

CEL-FI™ GO X MIMO

from WAVEFORM

Please Read This First

We know, reading manuals isn't always fun. But we promise it's worth it.

We've helped thousands of customers install the Cel-Fi GO X and boost their signal. We've compiled everything we've learned in this manual.

Give it a read before you start: it'll save you time and help you get the best performance out of your GO X MIMO setup.

Please note: Your two Cel-Fi GO Xs will come pre-programmed to boost Verizon signal.
You will need to change the carrier on both units using the Wave app if you are using a different provider.

About Waveform

The GO X MIMO Kit is manufactured by Cel-Fi, but developed and supported by Waveform and our team of Signal Specialists.

We've helped over 30,000 customers boost their signal since our company was founded in 2007. We've installed and configured thousands of devices in buildings across the country, and **we're here to help**. If you have any issues at all, please don't hesitate to reach out.



52 Maxwell,
Irvine, CA 92618



+1 (800) 761-3041



www.waveform.com
help@waveform.com

b. Signal Quality (SINR)

Signal quality is probably **the most important measure of your cell signal**. In 4G LTE networks, signal quality is called “SINR,” which stands for “Signal to Interference Plus Noise Ratio.”

In general, the better the signal quality, the faster your download speeds will be. Improving this measure can have a big impact on your system’s performance.

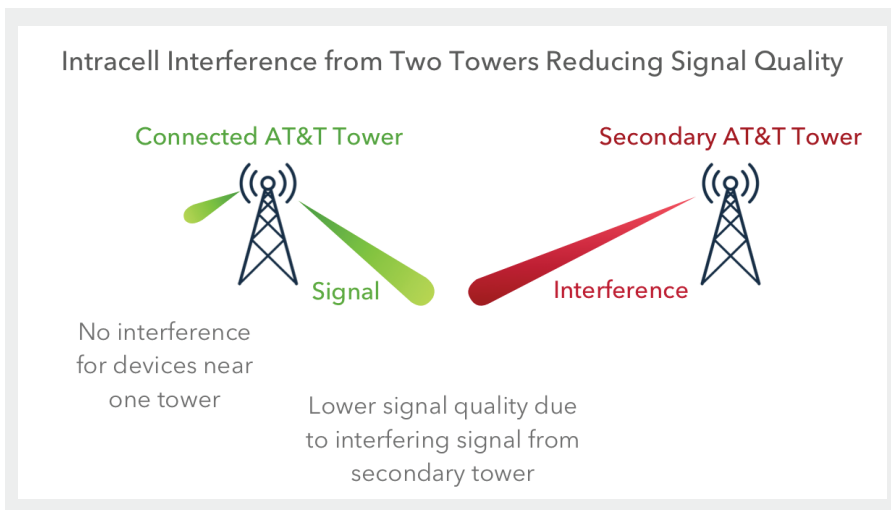
Why does signal quality drop? It's actually because **cell towers interfere with each other**.

Every cell tower transmits signal on the same set of bands.

If you’re located between multiple cell towers, your phone has a hard time clearly “hearing” the cell signal from the tower you’re connected to. This is called “**intracell interference**.”

A signal booster like the GO X won’t increase your signal quality directly. However, by shielding and aiming the directional outdoor antenna that’s included in your kit you can find higher quality signal, and the GO X's will amplify that signal and rebroadcast it indoors.

We’ll explain exactly how to position and aim your outdoor antenna later in this manual.

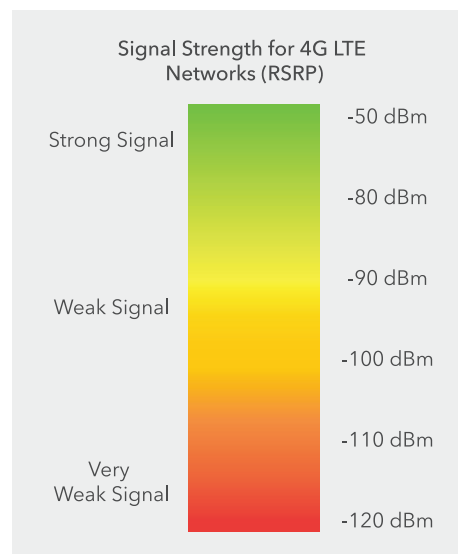


c. Signal Strength (RSRP)

The main measure of signal strength for LTE networks is called “RSRP.” Signal strength is measured in dBm and is always a negative number.

Signal boosters like the GO X amplify your signal so you have higher signal strength. The GO X has 100 decibels of gain (a measure of amplification). That means that it’ll cover **a larger area with stronger signal than most boosters**.

Stronger signal can help you get better data rates and a more reliable connection. But signal quality is critical as well.



03 Wave App and Carrier Selection

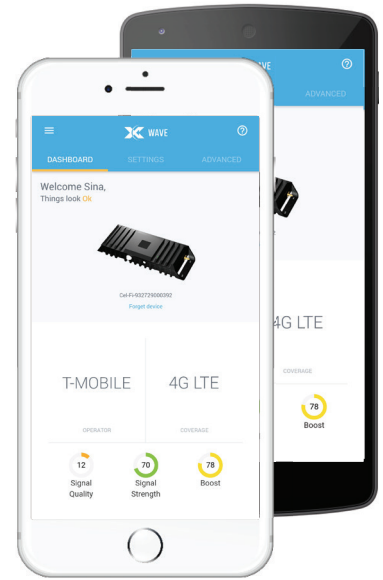
First, prior to installing any of the antennas or running any of the cables, each GO X needs to be set up in the Wave App.

It's important that both GO X's share the same settings. Any time you make a change to one GO X, make sure to mirror that to both.

1 Plug each GO X into a power outlet to power them on, don't connect any antennas just yet.

2 Download the Wave app at waveform.com/waveapp.

3 Open the app while keeping your phone within 4 feet of both GO X units to start pairing. This may take a few minutes. The app will say "searching" and then allow you to select a system to connect to. **Select either of the devices and hit "Connect"**.



To make switching between GO X's easier, **don't select "Remember this device"**. If you've remembered a GO X, hit "Forget device" on the homescreen to go back to device selection.

4 Your GO X's are preprogrammed to boost Verizon. To select a different carrier, go to "Settings" then "Operator". Changing carriers takes a few minutes - don't turn off your booster or move your phone away during the process. **For AT&T customers**, choose "AT&T LTE Preferred" to ensure that the GO X boosts as many LTE bands as possible.

5 Now connect to your second GO X by tapping "Connect to another system" on the dashboard, select the other serial number, and repeat step 4 to set the carrier. **Before switching**, it's helpful to memorize the last couple digits of the first GO X's serial number to help ensure you select the second GO X when reconnecting.

Please note: Only **one device** (your phone or tablet) can connect to **one Cel-Fi GO X** via Bluetooth at a time. But don't worry - every device in the building will see better cellular signal, the Wave app is only used to change settings and monitor the GO X's.

Troubleshooting Wave App Pairing:

- If the Wave app is unable to connect to one of your devices, try force-closing the app.
- If force-closing the app doesn't help, restart your phone and power cycle the GO X by unplugging the power adapter.

05 Positioning & Aiming the Outdoor Antenna

Finding the best location for the MIMO outdoor antenna is the **most important part of the install**. In this section, we explain the simplest method for positioning and aiming. Section 12 covers some more advanced information you can use to optimize your signal further.

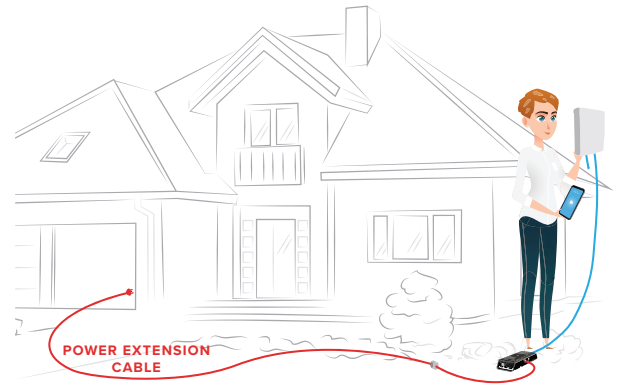
The Goal

Your aim is to find the best **location** and **direction** for the outdoor antenna that maximizes signal strength and in particular, signal quality, for the frequency bands available in your area.

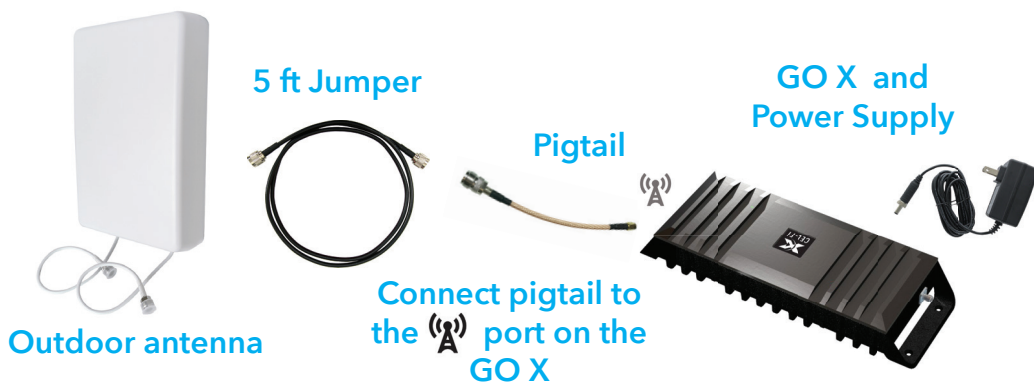
Set up one GO X as a Signal Meter

To keep things simple, you'll only use one of your GO X's for this step. Keep the other unit turned off.

If you have a long power extension cable, we recommend taking the GO X outside with you and using the 5 ft cable included in the kit to set up the GO X as "signal meter."



Here are all the parts you'll be using. It doesn't matter which port you use on the antenna:



Don't have a long power extension cable? Keep the GO X indoors near a power socket, and use the 30 ft twin coax cable included in the kit (in place of the 5 ft jumper) to take the outdoor antenna outside. The downside of this approach is that you won't easily be able to stay connected to the GO X via Bluetooth, so you may need a second person near the booster watching the Wave app as you test antenna positions.

Using the Antenna Position Test

The Wave app has a special “Antenna Position Test” that you can find under the “Settings” tab in the “Antenna Settings” dropdown.

Connect to the GO X you're testing with, and start the antenna position test. You'll want to test a few positions around your building.

With each location and direction you try, you can “Capture” results. Tests take about a minute each. Ideally, we want to find a location with a score of **115 or higher**.

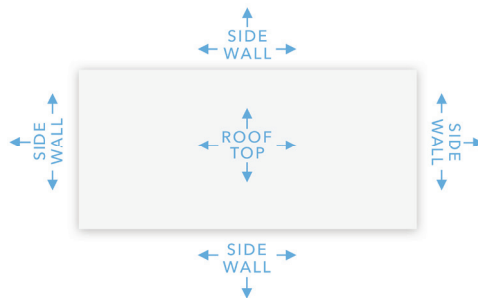
Feel free to **make additional notes of your test results in the table at the back of this manual.**

If you have very weak or low-quality signal outdoors, then it may be hard to get over 100 or even 90. It's okay if that's the case, just find the best score you can. Alternatively, you might find that the first location you try is over 115. That's great! It's still worth trying more locations to optimize for the very best signal.

Please note: Don't be surprised if your antenna position score goes down when you connect your internal antenna(s) later on. That is totally normal!

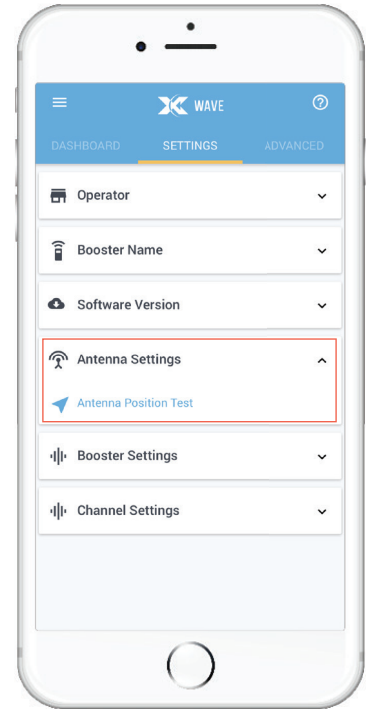
How to Position & Aim

Finding the right outdoor antenna location and direction takes some patience, but it's absolutely worth it and will have a big impact on your system's performance. Here are all the locations and directions we recommend testing your outdoor antenna:



Why **don't we recommend using the highest point on the roof?** It's simple: Signal strength is generally higher on the roof, signal quality is often better on the side of the building.

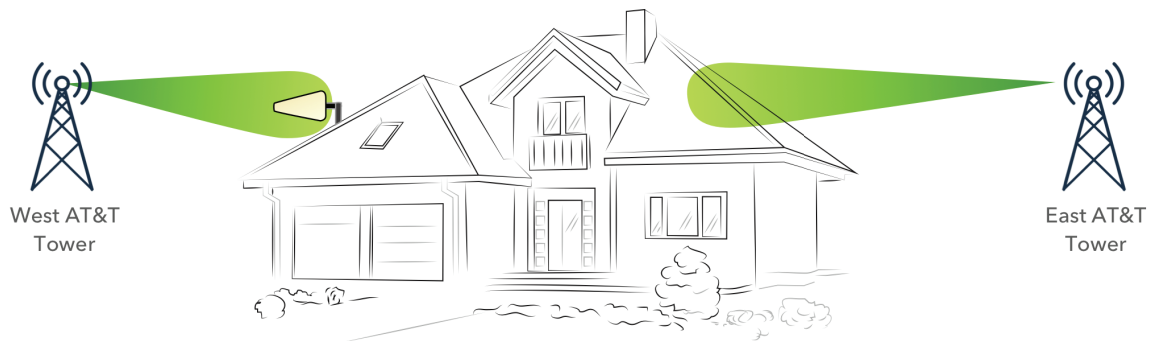
In section 2 of the manual (go back and read it if you haven't!) we explained that low signal quality happens because of “intra-cell interference.”



The best way to improve signal quality is to “shield” the outdoor antenna from any other towers in the area, by putting it on the side of the building.

When the signal quality outdoors is low, the goal is to shield the outdoor antenna to reduce the signal from other nearby towers:

For some people, the top of their roof (where signal is the strongest) provides the best signal. For others, it’s the side of the house. The only way to find which is best is to test.



06 Set up a Temporary Install

Once you’ve found the best outdoor antenna location according to the Antenna Position Test, it’s time to temporarily secure the outdoor antenna, connect the second GO X, and set up a “temporary install.”

The following 4 pages explain **mounting the indoor antennas, antenna separation, and how to assemble your GO X MIMO system.** Read them before you start.

We recommend securing the outdoor antenna temporarily, and running the twin coax cable indoors through a window or a door without drilling any holes. Now connect both of your GO X's and in turn connect them to the indoor antenna.

Once you’ve done that, you can test your coverage and data rates. If everything is looking good, you can move to a permanent install. More on this in section 10.

If you’re having issues with your temporary setup, or aren’t happy with the performance, simply **call us at (800) 761-3041 or email help@waveform.com.** We’ll be happy to help assist - we can often suggest an easy solution to the most common problems.

07 Indoor Antennas: Types & Placement

Before choosing a location for your indoor antennas, you'll need to understand how your indoor antennas broadcast signal. Depending on which kit you purchased, you'll have either dome or panel antennas included in the box.

Panel Antennas

A panel antenna has a narrower "spray" (technically called a "beamwidth"). This means that it directs signal in one direction, and *not* in a circle, like a dome antenna. Panel antennas should be installed on a wall near the perimeter of the coverage area for best results. For example, you might use a panel at the end of the hallway or at one end of your house.



Dome Antennas

Dome antennas should be installed in the ceiling, centrally to the area you are looking to cover. Some (but less) signal will also radiate upwards to cover the floor above. You'll need to have access to an attic or crawl space to run the cable.

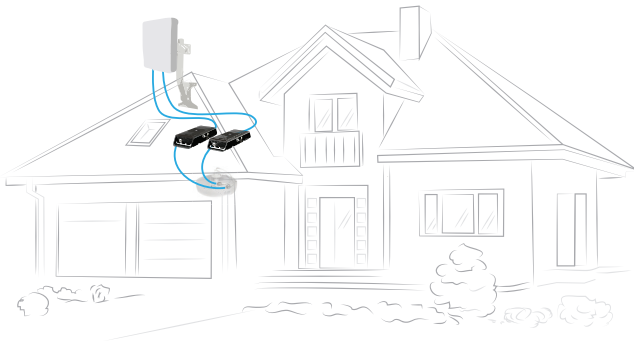


08 Indoor Antennas: Separation

Antenna separation is critical to installing your indoor antennas.

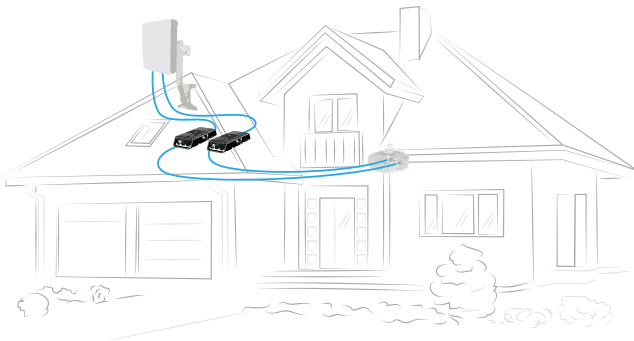
If you don't have enough separation, the Cel-Fi GO X boosters will throttle their gain (amplification) to avoid "oscillation." Oscillation is a type of feedback that occurs if the gain of the system is higher than the "RF separation" between the indoor and outdoor antennas.

You can improve your separation by moving your indoor antenna. Keep your outdoor antenna in the location with the best signal. **If you have more than one indoor antenna, the total separation is determined by whichever antenna is closest the outdoor antenna.**



Example of Poor Separation

- ✗ Not enough vertical and/or horizontal separation between outdoor and indoor antenna.
- ✗ Not enough building materials between indoor and outdoor antenna.



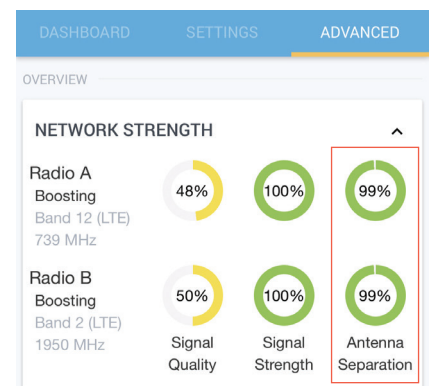
Example of Good Separation

- ✓ Plenty of vertical and/or horizontal separation.
- ✓ Outdoor antenna pointing away from indoor antenna.
- ✓ Multiple layers of building materials between antennas.

How to Tell If You Have Enough Separation

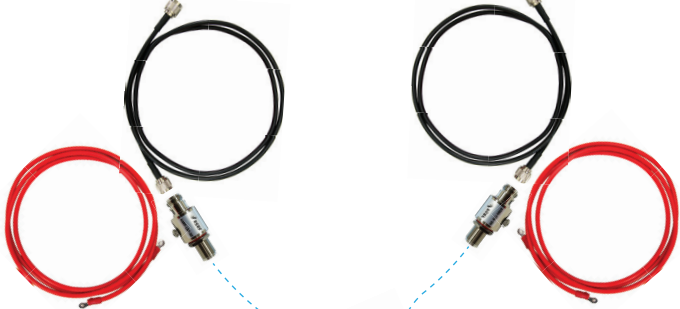
The Wave app shows a percentage score for separation on both the Dashboard and Advanced tabs.

Ideally, we want a score of 80% or higher for each "boosting" band, on both boosters. In small buildings that might not be possible - just do the best you can.





Outdoor MIMO Panel Antenna & Mount



2x Lightning Surge Protector Kits

Includes 5 ft jumper cable and 5 ft red grounding cable.

Should ideally be installed outdoors, just before cable enters the building.

Connect Lightning Surge Protectors to the building's ground with 10 AWG or higher grounding cable.



30 ft Twin RS240 Cable

2x Cel-Fi GO X

Can be installed indoors or outdoors, provided a power outlet is available.

2x AC Power Adapter



Towards the Indoor SMA to N-type Pigtail Adapters

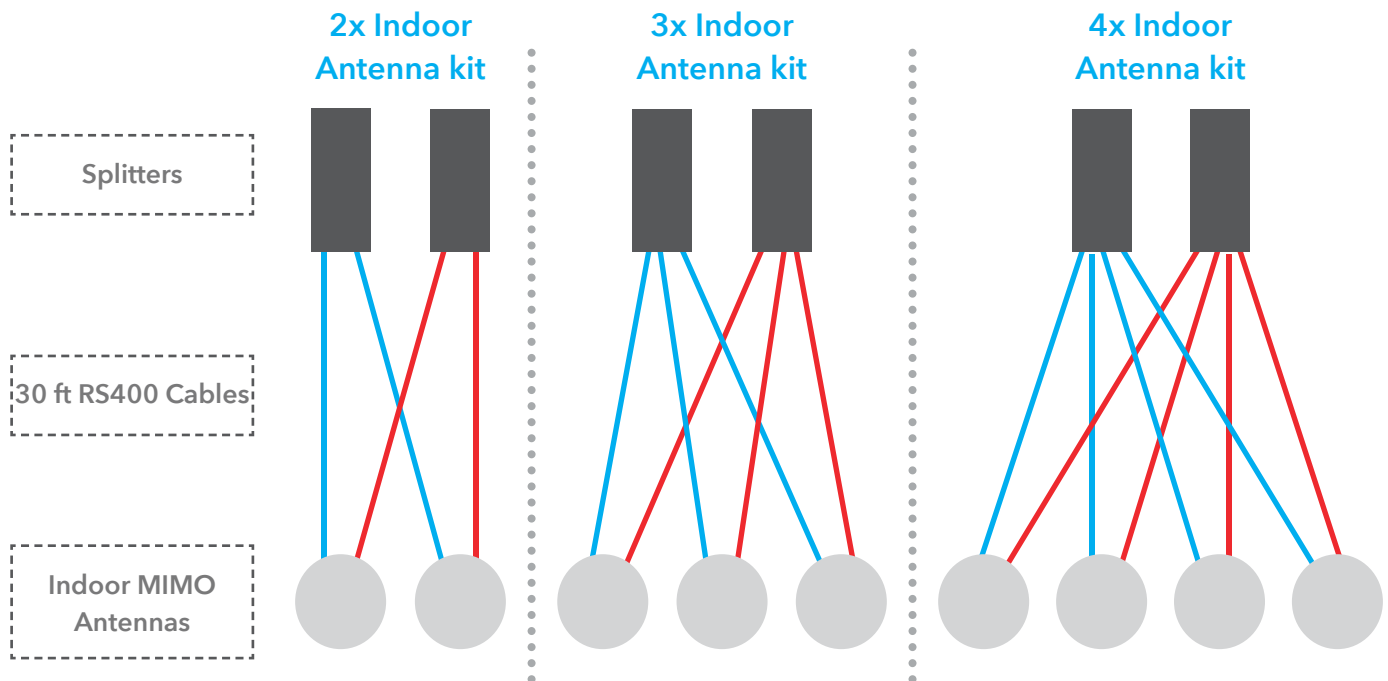
10 Assembling the "Indoor" Side of Your Kit

Assembling the "Indoor" Components

Refer to the diagram to the right as needed



- 5 Connect a SMA to N-Type Male Pigtail Adapter to the 📶 port of each of GO X booster and hand-tighten the connection.
- 6 For kits with 1x indoor antenna, connect the 30 ft RS400 cables to each pigtail adapter. For kits with 2x, 3x, or 4x indoor antennas, use the 1 ft jumpers to connect a splitter to each pigtail adapter, then connect the 30 ft RS400 cables to these splitters.
- 7 For kit with 1x indoor antenna, connect the two 30 ft RS400 cables directly into the indoor antenna and hand-tighten the connectors. For kits with 2x, 3x, or 4x indoor antennas, connect the 30 ft RS400 cables for each splitter into a different indoor antenna and hand-tighten the connectors, *as shown in the diagram below:*



Tip: Use Painter's/Masking Tape to label the RS400 cables as "GO X #1" and "GO X #2" to keep track of which RS400 cables go to each Cel-Fi GO X.



Towards the Outdoor
30 ft Twin RS240 Cable

2x SMA to N-type Pigtail Adapters

2x Cel-Fi GO X
 Can be installed indoors or outdoors, provided a power outlet is available.

2x AC Power Adapter

1 ft RS200 Jumper
 Only included in kits with 2x, 3x, or 4x indoor antennas.

2x Splitter
 Only included in kits with 2x, 3x, or 4x indoor antennas. Type depends on the kit you purchased.

30 ft RS400 Cable
 Two per indoor antenna. Quantity depends on the kit you purchased.

Indoor MIMO Dome or Panel Antennas
 Type & Quantity depends on the kit you purchased.

Tip: Make sure that the two cable paths for each indoor antenna connect to a different Cel-Fi GO X amplifier. If an indoor antenna has both cables paths connected to same Cel-Fi GO X, it will not broadcast a MIMO cell signal.

12 Optional: Test Band Combinations

In many areas, the GO X will only find a single band to boost. You can see this under the Advanced tab: one of the GO X's radios will say *Boosting* and the other will remain *Scanning*. If that's the case, there's only a single band available for the GO X's to amplify.

However, in some areas, your GO X amps may find two bands. If that's the case, you may be able to optimize your data rates by manually testing different bands. Just **make sure you set both GO X's to the exact same band combinations**, or else you won't get a MIMO signal.

Here are the steps we recommend following:

1. Discover all available bands

There may actually be more than 2 bands available outdoors. The GO X's will attempt to boost the best two available, but sometimes data rates may be better on other bands. If you manually disable the first two bands that the GO X has selected, you can force both GO X's to scan and show you what other bands are available.

2. Test each band individually, then together

When your phone detects multiple bands, it will attempt to "carrier aggregate" and connect on multiple bands simultaneously. Unfortunately, carrier aggregation isn't perfect - sometimes it works well, but in other cases, it can actually decrease your data rates.

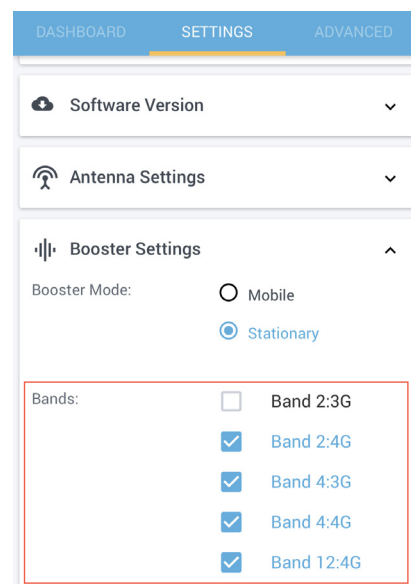
To get the absolutely best data rates, you can try running speed tests with both GO X's amplifying each band individually, and then testing different combinations of bands. **Refer back to section 2d for more guidance on different bands. Make notes of your test results in the table at the back of this manual.**

How to disable and enable bands

You can disable and enable bands under the "Booster Settings" dropdown in the settings tab of the Wave app.

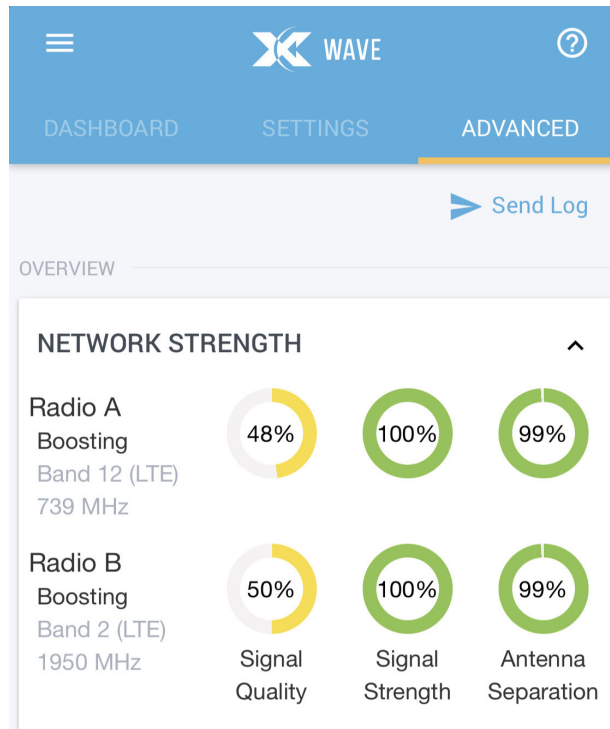
Each time you enable or disable a band, **the GO X's will rescan to find signal**. It can take a few moments until the GO X finds and starts boosting signal. Always set both GO X's to the same bands.

After the GO X's start amplifying a new band, **toggle on airplane mode on your phone for a few moments, then turn it off again**. This will force your phone to connect to the newly boosted band.



13 The "Advanced" Tab

One of the best features of the GO X is that it actively decodes the cellular signals before amplifying. You can find out more about the systems' status' at any given moment in the "Advanced" tab.



The most important information is summarized at the top of the screen, under the "Overview" section. The information here is divided into two "radios" - the GO X's two radios are what allow it to amplify up to two bands simultaneously.

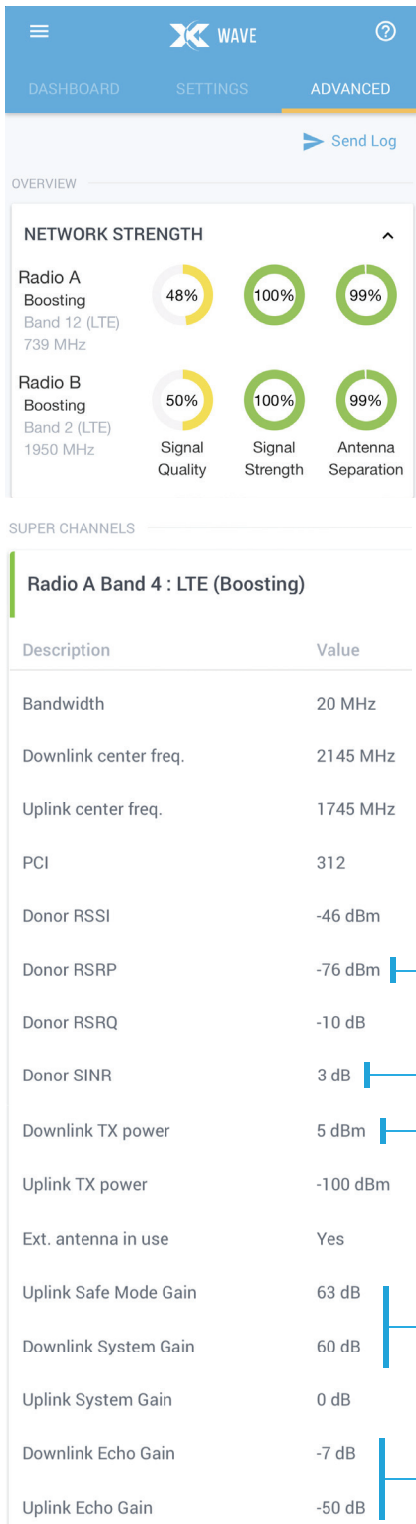
For each radio, the advanced tab tells you if it is "scanning," or if it has found a signal and started "boosting." When the radio is scanning, you'll notice that the frequency changes often. Once it's boosting, the frequency will no longer change.

Once the GO X is boosting on one of the radios, the Wave app will show a percentage for signal quality, signal strength, and antenna separation. **Signal quality and signal strength are determined by your outdoor antenna's location and direction.** Antenna separation is determined by the separation between the indoor antennas from to the outdoor antenna.

While **the goal during the install is to get the highest percentages possible** for each of these values, you may find that you are unable to get them into the green ranges. That's okay - they're just a guide to help you during the install!

The GO X also gives a lot more diagnostic information under the "Super Channels" dropdowns for each boosted band.

You won't need to use this information in most cases, but we've documented some of the most important numbers below.



The "Send Log" button allows you send a diagnostic log from your device if our support team needs one.

"Overview" Diagnostics Information

This section lists the two Radio's and their signal quality, signal strength, and antenna separation percentages. Ideally you want the Signal Quality above 20%, Signal Strength above 10%, and Antenna Separation above 60%.

"Super Channel" Diagnostics Information

This section lists diagnostic information on the two bands being amplified. Select a Radio to expand the details (as shown).

The "Donor RSRP" value shows the signal strength being received from the outdoor antenna.

The "Donor SINR" is a measure of signal quality. Ideally, you want a number higher than 3 dB here. The higher the SINR, the more bars, and the better your data rates.

The "Downlink TX Power" shows the strength of the signal being rebroadcast. The higher this number, the greater the coverage area. Ideally you want 0 dBm or higher.

The Uplink and Downlink System Gain show the current uplink and downlink amplification of the system. Uplink may sometimes show 0 dB when phones aren't in use. That's normal.

The "Echo Gain" reflects how much separation you have between the outdoor antenna and the indoor antennas. If either number is at or near 10 dB, you'd benefit from more separation.

15 Upgrading Antennas

If you have direct line of sight to the nearest tower (no obstructions, including trees) and you'd like to increase your signal quality and strength even further, you may want to consider upgrading your outdoor antenna.

We particularly recommend our **Log Periodic Antenna** or **Grid Parabolic Antenna**.

Waveform Log Periodic Antenna

waveform.com/log-periodic

- Up to 10 dBi gain with 56 - 82 degree beamwidth
- Easy to set up and aim
- Provides a small improvement over your MIMO Panel Antenna



Waveform Grid Parabolic Antenna

waveform.com/grid-parabolic

- Up to 23 dBi gain with 9 - 23 degree beamwidth
- Adjustable feedhorn for frequency-specific gain improvements.
- Provide a large improvement over your MIMO Panel Antenna



If you choose to upgrade, you'll need replace your single outdoor MIMO Panel Antenna with two of either of these antennas and then cross-polarize them to ensure a proper MIMO connection.

Feel free to call us at +1 (800) 761-3041 if you're unsure whether the log periodic or grid parabolic antennas would help in your situation.

Your Measurements



Use the table below to make notes of your measurements while positioning and aiming the outdoor antenna of your MIMO Cel-Fi GO X kit.

Position & Direction	Band(s)	Position Test Score	Download Speed	Upload Speed



Need help? We're ready and waiting.

Signal boosters aren't always easy to install. In fact, getting everything up and running can sometimes be a pain. But the end result is worth it.

One of the benefits of buying from Waveform is our **lifetime technical support** on every system we sell. We've installed hundreds of these devices ourselves, and can walk you through troubleshooting and fine-tuning your installation for best results.

Simply call us at (800) 761-3041 or email help@waveform.com. We're generally available from 9am-5pm PT, Monday to Friday.

We **love** helping solve tricky install problems.



v2.0



52 Maxwell,
Irvine, CA 92618



+1 (800) 761-3041



www.waveform.com
help@waveform.com