

## How to select the right antenna for indoor 4G/LTE router

### Summary

This article shows how to select the right antenna type and parameter for BEC 4G/LTE indoor router. Choosing the right antenna is not as simple as picking a random high gain 4G antenna and expecting it to work! There are several types of antennas and connectors. Even the cable type and length can make a difference.

### Antenna Selection

Before you purchase the antenna, there are several things you need to consider:

1. **Connectors**

BEC 4G/LTE indoor router support SMA-male antenna connector type which shows in figure 1.



Figure 1. SMA-Male connector

2. **Cell towers maximum range**

Before purchasing any antenna, first check that 4G/LTE reception is possible with a router. For example, try operating the router outdoors or outside an upstairs window facing the cell tower. If a router fails to connect in 3G or 4G mode, an antenna will very unlikely help.

Cell towers determine the distance based on the signal round trip time between it and the user's equipment. Devices with round trip times over the configured threshold will be considered out of range, preventing a connection.

### 3. Frequency and gain

Different LTE band will come with different frequency. You could check it at: [http://niviuk.free.fr/lte\\_band.php](http://niviuk.free.fr/lte_band.php). Normally, the antenna will come with the spec which shows in figure 2.

A. Electrical Characteristics	
Frequency	700 ~ 960 MHz 1710 ~ 2700 MHz
S.W.R.	<= 2.0 @ 824 MHz <= 2.0 @ 1880 ~ 2300 MHz
Antenna Gain	0.5 ± 0.5dBi @ 700 ~ 960 MHz 2.0 ± 0.7dBi @ 1710 ~ 2700 MHz
Efficiency (%)	40 % @ 700 ~ 960 MHz 76% @ 1710 ~ 2700 MHz
Polarization Linear	
Impedance	50 Ohm
B. Material & Mechanical Characteristics	
Material of Radiator	Cu
Material of Plastic	BODY: ABS HINGE:ABS
Cable Type	RG-178U-03
Connector Type	SMA Male
C. Environmental	
Operation Temperature	- 40 °C ~ + 65 °C
Storage Temperature	- 40 °C ~ + 80 °C
Antenna Color Storage life	< 2 year

Figure 2. Antenna example spec

Also, you need to consider the antenna gain and efficiency. Higher gain and efficiency could get the better signal. With antenna manufacturers trying to outdo each other on marketing, a lot of antennas have false gain ratings. If a wideband antenna gain rating is over 15dB, it very likely is a false rating.

### 4. Cable loss

Depending on the antenna material and length, we need consider the cable loss before purchase the antenna. The high cable loss will make the signal worse.

Following formula/equation is used in this RF cable loss calculator:

Cable Loss (dB per 100ft) =

$$k1 \times \sqrt{F(\text{MHz})} + k2 \times F(\text{MHz}) + \text{CLF} \times \sqrt{F(\text{GHz})}$$

Where,

k1 = 0.11694 (for B7810A cable, depends on cable type)

k2 = 0.00036 (for B7810A cable, depends on cable type)

CLF = connector loss factor

{0.12 (St-to-St), 0.21(St-to-RA), 0.30(RA to RA) }

## 5. Single vs. MIMO

All antennas with two cable connections are MIMO antennas. With 4G MIMO, one antenna is polarized at a 90-degree angle to the other. This effectively doubles the bandwidth by transmitting on opposite polarities simultaneously within the same band. All BEC 4G/LTE indoor devices support MIMO.

## 6. Antenna Types

**Omni-directional dome antennas (Figure 3)** broadcast and receive signals from all sides. They are designed for central locations with 360° coverage. Like outdoor antennas, their power is measured by their “gain”. They need to be mounted to the ceiling for best results. They offer coverage across one floor and are not suitable for covering multiple floors.



Figure 3. Omni-directional dome antennas

**Panel antennas (Figure 4)** are directional antennas. Panel antennas allow optimum reception to targeted areas. Like with outdoor antennas, a directional antenna is stronger than an omnidirectional antenna which means the signals it broadcasts are stronger. It can be mounted to either the wall or ceiling. We usually recommend placing it on the ceiling for maximum coverage but in some spaces (like a long narrow hallway) the panel antenna can be placed on the wall.



**Figure 4. Panel antennas**

**Omnidirectional antennas (Figure 5)** receive and send signals in a 360° radius. They can receive signals from multiple cell towers and are best for boosting signal on many different carriers. They are excellent in most situations where the existing outside signal strength is moderate to strong. If the outside signal is weaker than that, you may need the directional yagi antenna instead. (We have a guide to testing your outside signal strength.) The power of an omni antenna is measured by its “gain”. Gain means the strength and reach of the antenna’s signal. An antenna with high gain will receive a more powerful signal from the cell phone towers. An omni antenna is a good choice if you have moderate to strong existing outside signal, and you want to boost signal across multiple carriers.



**Figure 5. Omnidirectional antennas**

**Yagi antennas (Figure 6)** are powerful directional antennas. A yagi antenna needs to be set up pointing in the direction of the cell tower, and because it is directional it will only pick up signal in that direction. Like an omni antenna, the power of the yagi antenna is measured by its “gain”. It’s very powerful at picking up weak signal in one direction, and we recommend it for situations where existing outside signal is weak, and you only want to boost coverage for one carrier (or if more than one carrier has a cell tower in that direction). If you need to boost signal coming from different directions, it is possible to set up more than one yagi antenna. The antennas would need to be placed at least 10ft apart and must not be pointing towards each other to avoid creating oscillation (feedback). The multiple antennas are then connected to the amplifier inside using a signal splitter. Contact us for more help with this.



**Figure 6. Yagi Antenna**

## Antenna Placement

Outdoor antenna should be placed as high up as possible, in the area receiving the best possible signal. A yagi directional antenna will need to be pointed in the direction of the nearest cell tower.

It is important that you are not in contact with the directional antenna when taking a signal strength reading. When you hold or touch an antenna with exposed metal surfaces, your body distorts the signal and interferes with the antenna's performance.

Contacting the antenna can produce inaccurate readings, which can lead to less than optimal yagi antenna positioning and reduced performance from your amplifier kit.

Outdoor antenna need to be very securely attached - they're going to be exposed to a lot of weather out there! They can be attached to a roof, a wall, or a pole. Most kits include attachments, and we sell a range of compatible mounting hardware if what you need isn't already included.

The indoor antenna should be placed facing the LTE tower or placed closing the window which faces the LTE tower.