XR Series Router Antenna FAQ

APPLICATION NOTE

AirLink XR Series routers are Sierra Wireless's highest throughput and most capable cellular routers. XR Series 5G routers support peak 5G cellular download speeds of >4 Gbps and peak 5G cellular upload speeds of >600 Mbps. To achieve the best possible 5G cellular performance and reliability, **XR Series 5G routers must be connected to 4×4 MIMO 5G cellular FAKRA-based antennas that support the full cellular frequency range of 600 MHz to 6 GHz**.

Carrier networks typically evolve over time. For example, cellular signal modulation schemes may change and the range of supported bands often evolves. For this reason, using non-4×4 MIMO antennas may indicate acceptable performance initially, but that could change in the future as carriers evolve their networks. It is much more cost effective to deploy XR Series routers with the correct antenna initially than it is to retrofit the correct antenna later following a performance-impacting carrier change.

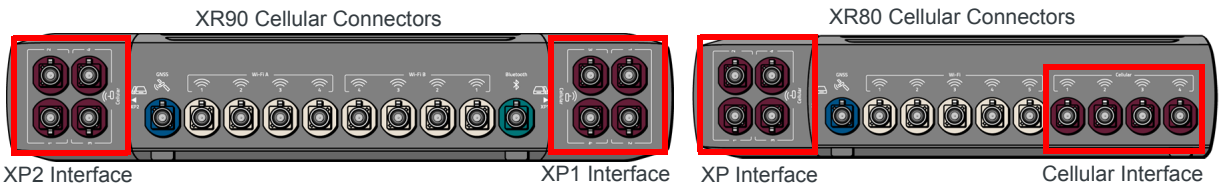
Sierra Wireless offers a range of 5G capable antennas in combination with Wi-Fi and GNSS antennas in a variety of form factors. For XR Series 5G routers, Sierra Wireless doesn't support using, or reusing, 4G cellular antennas because 4G cellular antennas do not support the full 5G cellular frequency range, which would mean the XR Series 5G routers will not achieve their full 5G performance.

The FAQ outlines best practices for the following:

Sierra Wireless antenna resources

- Antenna portfolio page
- Antenna Selection Guide [PDF download]

1. XR Series Cellular Antennas



What are the XR Series supported cellular MIMO configurations?

- The XR Series only supports 4×4 MIMO cellular antennas.
- All cellular antenna elements are used and must be connected.

Can I use a 4G antenna with my XR 5G router?

- No. 4G cellular antennas do not support the full 5G 600 MHz to 6 GHz cellular frequency range.

Can I use two 2×2 MIMO third-party 5G capable antennas?

- No. Only 4×4 MIMO 5G antennas are supported.

Can I use 2×2 MIMO third-party 4G capable antennas?

- No, Sierra Wireless does not support 2×2 MIMO 4G antennas. Only 4×4 MIMO 5G antennas are supported for XR.

Can I connect a cellular antenna that has fewer than four antenna connectors?

- No. The XR Series routers require four antenna elements to support 4x4 MIMO. All four cellular connectors on an XR Series cellular interface must be connected.

Do I need to use 50Ω terminators on unused cellular antenna connectors?

- XR Series routers only support 4×4 MIMO cellular antennas, therefore 50Ω terminators are not required.

Which antennas can I use with the XR80 LTE Cat 20 router?

- See Sierra Wireless antenna resources above.

Can I use an SMA to FAKRA adapter to use a SMA-based third-party cellular antenna?

- Sierra Wireless does not support using SMA to FAKRA adapters, as any adapter introduces signal losses and reduces performance.
- If you must use a SMA to FAKRA adapter with a third-party antenna, make sure the antenna is designed for 600 Mhz to 6 GHz, including the cable.

Can I use a third-party SMA-based 4×4 MIMO 4G antenna with my XR 4G router?

- Sierra Wireless does not support the use of SMA to FAKRA adapters, as any adapter introduces signal losses and reduces performance.

Are there SMA to FAKRA adapters available to convert from an SMA-based antenna to FAKRA?

- Sierra Wireless does not support nor sell SMA to FAKRA adapters.

Will Sierra Wireless offer SMA to FAKRA adapters for sale?

- No

Why is the Sierra Wireless 5G dome antenna taller than the Sierra Wireless 4G dome antenna?

- The 5G dome antenna is slightly taller to provide maximum 5G performance via the optimal spatial separation of the antenna elements.

What are the Sierra Wireless Sharkfin antenna options?

- See Sierra Wireless antenna resources above.

Does Sierra Wireless support single antennas that include cellular, Wi-Fi and GNSS?

- See Sierra Wireless antenna resources above.
- For the XR80 we do offer 10-in-1 antennas.
- For the XR90 you will need two or more antennas depending on your configuration.

Can I use cellular paddle antennas?

- No—Sierra Wireless does not supply or support the use of cellular paddle antennas because they may violate transmit power limits.

Can I extend the antenna cables?

- Yes, noting that longer cables have additional losses, and the best practice is to reduce the number of cable connectors. Sierra Wireless antennas ship with pigtails attached to the antenna, and the best practice is to attach the longer cable directly to the pigtails rather than extending the already long cable. You can also request ultra low loss cables (LMR 400+) from your antenna vendor if you need to use longer cables.

Can I shorten the antenna cables?

- No. Sierra Wireless does not support shortening the antenna cables.

Can I use third-party multi-element cellular antennas?

- No. Sierra Wireless does not support using third-party multi-element cellular antennas.

2. XR Series Wi-Fi Antenna

What is DFS?

- From Wikipedia: Dynamic Frequency Selection (DFS) is a channel allocation scheme specified for wireless LAN, commonly known as Wi-Fi. It is designed to prevent electromagnetic interference with other usages of the C band frequency band that had predated Wi-Fi, such as military radar, satellite communication, and weather radar.
- DFS channels are 160 Mhz wide and may be restricted to indoor or outdoor usage depending on your region.
  - https://en.wikipedia.org/wiki/List_of_WLAN_channels

Do XR Series routers support DFS?

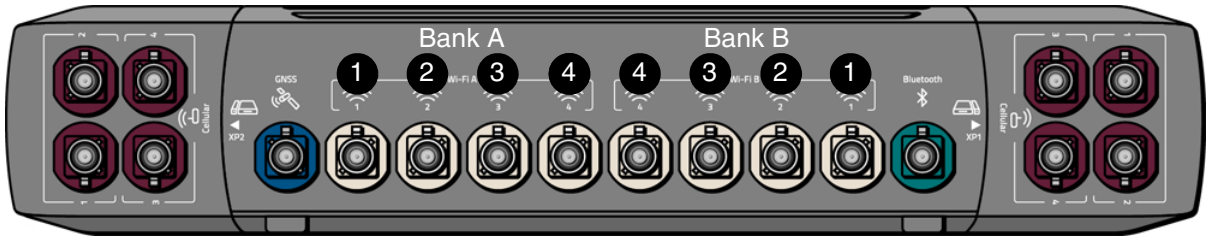
- Yes. DFS frequencies are available depending on your region and location (indoor vs. outdoor).

What does the XR80 5th antenna do?

- The 5th antenna is dedicated to 5 GHz network discovery and 5 GHz STA (Client mode) DFS channel clearing.

What are the XR90 supported Wi-Fi MIMO configurations?

XR90 Wi-Fi Connectors (Banks A and B)



- Each Wi-Fi bank can be selected as an AP or STA (Client/Depot) independently.
- 4×4 MIMO selected in AirLink OS uses all FAKRA connectors.
- 2×4 MIMO selected in AirLink OS uses Wi-Fi-1 and Wi-Fi-2 FAKRA connectors.
- 1×4 MIMO selected in AirLink OS uses Wi-Fi-1 FAKRA connector.

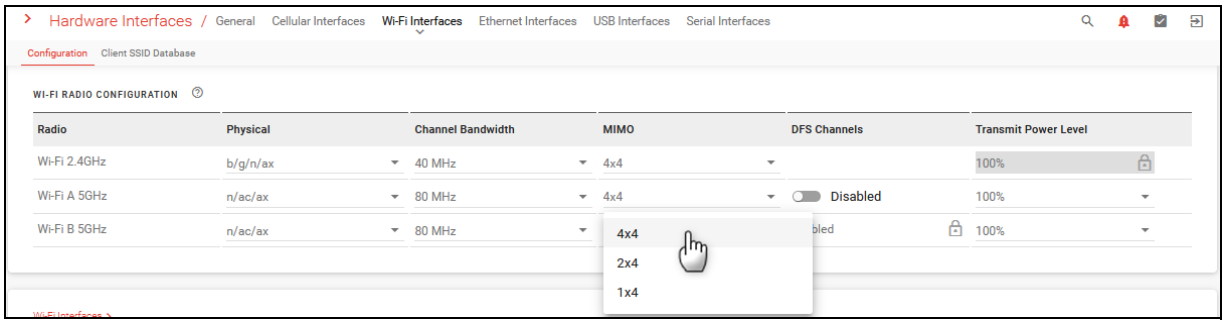


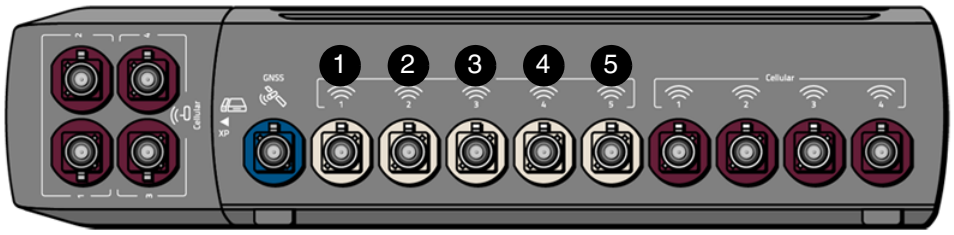
Figure 1: XR90 MIMO Selection (AirLink OS 3.0)

XR90 Wi-Fi Configuration Table

Mode	AP		STA/Client		MIMO Configurations			
	5 GHz	2.4 GHz	5 GHz	2.4 GHz				
Dual-band STA + AP	✓	✓	✓	✓	1×1 MIMO Connect to 1 Requires 2 antennas	2×2 MIMO Connect to 1 and 2 Requires 4 antennas	3×3 MIMO Not supported	4×4 MIMO Connect to 1, 2, 3, 4 Requires 8 antennas
5 GHz STA + AP	✓		✓					
2.4 GHz STA + AP		✓		✓	1×1 MIMO Connect to 1 Requires 1 antenna	2×2 MIMO Connect to 1 and 2 Requires 2 antennas	3×3 MIMO Not supported	4×4 MIMO Connect to 1, 2, 3, 4 Requires 4 antennas
Dual-band AP	✓	✓						
Dual-band STA			✓	✓				

What are the XR80 supported Wi-Fi MIMO configurations?

XR80 Wi-Fi Connectors



- Wi-Fi-5 is not used in AP mode.
- Wi-Fi-5 in STA (Client mode) 5 GHz mode listens for a Depot 5 GHz Wi-Fi access point.
- Wi-Fi-5 in STA 2.4 GHz mode is not used.
- With STA 5 GHz enabled:
  - Wi-Fi-5 is used to pre-clearing DFS channels. The 5th Wi-Fi antenna allows the router to “listen” for available DFS channels, minimizing the wait time to use a DFS channel.
    - A Channel Availability Check (CAC) is performed during power on and can take between 1 and 10 minutes depending on your region. With DFS enabled, the router must stop transmitting if a radar signal is detected, and move to another channel with the CAC procedure.
  - Wi-Fi-5 “listens” for the Depot SSID without impacting the performance of the AP.
  - 4×4 MIMO selected in AirLink OS uses all five FAKRA connectors.
  - 2×4 MIMO selected in AirLink OS uses Wi-Fi-1 and Wi-Fi-5 FAKRA connectors.
    - In this configuration the STA is operating as 1×1 MIMO since Wi-Fi-5 is needed for Depot detection and not for Wi-Fi traffic.
  - 1×4 MIMO selected in AirLink OS uses Wi-Fi-1 and Wi-Fi-5 FAKRA connectors.
- With AP 5GHz enabled, the following are supported:
  - 4×4 MIMO selected in AirLink OS uses Wi-Fi-1 to Wi-Fi-4 FAKRA connectors.
  - 2×4 MIMO selected in AirLink OS uses Wi-Fi-1 and Wi-Fi-2 FAKRA connectors.
  - 1×4 MIMO selected in AirLink OS uses Wi-Fi-1 FAKRA connector.
  - Wi-Fi 5 is not used and does not need to be terminated.
- With only AP 2.4 GHz enabled, the Wi-Fi-5 is not used.

XR80 Wi-Fi Configuration Table

Mode	AP		STA/Client		MIMO Configurations: Number of antennas available				
	5GHz	2.4GHz	5GHz	2.4GHz	1	2	3	4	5
Dual-band STA + AP	✓	✓	✓	✓	Not supported	Not supported	1×1 5GHz + Scan + 1×1 2.4GHz Connect to 1+4+5 Requires 3 antennas[a]	2×2 5GHz + Scan + 1×1 2.4GHz Connect to 1+2+4+5 1×1 5GHz + Scan + 2×2 2.4GHz Connect to 1+3+4+5 Requires 4 antennas	Up to 4×4 5GHz, up to 4×4 2.4GHz, 1×1 5GHz Scan Connect to 1+2+3+4+5 Requires 5 antennas
2.4 GHz AP and 5 GHz STA + AP		✓	✓	✓					
5 GHz STA + AP	✓		✓			1×1 MIMO 1×1 Scan Connect to 1+5[a]	2×2 MIMO 1×1 Scan Connect to 1+2+5 Requires 3 antennas	3×3 MIMO 1×1 Scan Connect to 1+2+3+5 Requires 4 antennas[a]	4×4 MIMO 1×1 Scan Connect to 1+2+3+4+5
5 GHz STA			✓						
2.4 GHz STA + AP and 5 GHz AP	✓	✓		✓		1×1 5GHz 1×1 2.4GHz Connect to 1+4[a]	1×1 5GHz + 2×2 2.4GHz Connect to 1+3+4 2×2 5GHz + 1×1 2.4GHz Connect to 1+2+4[a]	2×2 5GHz + 2×2 2.4GHz MIMO or 4×4 5GHz + 4×4 2.4GHz MIMO Connect to 1+2+3+4	2×2 5GHz + 2×2 2.4GHz MIMO or 4×4 5GHz + 4×4 2.4GHz MIMO Connect to 1+2+3+4[b]
2.4 GHz STA + AP		✓		✓	1×1 MIMO Connect to 4[a]	2×2 MIMO Connect to 3 + 4	3×3 MIMO Connect to 2+3+4[c]	4×4 MIMO Connect to 1+2+3+4	Up to 4×4 5GHz + 4×4 2.4GHz MIMO Connect to 1+2+3+4[b]
2.4 GHz STA				✓					
2.4 GHz AP		✓							
5 GHz AP	✓				1×1 MIMO Connect to 1	2×2 MIMO Connect to 1 + 2	3×3 MIMO Connect to 1+2+3	4×4 MIMO Connect to 1+2+3+4	

a. Not recommended. 1×1 operation is not recommended because almost all clients and depot access points will support 2×2 minimum.
b. Wi-Fi 5 not required in this mode.
c. 3×3 MIMO configurations are not recommended, because the AP cannot be set to 3×3; STA will connect reliably to 3×3 depot access points.

Do I need to use 50Ω terminators on unused Wi-Fi antenna connectors?

- No

Are Wi-Fi paddles supported?

- Sierra Wireless does not support or sell Wi-Fi paddles.

Can I shorten the antenna cables?

- No. Sierra Wireless does not support shortening the antenna cables.

Can I use third-party multi-element Wi-Fi antennas?

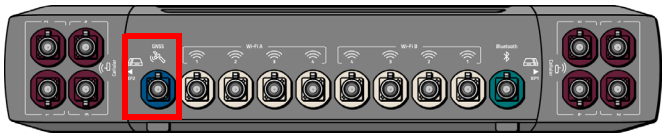
- No. Sierra Wireless does not support using third-party multi-element Wi-Fi antennas.

Wi-Fi Glossary

Term	Definition
Band	Refers to the Wi-Fi frequency bands being used; 2.5 GHz, 5 GHz, etc
Channel	Refers to the Wi-Fi channel in Wi-Fi band
DFS	Dynamic Frequency Selection - the ability to use certain Wi-Fi channels if they do not interfere with higher-priority functions that use the same spectrum, such as airport and marine radar. A Wi-Fi router with DFS enabled will gracefully move to a different channel when higher priority co-channel interference is detected.
Dual band	This means that a Wi-Fi router is capable of operating in either 2.4 GHz or 5GHz bands, but not necessarily at the same time. The term "dual band" is usually qualified with the word "concurrent" when both are available at the same time and using the same antennas.
Dual concurrent	The Wi-Fi router is capable of operating on two different frequency bands (2.4 GHz and 5 GHz) at the same time. Sometimes referred to as "dual-band, dual-concurrent" or DBDC.
Dual radio	Two separate Wi-Fi radios (e.g. a 5 GHz radio separate from a 2.4 GHz radio) which means greater performance and configuration flexibility e.g. additional bands, operational modes, and/or higher throughput.
MIMO	Multi-In Multi-Out - multiple streams of Wi-Fi data to provide greater throughput. MIMO usually contains two numbers, such as “1×4” where the first is the number refers to the number of transmitting antenna elements and the second number refers to the number of receiving antenna elements. An antenna element is usually used for both receiving and transmitting but not always.
Mode: AP + STA	Wi-Fi routers can provide LAN or WAN access to connected Wi-Fi clients (access point (AP)) or can connect to a depot or station access point (STA, short for Station). Some Wi-Fi routers can operate in both AP and STA modes at the same time using the same antennas. In this configuration the AP and STA bandwidth is shared if the Wi-Fi router contains a single radio.
Repeater mode	Operating as an extension of a depot or STA (station) network. The result is that the router's access point (AP) operates with the same channel and bandwidth as its uplink, which is determined by the depot or station network. Provides more flexibility but lower throughput than dedicated AP or STA operation.
Time-slice mode	This term describes when the Wi-Fi radio continuously switches between operating as an access point and uplink. This allows the AP to operate on a different channel than a depot network. This provides more Wi-Fi router flexibility but provides lower throughput than dedicated AP or STA operation.
Tri-band	This term describes Wi-Fi routers containing both 2.4 GHz and 5 GHz radios operating as access points (AP) along with a third Wi-Fi radio dedicated to uplink or "backhaul", to provide greater throughput. This is not technically tri-band, but tri-channel operating in two bands.
Tri-channel, dual band	This is a more technically accurate term than "tri-band" because two channels are being used within the 5 GHz band and a third channel is being used in the 2.4GHz band.

3. XR Series GNSS Antenna

XR90 GNSS Connector



XR80 GNSS Connector

Does the XR Series support active and passive GNSS antennas?

- Only active GNSS antennas are supported.

What are my options for Sierra Wireless GNSS antennas?

- See Sierra Wireless antenna resources above.

If I don't need GNSS, does the GNSS antenna connector need to be terminated?

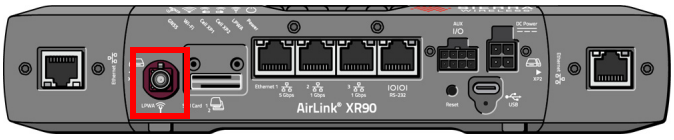
- No, it does not need to be terminated, but it is recommended to disable the GNSS and turn the bias off in AirLink OS.

If I'm not using GNSS, should I turn it off in AirLink OS?

- Yes

4. XR Series LPWA Antenna

XR90 LPWA Connector



XR80 LPWA Connector

What is the LPWA antenna used for?

- It is used for ALMS out-of-band management when all other WAN links are unavailable.

Is it included in the box?

- Yes, a wired FAKRA-based paddle antenna is included in the box.

Do I need to connect the LPWA antenna?

- Yes, you need to connect the LPWA to benefit from ALMS out-of-band management.

Where should I mount the LPWA antenna?

- Mount it where it will receive a good cellular signal.

Can I use a third-party paddle antenna?

- Yes, but make sure it supports the correct frequency range.

Does Sierra Wireless have a paddle version of the LPWA for sale?

- No

5. XR90 BT Antenna

- Bluetooth is not currently supported.

Document History

Revision number	Release date	Changes
1	May 2022	First release
2	May 2022	Revised Cellular Antenna section, added illustrations
3	April 2023	Added Wi-Fi configuration tables and glossary

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