MHz	5 dBi	Not allowed
5250-5350 MHz	5 dBi	Not allowed
5475-5725 MHz	5 dBi	Not allowed
5725-5850 MHz	5 dBi	Not allowed

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## IBR1700-600M Specific Regulations

Antennas connected to the MAIN and AUX ports on products that include 600M modems must have a system gain (antenna gain minus cable loss) less than the following values:

Frequency	Maximum Gain
600-800 MHz	Cannot exceed FCC EIRP Limits
800-1000 MHz	Cannot exceed FCC EIRP Limits
1700-1800 MHz	Cannot exceed FCC EIRP Limits
1800-2000 MHz	Cannot exceed FCC EIRP Limits
2300-2400 MHz*	1.0 dBi
2500-2600 MHz	Cannot exceed FCC EIRP Limits

*\*Operation in the 2300-2400 MHz band is allowed indoors only, and the antenna must be more than 50' from any roadway. If the antenna is installed outdoors, within 50' of any roadway, or if the antenna system gain is greater than 1.08 dBi in this band, the installer must disable LTE Band 30 in the Connection Manager>Modem properties>Modem tab.*

Antennas connected to the WiFi ports on IBR1700 series devices must have system gain (antenna gain minus cable loss) less than the following values:

Frequency	Dipole Antennas	Other Antennas
2402-2843.5 MHz	5 dBi	Not allowed
5150-5250 MHz	5 dBi	Not allowed
5250-5350 MHz	5 dBi	Not allowed
5475-5725 MHz	5 dBi	Not allowed
5725-5850 MHz	5 dBi	Not allowed

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## IBR900-1200M-B Specific Regulations

Antennas connected to the MAIN and AUX ports on products that include 1200M-B modems must have a system gain (antenna gain minus cable loss) less than the following values:

Frequency	Maximum Gain
617-698 MHz	9 dBi
699-787 MHz	6 dBi
788-798 MHz	6.4 dBi
1710-1785 MHz	5.5 dBi
1850-1920 MHz	8.51 dBi
2000-2020 MHz	9 dBi
2300-2400 MHz*	1.08 dBi
2496-2690 MHz	5.5 dBi

*\*Operation in the 2300-2400 MHz band is allowed indoors only, and the antenna must be more than 50' from any roadway. If the antenna is installed outdoors, within 50' of any roadway, or if the antenna system gain is greater than 1.08 dBi in this band, the installer must disable LTE Band 30 in the Connection Manager>Modem properties>Modem tab.*

Antennas connected to the WiFi ports on IBR900 series devices must have system gain (antenna gain minus cable loss) less than the following values:

Frequency	Dipole Antennas	Monopole Antennas	PIFA antennas	Other Antennas
2402-2843.5 MHz	2.47 dBi	1.5 dBi	1.5 dBi	Not allowed
5150-5250 MHz	2.47 dBi	1.0 dBi	2 dBi	Not allowed
5250-5350 MHz	2.47 dBi	1.0 dBi	2 dBi	Not allowed
5475-5725 MHz	2.47 dBi	0.9 dBi	1.9 dBi	Not allowed
5725-5850 MHz	2.47 dBi	0.9 dBi	1.9 dBi	Not allowed

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## IBR900-600M Specific Regulations

Antennas connected to the MAIN and AUX ports on products that include 600M modems must have a system gain (antenna gain minus cable loss) less than the following values:

Frequency	Maximum Gain
600-800 MHz	Cannot exceed FCC EIRP Limits
800-1000 MHz	Cannot exceed FCC EIRP Limits
1700-1800 MHz	Cannot exceed FCC EIRP Limits
1800-2000 MHz	Cannot exceed FCC EIRP Limits
2300-2400 MHz*	1.0 dBi
2500-2600 MHz	Cannot exceed FCC EIRP Limits

*\*Operation in the 2300-2400 MHz band is allowed indoors only, and the antenna must be more than 50' from any roadway. If the antenna is installed outdoors, within 50' of any roadway, or if the antenna system gain is greater than 1.08 dBi in this band, the installer must disable LTE Band 30 in the Connection Manager>Modem properties>Modem tab.*

Antennas connected to the WiFi ports on IBR900 series devices must have system gain (antenna gain minus cable loss) less than the following values:

Frequency	Dipole Antennas	Monopole Antennas	PIFA antennas	Other Antennas
2402-2843.5 MHz	2.47 dBi	1.5 dBi	1.5 dBi	Not allowed
5150-5250 MHz	2.47 dBi	1.0 dBi	2 dBi	Not allowed
5250-5350 MHz	2.47 dBi	1.0 dBi	2 dBi	Not allowed
5475-5725 MHz	2.47 dBi	0.9 dBi	1.9 dBi	Not allowed
5725-5850 MHz	2.47 dBi	0.9 dBi	1.9 dBi	Not allowed

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## IBR600C-150M-D Specific Regulations

Antennas connected to the MAIN and AUX ports on products that include 150M-D modems must have a system gain (antenna gain minus cable loss) less than the following values:

Frequency	Maximum Gain
617-698 MHz	8.55 dBi
699-787 MHz	8.55 dBi
788-798 MHz	8.73 dBi
1710-1785 MHz	5 dBi
1850-1920 MHz	8 dBi
2000-2020 MHz	9 dBi
2300-2400 MHz*	1.08 dBi

*\*Operation in the 2300-2400 MHz band is allowed indoors only, and the antenna must be more than 50' from any roadway. If the antenna is installed outdoors, within 50' of any roadway, or if the antenna system gain is greater than 1.08 dBi in this band, the installer must disable LTE Band 30 in the Connection Manager>Modem properties>Modem tab.*

Antennas connected to the WiFi ports on IBR900 series devices must have system gain (antenna gain minus cable loss) less than the following values:

Frequency	Dipole Antennas	Monopole Antennas	PIFA antennas	Other Antennas
2402-2843.5 MHz	2.47 dBi	1.5 dBi	1.5 dBi	Not allowed

## IBR600B-LP4 Specific Regulations

Antennas connected to the MAIN and AUX ports on products that include LP4 modems must have a system gain (antenna gain minus cable loss) less than the following values:

Frequency	Maximum Gain
777-862 MHz	9.72 dBi
1710-1785 MHz	5.78 dBi
1850-1920 MHz	7.51 dBi

*\*Operation in the 2300-2400 MHz band is allowed indoors only, and the antenna must be more than 50' from any roadway. If the antenna is installed outdoors, within 50' of any roadway, or if the antenna system gain is greater than 1.08 dBi in this band, the installer must disable LTE Band 30 in the Connection Manager>Modem properties>Modem tab.*

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Antennas connected to the WiFi ports on IBR600B series devices must have system gain (antenna gain minus cable loss) less than the following values:

Frequency	Dipole Antennas	Other Antennas
2402-2843.5 MHz	5.0 dBi	Not allowed

## References

For additional information in identifying and purchasing antennas that work with Cradlepoint products and that meet FCC regulations, refer to any of the following vendors:

