QUATRA EVO Installation and User Guide

MODEL NUMBERS:
NU: Q42-Z1CNU
CU: Q41-BXCU

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About This Guide

There are a variety of CEL-FI QUATRA product variants available, supporting a variety of band configurations, for multiple regions. This manual is applicable to the CEL-FI QUATRA EVO M/N: Q42-Z1CNU and Q41-BXCU ONLY, and does not apply to any other QUATRA variant.

Caution: Changes or modifications to this product not expressly approved by Nextivity may void your right to operate the equipment.

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01. Introduction to QUATRA EVO

Understanding Cellular Coverage

Spotty cellular coverage, poor voice quality, dropped calls, and dead zones continue to plague occupants in buildings of all shapes and sizes. Nextivity's CEL-FI QUATRA EVO solves that problem. It is an affordable, all-digital solution, providing uniform, high-quality cellular signals throughout a building. CEL-FI QUATRA EVO is scalable to fit buildings of all sizes and is operator approved and guaranteed network safe.

Unlike traditional analog boosters and passive DAS technology, QUATRA EVO delivers higher quality cellular signals for all supported operators, with higher coverage power, utilizing lossless category cable signal transport (CAT 5e or better). The Coverage Unit radio heads (CUs) are powered via Power over Ethernet (PoE), delivering an un-attenuated signal throughout the building to each CU. CEL-FI QUATRA EVO can be installed in just days (compared to months typical of other solutions), and at a price point that meets the middleprise budget.

EVO is also pre-approved and does not require operator project approval, or a retransmission agreement.

The QUATRA EVO Solution

The EVO version of the QUATRA 4000 series is configurable to either single or dual operator mode.

While cellular networks are outside, the majority of cell phone use takes place indoors. A recent study showed 80% of business users inside complain of poor coverage or dropped calls. Modern building materials, while improving energy efficiency, will block or inhibit cellular service from the outside network. To exacerbate the issue, cellular coverage is increasingly critical. In fact, cellular coverage can be considered a safety or even regulatory requirement, depending on the region. Building owners need a flexible, high-quality solution. Installers and Value-Added Resellers need a product that can serve the majority of building types and not take months to deploy.

- Nextivity created a new CEL-FI solution category that combines its core technology with the architecture of an Active DAS – to deliver an Active DAS Hybrid – carrier-grade but built for Installers.

- Integrators and carriers have partnered with Nextivity to deliver a smart solution designed for middleprise buildings - CEL-FI QUATRA solutions.
- Nextivity solutions include QUATRA Bill-of-Materials Estimators, to help installers select the appropriate equipment in the right quantity, to reduce the time required for the (pre) planning effort.
- CEL-FI's all-digital, scalable, PoE Category cable-based solution makes it ideal for Single or Dual-Carrier environments.

Speed of Installation, higher quality in-building cellular solutions, and cost savings – are some of the reasons building owners, facility managers, and IT professionals are making the smart investment in CEL-FI QUATRA solutions.

CEL-FI QUATRA EVO Key Features

- Carrier Grade, FCC-certified Smart Signal Booster
- Support for AT&T, Verizon, T-Mobile (other operators may be requested)
- Relays four bands for one (1) operator or two (2) bands for each of two operators
- Independent operator donor ports allows for independent operator optimization
- Single combined (CU) server port enables driving either a serving antenna or passive DAS field
- 100 dB max system gain per channel
- 75 MHz total relay bandwidth
- Support for up to six (6) CUs (twelve with a HUB)
- N-type(f) RF connectors (donor and server)
- Internal modem for remote management (SIM slot access)
- Industrial aluminum powder-coated housing
- Up to 100m cable distance between NU and CU (using Cat5e), or 150m using 22/23AWG CAT6/7
- QUATRA Range Extender (QRE) doubles CU cable length (up to 300m)
- The Fiber QRE can further extend CU cable length an additional 2km
- 20-22 dBm uplink power per operator per band
- 16 dBm downlink power per cellular channel

A Solution Anyone Can Confidently Deploy

CEL-FI QUATRA EVO is designed to improve indoor signal coverage without any risk of interference on the mobile network. CEL-FI QUATRA EVO provides a sophisticated network-safe solution that has been rigorously tested globally, through multiple generations, engineered to deliver multiple levels of network protection:

- Uplink power control to prevent desensitizing the network
- Echo-cancellation and feedback control to prevent oscillation of the system
- Uplink muting, when handset (UE) use is not detected
- Signal qualification (channels are individually qualified, so noise or very poor signals won't be amplified and degrade the network)
- The CEL-FI WAVE Platform cloud-based portal enables remote monitoring of the equipment and network KPI's, such as channel configurations, RSRP, RSCP, SINR, and system gains, providing control and optimization insight.

02. Regulatory

FCC Part 20 Certified

The QUATRA EVO is FCC Part 20 certified for the following bands and combinations:

Single Operator Mode:

DONOR ANTENNA PORTS	Ports A plus C
AT&T	2 + 4 + 5 + 12
T-Mobile	2/25 + 4 + 5 + 12
Verizon	2 + 4 + 5 + 13

Dual Operator Mode:

DONOR ANTENNA PORTS	Port A	Port C
AT&T + Verizon	AT&T 2 or 4 + 5 or 12	Verizon 13 + 2 or 4
T-Mobile + AT&T	AT&T 2 or 4 + 5 or 12	T-Mobile 2 or 4
T-Mobile + Verizon	T-Mobile 2 or 4 + 5 or 12	Verizon 13 + 2 or 4

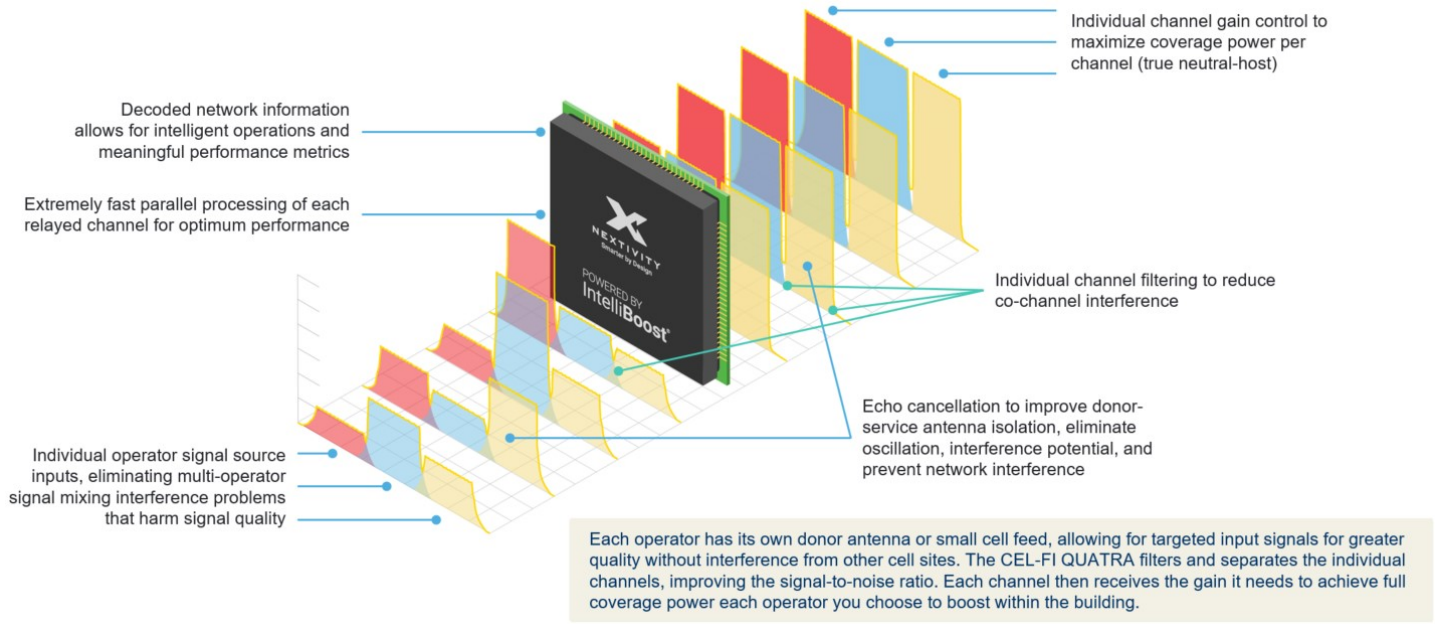
03. System Overview

How Does It Work?

CEL-FI QUATRA EVO is a powerful 3G/4G/5G cellular signal distribution solution. CEL-FI QUATRA EVO is fundamentally comprised of a Network Unit (NU) and up to six (6) Coverage Units (CU) per NU. The NU receives the cellular donor input signals from up to two (2) operator donor signal sources. The signal source can be off-air (over-the-air antennas) from the macro network, or delivered via a local small cell.

The NU receives and individually processes these operator channels, allowing higher gain for weaker channels (up to 100 dB) to ensure full coverage power for each operator channel, regardless of their relative input power variations. The channels are digitized and sent over a pair of category cables to each CU for retransmission through one or more service antennas. These lossless CU cables may be up to or exceed 2km in length using various available cable extender accessories.

The result is that each cellular channel is individually filtered and amplified to full coverage power within the building, with better signal quality, and without network interference.



The system may also be used with one QUATRA EVO FIBER HUB, which doubles system capacity to twelve (12) CUs. The EVO HUB is connected to the NU with up to 2km of optical fiber cable and SFP+ Modules (sold separately), and it uses donor signals from the connected NU. The HUB, along with QUATRA Range Extender and Fiber Range Extender accessories, allow CUs to be placed in excess of 5km of cable length from the NU, making it possible for extensions of the system to easily cover nearby buildings as well.

Donor signals may also be shared between multiple EVO systems, allowing much larger buildings to be covered.

NOTE: The EVO HUB and QUATRA 4000/4000i/4000c HUB are not compatible. Please be sure and order the correct HUB for your system. However, QRE and fQRE accessories are compatible across all 4000 series HW.

NOTE: The QUATRA EVO system includes a very powerful remote management platform called the **WAVE Portal**, that may be securely accessed from an internet browser. EVO should be connected to the **WAVE Portal** for remote diagnostics and management, at least for initial settings. Connecting the system to the cloud is easy, and the portal is a very useful tool to help you get the most out of your systems. Your preferred connection method should be determined when planning a system layout (see details below).

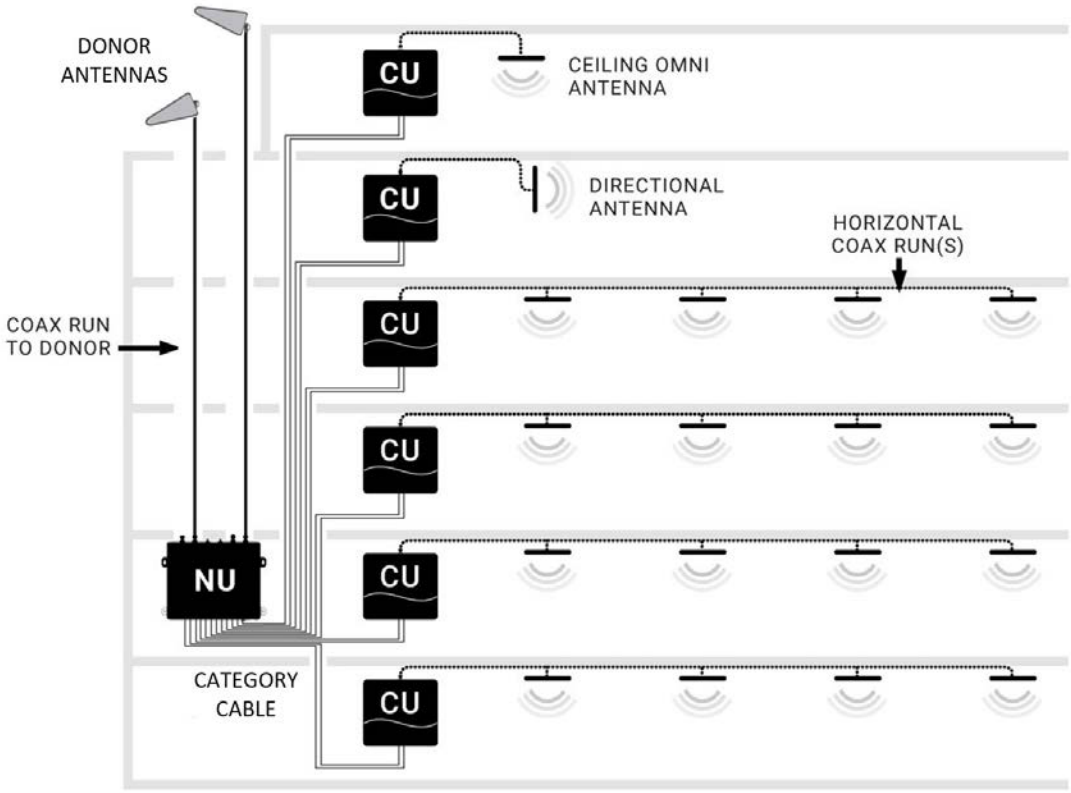
CEL-FI QUATRA EVO Service Agreement

- Every NU will be bundled with a 1-year product Service Agreement

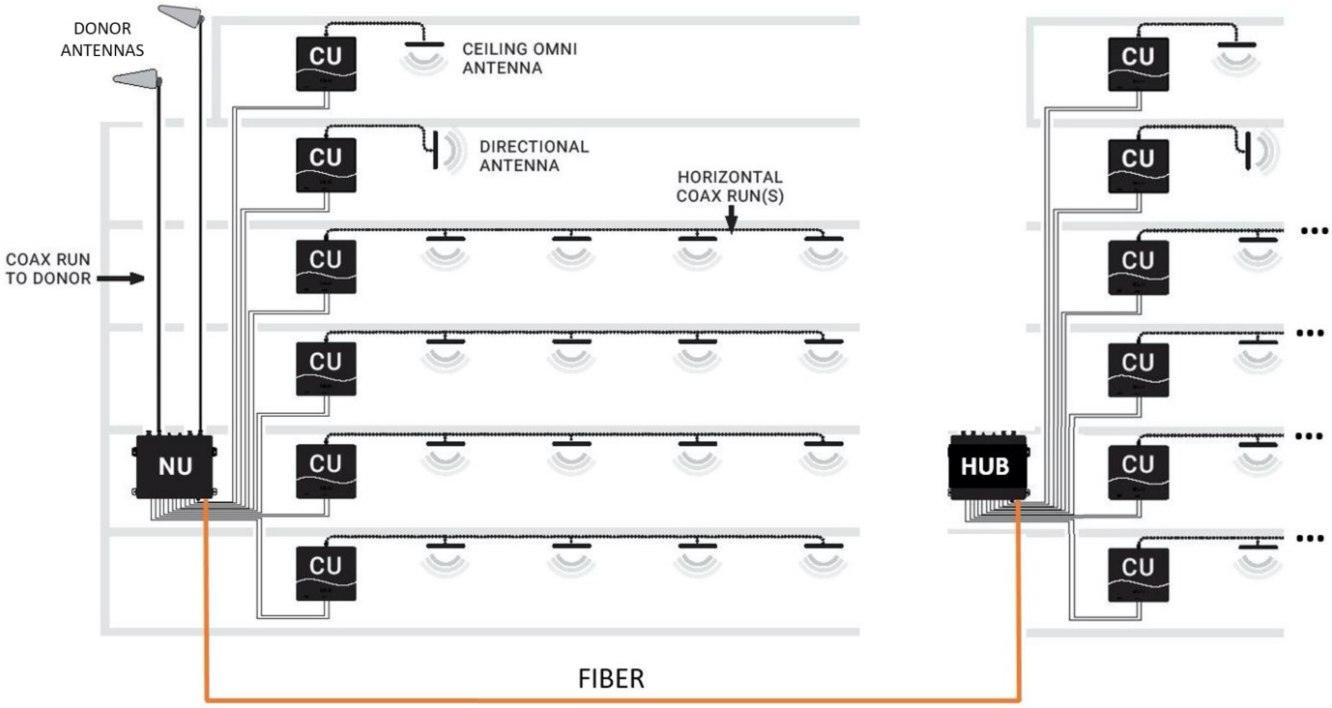
- The Service Agreement may be renewed on an annual basis
- The Service Agreement includes a 1-year SIM service plan, if you chose to use the internal modem for your **WAVE Portal** connection.
- Upon request, once the system installation is complete, Nextivity will review key system KPI's and provide feedback on the installation.

Learn more about our Service Agreement.

Architecture Overview Examples



QUATRA EVO System Architecture

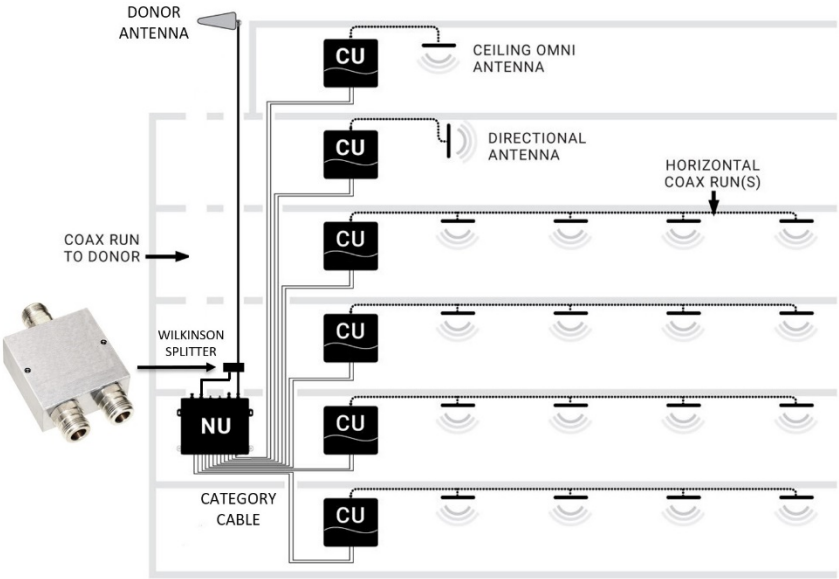


QUATRA EVO System Architecture with Fiber HUB option

Real World Examples

1. Off Air Install, 75K ft² building, <u>Single</u> Operator

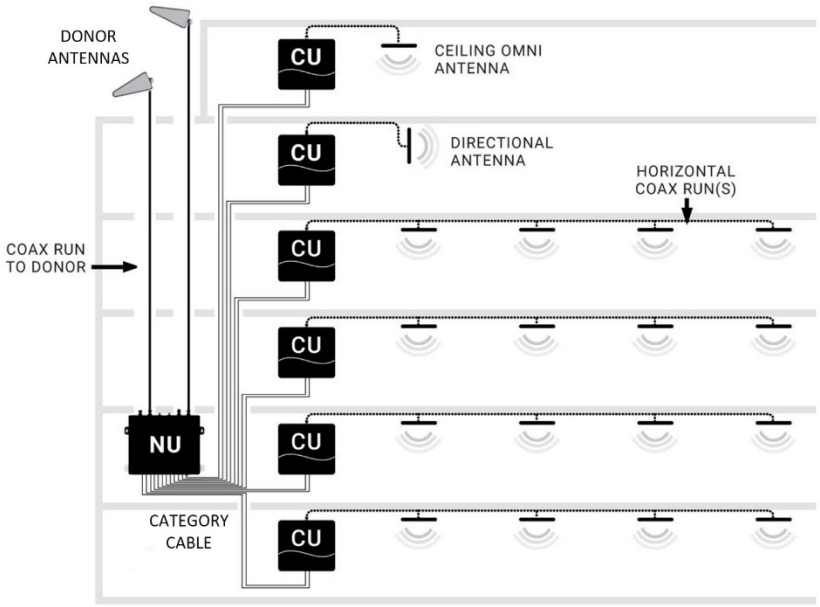
In this example, CEL-FI QUATRA EVO is providing wireless coverage for a single cellular operator in a six story 75,000 ft^2 building. One donor antenna is located on the top of the building to ensure the best signal-to-noise ratio for the cellular operator, and the signal feed is split to feed both NU donor ports. A CU is placed on each floor, and a distributed antenna system (DAS) field is run out from each CU to provide great coverage.



2. Off Air Install, 75K ft² building, <u>Dual</u> Operator

In this example, CEL-FI QUATRA EVO is providing wireless coverage for two cellular operators in a six story

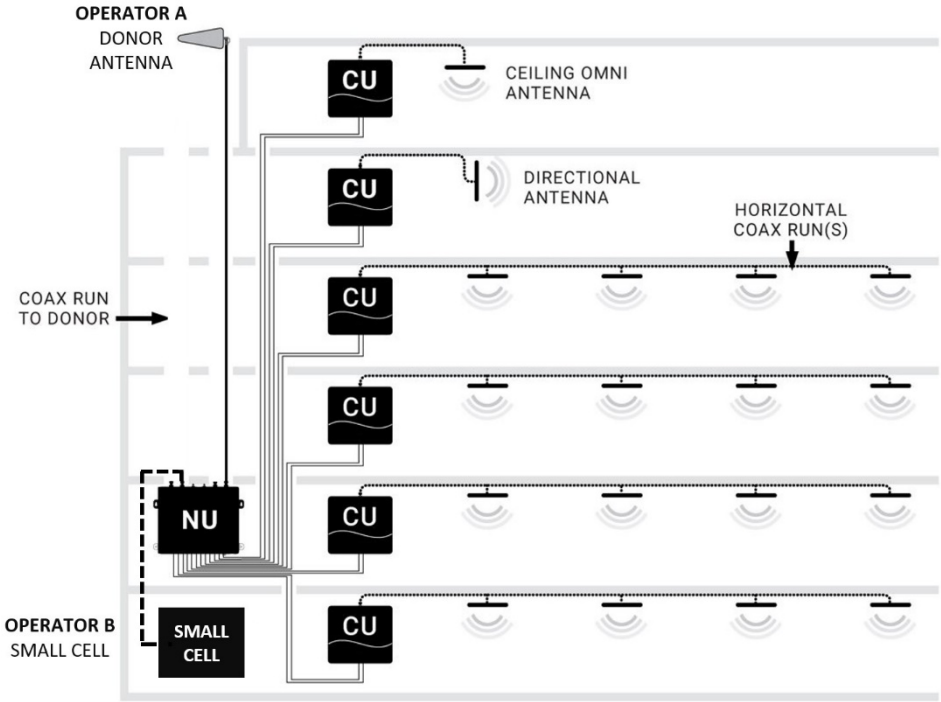
75,000 ft^2 building. Individual donor antennas are located on the top of the building to ensure the best signal-to-noise ratio for both cellular operators. A CU is placed on each floor, and a distributed antenna system (DAS) field is run out from each CU to provide great coverage.



3. Off Air + Small Cell Install, 75K ft^2 building, Dual Operator

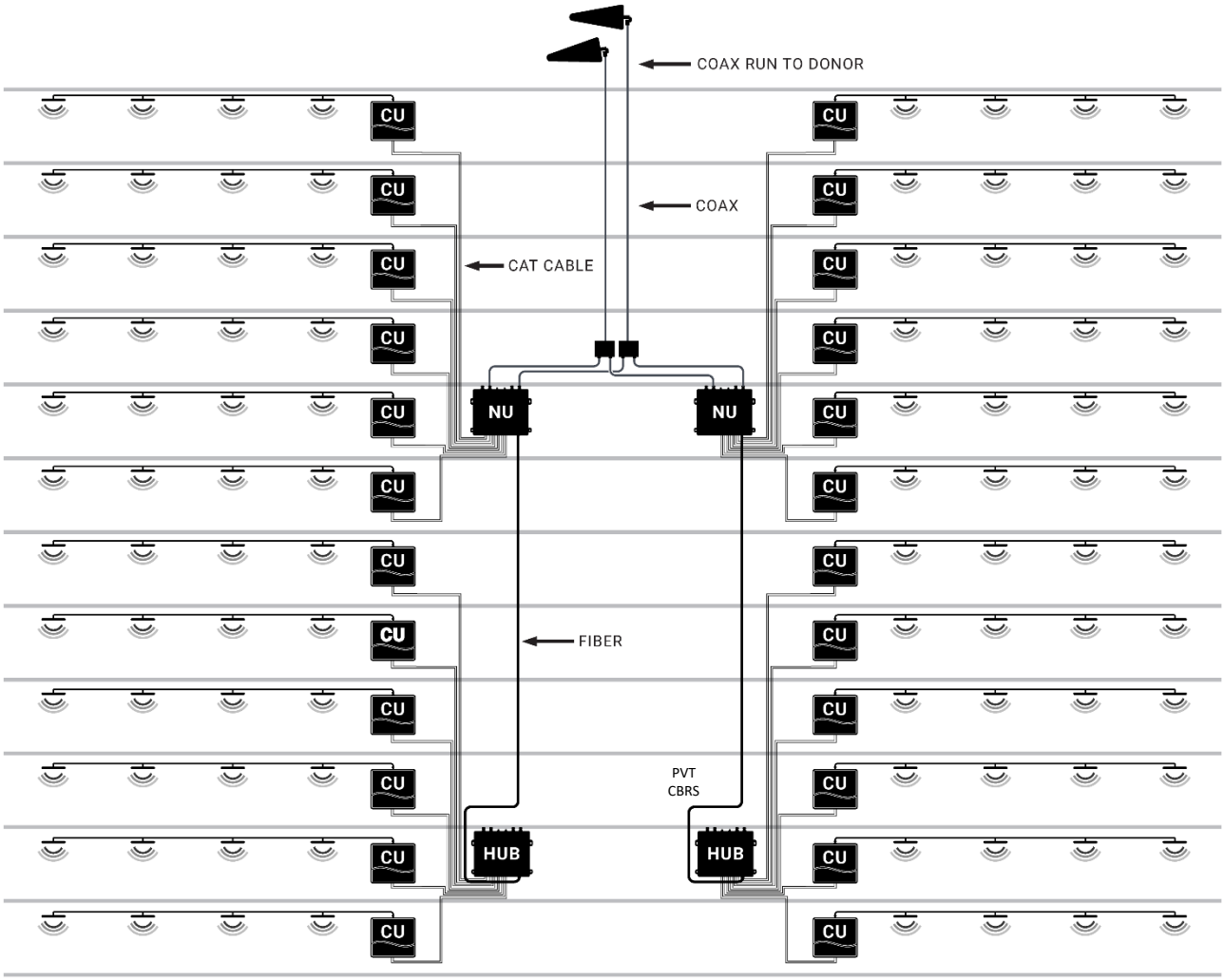
In this example, CEL-FI QUATRA EVO is providing wireless coverage for two cellular operators in a six story 75,000 ft^2 building. Operator A is using an Off-Air donor antenna because the donor signal outside the building is healthy. However, Operator B is using a Small Cell signal source, because the outdoor donor signal was inadequate. A CU is placed on each floor, and a distributed antenna system (DAS) field is run out from each CU to provide great coverage.

Small Cell attenuation of 60 dB is typical, however it depends on the small cell. Consult the Small Cell Guide, or contact Support for more information.



4. Larger 300K ft² Building with two NU+HUB Systems, Dual Operator

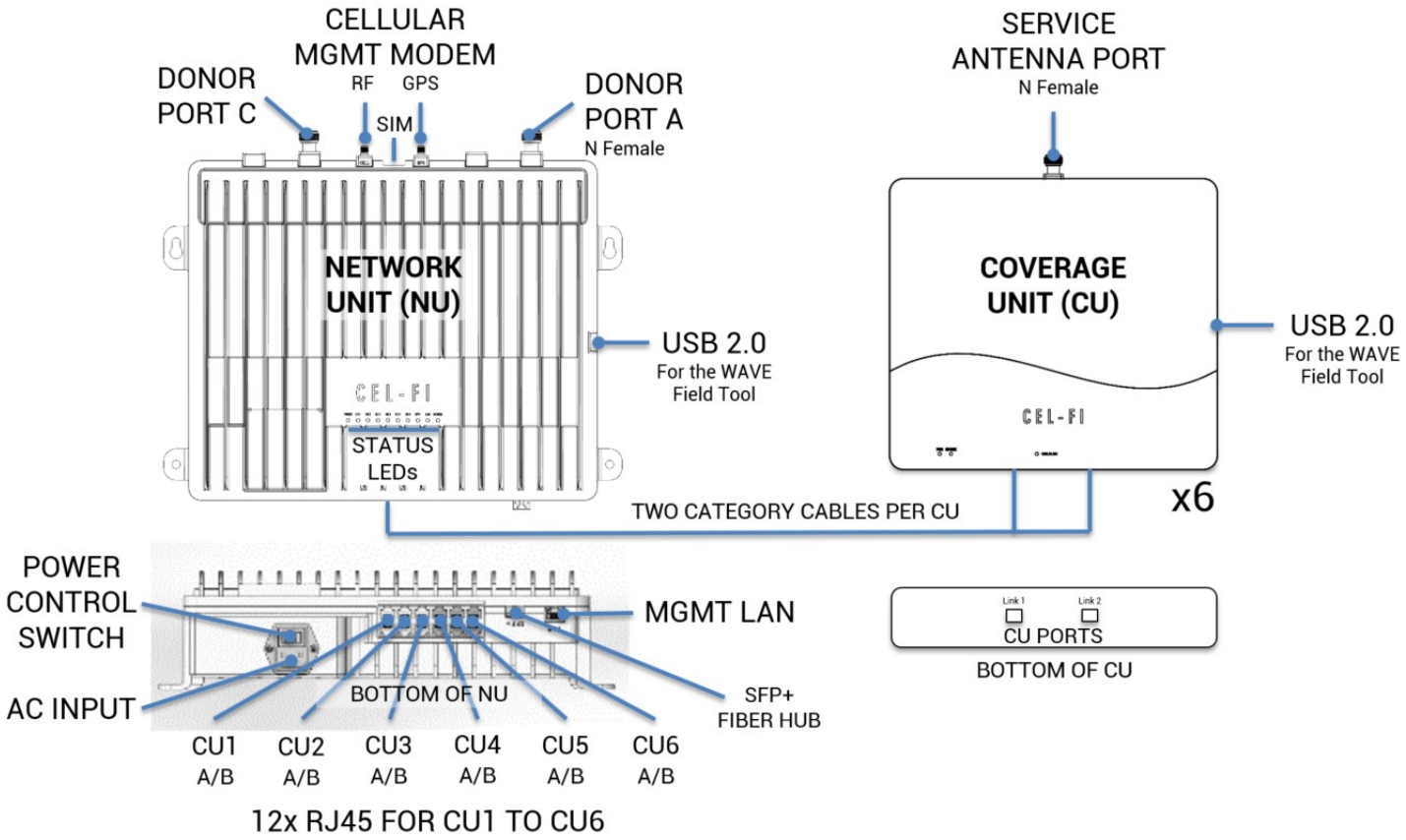
This building uses two donor antennas; one for each operator. The donor feeds are split two-ways to feed the two systems. Each QUATRA EVO NU is connected to a HUB, and the NUs and HUBs are connected to CUs throughout the building, and then each CU is connected to a DAS field, providing coverage to the building.



04. Hardware Components

CEL-FI QUATRA EVO is a modular solution with two (2) foundational components: the Network Unit (NU) and the Coverage Unit (CU. In traditional DAS terminology, these could be known as the Head End (NU) and the Remote Unit (CU).

The signal sources are brought into the system at the NU, via a wired connection through a donor antenna or small cell RF connection. Those signals are digitized and individually processed and sent to the CUs for retransmission, each normalized to full coverage power. Power is provided to the entire system through AC power at the NU. The CUs are powered via Power over Ethernet (PoE), and therefore do not require a separate power source at their location.



Network Unit (NU)

The NU is the head end for the QUATRA EVO system. The signal sources (one for each port/operator) are connected to the NU. Then they are digitized and distributed over two Category cables to each CU, along with power (PoE) for the CU.

QUATRA EVO NU

Note: Only cellular signals may be connected to the donor ports. Other types of radio signals will not work, and may damage the system.

The NU has two (2) N-type(f) RF ports on the top for operator donor signals.

There are two (2) SMA(f) ports on the top of the NU. One functions as the external antenna connection for the unit's internal cellular modem, and the other is for GPS. *The GPS port is unused (future functionality).*

Power

- AC Power Supply (inside the NU)
- AC power cord

Physical Interface

- RJ45 ports (13)
- Twelve RJ45 ports (2 for each of the 6 CUs)
- One LAN port for remote management
- SFP+ module dock (for use with a Fiber HUB)
- N-type(f) RF Ports (2) for Donor Antennas
- SMA(f) ports (2 for the internal LTE modem)

User Interface

- LED interface (front) to indicate system status. (For detail on the LED go to LEDs.)
- Power
- CU1
- CU2
- CU3
- CU4

- CU5
- CU6
- SFP+
- LAN
- MODEM

Power Supply Cable

Coverage Unit (CU)

The CU receives the digitized cellular signal from the NU, converts them back to RF, then amplifies and distributes the service from its N-type(f) RF port. Service can be deployed through a single connected antenna, or through a DAS field.

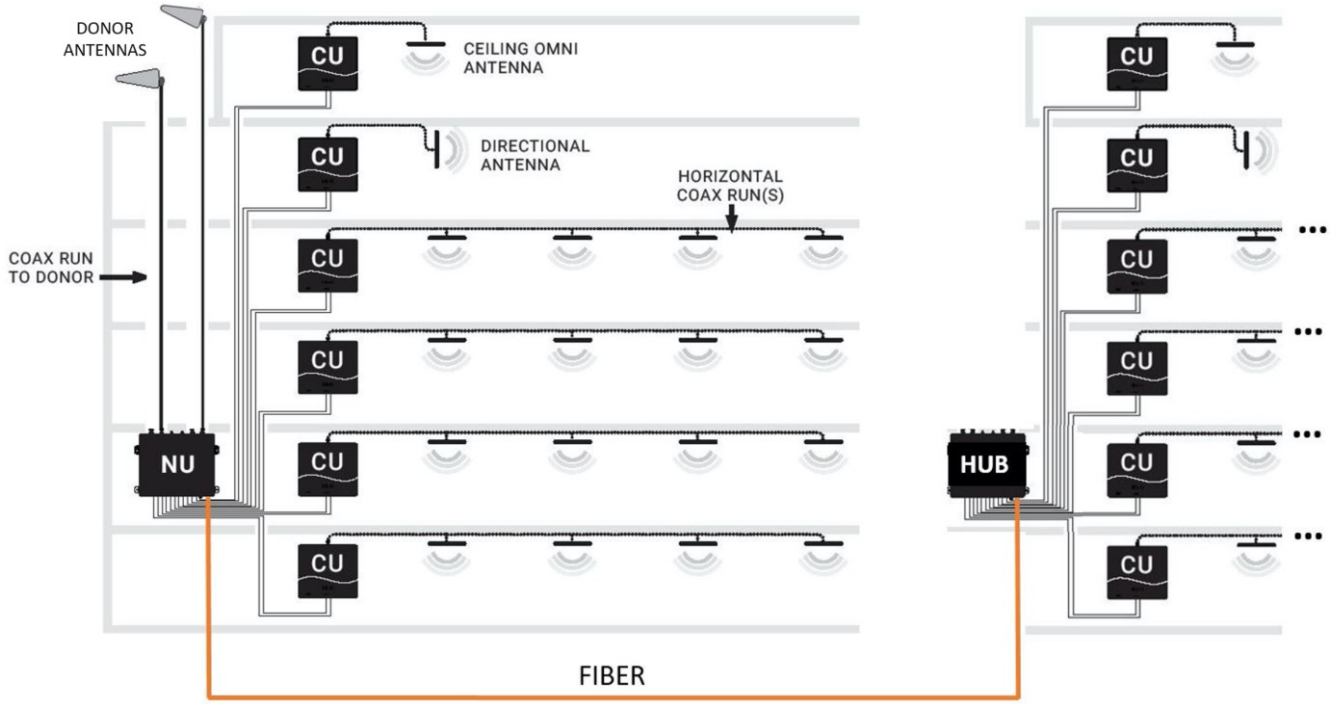
QUATRA EVO CU

Accessories

QUATRA EVO FIBER HUB
Model Number: Q40-Z1FNU

The HUB functions much like an NU, except it does not have donor antenna ports. It connects to an NU over optical fiber cable (up to 2km) using SFP+ modules, and it adds up to six more CUs to an NU (twelve CUs total). Please note that the QUATRA EVO HUB is not compatible with other QUATRA 4000 Series HUBs.

QUATRA EVO FIBER HUB



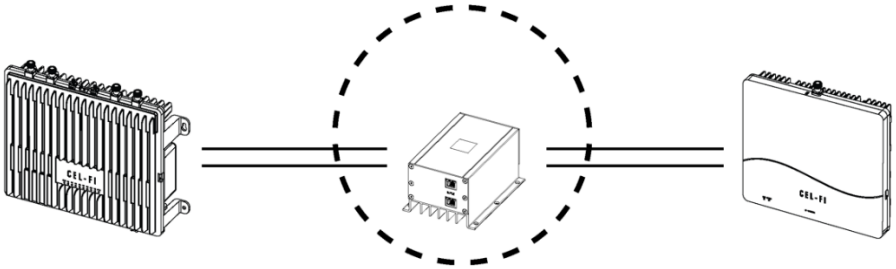
QUATRA 4000 Range Extender and Fiber Range Extender

The QUATRA Range Extender (QRE) unit is a device that extends the standard 100 meter category cable length from NU to CU up to 200 meters with Cat5e, or up to 300m if CAT6/7, 23AWG cable is used. It is

installed halfway along the NU to CU cable, and requires no external power. There are two RJ45's on the input (NU) side, and two RJ45's on the output (CU) side. Traditional Ethernet extenders do not understand QUATRA signaling and will not work with QUATRA.

The QUATRA Fiber Range Extender (fQRE) system is a similar product that converts QUATRA EVO specific signaling to optical fiber and then back to category cable for up to an additional 2km of CU cable length. See fQRE product information at www.cel-fi.com for more information about the fQRE.

Please note that the QUATRA 4000 QRE and fQRE both work with the Q4000, 4000i, 4000c and EVO models.



Donor Antennas

The donor antennas are used to provide off-air signals to individual operator donor input ports. The objective is to provide the best quality operator signals to the NU. A variety of donor antennas are available from Nextivity. The right donor antenna choice can make the difference between a good outcome and a great outcome. Please refer to other antenna-specific documents for choosing the right donor antenna.

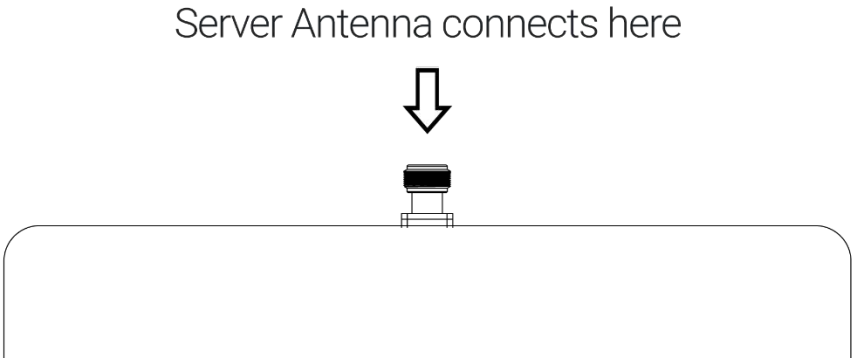
CEL-FI Donor Antennas - Model Numbers A32-V32-201 (WBD) and A62-V44-201 (LPDA-R)

CEL-FI Donor Antennas

Nextivity recommends its LPDA-R antenna for use as a great donor antenna for most situations. Learn more about our Antenna options.

Server Antennas

Server antennas connect to the N-type(f) RF port on the CU.



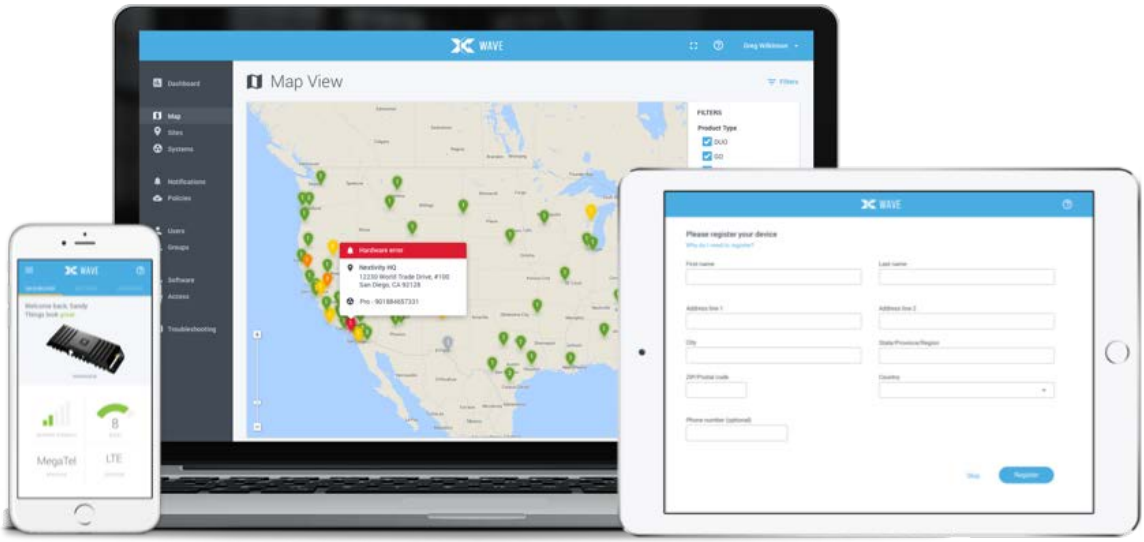
Server Antenna port

A variety of Server antennas are available from Nextivity. Visit the Antenna Product page for details and updates.

Couplers

RF couplers or tappers may be used with CUs when multiple service antennas are desired. Careful system design should be implemented to insure sufficient power levels into all antennas. Couplers should be specified that are appropriate for the power and frequency bands that EVO supports.

0.5 The WAVE Portal



Introduction

The **WAVE Portal** is Nextivity's SOC2 Type 1 compliant cloud-based software platform from which CEL-FI apps and connected devices are hosted and driven. Current-generation CEL-FI products feature embedded connectivity that allows them to connect to the WAVE cloud. The **WAVE Portal** and apps are used to facilitate software updates, registration, commissioning, installation, optimization, and troubleshooting. The CEL-FI WAVE platform continues to expand in features and function.

In order to use the **WAVE Portal** and related capabilities, you must be registered with the system.

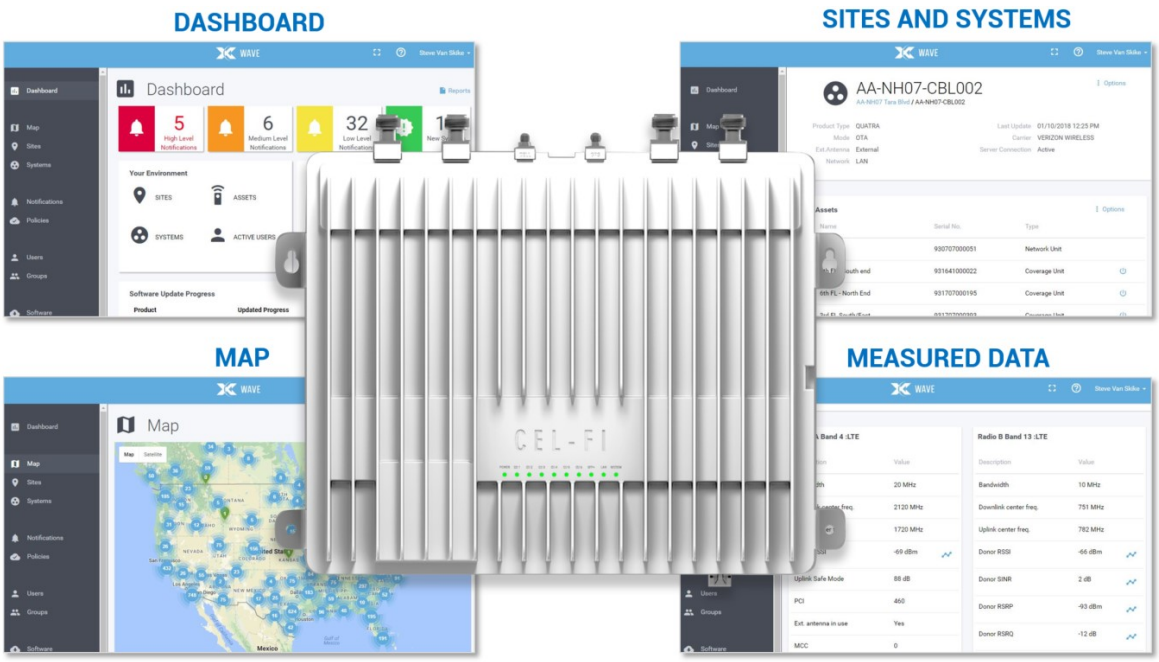
- Request access to the WAVE Portal
- Login to the WAVE Portal

The portal constantly monitors your systems and tells you how to resolve alarms or improve performance with explicit guidance, all from your smartphone or computer browser. See CEL-FI training modules for easy to understand videos and slide tutorials.

<u>The internet/portal connection method should be determined and prepared for prior to installation. This will ensure that the portal is connected and available for commissioning and settings</u>.

Some of the many things the portal can do:

- Monitor system health and display, email, or text alarm notifications
- Manage Settings remotely (sale and service lease functions)
- Real-time performance tips for best performance, based on your system data
- Remote troubleshooting with hourly KPI measurements – Saves time and money, without a truck-roll
- Helps you take coverage measurements and generate reports with the **COMPASS XR** unit
- Keeps your software up to date, so you always have the latest features
- Maps your systems so you know where they are (global)
- Data archive for all of your site documents, including floorplan-system layouts



0.6 Installation

Important: Before any permanent installation, make sure all the components are planned and accounted for, as well as any wiring, cabling, power, mounting, antenna placements, and portal system access.

Overview

Several things need to be determined as part of installation planning and preparation.

- Perform a Site Survey with a measurement tool, such as the **COMPASS XR**, to determine current cellular service issues, candidate donor antenna locations, and where hardware and cabling may be installed.
- Plan the system using the CEL-FI online BOM Estimator or a tool such as iBwave, and your knowledge of the building floorplan and cable routing options. Where will CEL-FI hardware be mounted (NU, CUs, antennas, and optional HUBs or Extenders)? This includes a suitable power outlet for the NUs or HUBs.
- Install all system hardware according to the plan.
- Cable the system, including NU-CU category cables, and donor and service antennas and cables.
- Connect the system to the cloud and commission it on the **WAVE Portal** (*New Systems* page).
- Use the hardware LEDs, troubleshooting table in this guide, and the **WAVE Portal** to resolve any issues.
- Monitor and manage your system remotely using the **WAVE Portal**.

Note: For signal surveys, or to find candidate locations for donor antennas, we recommend Nextivity's ***COMPASS XR*** *tool. Ask your distributor for more information or visit us at www.cel-fi.com*

Note: IBWAVE or the Nextivity's BOM Estimator design tool (or other RF planning tools) are not required but are a good way to ensure the best performance outcomes. iBwave vex and template files may be found on the Nextivity Partner Portal pages. There BOM Estimator tool may be found here: BOM Estimator Tool

Installing the NU

Mounting

The CEL-FI QUATRA EVO NU is designed for simple wall or rack mounting; typically in an IT room with coaxial cable riser access to where the donor antennas are to be mounted (usually on the roof, or another exterior location with a quality donor signal from each cellular operator). The location should also have an available electrical outlet within reach of the supplied NU power cord.

Mounting accessories, including screws and anchors, for common material types (drywall, plywood, etc) are included with each NU.

Wall Mounting

The following tools are recommended:

- Power-drill/screwdriver
- Drill bit extender (3”+)
- Hammer
- Pencil, or other similar marker
- Level

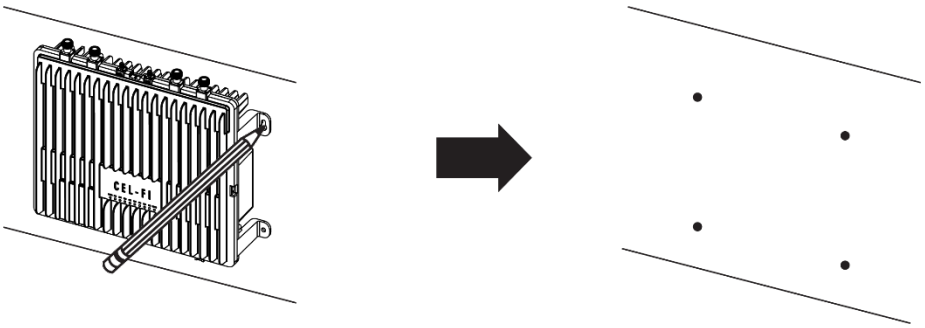
Caution: Make sure the area behind any surface is free of electrical wires or other dangerous elements prior to drilling.

The QUATRA EVO NU has four (4) secure mounting tabs, two on each side. The two topmost tabs have been key-holed, allowing the unit to be lifted onto preinstalled screw heads.

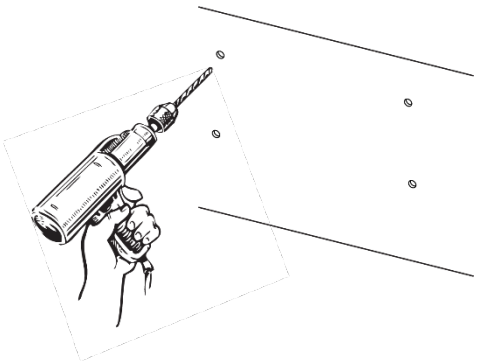
Note: The Mounting Instructions below use the standard drywall mounting anchors and screws included with the unit. If the NU is to be mounted onto other surfaces, make sure the appropriate anchors and screws are used (not included).

1. To mount the NU, first determine the approximate location on the wall for the unit, leaving room for connectors and cabling.

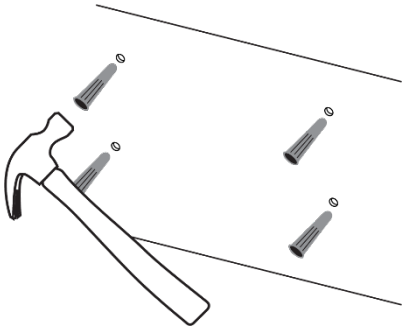
2. Hold the unit up on the wall and, using a pencil or similar marker, mark one of the top (right or left) points.



3. Drill the holes for the anchors.

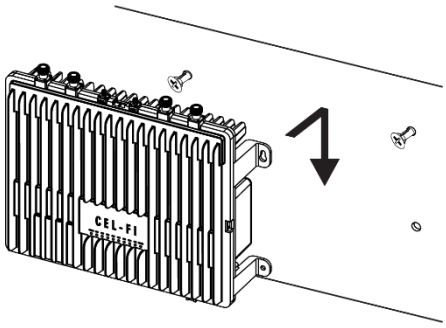


4. Hammer in the anchors.

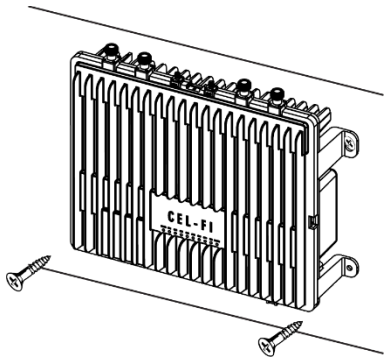


5. Partially screw in the top two screws.

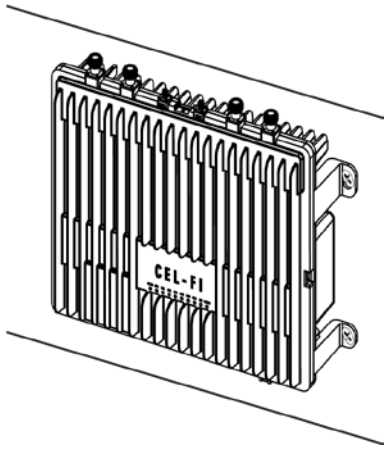
6. Hang the unit from the top two screws, through the eyeholes. Adjust the unit to level and then tighten the screws.



7. Screw in the bottom two screws.



8. Mounting is complete.



Rack Mounting

NUs and CUs may also be secured to vented (perforated) IT rack shelves. Please make sure that your shelf is adequately vented (unit operating temperature is available on the **WAVE Portal**).

Connecting Donor Sources

The QUATRA EVO has two independent N-type(f) RF ports for connecting off-air antennas or small cell donor signals. Please connect your donor cables according to the Single or Dual Operator Mode you intend to use (see the illustrations below).

NOTE: Small cell inputs and off-air inputs can be used in the same system, but not for the same donor port.

NOTE: Once the donor source cables are connected, you will use the **WAVE Portal** to configure the ports for Single or Dual Operator Mode, select your operator(s), and select Small Cell Mode for any port that is to be fed with a small cell signal. These configuration options are described later in this manual.

Cellular Donor Antenna Input

The donor antenna is used to collect the donor signal from the external (over-the-air) operator network. Better donor signals lead to better customer experiences, improved voice quality and data throughput. A signal-to-noise ratio (SiNR) of > 5 dB is strongly recommended for each given operator's source signal, however lower quality signals will work if that is all that is available for the site. Better SiNR leads to better throughput and "bars" of signal strength on cellphones.

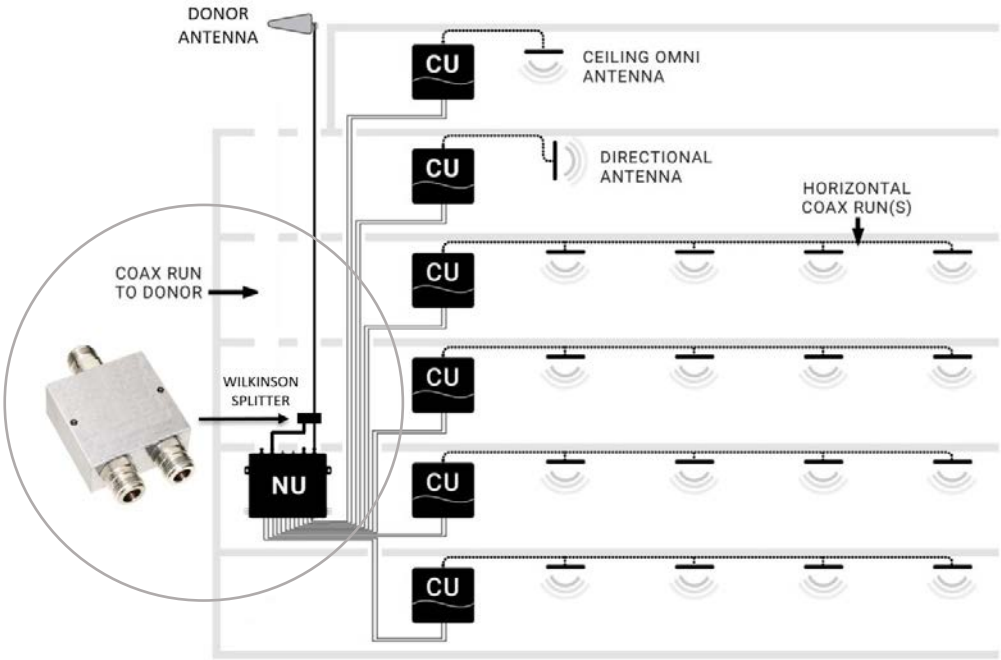
Each donor antenna should be mounted safely and securely where it can access the desired cellular network, with a clear unobstructed view of all candidate cell sites. Donor antennas should be mounted a few feet above the roof or roof-edge walls (minimum), at least 12 inches apart from each other. A coaxial cable connects the donor antenna to the NU's RF port for each given operator, usually through a properly grounded lightning arrestor.

Please watch our donor antenna best practices video by clicking on the link below. This video and many other videos and webinars may be found under the Webinars link at the bottom of www.cel-fi.com

https://www.cel-fi.com/casestudy/cel-fi-quatra-antenna-selection/

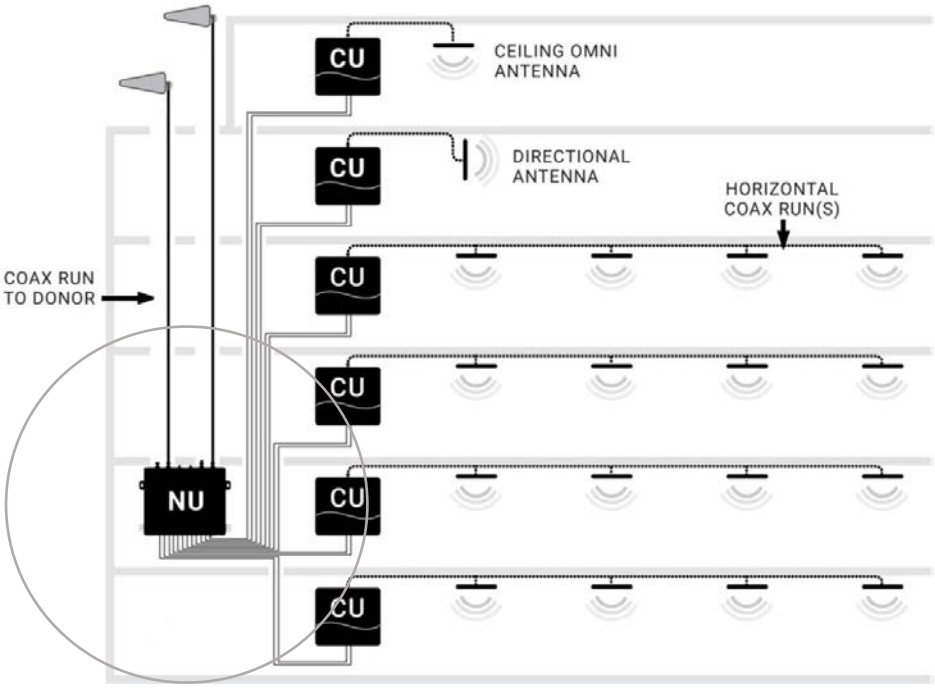
Single Operator Mode

In this mode, connect the single operator donor antenna cable to both NU donor ports using a splitter.



Dual Operator Mode

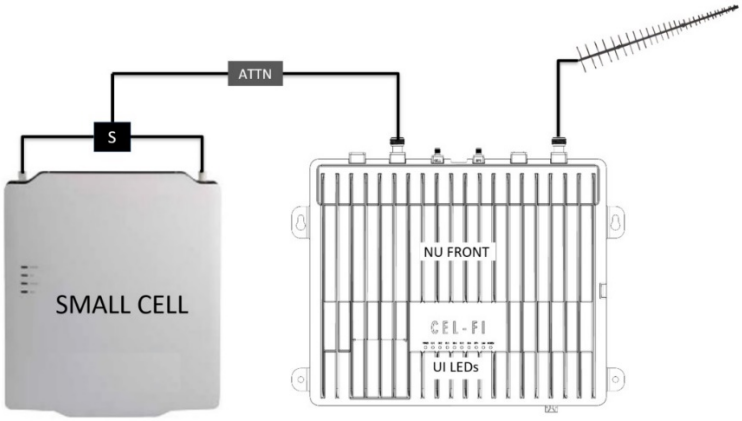
In this mode, connect a dedicated operator donor antenna to each donor port.



Cellular Small Cell Donor Input

If a small cell is used as the donor source, it should be commissioned and its service verified according to its setup procedure, so it is already providing tested service before EVO is powered ON. The recommended input signal level for a small cell, after connection losses and attenuation, should be between -75 and -80 dBm RSRP into the NU donor port for that operator. It is easy to verify this power level using the **Radio Data** page on the **WAVE Portal** once the system is operational. 60 dB is a typical attenuation level, however your value may be different depending on the output power of the small cell.

Note: For more information about connecting small cells, see the QUATRA Approved Small Cell Guide.



Installing CUs

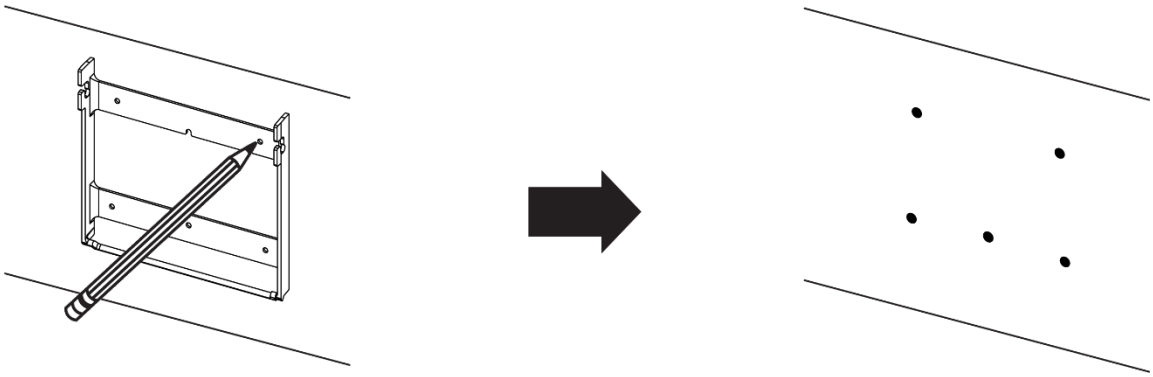
CU Wall Bracket Mounting

The CU comes with a wall mounting bracket in the box. To mount the QUATRA EVO CU, simply follow these steps:

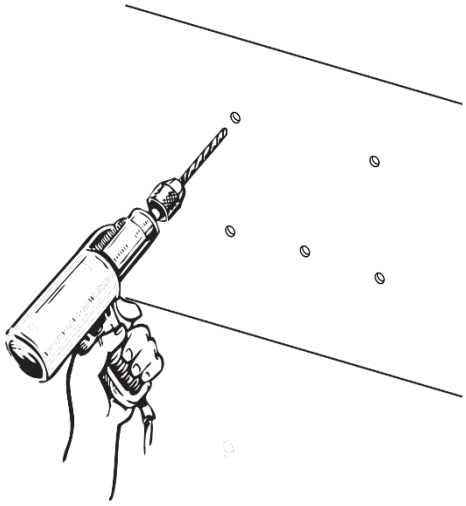
1. Determine the mounting location. Note: Whenever mounting any CEL-FI gear on a wall or ceiling, make sure the area is free of any dangerous electrical wires, other safety hazards, or any other objects that could be damaged or effect the quality or stability of the mounted unit.

2. Position the QUATRA EVO CU wall mount on the wall in the desired mounting location.

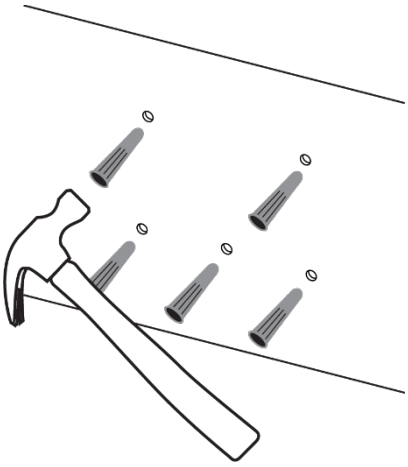
3. Holding the mounting bracket in place, mark hole locations with a pencil.



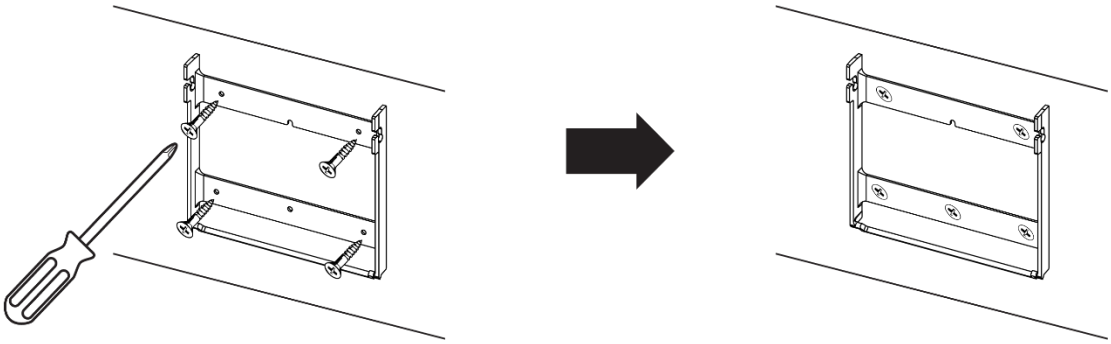
4. Drill the holes.



5. Hammer in the anchors.

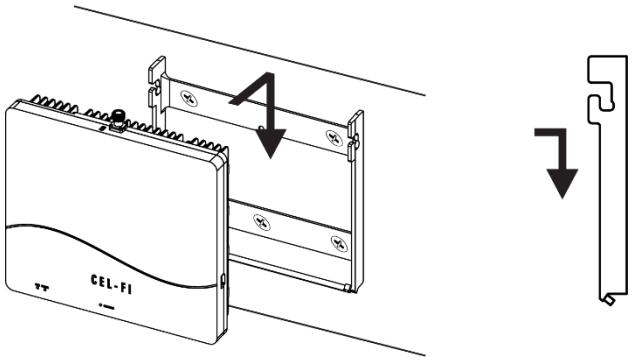


6. Attach the bracket to the wall with the included screws.

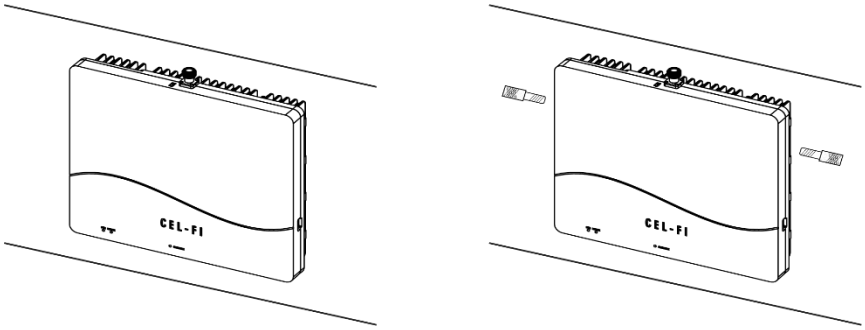


7. Once the bracket is firmly attached to the wall, the CU can be attached to the bracket.

8. With the bracket in place, attach the CU.



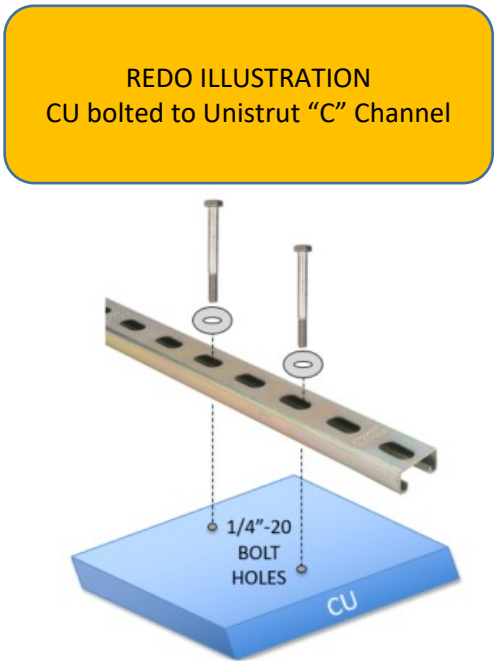
9. Tighten both Locking Screws to ensure the CU is securely attached to the mounting bracket.



CU Unistrut Hardware Mounting Option

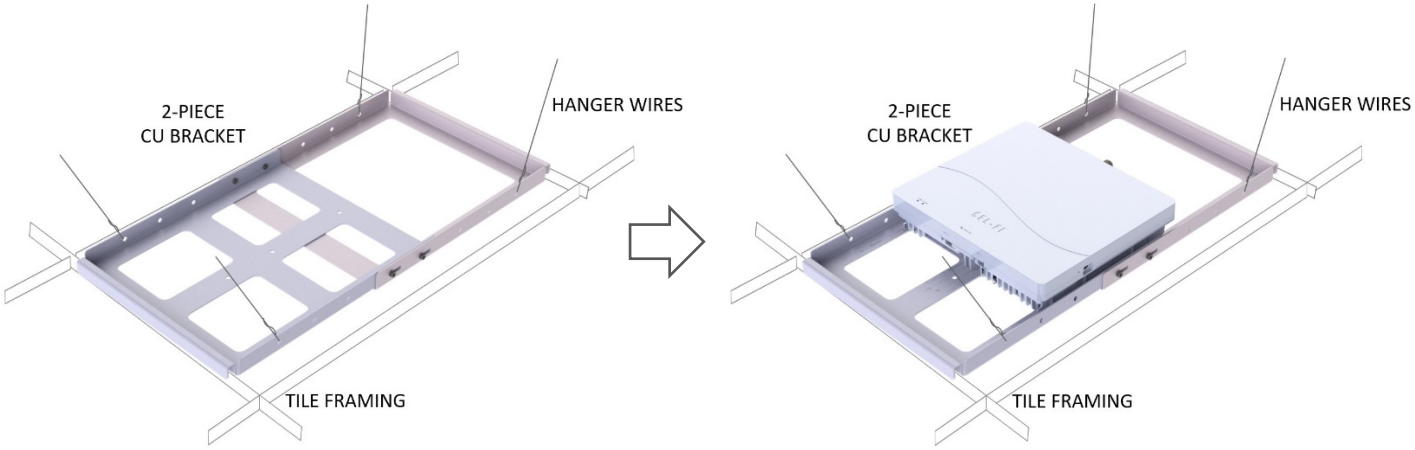
The CU may also be mounted using Unistrut mounting hardware configurations. Consult your Unistrut supplier for hardware options to suit your installation environment.

The example below shows the CU being bolted to a Unistrut C-Channel using two 1/4-20 thread bolts.



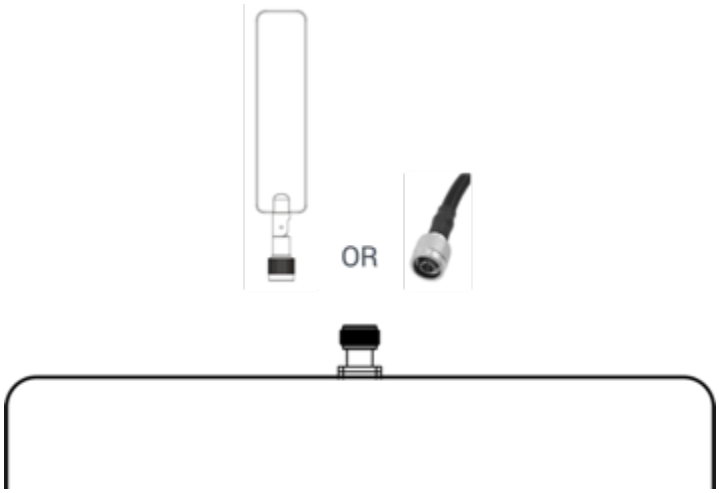
CU Ceiling Tile Bracket Mounting Option

The CU may be mounted on a suspended ceiling frame, using the optional Ceiling Tile mounting bracket (see the bracket mounting instructions that come with the bracket kit).



Connecting Server Antenna(s)

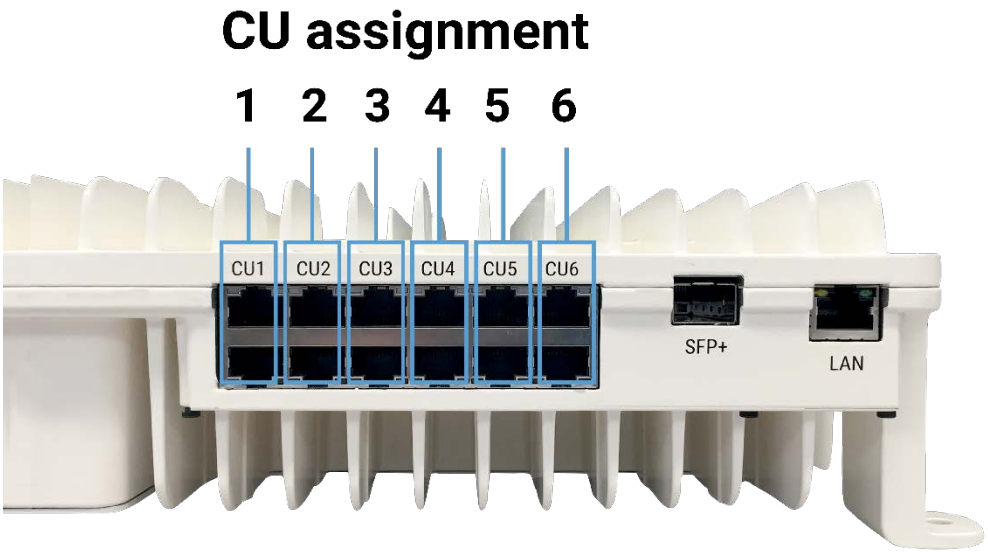
The CU has an N-type(f) connector on the top of the unit for attaching an antenna. An Omni-directional antenna may be used (for example for open spaces), or a coaxial cable can be connected with a series of passive antennas attached (best for hallways and office spaces).



Connecting Server Antenna or Cable

Cabling the NU to the CUs

Each CU connects to the NU using two category cables (Cat5e or better). QUATRA signaling is not Ethernet compatible, so routers, switches, bridges or other active Ethernet devices may not be used. Patch panels or punch-down blocks may be used.



CU port assignment on the NU

Follow general category cable routing practices. The system constantly monitors all CU cables, and a red CU LED means that the NU cannot communicate with a CU properly.

General CU Cabling Rules:

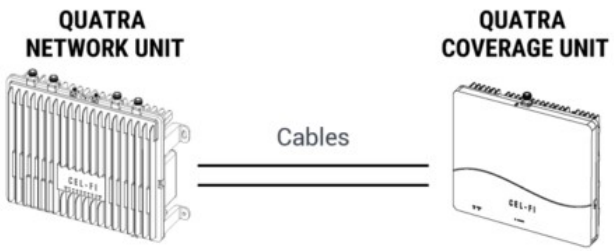
- QUATRA EVO uses category cables, commonly used as Ethernet cable. However, QUATRA EVO cables are NOT ETHERNET/LAN COMPATIBLE!
- CU cables must pass 1000BaseT (gigabit).
- CU cables may pass through patch panels, but not active equipment such as routers or switches that will not understand QUATRA signaling.
- CU cables should follow normal low voltage cable pathways.
- Do not run CU cables alongside AC power lines or other sources of interference such as lighting.
- Crossing power lines at 90 degrees is OK.
- Only QUATRA extenders may be used to extend a CU cable in length. Off-the-shelf Ethernet extenders or fiber interfaces will not work. Install the QUATRA extender halfway along the cable length.
- CU cable lengths up to 150 meters (150m+150m with a QRE) are possible with thicker gauge 22/23 Category cables.
- ONLY USE PURE COPPER CATEGORY CABLES. CCA (Copper Clad Aluminum) cables are not suitable for PoE applications.

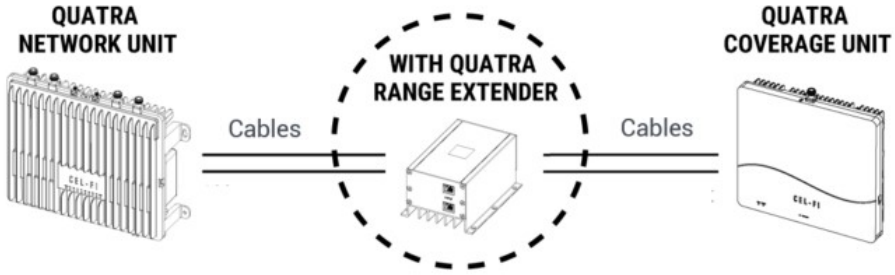
Troubleshooting:

- Check that each CU cabling rule has been satisfied.
- Debris in the port – blow off the connector/port and insert the connector a few times to “clean” the contacts.
- Test the port on the NU or CU to see if there is movement. If there is any movement then the port may be damaged.
- Plug the CU directly into the NU using a short known good machine-made Category cable to determine if the hardware or cabling is at fault.
- Redo the terminators on either end of the cable in alarm.
- Check that the RJ45 terminators are correct for the cable being used (cable diameter spec for example).
- Consider punch-down Ethernet Surface Mount Boxes to remove the human cable termination component. This is more in line with standard IT practices that favor screw or punch-down terminations and machine-made cables. They are more reliable, and end-point machine made jumpers are easily swapped out if they fault.

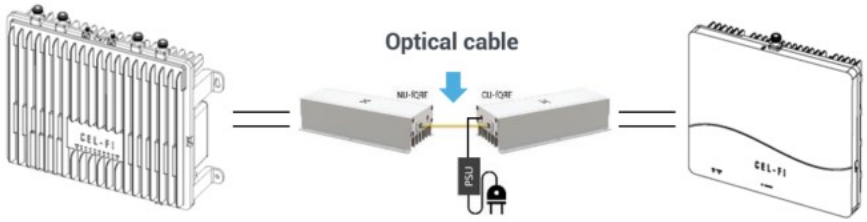
Using a QRE

If category cable lengths greater than 100 meters from NU to CU are required (150m if using 22/23 AWG CAT6/7 cable), a QUATRA RANGE EXTENDER (QRE-4K) may be used in the middle of the cable run to achieve lengths up to 300m.





If even longer CU cables are required, use the QUATRA Fiber QRE for up to an additional 2km of cable length.



Note: Only the QUATRA 4000 RANGE EXTENDER (QRE-4K) may be used. The QUATRA 1000 and QUATRA 2000 QRE is not compatible with the QUATRA EVO.

Creating a Connection from your EVO to the WAVE Portal

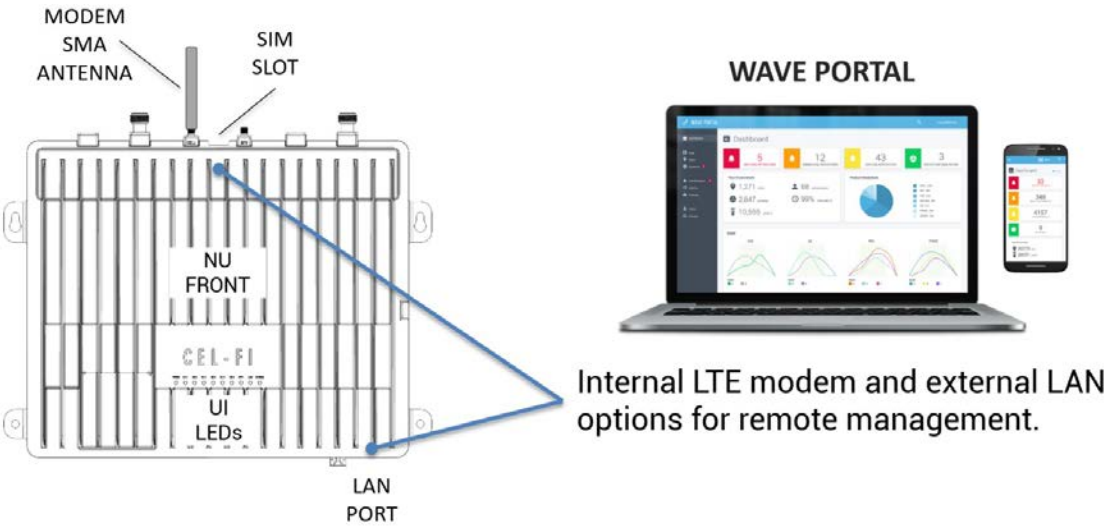
The connection method should be determined, and prepared, prior to the EVO installation. This will ensure that the portal is connected and available for commissioning and settings once EVO is powered ON.

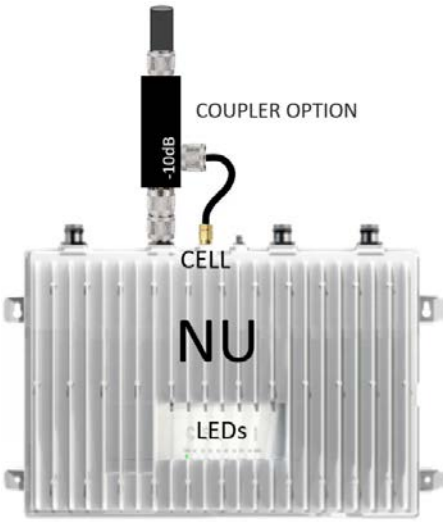
There are two ways to connect the NU to the cloud portal. If you do not have a portal login, please Request Portal Access.

The first connection method is through a wired LAN connection, which requires that firewall settings have been prepared ahead of time. Learn More about LAN Firewall Settings. You can test your firewall settings by plugging the LAN cable into a Windows 10 and higher PC, and running the Connectivity Test on the **WAVE Field Tool** that may be downloaded from here.

The second connection method is to use the cellular modem that is built into the NU. To use this method, screw an SMA(m) cellular antenna onto the SMA(f) port labeled CELL (GPS does not need to be connected). If there is no cellular service where the NU is located, you can also connect the SMA(f) CELL port to one of the donor antenna feeds using an RF coupler (e.g. -10 dB value).

Your modem SIM may be factory installed, or you will need to insert it once located with product packaging. If the SIM is not provided, or it does not work in your country, you may configure your own SIM APN using the **WAVE Field Tool** (for more information, please see your point of sale, or contact Nextivity Support).





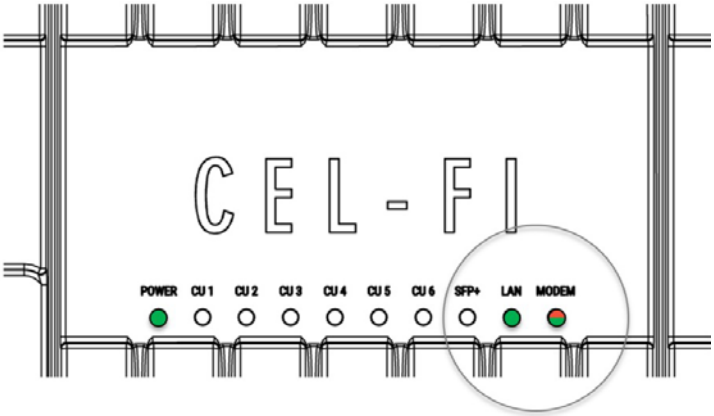
Power on the Completely Installed System

Now that all hardware, antennas, cabling, donor signals, and a portal connection have been installed, it is time to power up the system.

The QUATRA EVO system is powered from the NU. The NU comes with a power cord that plugs into the bottom of the NU. The CUs are Powered-over-Ethernet (PoE) and therefore do not have independent power supplies that need to be plugged in.

Note: It is recommended to zip-tie or otherwise secure the power cord once the system is powered-up, to prevent accidental unplugging.

Note: Once the NU is powered ON, the NU will automatically reach out to the **WAVE Portal** in the cloud and the LAN LED should be solid green, or blinking green to indicate traffic. If the NU internal modem is being used, then the Modem LED should blink Green-Red to indicate proper operation.



If your system is visible on the NEW SYSTEMS page, select it to begin commissioning. Note that the status icon must be green to indication that the system is online. Otherwise, troubleshoot the portal connection and then retry. You may use the **WAVE Field Tool** link below to test the portal firewall connection using a Windows 10 or later PC. This tool has many features, including the **Connectivity Test** to emulate the NU connection to test your firewall.

- Learn More about LAN Firewall Settings
- WAVE Field Tool

Commissioning and Settings on the WAVE Portal

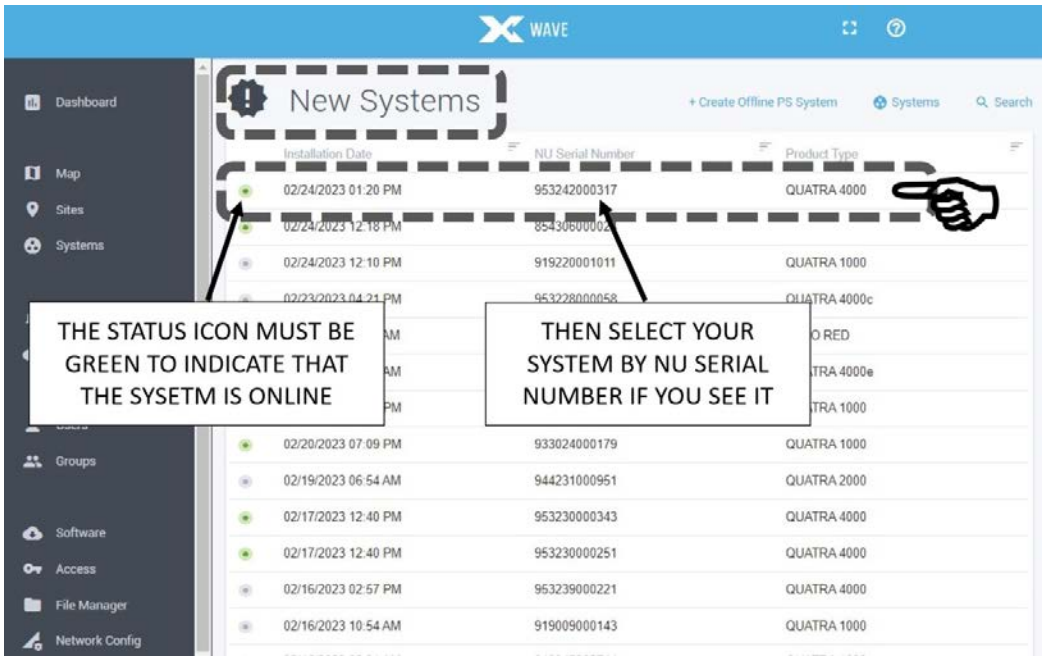
The full functionality of the **WAVE Portal** goes beyond the scope of this user guide. However, it an integral component of any installation. It is accessible using your PC, Tablet, or cellphone internet browser.

Each cloud connected system sends hourly performance data to the portal, so performance is trackable over time. If you are actively viewing the **Radio Data** page for a system on the portal, the portal requests real time data updates from the NU. Some of the portal features are as follows:

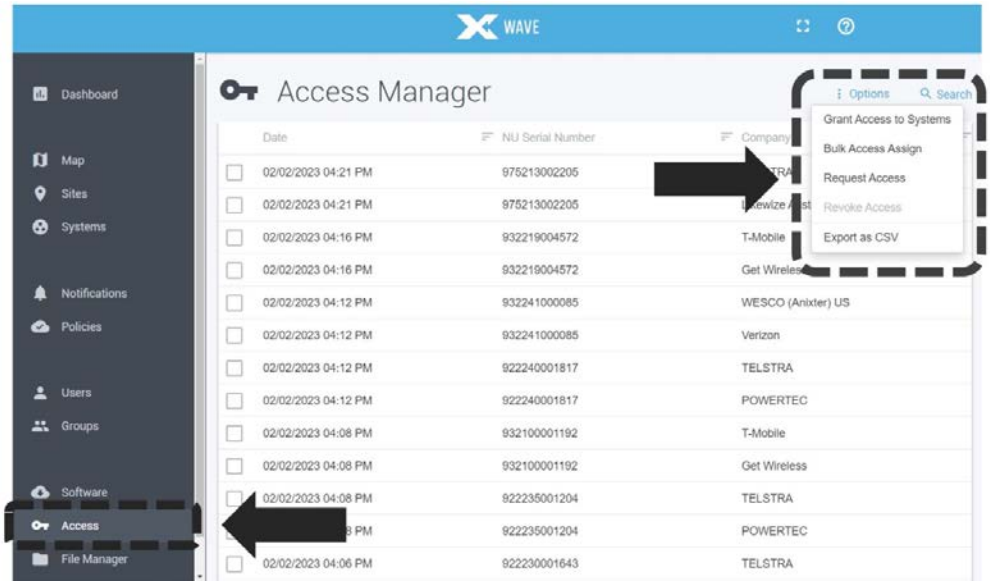
- Installation Map (global)
- Statistics and alarms
- Notifications (alarms, texts, email)
- Installation Site details
- Detailed system performance information
- Settings and control
- Software updates
- Remote diagnostics
- Automated analysis and guidance with improvement suggestions for each install
- Floorplan coverage grid test interface for the **COMPASS XR** (Cellular and Public Safety)
- Grid test automated report generation
- Cloud storage for your site documentation

The purpose of the portal is to save you time and money, and to help you realize maximum performance from each system you install. If you do not already have portal access, you may request it on our Support page: https://www.cel-fi.com/support/

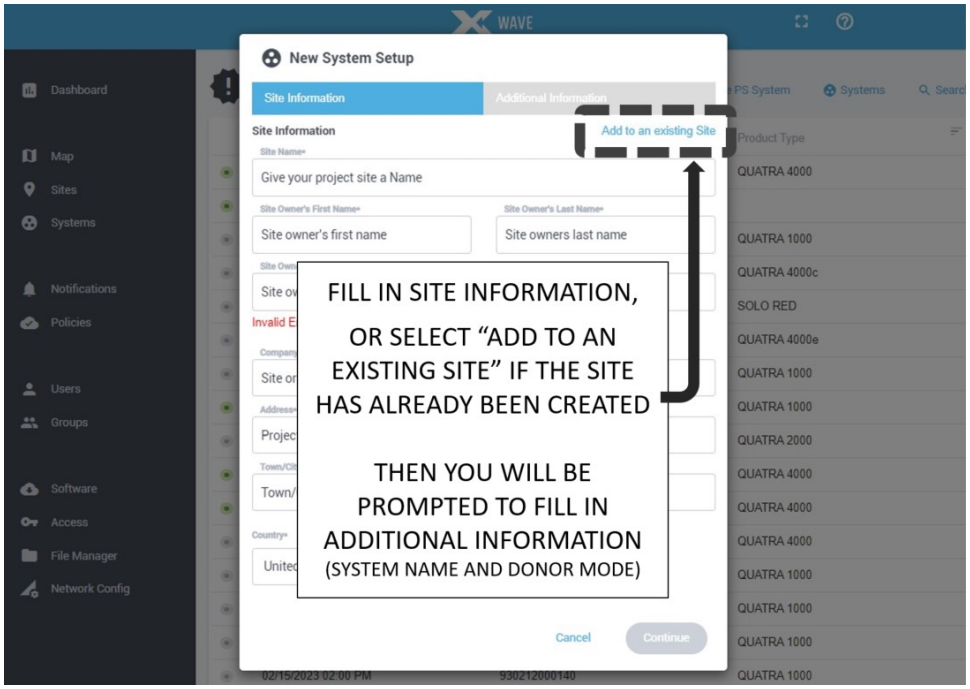
Go to the **New Systems** page and select your NU by its serial number, and follow the commissioning prompts.



If you do not see your NU on the portal within ten minutes after powering up the NU (**New Systems** page or **Systems** page), then you may need to register it with your portal login account. Click on the portal **Access** tab (lower left portal screen), and select the **Request Access** option under the upper right screen **Options** menu. Input the NU serial number and the SKU from the NU carton label, and access is immediately granted. If the NU carton has been discarded, contact your point of sale or Nextivity Support to obtain access.

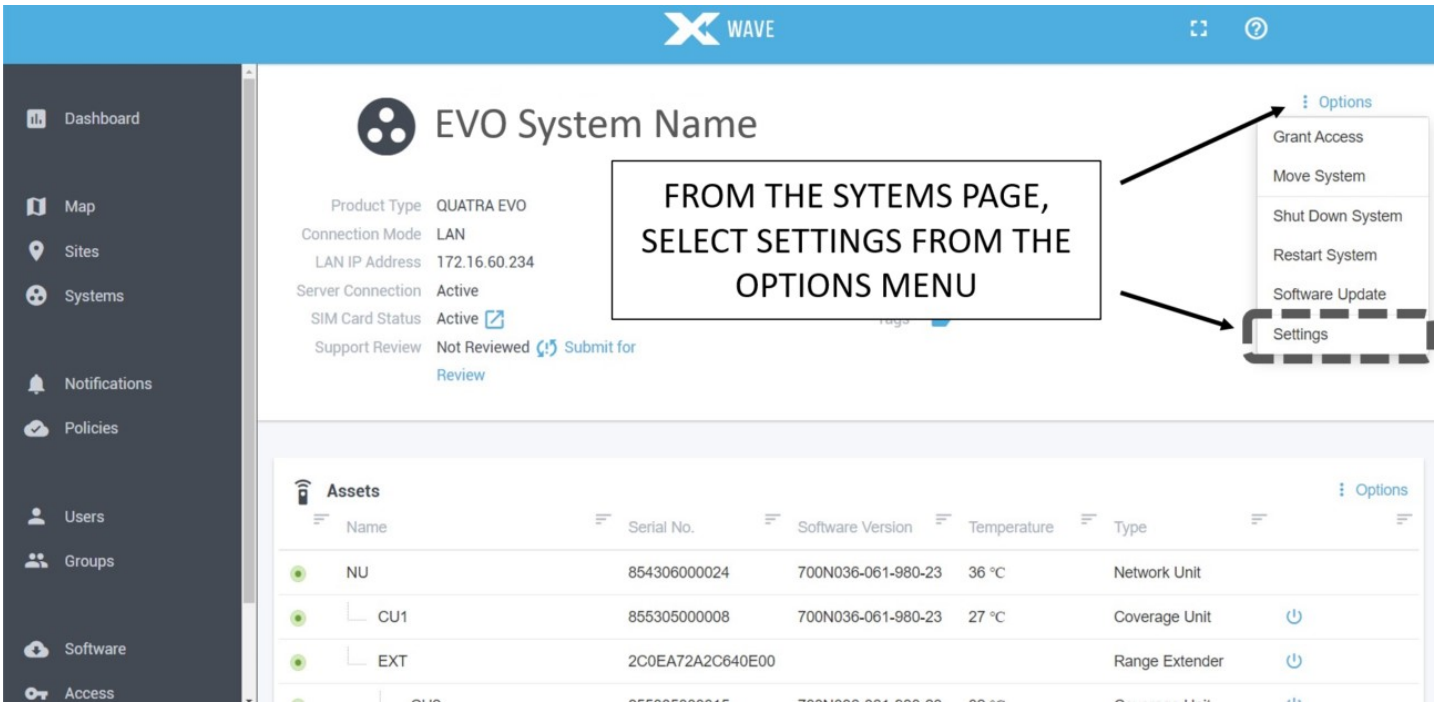


By now you should have been able to see the online NU on the portal, and select it to begin the guided commissioning process. You will be prompted to provide Site name and address details, or you may skip the step by adding the system to an existing Site where these fields have already been filled out. Then you will be prompted to input the system Name and Mode.



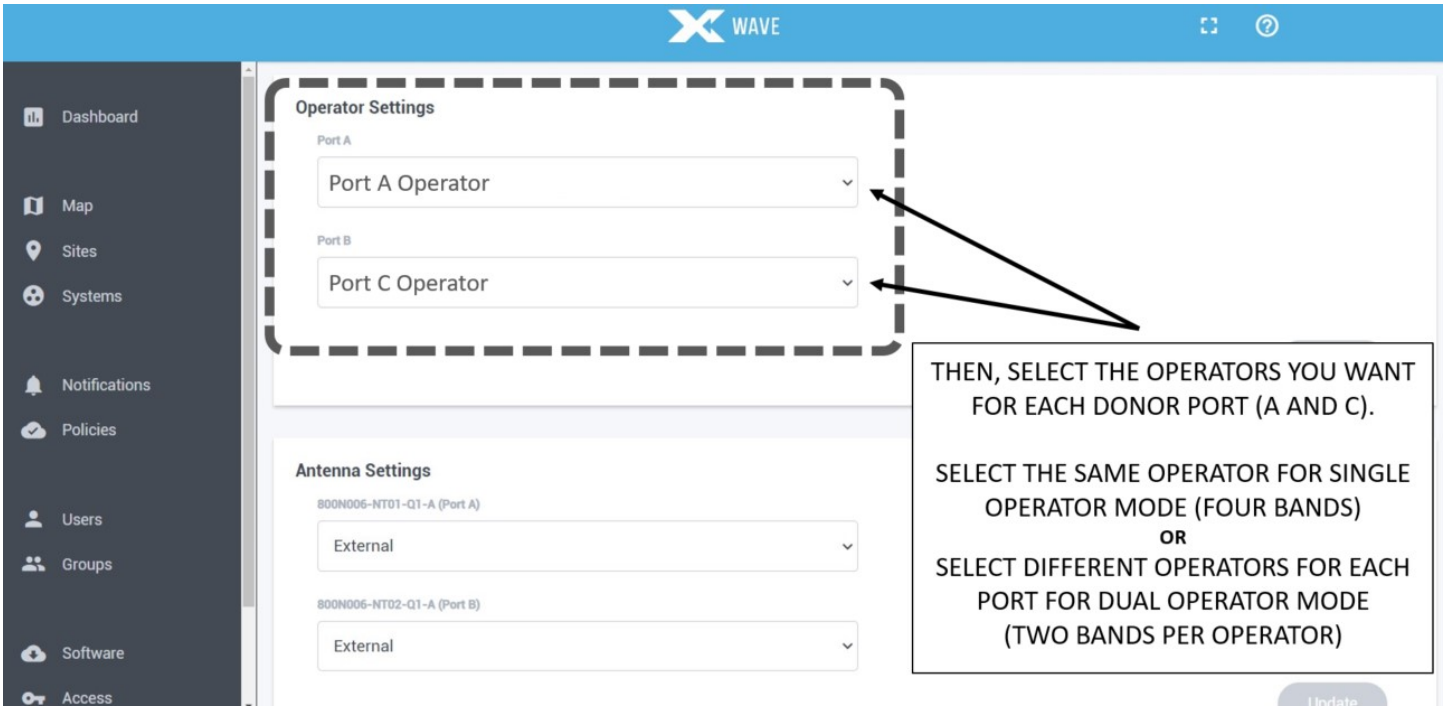
Once these commissioning steps are complete, your system will leave the **New Systems** list, and it will appear on the **Systems**, **Map**, and **Site** pages where all "in-service" systems are managed.

Next, set the preferred operational mode from the **Settings** menu. Open the **Options** menu on the **Systems** page, and select **Settings**.



On the **Settings** page, use the drop-down **Operator Settings** fields to select the operators you want to assign to Port A and Port C. Select the same operator for both ports for Single Operator Mode, or select different operators for Dual Operator Mode.

The system will automatically assign the channels with the highest priority and quality to each radio. Or, you may scroll down in the **Settings** page to manually configure the bands and channels you prefer.

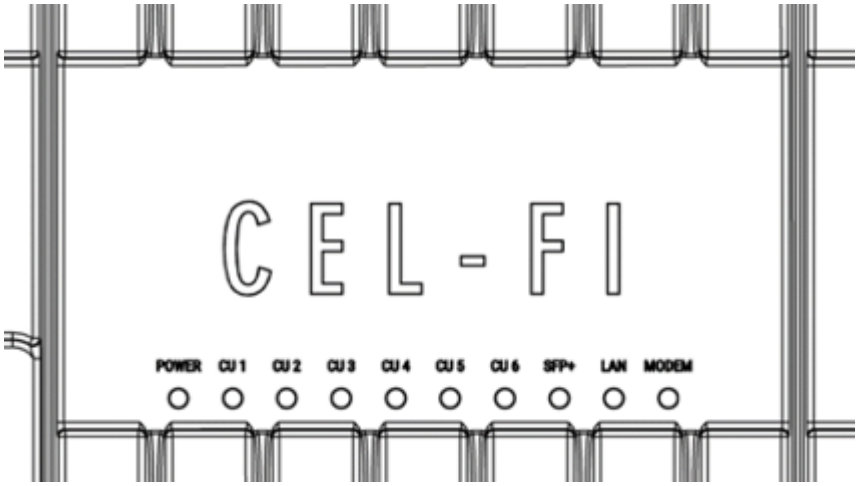


0.8 Diagnostics

Performance and Diagnostics are accomplished with system LEDs, and through the **WAVE Portal**.

NU LEDs

The QUATRA EVO NU has ten (10) LEDs on the front of the unit, used as status indicators, during setup and normal operation. The LEDs are labeled.



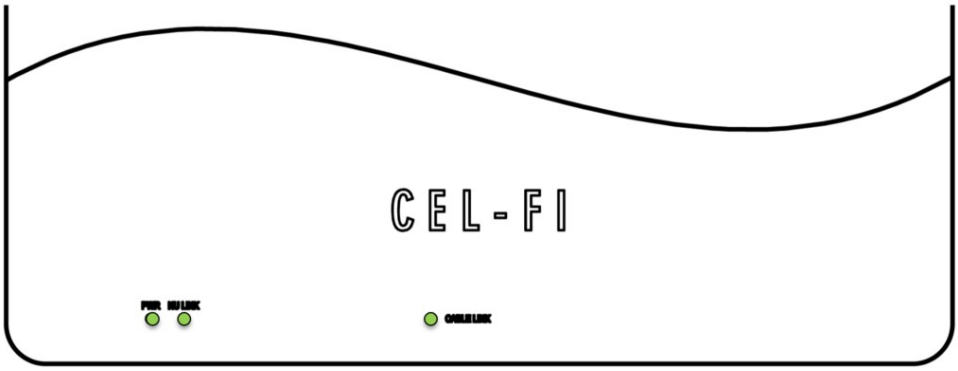
NU LEDs

The LEDs on the front of the QUATRA EVO function as follows:

LED Label	LED State	Meaning
POWER	NO LIGHT	No power
	SOLID GREEN	Powered and operating normally
	FLASHING GREEN	Scanning to acquire network signals
	SOLID RED	Hardware error
	FLASHING RED	Error
CU1, CU2, CU3, CU4, CU5, CU6	NO LIGHT	Not connected properly, no power
	SOLID GREEN	Connected, powered and operating normally
SFP+	SOLID GREEN	SFP+ module installed, and communicating properly
	FLASHING GREEN	SFP+ module installed, not communicating
LAN	SOLID GREEN	Link is up
	FLASHING GREEN	Link is up and active
MODEM	SOLID GREEN	Modem is installed, connected, and has an IP address
	FLASHING GREEN	Modem is attempting to connect
	FLASHING RED-GREEN	Modem is functioning properly

CU LEDs

Each QUATRA EVO CU has three (3) LEDs on the front of the unit, used as status indicators, during setup and normal operation. The LEDs are labeled.



CU LEDs

The meaning for each LED on the CU is shown in the table below.

LED Label	LED State	Meaning
POWER	NO LIGHT	No power
	SOLID GREEN	Powered and operating normally
	FLASHING GREEN	Network scanning
	SOLID RED	Hardware error
	FLASHING RED	Error
NU LINK	NO LIGHT	Logical Link: Down
	SOLID GREEN	Logical Link: Up
CABLE LINK	NO LIGHT	Physical Link: Down
	SOLID GREEN	Physical Link: Up

WAVE Portal Notifications

The portal has many useful features. Once a system is online, check the **Systems** page for **Active Alarms**, or **Alarm Notification History** in the event of recurring alarms that may not be currently active.

CEL-FI systems support a variety of standard alarm conditions. **Policies** are your own account settings for alarms, alarm severities, and whether you want them displayed on the portal (console), or emailed or texted to individuals or groups. Each new user (company) is given a “Default Policy” with the basic alarms already in it. You may edit this policy as you please, or create new policies. For example, you may want different policies for different regions. It is the responsibility of policy holders to add new alarms that may be introduced with new products. It is recommended that all of your policies have all possible alarms, so they can properly report alarms for all products where alarm options may differ.

Alarms for a given system are displayed on its **Systems** page. If you would like a list of all alarms across all of the systems your company has installed, refer to the **Notifications** tab.

For information on how to resolve any alarm, simply select the alarm notification in the **Alarm Notification History** window, and help text will be displayed.

Below is a non-exhaustive list of basic alarm categories.

Troubleshooting (WAVE Portal Alarm Notifications)

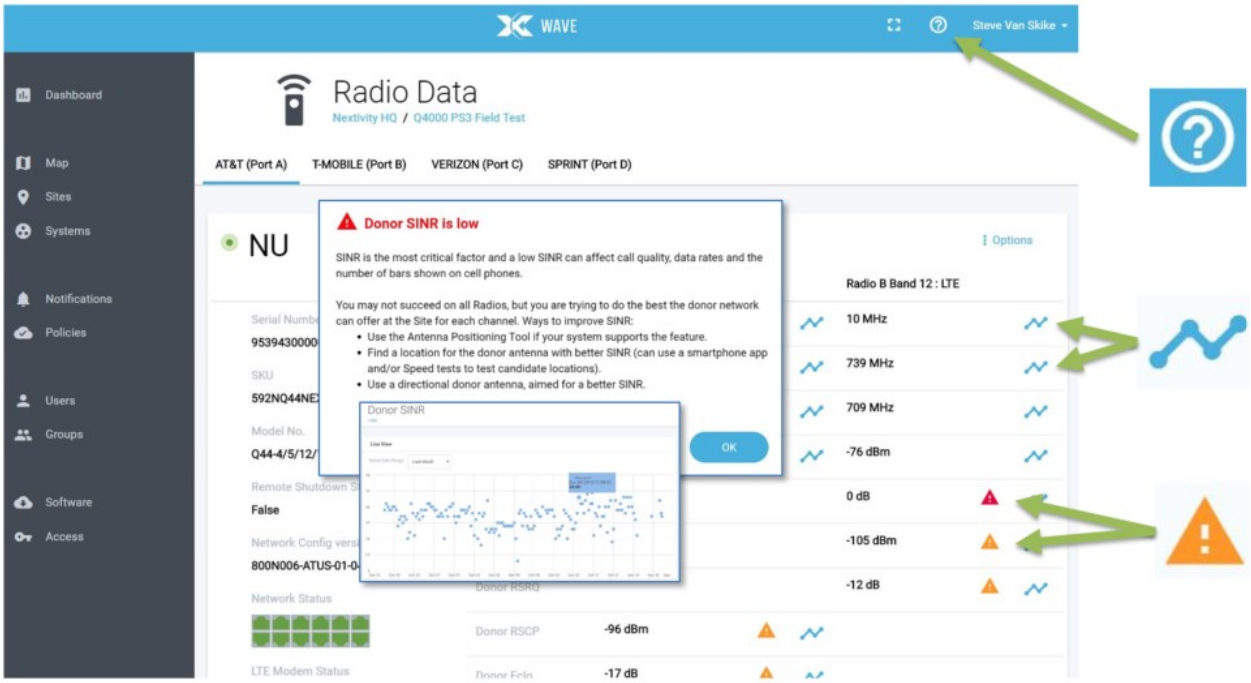
Alarm	Description

NU Hardware Error	Power cycle the NU and check for software updates. If problem persists, return NU for service.
Insufficient Donor Signal	Relocate NU where a stronger signal exists, or use an external antenna for the NU. If using a small cell, verify the small cell can process calls and check the connections to the NU. Power cycle the NU.
CU Hardware Error	Troubleshoot any NU error first, and check for software updates. Make sure CU cables do not exceed recommended cable length maximums. Note that standard Ethernet Extenders or active LAN switches and routers will not work with CU cabling. Power cycle the CU by detaching and reattaching the LAN cable. Test CU by plugging it into back of NU with short test cable.
Donor Signal Too Strong	Move NU, or re-aim NU external antenna. Strong signal source may be from another Operator's device (cell tower, local small cell, or booster).
NU is Overheating	The NU should be upright and the air vents not blocked. Move NU to a cooler area.
CU is Overheating	Make sure the CU air vents are not blocked, or move the CU to a cooler location.
Too Close	One of your CU is too close to your NU. Try moving the units farther apart (or move units so more signal blocking structures isolate them from each other).
Too Far	One of your CU is too far from your NU. Try moving the units closer together.
Disabled by Operator/Vendor	Your system has been disabled by the mobile network operator or vendor. Contact your vendor for further assistance.
Location Lock	Your system has been moved from its original address. Please move the system back to its original location or register your new address with your wireless provider.
Registration Required	Systems are pre-enabled and operator registration is obligatory.
Self-Test Failed	Power cycle the unit and check for software updates. If problem persists, return the unit for service.
Small Cell Not Detected	NU Mode is set to small cell. Verify that small cell is connected and operational, or set NU Mode to Internal or External Antenna if no Small Cell used.
Small Cell Detected	Small Cell Detected but NU is not set to Small Cell. Use the **WAVE Portal** to set NU Mode to Small Cell.
Antenna Configuration Error	Too Many CU connected. More than one CU in use for Off-Air configuration. Use the **WAVE Portal** to set Mode to External Antenna, and NU should be connected to an external antenna.
Antenna Positioning Required	Antenna positioning incomplete. Use the **WAVE Portal** to aim the NU donor antenna.
CU Link Lost	The cable link between NU and CU is behaving unreliably or reporting an error. Ensure the CU cable is not damaged and its connectors are securely plugged in on both ends.
CU Shutdown from Portal	CU's 1 through 6 has been shut down from the Portal.

WAVE Portal Guidance Alerts

The portal has many useful features for evaluating service or diagnosing issues, all without the need to visit a Site.

- If you need help on a portal topic, select the (?) Help icon for more information.
- If you want to see how RF service parameters have been behaving over time, select the blue Chart icon next to the KPI for a chart of the data over time.
- If you see a guidance alert icon, you can select it to bring up helpful advice on how to improve performance.



You will find more information and tutorial videos at cel-fi.com to help you become a portal expert.

09. Tips

Most installation issues involve these three categories. Mastering each one helps assure a quick installation, and best performance.

- WAVE Portal connectivity
- CU cables
- Donor antenna selection, placement, and aiming

WAVE Portal Connectivity

This topic has already been covered at length in this guide. If using the wired LAN connection, use the **Connectivity Test** function in the downloadable **WARE Field Tool** to test your firewall settings if needed.

If using the internal modem, make sure that a cellular signal antenna is plugged into the CELL port atop the NU, and that this antenna connection is providing a usable cellular signal. Also verify that a SIM card is properly inserted into the SIM card slot on the NU, and that the SIM card has an active service plan. If the NU is online, you can check the modem state using the **SIM Card Status** button on the **Systems** page. If using your own SIM, be sure to set up the APN properly using the **WAVE Field Tool**.

Once a system is online, always update the software by selecting **Software Update** using the **Options** menu on the **Systems** page. This will harmonize the software versions on all of your EVO components, and help ensure that you have the latest features and software improvements.

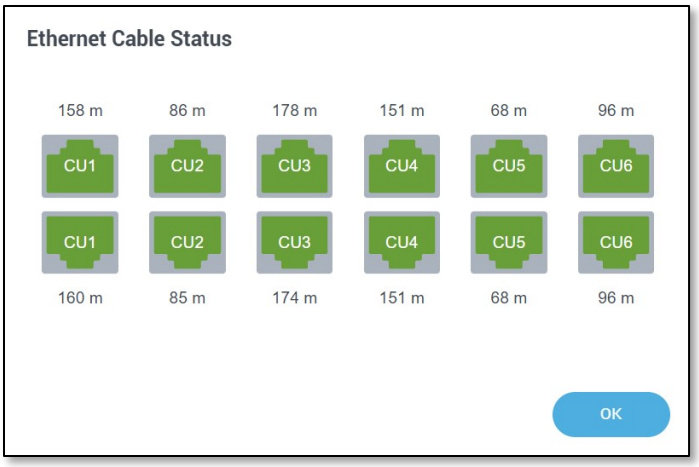
See Nextivity Support materials at www.cel-fi.com for helpful documents, videos, and the CEL-FI University training materials on how to use the portal to your advantage.

CU Cables

Alarms on the CU category cables are the most common alarm during an installation, and they are easy to resolve. Trust the CU# LEDs on the NU. CU cables are constantly tested by the system. If the LEDs indicate a problem, test the cables.

You can always test a CU with short machine-made Ethernet cables by plugging the CU directly into the NU. If the NU and CU function properly, then troubleshoot both cables to the CU.

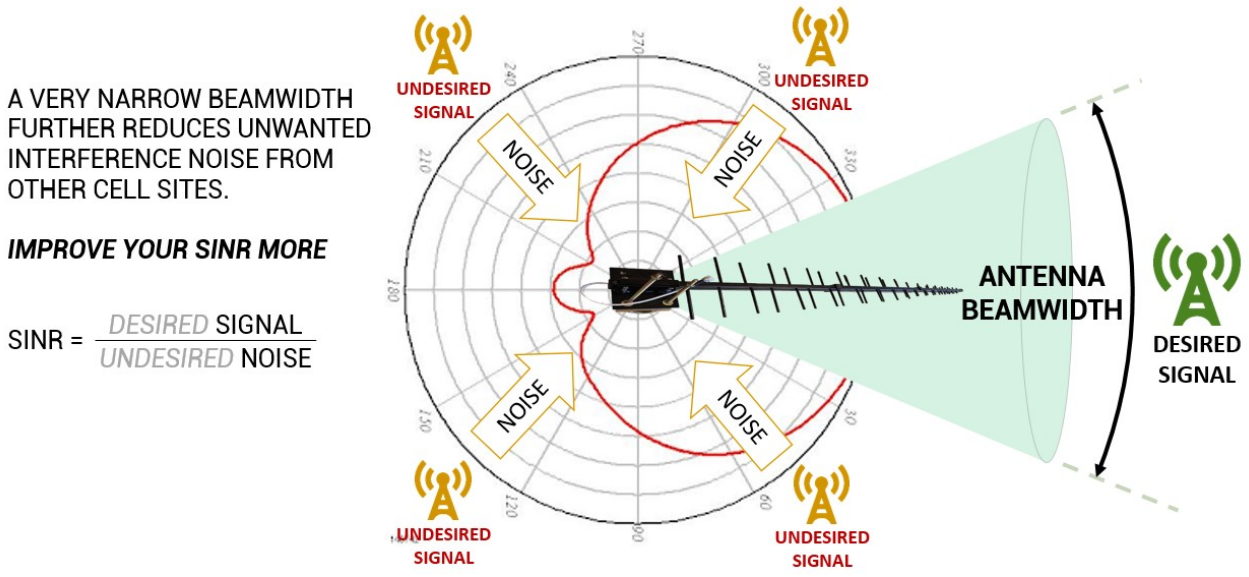
Proper category cabling practices may be found in the CU installation sections of this guide. Usually, merely re-crimping the cable RJ45 terminations, and re-inserting the RJ45 terminators a few times to clean the contacts will resolve the problem. You can also select the **CU Cable Port** graphic in the **Radio Data** page for your system, where you can view whether a cable is in service (green), and see the cable length as measured by the system in meters. If a cable is too long, a QUATRA Range Extender should be installed halfway along the CU cable length.



Donor Antenna Selection, Placement, and Aiming

Nextivity CEL-FI systems have a major advantage over other system designs, in that each operator's channels are independently extracted and processed. This makes is possible to have a separate donor antenna for each operator, making it possible to aim an operator's donor antenna directly at the operators cell site.

In this fashion, a donor antenna for a CEL-FI system is acting much like a filter, to reject unwanted interference signals from undesired cell sites or other interference sources. The result is improved SINR and RSRQ signal quality, which directly translates into more phone signal bars and faster better cellular service.



Please take your time when carefully selecting the best location to mount the donor antennas. For a shorter building, the antennas are normally mounted on the top of the building where they may be pointed in any direction where signals are coming from. For taller buildings, such as high-rise buildings in metropolitan areas, roof mounted antennas may have poor signal power, or too much signal power from too many interfering cell sites. In this case, your best option may be a small donor antenna mounted closer to the street level where the operators have optimized their networks to serve pedestrians.

Please watch the following video on donor antenna practices. Good signal quality in, means good signal quality out. Once you become good at donor antennas, you become a great installer.

https://www.cel-fi.com/casestudy/cel-fi-quatra-antenna-selection/

Useful Toolbox Items for Installs

We recommend that you bring the following items to every install, because every installation site is different, and you often won't know what you need until you begin the installation.

ITEM	WHY YOU MAY NEED IT
2x6ft Ethernet cables (machine made)	If a CU cable is alarming, you can use the cables to connect the CU directly to the NU to verify it is functioning properly. Then troubleshoot the CU cables.
N Attenuators (10 and 20 dB values)	Use to attenuate an extremely strong donor signal, which might cause the signals to not be relayed with good SINR, or with the gain needed for full DL power. NOTE: Some global operators, and the FCC, have rules to reduce gain if a donor signal is too strong.
2-Way and 3-Way splitters, N type(f) connectors	Splitting donor signals to multiple NU ports if needed.
Various short N-N type cables and barrels	Misc. connection needs.
SMA(m) Cellular antenna	Spare for the NU modem.
10dB coupler and N(m) to SMA(m) cable	If no signal is available at the NU CELL modem port, you can use the coupler to connect the CELL port to one of the donor coaxial feeds.
LPDA-R, Wideband Directional, whip, and larger and smaller Panel antennas.	Donor antenna options. Highly directional (narrow beam) antennas are usually best, but if the best quality donor signal is closer to street level, you may want a panel antenna, or even a small whip antenna (stealth).

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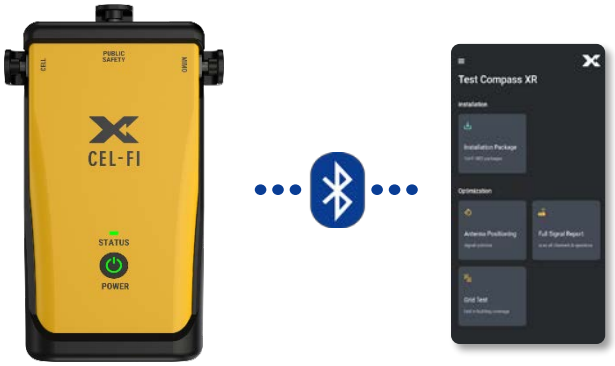
10 Helpful Tools and Signal Quality

WAVE PRO and COMPASS XR

COMPASS XR is a hand-held battery operated device specifically designed to simplify the installation of Nextivity systems. The **WAVE PRO app** connects to and controls **COMPASS XR** over Bluetooth.



COMPASS XR and the **WAVE PRO App**

COMPASS XR and the **WAVE PRO app** have many useful features, including:

- Donor Antenna Aiming
- Full Cellular band scans for 4G and 5G, plus Public Safety 700/800 bands
- Grid Testing
- System Configuration, Settings and Diagnostics (Nextivity Public Safety systems)

WAVE Field Tool

The **WAVE Field Tool** runs on Windows 10 or higher, and has many useful tools such as:

- Cloud Connection test (NU to the WAVE Portal)
- SIM card maintenance
- DHCP/Static IP Settings
- Factory reset
- Cloud Reset
- Full system software update/reload

For more information about **COMPASS XR**, the **WAVE Field Tool**, or other useful tools and resources, please contact your point of sale or Nextivity at www.cel-fi.com

Donor Signal Quality

A good donor signal, arriving as cleanly as possible, to the NU, is perhaps the most important consideration in driving the best experiences and outcomes with QUATRA EVO.

With regard to 4G or 5G, there are two metrics of particular importance to monitor and optimize:

1. RSRP. Reference Signal Receive Power. It is the power of the LTE Reference Signals spread over the full bandwidth and narrowband. A minimum of -20 dB SINR (of the S-Synch channel) is needed to detect RSRP/RSRQ.

In the context of CEL-FI QUATRA EVO, the following stratification of quality is recognized:

RSRP	Signal Strength
> -90 dBm	Excellent
-90 dBm to -105 dBm	Good
-106 dBm to -120 dBm	Fair
< -120 dBm	Poor

2. SINR. Signal to Noise Ratio. The SINR is the ratio of the usable (desired) signal over the noise. The following metrics should be used when assessing SINR in the context of Cel-FI QUATRA EVO.

SINR Value	Throughput
> 10	Excellent
6 to 10	Good
0 to 5	Fair
< 0	Poor

11. CEL-FI Antennas

Grounding and Lightning Protection

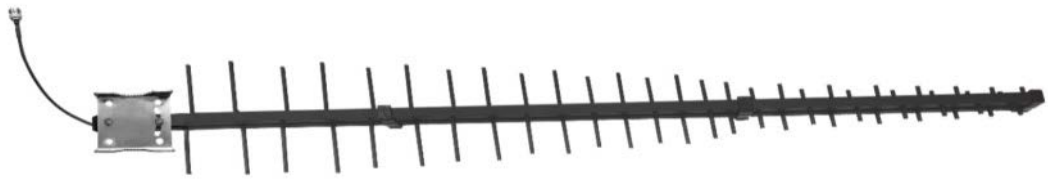
Installers of CEL-FI QUATRA EVO are encouraged to follow the lightning protection guidelines documented in the National Electrical Code (NEC) and NFPA 780, and/or local codes.

Donor Antennas

The QUATRA EVO is designed to be used with the following antennas.

1. LPDA-R Antenna

Model Number: A62-V44-201https://cel-fi.com/antennas/lpda-r-antenna/



The CEL-FI LPDA-R Antenna offers a powerful 12 to 14 dBi gain (depending on operator frequency) over 617–4000 MHz and is designed to reduce out of band noise, to improve SiNR and overall signal quality. Mounting is made simple with the included U-Bolts. This CEL-FI product also features a 10K ohm resistor that enables the antenna connection to be validated by CEL-FI NUs equipped with the antenna sensing capability.

- 12–14 dBi gain
- N-type(f) connector
- 5G-ready
- Narrow beam-width to reduce noise
- Rugged construction for harsh environments
- Includes a 10K ohm resistor for special CEL-FI applications

2. CEL-FI Wideband Directional Antenna

Model Number: A32-V32-201

The CEL-FI Wideband Directional Antenna is an outdoor vertically polarized highly directional antenna for Cellular Boosters; with 10 dB gain in the low bands and 11 dB gain in the high bands. The weather resistant housing is built with UV stabilized ABS plastic casing. The unit includes standard brackets for mounting.

- Outdoor/Indoor use
- Boosts Cell Signal by up to 11 dBi
- N-type(f) connector
- 5G-ready
- 700 – 2700 MHz Frequency
- Vertical Polarization
- Directional

Server Antennas

The QUATRA EVO CU has a single RF output port in the form of an N-type(f) connector on the top of the unit. A single whip or blade-style antenna can be attached directly, or a distributed antenna system can be deployed.

Antenna Selection

There are two types of indoor antenna to choose from:

Omni-directional dome antennas broadcast and receive signals from all sides. They are designed for central locations with 360º coverage requirement. Like outdoor antennas, their power is measured by their “gain”. They are typically mounted to a ceiling for best results.

Nextivity has standard dome antennas and also offers ‘low-profile’ server antennas that are thin and occupy less visual space.

Panel antennas 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 in a particular direction. 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 a wall.

Nextivity has a few different panel antenna options, with different levels of gain and directivity.

1. Indoor Omni Dome Antenna

Model Number: A11-V43-121

The Indoor Omni Antenna receives and transmits signal in a 360° pattern and are compatible with the 698 - 2700 MHz frequency ranges that include 3G, 4G and 5G signals.

- Indoor use
- N-type(f) connector
- 5G ready
- 50 ohm
- 698 - 2700 MHz
- Omni-directional

2. (Low-Profile) LP SISO Indoor Omni Antenna

Model Number: A11-H43-201

Nextivity's CEL-FI LP SISO Indoor Omni Antenna provides a 360-degree horizontal coverage pattern in an ultra-modern, low-profile, high performance industrial design.

- Indoor use
- N-type(f) connector
- 5G-ready
- 50 ohm
- 617–4000 MHz
- Ultra low-profile

12. Advanced Information - Antennas and QUATRA EVO

Antenna Kitting Section

In order to comply with FCC/ISED RF Exposure requirements:

1. The donor antenna must be installed to provide at least 65 cm separation from the human body at all times.
2. The server antenna must be installed to provide at least 20 cm separation from the human body at all times.

Antenna systems to be used with QUATRA EVO are limited per table below:

Port	Max System (Antenna & Cable) Gain
CU	0.01 dBi for WCDMA Band 5 1.16 dBi for LTE Band 4 1.44 dBi for LTE Band 12 1.16 dBi for LTE Band 13 0.14 dBi for LTE Band 25
NU Port A	8.32 dBi for WCDMA Band 5 6.63 dBi for LTE Band 4 8.08 dBi for LTE Band 12 6.52 dBi for LTE Band 25
NU Port C	6.63 dBi for LTE Band 4 7.99 dBi for LTE Band 13 6.52 dBi for LTE Band 25

13. Specifications

For details, please refer to the CEL-FI QUATRA EVO Data Sheet

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14. Trademarks

CEL-FI, IntelliBoost, and Nextivity logo are trademarks of Nextivity, Inc.

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15. Warranty & Limitation of Liability

Nextivity Inc., provides a limited warranty for its products.

For details, please refer to cel-fi.com/warranty.

In no event shall Nextivity, nor its directors, employees, agents, suppliers or End Users, be liable under contract, tort, strict liability, negligence or any other legal or equitable theory with respect to the Products or any other subject matter of this Agreement (i) for any lost profit, cost of procurement of substitute goods or services, or special, indirect, incidental, punitive, or consequential damages of any kind whatsoever or (ii) for any direct damages in excess of (in the aggregate) the fees actually received by Nextivity from End User with respect to the Products actually purchased and paid for.

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16. Compliance

In the event of regulatory compliance issue, please contact Nextivity Inc. directly.

Contact information is available at cel-fi.com/doc

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17. Glossary

Term	Definition
MIMO	Multiple In, Multiple Out
SISO	Single In, Single Out
SiNR	Single to Noise ratio
RSRP	Reference Signal Receive Power
RSSI	Received Signal Strength Indicator
Donor Antenna	Antenna used to capture the exterior macro cellular network signal, and provide such signal to the system.