



# BHW Technologies (博泓微科技有限公司)



Advanced RF IC, Antenna, Filter, RF Front-End  
and Wireless System Solutions

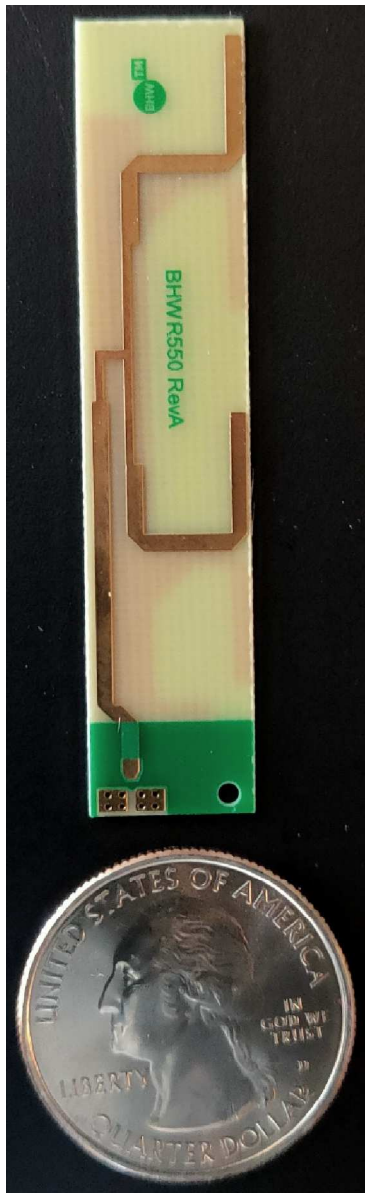
## BHW AppNote #026

Improving Range and Throughput of 5GHz Wi-Fi with  
BHWR550 Array Antenna

Rev. 3.1

[www.bhw-tech.com](http://www.bhw-tech.com)

# BHWR550 5GHz Broadband Array Antenna



## Product Overview:

- Patented Two-Element Array Antenna Architecture
- 5.15-5.85GHz Operation Frequency Range
- VSWR < 2:1 over 5.15-5.85GHz
- Near-Omni Radiation Pattern in Horizontal Plane
- Gain ~4dBi, Optimized for MU-MIMO Beamforming
- High Efficiency: 65%
- Stable VSWR over Housing/Cabling Effects
- Au-Plated Finish for Maximal Efficiency
- Compact 12x57x0.6mm for IPX/UFL Cable Assembly
- Suitable for Replacing External Antennas in Wi-Fi Routers and other Products without Compromise in Performance

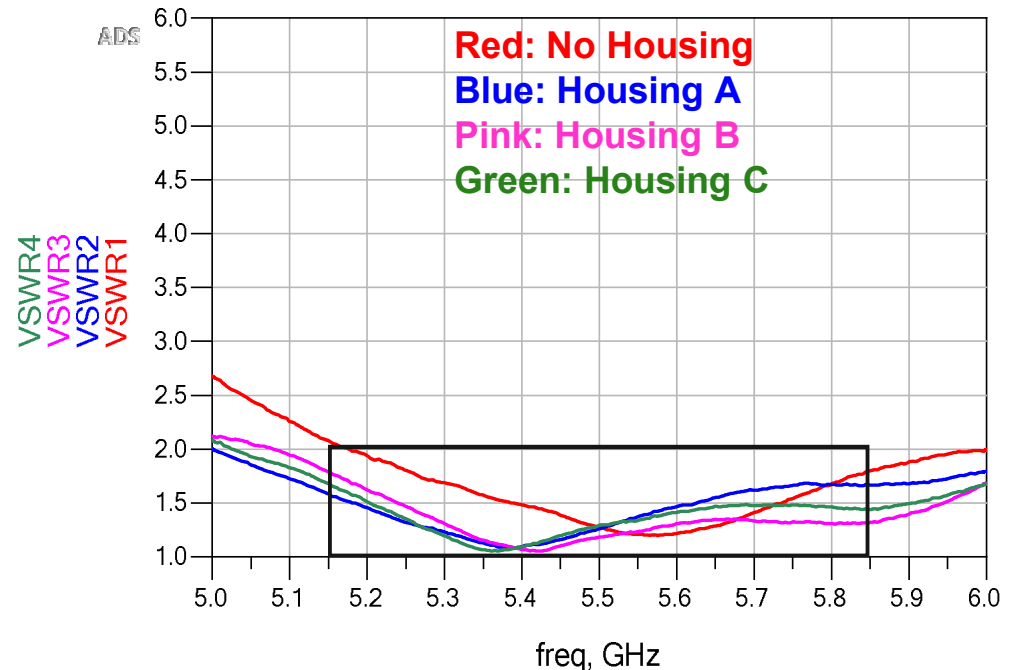
## Applications:

- Wi-Fi MU-MIMO Solutions
- Wi-Fi 3/4/5/6 Routers/Repeaters
- Wi-Fi Modules/Data Links
- 5GHz Audio/Video Streaming
- Generic 5GHz Radio Designs
- FPC Antenna Replacement with Minimum Frequency Shift

# BHWR550 VSWR with 1.37mm IPX Cable



## Input VSWR vs Housing Effect



### Notes:

- IPX cable with 1.37mm outer diameter was soldered to BHWR550 on one end and to 50-Ohm microstrip line based PCB on the other
- VSWR < 2:1 over 5150-5850MHz for all test cases
- VSWR improves slightly when antenna is placed inside housing
- No significant change in VSWR was observed by applying three types of housings to BHWR550

# BHWR550 for IPX Plug/Receptacle Assembly



## Test Samples

#1

#2

#3

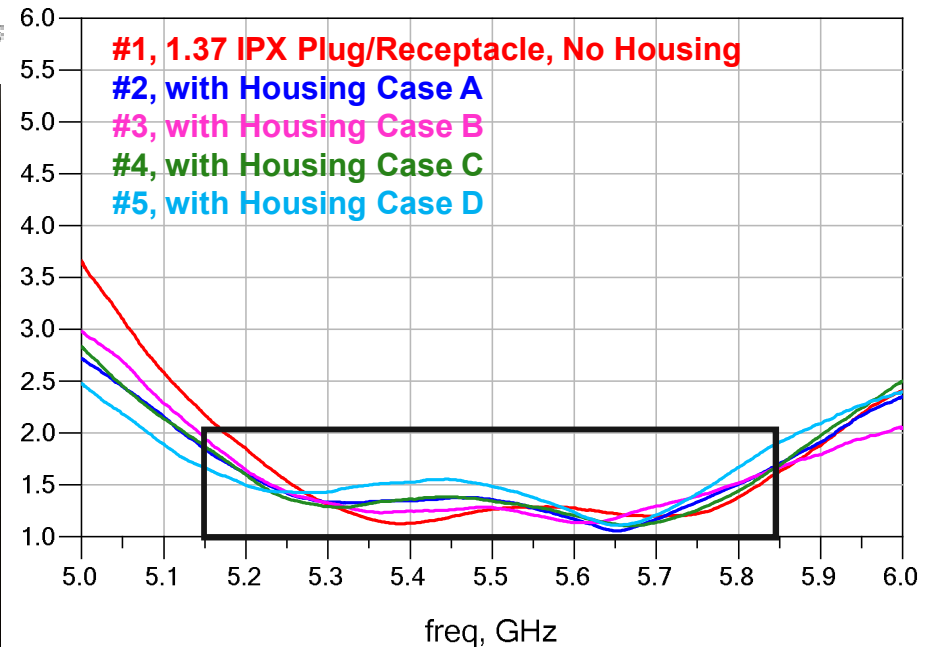
#4

#5

ADS



## Measured Input VSWR



### Notes:

- A through-hole with ~70mil diameter was drilled underneath the IPX receptacle on the tester board to restore nominal 50-Ohm impedance environment
- One piece each of low-loss sponge with single-side adhesive (~10x7mm in size) was added to the top and back side of the antenna to fix its position roughly at the center inside the housing
- The thickness of the sponge can be selected according the thickness of antenna housing
- VSWR<2:1 across 5150-5850MHz can be achieved for most antenna housings without any additional L/C matching on PCB

# BHWR550 for FPC Antenna Alternatives



## Test Samples

Front View

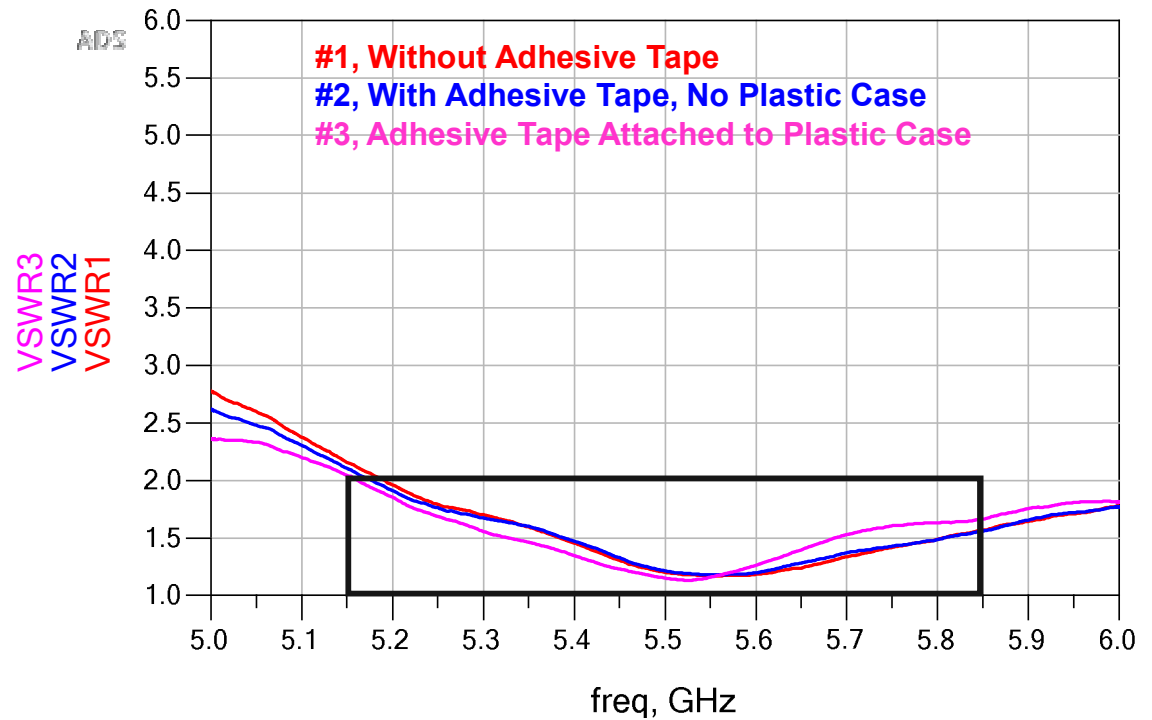
**#1**  
Without  
Tape

**#2**  
Tape  
Only

**#3**  
Attached  
To Case



## Input VSWR with/without Plastic Case



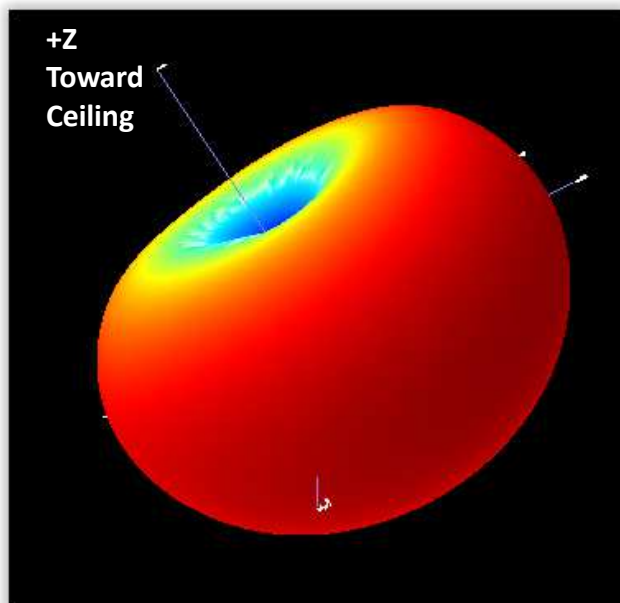
### Notes:

- Adhesive tape with size 8x20x1.3mm was added to the back side of BHWR550
- To ensure minimum shift in antenna performance, please select adhesive tape with minimum thickness of 1mm
- Adhesive tape should not block the radiating dipole elements to guarantee optimal antenna performance
- VSWR<2:1 over 5150-5850MHz for all cases
- VSWR may change slightly when the antenna is attached to different types of plastic housing, but should not exceed 2:1 for most practical use cases

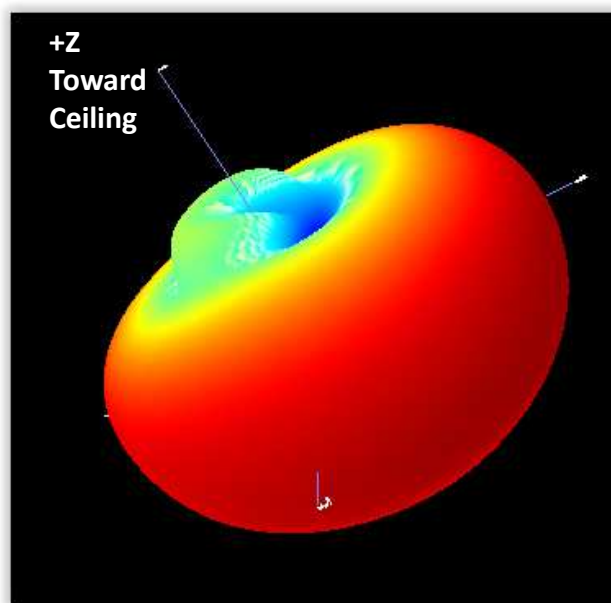
# BHWR550 Radiation Pattern: 3D Plots



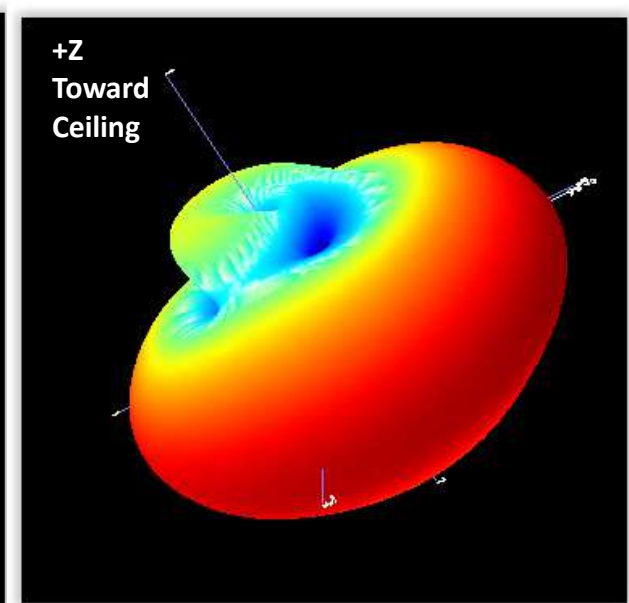
**BHWR550  
5150MHz**



**BHWR550  
5500MHz**



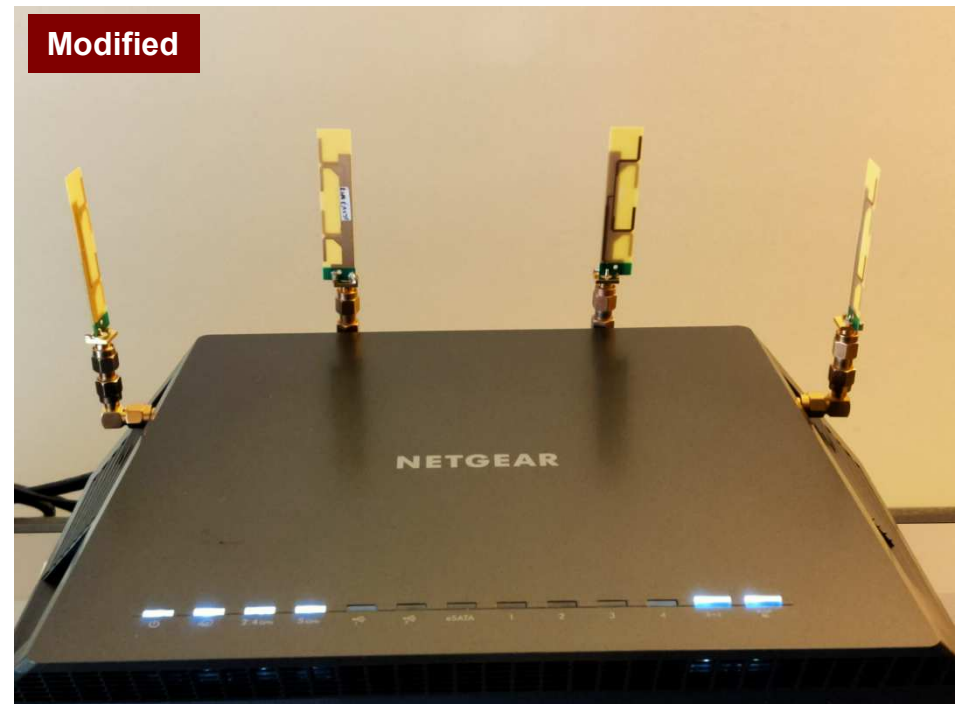
**BHWR550  
5850MHz**



# BHWR550 Wi-Fi Signal Strength Benchmark



## Replacing Antennas on Netgear Nighthawk X4S R7800 with BHWR550



### Notes:

- Netgear Nighthawk X4S R7800 is dual-band 4x4 MU-MIMO router with four dual-band antennas, each ~180mm in total height.
- The four original antennas were replaced by BHWR550 (12x57mm) for benchmark test of 11ac throughput in the 5GHz band.
- Netgear R7800 was connected to a laptop with Ethernet cable to be used as TCP server for WiFi-to-LAN throughput test.
- WiFi Speed Test Pro (Android APP) on Samsung Galaxy S10e was used to test WiFi speed at various locations.

	NETGEAR R7800
<b>CPU</b>	Qualcomm dual-core IPQ8065 Internet Processor @ 1.7 GHz
<b>Switch</b>	Qualcomm Atheros QCA8337
<b>RAM</b>	512 MB
<b>Flash</b>	128 MB
<b>2.4 GHz Radio</b>	- QCA9984 4x4 MU-MIMO 802.11ac radio - Skyworks SE2623L 2.4 GHz power amp (x4)
<b>5 GHz radio</b>	- QCA9984 4x4 MU-MIMO 802.11ac radio - RFMD RFP5542 5 GHz PA module (x4)

Source: SmallNetBuilder.com

# BHWR550 Wi-Fi Signal Strength Benchmark



Signal Strength & Throughput on Galaxy S10e with R7800 on TV Top in Living Room

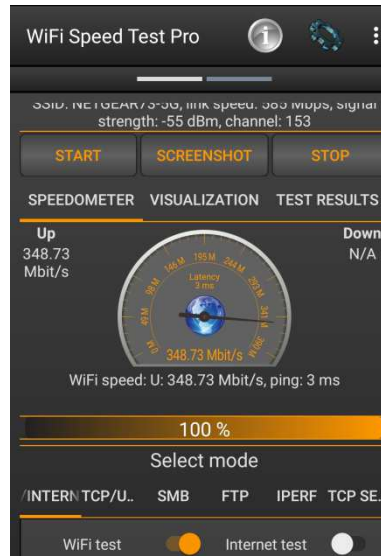
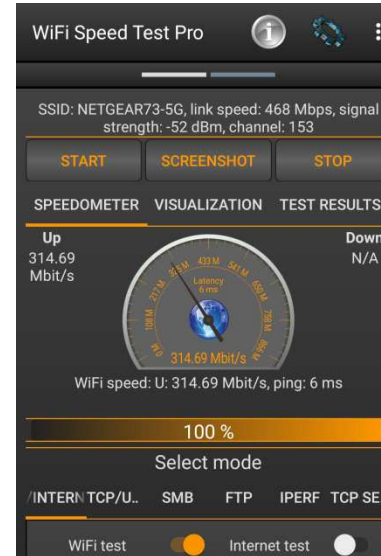
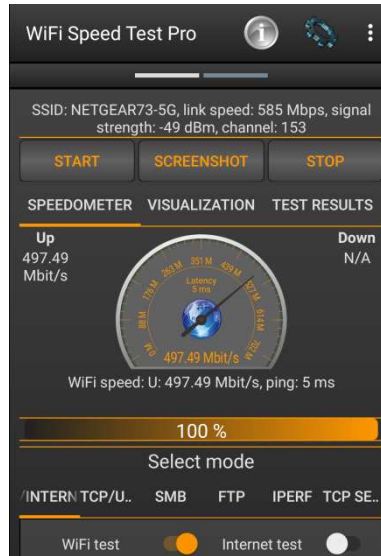
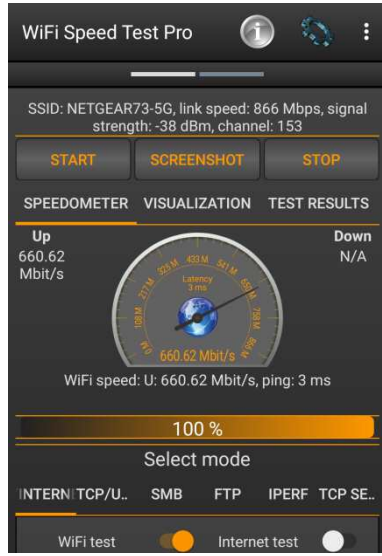
Living Room

Bedroom

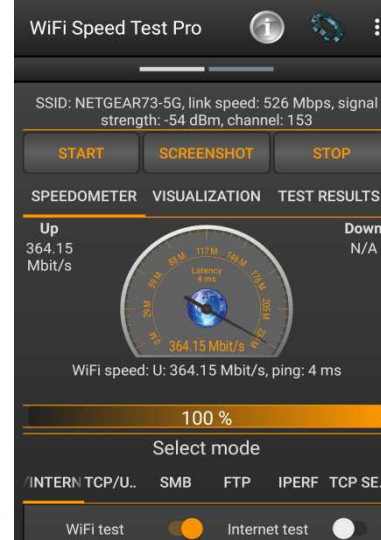
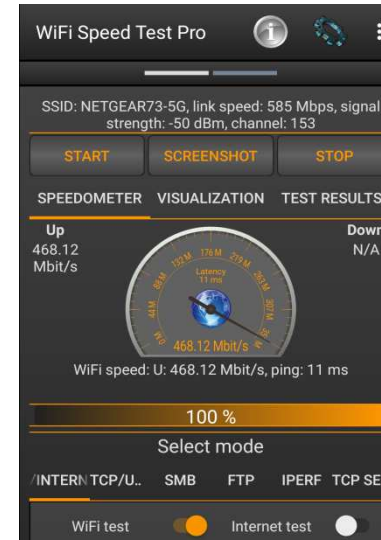
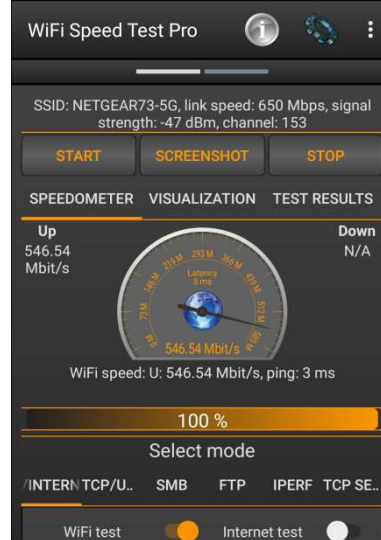
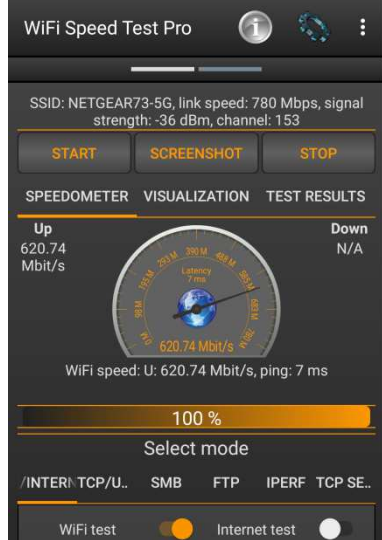
Kitchen

Lab

Original Antenna



BHWR550

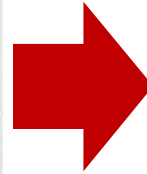




# BHWR550 for Embedded Wi-Fi Router Antenna



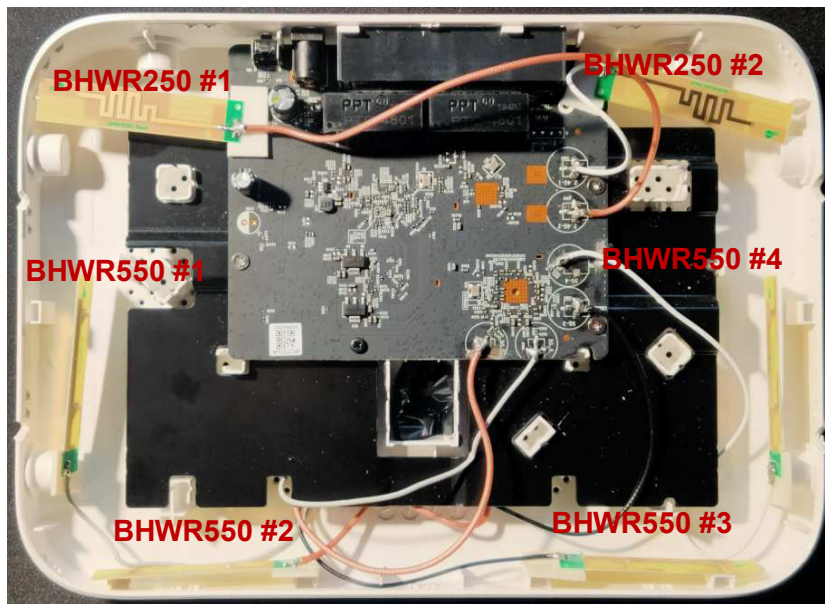
Original



Modified



Note: This experiment is for feasibility study only. Actual implementation of these embedded antennas should be designed properly for specific product IDs.



# BHWR550 for Embedded Antenna: Benchmark Test

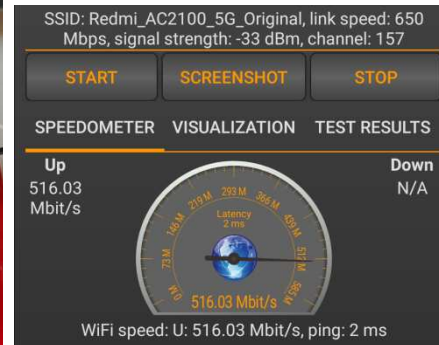


**Unit #1:  
Original**

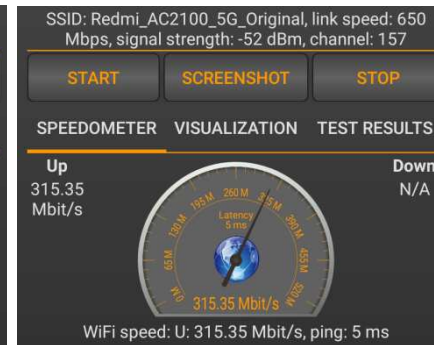


## Signal Strength & WiFi-to-LAN Throughput Test

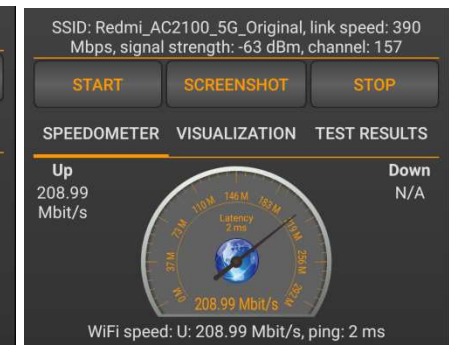
**Site 1  
LOS ~3m**



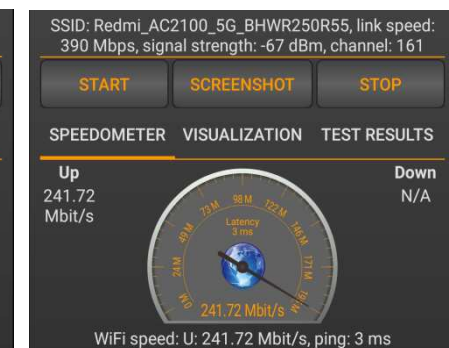
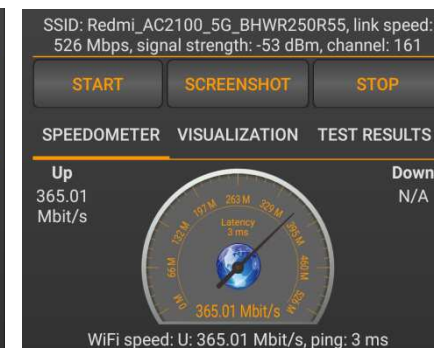
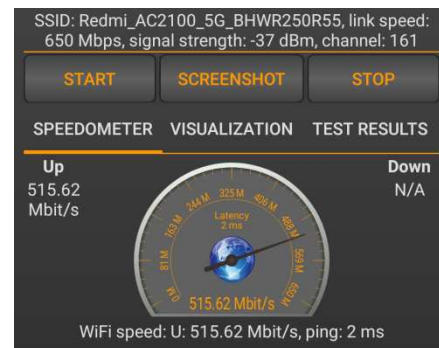
**Site 2  
NLOS (1 Wall)**



**Site 3  
NLOS (2 Walls)**



**Unit #2:  
Modified**



**Notes:**

- Redmi AC2100 dual-band router Unit #2 was modified by replacing six original antennas with BHWR250 (x2) and BHWR550 (x4).
- All six antennas were moved inside the router for improved aesthetics, as well as manufacturing cost reduction.
- The two router units were placed at the same location and connected to a laptop with Ethernet cable to be used as TCP server for WiFi-to-LAN throughput test.
- WiFi Speed Test Pro (Android APP) on Samsung Galaxy S10e was used to test WiFi speed at various locations.
- This benchmark test is for feasibility study only. The test results are preliminary due to non-ideal positioning of embedded antennas inside the router case. Expect slightly improved performance after antenna positioning is optimized for new ID design.

# BHW RF Front-End AppNote Library



*This is an abridged version of BHW AppNote #026. Please contact BHW Support or your local sales rep/distributor for a complete copy of the document and other related information.*

# BHW RF Front-End Solutions AppNote Library



In addition to standard datasheets and EVB/BOM info, BHW publishes an AppNote series that address various topics on RF front-end design and performance over a wide frequency range from 300MHz to 6GHz, as an effort to assist customers in developing cutting-edge, cost-competitive products:

- BHW AppNote #001 - Cross-Over Cascade of BHWM253 to Boost Tx Power and Rx Sensitivity of 2.4GHz Systems
- BHW AppNote #002 - Accurate Benchmark of GNSS CNO Using the Power-Splitter Method
- BHW AppNote #003 - Boosting Wi-Fi Tx Power and Rx Sensitivity with BHWA251 and BHWM252
- BHW AppNote #004 - UHF 900MHz RF Front-End Solution Using BHWA251 Half-Watt PA and BHWL160 Sub-1dB-NF LNA
- BHW AppNote #005 - Sub-1GHz Applications of BHWA350 2-in-1 Wideband Fully Matched Amplifier
- BHW AppNote #006 - Low-Noise High-IIP3 LNB Architecture for Dual-Band High-Precision GNSS Using Cascade of BHWL160
- BHW AppNote #007 - UWB RF Front-End Solution Using BHWA350 and BHWM552
- BHW AppNote #008 - High-Power 5.8GHz RF Front-End Solution Using BHWA555 and BHWM552 for ETC, V2X and Wireless Video
- BHW AppNote #009 - 5.8GHz RF Front-End Using BHWA350 and BHWM552 for Wireless Audio
- BHW AppNote #010 - Multi-Constellation GNSS Active Antenna Using BHWL161 Cascade and Single-Fed Dual-Band Antenna
- BHW AppNote #011 - BHWL161 Super-Compact Low-Power Low Noise Amplifier for Range Extension of 2.4GHz RC and IoT
- BHW AppNote #012 - Enabling Cost-Effective High-Precision GNSS Using BHWL161 and Linear-Polarization PCB Antenna
- BHW AppNote #013 - GNSS Noise Floor vs Receiver Architecture
- BHW AppNote #014 - Designing Ultra Low-Power High-Performance GNSS Products Using BHWL160 GaAs PHEMT LNA
- BHW AppNote #015 - BHWL161 GNSS Full-Band High-Performance LNA in Super-Compact 1x1mm DFN with Relaxed Pin Pitch
- BHW AppNote #016 - Improving GNSS NF Measurement Accuracy Using Broadband LNA BHWL161 as Pre-Amp
- BHW AppNote #017 - High-Efficiency, Low-NF 2.4GHz Front-End Solution for IoT Using BHWA251 and BHWM252
- BHW AppNote #018 - Optimizing BHWA555 Wideband One-Watt PA for Long-Range 5.8GHz Transmitter Applications
- BHW AppNote #019 - Miniature 2.4GHz RF Front-End with Integrated Chip Antenna and BHWM253 for TWS and IoT
- BHW AppNote #020 - Multiplying the Range for 2.4GHz Music Streaming with BHWR250L Active Integrated Antenna (AiA)
- BHW AppNote #021 - Range Extension for 2.4GHz Wireless Systems with BHWR250M Active Integrated Antenna (AiA)
- BHW AppNote #022 - Enabling Long-Range Angle-of-Arrival for High-Precision Indoor Positioning with BHWR250N RF AiA
- BHW AppNote #023 - Extend the Range for 5.8GHz Audio/Video Streaming with BHWR580M Active Integrated Antenna (AiA)
- BHW AppNote #024 - Improving 5.8GHz Radio Link Budget with BHWR580L Active Integrated Antenna (AiA)
- BHW AppNote #025 - Improving Range and Throughput of 2.4GHz Wi-Fi with BHWR250 Array Antenna
- BHW AppNote #026 - Improving Range and Throughput of 5GHz Wi-Fi with BHWR550 Array Antenna
- BHW AppNote #027 - Multi-Band High-Accuracy GNSS Solutions Using BHWP150 DFN1x1 Ultra-Compact Power Divider & Combiner
- BHW AppNote #028 - Use BHWM252 Cascade to Extend Range of 2.4GHz Wireless Systems with Single-Port SoCs
- BHW AppNote #029 - Improving Range of 2.4GHz Wireless Microphones and Audio Systems with BHWR250A Active Integrated Antenna (AiA)
- BHW AppNote #030 - Simultaneous Improvement in Range and Battery Life of 2.4GHz Wireless Systems with BHWR250M AiA

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