

4x4 MIMO Log Periodic Antenna Kit

by 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 improve signal to their cellular routers. 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 4x4 MIMO Log Periodic Antenna kit.

About Waveform

Your 4x4 MIMO Log Periodic Antenna Kit is designed, sold, and supported by Waveform and our team of Signal Specialists.

We've helped over 50,000 customers improve 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.



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www.waveform.com
help@waveform.com

What's in the Box

Antennas

Your package will contain **four Log Periodic Antennas**. A 4x4 MIMO Log Periodic Antenna Kit is recommended if you have line-of-sight to your nearest cell towers. However, if you're surrounded by trees, buildings, or hills, we highly recommend looking into QuadPro, our 4x4 MIMO Panel Antenna kit.



4x Log Periodic Antennas & Mounting Equipment

Accessories (Only included with complete kit)


If you purchased a complete antenna kit, the parts listed below will also come included.



UltraFlex-Quad Cable
(20 ft cable included)
BROWN BAG



8x 

10x   10x 

8x    2x 

2x UltraPole Kits
(Manual included in box)
BROWN BOX



4x N-Male to SMA-Male Adapters
CLEAR BAG



4x U.FL Pigtail & 4x TS9 Adapters
CLEAR BAG



Optional: 4x Lightning Protector Kits
CLEAR BAG

Install Manuals, Who Needs 'Em?

Heads up: Using MIMO antennas to improve your signal can take a bit of patience.

We'd be surprised if you saw better data speeds immediately upon connecting the antennas. Be prepared to spend an hour or two to find the right location and direction for your antennas.

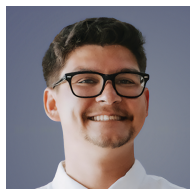
This manual is based on feedback from hundreds of customers like you. We've revised it dozens of times to make it as helpful as possible.

We promise **you'll be glad if you read it from start to finish before you get started**. It'll help you save time, avoid common pitfalls, and ensure your system works as well as possible.

Who We Are

Hi! We're Waveform. We've been around since 2007, and while we've grown a bunch since then, we're still a small team. There's just a handful of us answering texts, and picking up calls.

The four of us pictured below lead support and product development. Feel free to reach out to us at any time; our emails are all just our first names @waveform.com



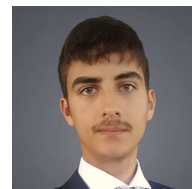
Ian (Support)



Marcus (Product)



Sina (CEO)



Cecil (Support)

Stuck? Have Questions? *Please*: Contact Us!

We're a small team, but we *really* care about helping you get the best results.

If you're having issues, please contact us. Sometimes a small tweak we suggest can make all the difference.

Even if everything goes smoothly, please let us know how your system is performing. We love getting feedback: Is there any way we could make the install process or this manual better?

Call us at (800) 761-3041, email help@waveform.com, or book a meeting with our dedicated support team at waveform.com/meet. We're available from 9am-5pm PT, Monday to Friday.

00 Before You Start

It's important that there's at least some 4G LTE or 5G signal outside or on the roof of the building where you're installing your 4x4 MIMO antenna kit, and ideally it should be "usable." If you don't have usable signal outside, proceed with caution, and consider giving us a call.

What Do We Mean by "Usable"?

When you take your cellular router or hotspot outdoors, you should have a reliable data connection even without connecting your new 4x4 MIMO Log Periodic Antenna Kit. When running a speed test, you should have at least 0.1 Mbps download and upload speed.

MIMO antennas will help condition the outdoor signal and get you better data speeds. But if the signal outside your building isn't usable to begin with, MIMO antennas might not help.

You can certainly still give MIMO antennas a shot, but you may still be unable to connect.

Compatibility

First, a quick reminder: The log periodic antennas in your 4x4 MIMO Log Periodic Antenna Kit support almost every 3G, 4G LTE, and low/mid-band 5G service in use in the US and across the world. Here are the bands that each antenna covers:



AT&T B2/n2, B4, B5/n5, B12, B17, B29, B30, B46, B66/n66, n77



verizon B2/n2, B4, B5/n5, B13, B46, B48/n48, B66/n66, n77



T-Mobile B2, B4, B5, B12, B25, B26, B41/n41, B46, B66, B71/n71, n77

CBRS, B48/n48

All supported LTE Bands: B1, B2, B3, B4, B5, B7, B8, B11, B12, B13, B14, B17, B18, B19, B20, B21, B22, B25, B26, B28, B29, B30, B32, B34, B37, B38, B39, B40, B41, B42, B43, B46, B47, B48, B50, B51, B53, B65, B66, B67, B69, B70, B71, B74, B75, B76, B85, B103, B106

All supported 5G Bands: n1, n2, n3, n5, n7, n8, n12, n13, n14, n18, n20, n25, n26, n28, n29, n30, n34, n38, n39, n40, n41, n46, n47, n48, n50, n51, n53, n65, n66, n67, n70, n71, n74, n75, n76, n77, n78, n79, n80, n81, n82, n83, n84, n85, n86, n89, n90, n91, n92, n93, n94, n95, n96, n97, n98, n99, n100, n101, n102, n105

**Your router's supported bands may vary from this list.*

How Much Improvement Should You Expect?

In short: It's hard to say. Many people see an increase in data speeds of between 50% and 200%, but some people may only see 10%. Our CEO often says that despite all the science, wireless signals often work in "strange and magical" ways.

One thing is for sure, **the more locations and directions you try the more likely you are to see a big increase in data speeds.** If you've gone through this manual and aimed your antennas as we suggest, but you're still not seeing much improvement, **please reach out to us for help.**

What tools do I need?

The mounting hardware of the log periodic antennas in your 4x4 MIMO Log Periodic Antenna Kit will require a **size-10mm wrench** to be assembled and **additional fasteners and tools** will be required to secure the J-Mount against your building.

If you are unsure which specific fasteners and tools to use for your building, **we recommend reaching out to a local contractor for guidance.**

01 Install Process Overview

This is the process that we suggest using for installing your 4x4 MIMO antenna kit:

- 1 **Read this manual**, ideally from start to finish, so that you understand the whole installation process before you begin.
- 2 **Assemble your log periodic antennas with your mount (Page 6)**. Start by assembling your mount and attaching your four cross-polarized log periodic antennas.
- 3 **Find the best antenna location and direction (Pages 7-9)**. This step is the most time-consuming, but it's worth the effort. Getting it right has a huge impact on your system's performance. Make notes of your readings in the table on page 9.
- 4 **Verify performance and hard-wire everything (Pages 10-12)**. Without making any holes in your roof or walls, temporarily run the cable indoors to your cellular router and run speed tests. If everything looks good, finalize the cable runs and hard-wire everything.
- 5 **Tell us how your system is doing**. We really love hearing how our customers' systems are performing. Send an email or give us a call and let us know how things look.

02

The pictures below show how your antennas should be secured to your mount. It's helpful to have your antennas attached to your mount for the next steps in section 3, so take some time to get the antennas set up before moving on.



For the best results and to ensure their drainage holes work properly, **mount the antennas in the orientation shown above**. For the Log Periodic Antennas in particular, **ensure their arrows are pointed upwards**. You can find more detailed instructions on how to attach your log periodic antennas to your J-Mount at [waveform.com/polemount-instructions](https://www.waveform.com/polemount-instructions)

Cross-Polarizing the Log Periodic Antennas

If you have four Log Periodic Antennas, angle each pair of antennas 45 degrees in opposite directions to achieve “cross-polarization”, as shown above. Cross-polarizing each pair of antennas and aiming all four of them in the same direction is **crucial for successful 4x4 MIMO connections**.

When mounting the antennas, **spread the pair of antennas about 3-4 ft apart or as far apart as your cables allow**. Treat all four antennas as a single antenna moving forward.

03 Positioning and Aiming the Antennas

Finding the right antenna position for your 4x4 MIMO antennas is the most important part of the install. In this section, we explain the best and simplest method for positioning and aiming. Section 7 covers some more advanced tips that we don't recommend for most users.

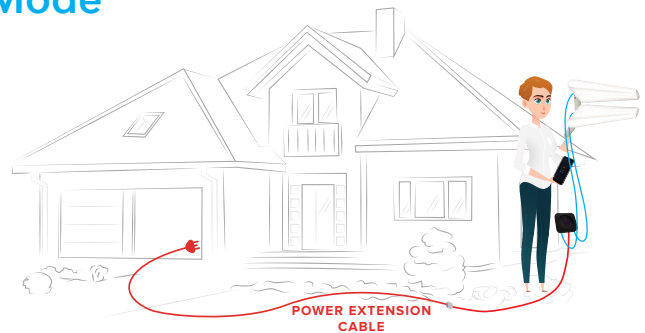
The Goal

Your goal is to find the **best location and direction** for your antennas. This location should **maximize the data speeds** from your cellular router. It can take a little patience, but spending some extra time here can have a huge impact on performance - it's worth the extra effort.

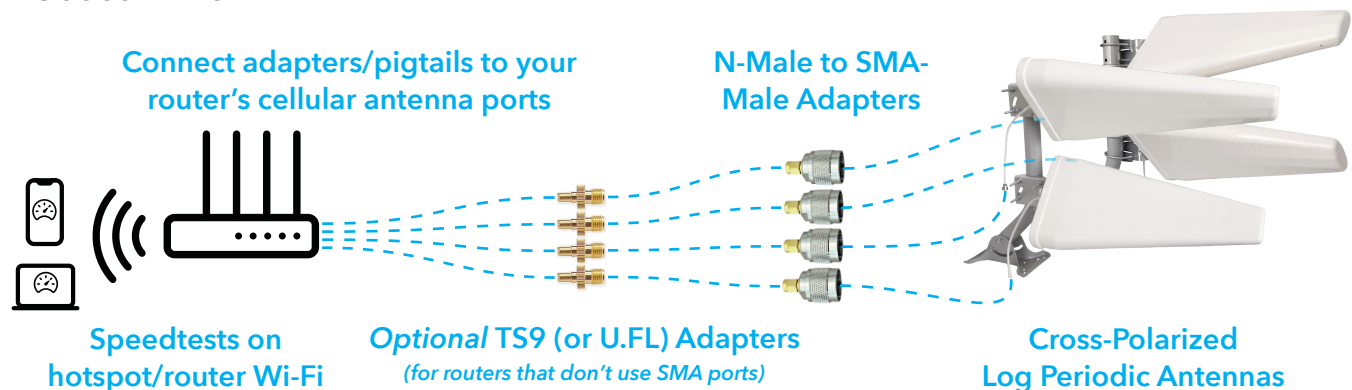
Set up Your MIMO Antenna in "Test Mode"

Is your cellular router battery-powered, or do you have a power extension cord?

If so, connect all four log periodic antennas directly to your router and take them outside to start testing different locations and directions.



Here's how to set up your router and antennas in Test Mode if you're using the adapters included in the kit:



Can't take your router with you outdoors? No problem. Just keep your router powered on indoors and use the included coax cables instead of the N-type to SMA adapters to take your log periodic antennas outside.

If you're leaving your router indoors, your speed tests may be limited by the router's Wi-Fi range rather than its cellular connection. We recommend asking someone to stay near the router so they can run speed tests as you try different positions with your antennas outside.

Not sure which ports to connect to? Some devices have both Wi-Fi and cellular external antenna ports. Make sure to attach your antennas to your router’s cellular ports and not it’s Wi-Fi ports. To help you identify which ports to connect to, refer to your router’s manual, our device-specific guides at waveform.com/hotspot-guides, or feel free to reach out to us.

Is holding all four Log Periodic Antennas difficult? Have someone assist you with moving and aiming all four antennas at the same time. If that isn’t possible, but you know your router’s primary cellular antenna port, connect just one of the antennas to that port for this process.

Running Speed Tests

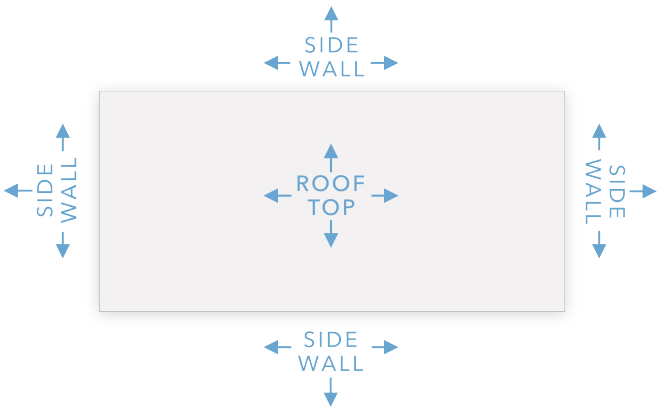
Since the goal is improved data speeds, it makes sense to **use a speed test app to measure your data speeds** through your cellular router’s Wi-Fi.

If you’re **testing with a phone**, download our favorite speed test app (“Speedtest by Ookla”) by visiting this URL: waveform.com/speedtest. For **testing with a laptop**, visit speedtest.net. Go ahead and run a couple of speed tests from a device connected to your router’s Wi-Fi. You’ll notice your results fluctuate a between tests – that’s normal.

Head outside and run 1-2 speed tests for each position and direction you try, then write down each of your results in the next page.

How to Position & Aim

Finding the right antenna location and direction takes some patience, but spending time to get it right can have a big impact on your system’s performance. Here are all the locations and directions where we recommend testing your MIMO antennas:



Don’t just go to the highest point of the roof! While signal is generally stronger the higher you go, there’s also often more interference. We’ve found it’s often better to mount the antennas on the side of the building where the structure can shield the antennas from interference.

Once you’ve found the best antenna location and direction, move on to section 5 below to get ready for your final installation.

04 Your Data Speed Measurements

Use the table below to make notes of your data speed measurements while you're positioning and aiming your antennas.

[illegible]

05 Assembling Your System

Once you've identified the best location for your antennas, it's time to set up a provisional install. You'll keep your antennas outside at the location you've selected, but run the cables and test your cellular router/gateway indoors.

Don't drill any holes in your walls yet! Start with a temporary install and test performance first.

If you purchased your log periodic antennas as a complete 4x4 MIMO Antenna kit, follow the steps below to assemble and install your 4x4 MIMO Log Periodic Antenna kit. If you purchased just our log periodic antennas, your assembly may look a little different.

Getting the Complete Kit Set Up

Refer to the diagram to the right as needed.

- 1 **Secure the log periodic antennas to your mounts if you haven't already.** *If your kit includes four log periodic antennas, be sure to cross-polarize them during this step, see section 2 for more information.*
- 2 **Mount your antennas outdoors** in the location and direction where you found the fastest data speeds using the method described in section 3.
- 3 **Connect the adapters & UltraFlex-Quad cable** to your log periodic antennas.
OR, if you purchased lightning arrestors, connect your antennas to the included adapters, lightning arrestors, then your UltraFlex-Quad cable. *Instructions on grounding are in the next section of the manual.*
- 4 **Connect the SMA-Male ends** of your UltraFlex-Quad cable to the cellular antenna ports of your router and hand-tighten the connections.
OR, if your cellular router has TS9 or U.FL ports, install the included adapters between your UltraFlex-Quad cable and your router, then hand-tighten the connections.

Install Tips

- **Before attempting to route the cables through your building**, lay the UltraFlex-Quad cable out flat to straighten it. This will make it easier to work with.
- **A finger-tight connection is sufficient** to secure the connectors. Tools are not required to tighten them and may cause damage.
- **Unsure how your pigtail adapters should connect to on your router?** Refer to the information on page 8 to help you identify which ports to connect to.

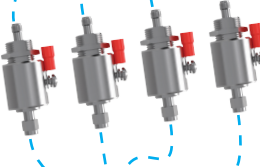
4x4 MIMO Cross-Polarized Log Periodic Antennas

Shown with the included UltraPole mounts.



4x N-Male to SMA-Male Adapters

Only included in our complete
4x4 MIMO kit.



Optional - 4x Lightning Arrestor Kits

Only included in our complete
4x4 MIMO with Lightning
Arrestors Kit.

Install outdoors, just before your UltraFlex-Quad cable enters the building.

Connect each Lightning Arrestor to the building's ground with 10 AWG or thicker grounding cable.

Additional instructions on grounding are found in the next section of the manual.

UltraFlex-Quad Cable

Only included in our complete
4x4 MIMO kit.

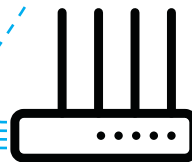


Optional - 4x TS9 or U.FI Pigtail Adapter

Only included in our complete
4x4 MIMO kit.

If your cellular router uses TS9 or U.FL connectors for it's cellular antenna ports, install the relevant pigtail here.

If your router uses SMA connectors instead, connect your UltraFlex-Quad cable directly to your router.



Your Cellular router

Connect the cables or pigtails to it's cellular antenna ports.

If you are unsure which ports to connect to, refer to page 8 for further guidance.

06 Test & Install Permanently

Before drilling holes in your walls, we recommend running cables temporarily through a window or door and testing to make sure that everything still works well.

If you're happy with your data speeds, you can start drilling holes and moving to a permanent install.

If you're having issues with your temporary setup, or aren't happy with the performance, don't panic! We can help you figure it out. **Call us at (800) 761-3041, email help@waveform.com, or book a meeting with our dedicated support team at waveform.com/meet.** We're available from 9am-5pm PT, Monday to Friday.

A Quick Note on Surge Protection & Grounding

We highly recommend picking up four Lightning Arrestor Kits from waveform.com/sma-lightning-arrestor to ground your outdoor antenna. They'd be installed just before the coaxial cable enters your building to protect your router from lightning and prevent high-voltage power from entering your building.

Both the lightning arrestors *AND* your mount itself should be grounded. We recommend using at least 10 AWG cable. Keep in mind the numbers increase as the cable gets thinner so 6 AWG and 8 AWG are both okay, but 12 AWG and 14 AWG are too thin.

If you have a satellite or HDTV antenna on your roof already, it's likely grounded. You can simply ground the mast and lightning arrestors to the satellite dish. Alternatively, you can ground your mast and antennas directly to a grounding rod. Most homes should have a grounding rod, but if yours doesn't you can purchase one at a local hardware store.

Even if you don't purchase a lightning arrestor, it's critical to ground your antenna mount, since it's metal frame makes it a prime target for lightning strikes.

You can find more detailed instructions on how to properly ground your antennas at waveform.com/grounding

Weatherproofing Outdoor Connections

Water can sometimes get into outdoor connections and cause issues. We strongly recommend that you **wrap all outdoor connections** with stretch-and-seal self-fusing silicone rubber tape (available from most hardware stores).

07 Advanced Optimization

By this point, you should have a really solid understanding of how to aim your MIMO antennas and get great performance. In fact, **we're convinced that for 95% of people, the instructions provided in this manual so far are more than enough.**

If, however, you'd like to go a little deeper and get technical to optimize your system even further, here are some general guidelines.

- 1 Look up your nearby towers** on cellmapper.net by performing a "Tower search" with the "eNB-ID" that your cellular router is connecting to. An eNB-ID is a unique cell tower identifier that can often be found in your cellular router's admin interface.
- 2 Aim your antennas at each nearby tower.** Run speed tests for each tower to find the fastest bands, and compare speed tests. **If your cellular router also supports bandlocking**, band lock it to every band that the tower transmits, and run speed tests for each tower on each band to find your fastest band(s) and tower.
- 3 Try enabling multiple bands** and using carrier aggregation to find the fastest band combination. Carrier aggregation is supported by most cellular routers and allows them to connect to two or more bands simultaneously. However, it doesn't always result in an faster data speeds so stick to a single band if that gets you the best results.

Unfortunately, **many cellular routers don't support band locking or carrier aggregation**, and some don't list eNB-IDs or any other tower identifiers, making these steps impossible. Every cellular router is so different that we could never cover them all with just one set of instructions.

However, **we've written up guides for some of the most common devices**, you can find them online at waveform.com/hotspot-guides. We suggest reading our guide for your router, or referring to your user manual.

We're Here to Help!

We know, there's a lot of information out there and this can get very technical. Don't be afraid!

If you're having difficulty, aren't happy with the performance of your system, or you'd just like a hand, we'd love to help! **Call us at (800) 761-3041, email help@waveform.com, or book a meeting with our dedicated support team at waveform.com/meet.** We're available from 9am-5pm PT, Monday to Friday.

08

- Having difficulties connecting your U.FL pigtails? Since U.FL connectors are very small and can be difficult to install on the first try, we suggest that you **use a locking or reverse-action tweezer to hold the cable in place** and a **pencil eraser to push the U.FL connector down**.

- **Are your TS9 adapters a bit loose?** Lightly **squeeze the end of the TS9 connector with your fingers** to improve it's grip. We know its not ideal, but TS9 connectors aren't threaded or standardized, so TS9 ports vary in depth between routers and they may not initially stay in place. While our adapter has been thoroughly tested, it's not always perfect for every device.

09

- If you have extra cable, don't coil it tightly.

If you have extra cable, make sure to keep any cable loops as large as possible to minimize any negative side-effects (4 ft or wider loops are best).

- If data speeds decrease over time, consider re-optimizing your system.

Occasionally carriers will change their towers to broadcast different bands, light up new towers, or simply turn off existing towers altogether. If your data speeds suddenly get worse, try re-aiming your antennas to get the best results.

- If you have the Log Periodic Antenna Kit, try alternative antenna mounting configurations.

For an additional performance boost with the log periodic antennas, other antenna configurations can be tried *depending on your local terrain*.

- » **For obstructed terrain** (i.e. locations surrounded by large buildings/hills/mountains etc.), try mounting the antennas horizontally side-by-side.
- » **For open terrain** (i.e. locations in large fields/plains/etc.), try mounting the antennas vertically top-to-bottom.

10 Tell Us How It Works

Did your installation go great? Are you having trouble aiming your antennas? Do you think our manual could be improved? Are your data speeds not quite what you were hoping?

Please tell us: Give us a call at (800) 761-3041, email help@waveform.com, or book a meeting with our fantastical support team at waveform.com/meet. We're available from 9am-5pm PT, Monday to Friday.

We're a small team who loves hearing how our products perform, and helping folks get the absolute best data speeds in any given situation.

So please, reach out!

Excited about your 4x4 MIMO antenna?
Get 5% for each friend, family, or neighbor you refer.

Hopefully by the time you've finished installing and tuning your MIMO antenna, you're as excited about this product as we are.

One of our biggest challenges is spreading the word. Most people don't know that products like our 4x4 MIMO Log Periodic Antenna Kit exist.

Help us get the word out: Everyone you refer gets 5% off their kit, and we'll also give you 5% of whatever they spend in cash (via PayPal).

Simply visit waveform.com/referrals to get started.



Need help? We're ready and waiting.

MIMO Antennas 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 give us a call at +1 (800) 761-3041, email us at help@waveform.com, or book a meeting with our fantastical support team at [waveform.com/meet](https://www.waveform.com/meet). We're available from 9am-5pm PT, Monday to Friday.

We love helping solve tricky install problems.



v5.0



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