

## Wearable Smart Radio – 5150~5895 MHz

### Advanced Mesh Router for Private Wireless Networks

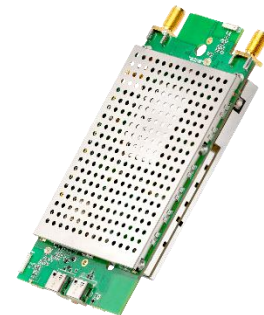
## Overview

The Wearable Smart Radio brings private wireless networking and dynamic mesh capabilities to connected workers. Each device is a node on a long-range Mesh Rider network and uses WiFi to bridge Tablets and Smartphones onto the network. The Wearable Smart Radio is used by field operations teams to collaborate by streaming voice, video, and data on a fast, low latency, and encrypted network.



The Wearable Smart Radio was designed to be conveniently carried. Embedded antennas are capable of streaming HD video to teammates up to 1.5 km away. External antenna ports are included to integrate with high-gain antennas for longer distances. The radio can be powered by a variety of sources, including tablets and standard battery banks. It is also available in an OEM form factor for embedded use cases.

As with all Smart Radio form factors, the Wearable is available in many frequency bands between 400 MHz and 6 GHz frequency range. This flexibility allows customers to use their industry specific frequency bands for deploying private wireless networks.



The Smart Radio employs Doodle Labs' patented Mesh Rider® technology with state-of-the-art RF and networking capabilities that enable communication further, faster, and more reliably than any comparable solution on the market. For example, optimized video streaming carries crystal clear 4K video while simultaneously carrying Ultra Reliable Low Latency (URLLC) command and control (C&C) data for machines.

**For more information, please visit:** <https://doodlelabs.com/smart-radio/wearable>

## Key Features - Smart Radio Platform

### PERFORMANCE RF

- Long range (field tested >100km) and high throughput (up to 100 Mbps) Mesh Rider waveform
- Interference resistant COFDM for robust link quality in difficult RF environments
- Exceptional Multipath and NrLOS MIMO performance
- Adaptive radio modulations from BPSK up to 64QAM, with fast per packet optimization to maximize link performance in dynamic environments
- Software defined channel size for efficient re-use of spectrum
- Convolutional coding, Forward Error Correction (FEC), ACK-retransmits, Maximal Ratio Combining, Spatial Multiplexing, and Space Time Block Coding for robust data transmission over noisy spectrum
- Single channel, Time Division Duplexing (TDD) for bi-directional traffic
- Resistant to high-power jamming signals
- ATPC for widely dispersed mesh network
- Built-in Spectrum Scanner to help mitigate interference issues

### PERFORMANCE NETWORKING

- Ultra-Reliable Low Latency Channel (URLLC) for Command and Control
- Optimized video streaming channel for Unicast and Multicast transport
- Self-healing/self-forming multi-frequency mobile mesh for highly reliable network with redundancy
- AES 256 and 128 bit encryption
- End-to-end IP architecture with Ad Hoc, WDS transparent bridge, Client, AP, and Internet Gateway operating modes
- Embedded network management APIs

### ADDITIONAL FEATURES

- Very small size, weight, and power for mobile applications
- Ethernet, USB, and UART interfaces to allow easy integration into different system architectures
- Leverage the benefits of the most extensible OpenWrt ecosystem and install 3<sup>rd</sup> party IoT applications
- Rugged, vibration resistant construction to meet MIL-specs
- MIL-spec temp range (-40C to +85C)
- High quality, manufactured in ISO 9001 and ISO 14001 certified facilities
- COTS – Commercial off the Shelf
- Extended lifespan and availability

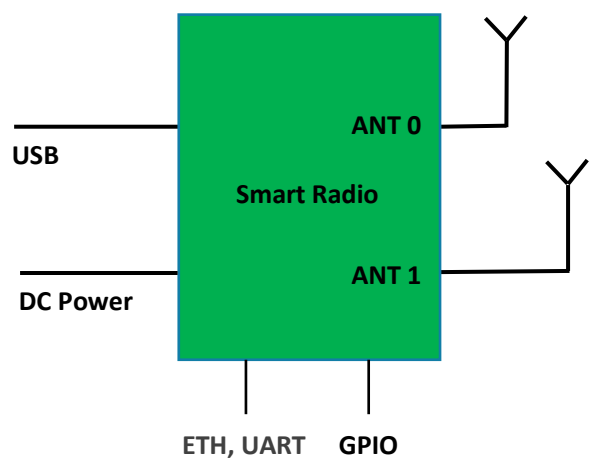
## Band Introduction – 5150~5895 MHz ISM Band

The 5 GHz band is license free in most of the world and can be used for any purpose. In the USA, Canada, and Central and Latin Americas, radios are permitted to transmit up to 4W of EIRP (30 dBm radio + 6 dBi antenna) to achieve several kilometer long links for IIoT applications like drones and ground robots. In Europe, the max allowed EIRP is 1W to achieve longer range than 2.4 GHz band.

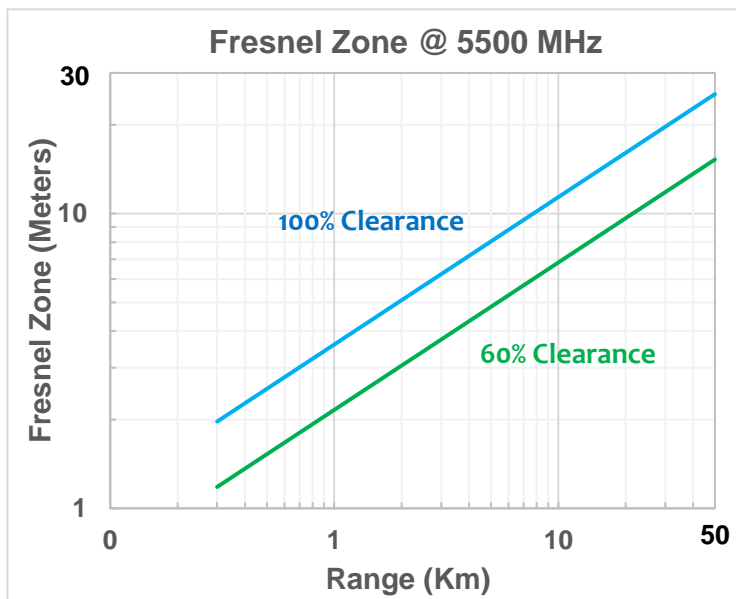
## System Integration

The Smart Radio has been designed to be nearly plug and play. Only USB and a power supply are required for integration.

Visit [Doodle Labs Technical Library](#) for extensive design-in documents.



## Fresnel Zone Clearance



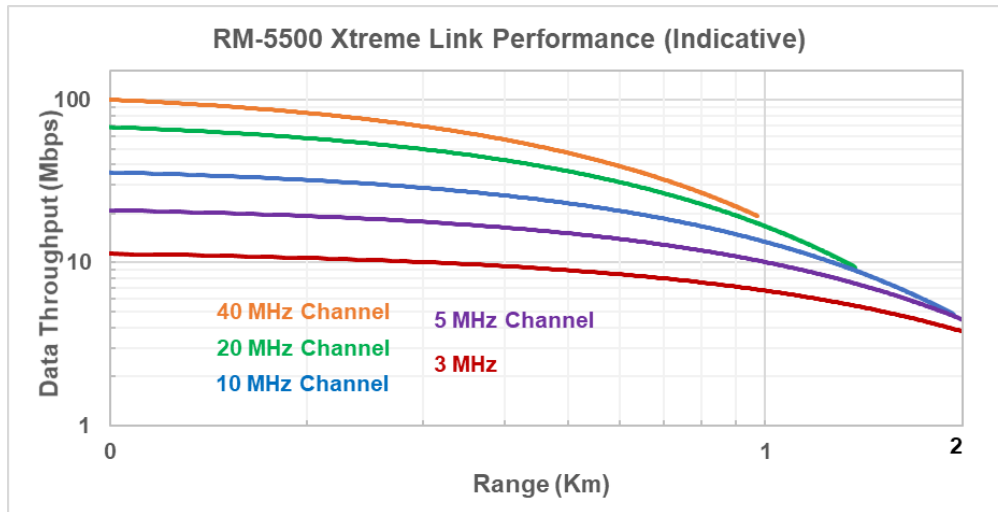
RF Line of Sight (LOS) is defined by Fresnel Zones which are ellipse shaped areas between any two radios. The radius of the Fresnel Zone at its widest point is shown the figure above.

The primary Fresnel zone is required to be at least 60% clear of any obstruction to ensure the highest performance of wireless link.

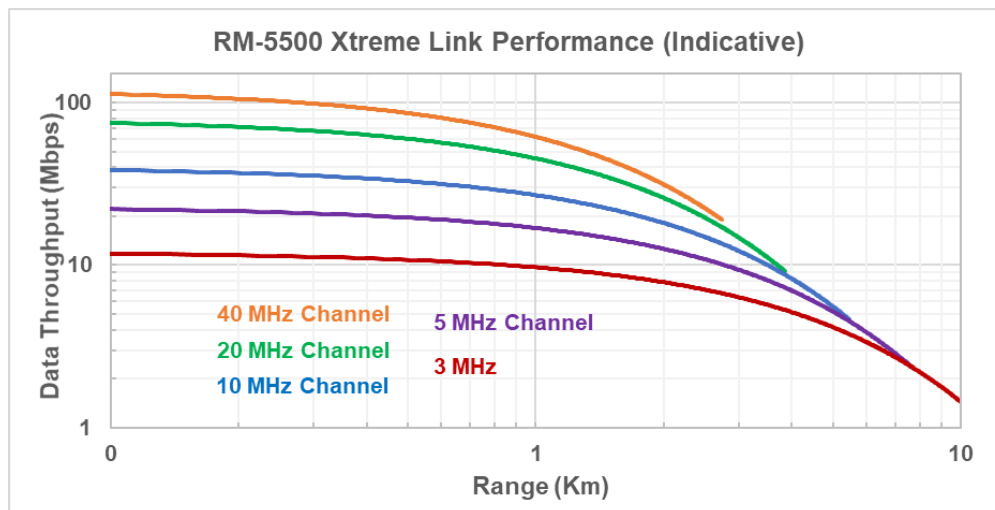
# Datasheet

## Link Distance

Smart Radio's Mesh Rider waveform has been field tested for >100km. The link distance depends on many factors, including antenna gain, line of sight obstructions, Fresnel zone clearance, and environmental noise conditions. The table below gives an indication of the radio's performance in a typical configurations. Refer to the Application Note – [Optimizing the RF Link](#) for more details.

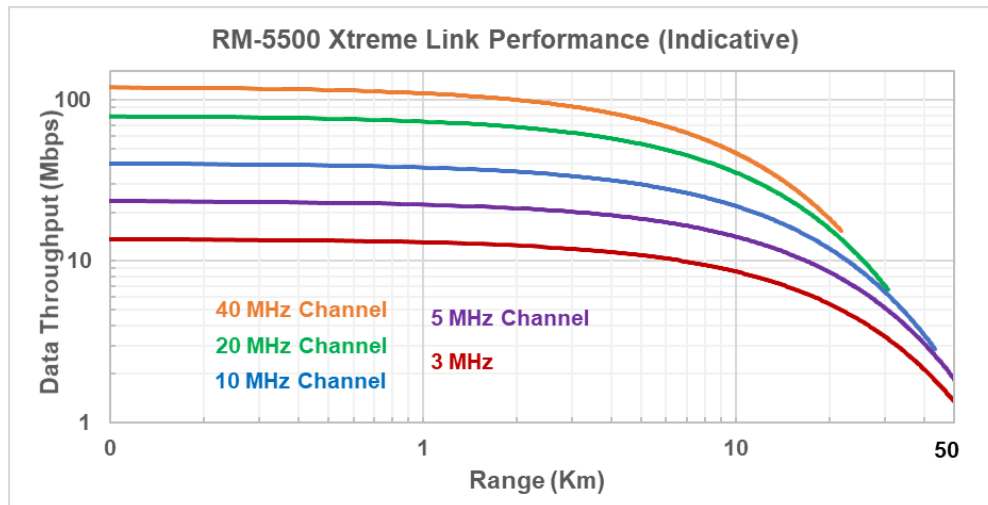


Indicative Link Performance of Extreme RM-5500-2K-X\* with **Embedded** Antennas. Radios at human height.

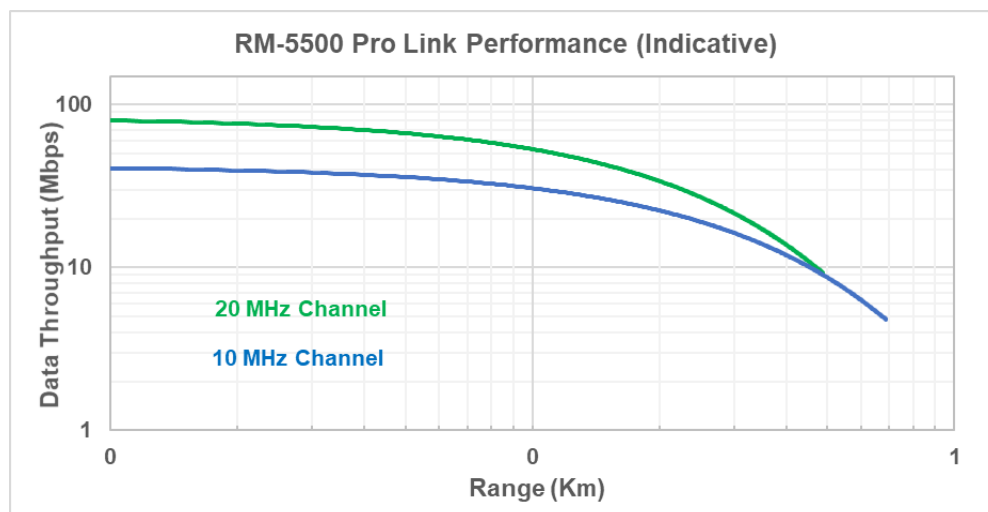


Indicative Link Performance of Extreme RM-5500-2K-X\* with **Attached** Doodle Labs 6 dBi Antennas. Unobstructed Fresnel Zone

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Indicative Link Performance of Extreme RM-5500-2K-X\* with **External** 15 dBi Antennas. Unobstructed Fresnel Zone



Indicative Link Performance of **Pro** RM-5500-2K-P\* with **Embedded** Antennas. Radios at human height

## Technical Specifications (5150~5895 MHz)



Model Category	Pro	Xtreme
<b>ORDERING CODES</b>		
Radio Configuration	2x2 MIMO	
Model # (Wearable)	RM-5500-2K-PW	RM-5500-2K-XW
Model # (OEM)	RM-5500-2K-PO	RM-5500-2K-XO
Evaluation Kit (Optional)	EK-5500-2K Includes: 2x Mesh Rider Antenna, External GPS Antenna, Breakout board, Cable, Mounting plate	
Design-In Documentation	<a href="https://www.doodlelabs.com/technologies/technical-library/">https://www.doodlelabs.com/technologies/technical-library/</a>	
<b>PERFORMANCE OVERVIEW</b>		
Max Operating Range with Embedded Antennas (Indicative)	0.5 Km	1.5 Km
Max Operating Range with 6 dBi Attached Antenna (Indicative)	NA	10 Km
Max Operating Range with high gain External Antenna (Indicative)	NA	20 Km (Recommended), (Max field demonstrated range >100km)
Max Data Throughput at 10-meter range with (Indicative)	80 Mbps (20 MHz Channel) 40 Mbps (10 MHz Channel)	100 Mbps (40 MHz Channel) 80 Mbps (20 MHz Channel) 40 Mbps (10 MHz Channel) 20 Mbps (5 MHz Channel) 12 Mbps (3 MHz Channel)
Over the Air Data Encryption	128-bit AES hardware data encryption @ full rate	256-bit AES (12 Mbps max throughput)

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Model Category	Pro	Xtreme
<b>Operating Modes</b>	WiFi Radio: AP, Client Mesh Rider Radio: Mesh, WDS AP, WDS Client Bridged or Internet Gateway with NAT	
<b>Command &amp; Control channel</b>	Ultra-Reliable Low Latency Channel (URLLC). Latency 1.5-10 ms	
<b>Video Channel</b>	Optimized video streaming with Unicast and Multicast transmission	
MESH RIDER RF SPECIFICATIONS		
<b>Protocol Compatibility (Long Range Mesh Rider)</b>	Fully compatible with Wi-Fi (IEEE 802.11 a,n)	
<b>Frequency Range</b>	5150-5895 MHz	
<b>RF Power Output (Typ) Each radio individually calibrated</b>	0.5W (27 dBm) @ MCS 0,8 0.5W (27 dBm) @ MCS 3,11 0.4W (26 dBm) @ MCS 5,13 250mW (24 dBm) @ MCS 7,15	1W (30 dBm) @ MCS 0,8 0.8W (29 dBm) @ MCS 3,11 0.4W (26 dBm) @ MCS 5,13 250mW (24 dBm) @MCS 7,15
<b>Channel Sizes (Software Selectable)</b>	10, 20 MHz	3, 5, 10, 15, 20, 40 MHz
<b>Radio Data Rate</b>	Auto adapting Modulation Coding Scheme (MCS0-15)	
<b>Antenna Signal Strength</b>	-25 to -85 dBm (Recommended), Absolute Maximum= +12 dBm	
<b>Receiver LNA Gain</b>	>20 dB	
<b>RF Power Control</b>	In 1 dBm steps, Tolerance $\pm 1$ dBm	
<b>Automatic Transmit Power Control (ATPC)</b>	Intelligently adjusts the transmit power for very close range operation	
<b>Integrated Antenna Port Protection</b>	Able to withstand open port, >10 KV (contact) and >15KV (open air discharge) as per IEC-61000-4-2	
<b>Wireless Error Correction</b>	FEC, ARQ	
<b>Frequency Accuracy</b>	$\pm 20$ ppm max over life	$\pm 10$ ppm max over life

Model Category	Pro	Xtreme
<b>WiFi HOTSPOT RF SPECIFICATIONS</b>		
WiFi Standard	IEEE 802.11n, 2x2 MIMO	
Frequency Range	2400-2482 MHz	
RF Power Output (Typ)	50 mW (17 dBm) EIRP	
Channel Size	20 MHz	
Radio Data Rate	Auto adapting Modulation Coding Scheme (MCS 0-15)	
Antenna Signal Strength	-25 to -85 dBm (Recommended), Absolute Maximum= +12 dBm	
Receiver LNA Gain	>20 dB	
RF Power Control	In 1 dBm steps, Tolerance $\pm 1$ dBm	
Wireless Error Correction	FEC, ARQ	
<b>NETWORKING SPECIFICATIONS</b>		
Mesh Router	Self-Forming/Self-Healing, Peer to Peer	
Video Multicast	High Rate	
Custom Software Package Manager	Image Builder, OPKG	
Radio Management	Web GUI (HTTPs), SSH, SNMP and JSON-RPC	
Access control	Password, MAC, IP, Port filtering	
Supported Protocols	IPv6, QoS, DNS, HTTPS, IP, ICMP, NTP, DHCP, VLAN	
Software Upgrade	Over the air software upgrade supported	



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<b>HARDWARE SPECIFICATIONS</b>		
<b>Power Input</b>	Power Port = 6 ~ 24V, USB-PD compliant for battery banks Data + Power port = 4.5 ~ 5.5V Power Port has higher priority and will be used when both ports are connected	
<b>Dimensions - Wearable</b>	130 x 75 x 23 mm and 245 grams	
<b>Dimensions - OEM</b>	127 x 63 x 13 mm and 125 grams	
<b>Mesh Rider Antenna Ports</b>	2x Embedded Antennas	2x Embedded Antennas and 2x SMA-Female connector for External antennas
<b>Host Interface</b>	WiFi (2.4 GHz), USB-Device	+ Ethernet (100 Base-T), 1x UART (3.3V), USB-Host, and 1x GPIO port (2.62V)
<b>Temperature range (Operating)</b>	-40°C to +70°C	-40°C to +85°C
	System's thermal design should ensure that the radio's case temperature is maintained within these specifications.	
<b>Ingress Protection (Wearable)</b>	IP62, Water spray falling at an angle of up to 15° from vertical.	
<b>Shock and Vibration Resistance</b>	Standard	Compliant to MIL-STD-810H for high shock and vibration
<b>DC Power Consumption</b>	<ul style="list-style-type: none"> <li>• 9W @ Max Data Troughput</li> <li>• 7W @ Max Range</li> <li>• 3.5W in Rx mode</li> <li>• 0.5W in Standby mode</li> </ul>	<ul style="list-style-type: none"> <li>• 14W @ Max Data Troughput</li> <li>• 12W @ Max Range</li> <li>• 3.5W in Rx mode</li> <li>• 0.5W in Standby mode</li> </ul>
<b>Reliability</b>	Standard	Extreme Reliability, IPC Class 2 standard with Class 3 options
<b>Integrated GPS</b>	NA	Simultaneous multiple constellations (GPS/Galileo/Glonass/BeiDou/QZSS), 1.5 meter CEP position accuracy, -163 dBm tracking sensitivity
<b>GPS Antenna</b>	NA	Embedded Antenna + SMA-Female connector for External antenna
<b>Integrated Altimeter</b>	NA	-698 to +11,775 m (20-bit), 1 Hz Refresh Rate. <a href="#">MPL3115A2</a>

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Integrated Temp Monitor	NA	-40 to +85 C (20-bit), 1 Hz Refresh Rate
Integrated CPU	MIPS 24K, 540 MHz, 32MB Flash, 64MB DDR2 RAM	
ESD Protection	IEC 61000-4-2 test criteria, Level 3 ( $\pm 6$ KV) for Contact Discharge and Level 4 ( $\pm 15$ KV) for Air Discharge	
MTBF	>235k hours (25 years)	
Humidity (Operating)	0% – 95% (Non-condensing)	
Life Cycle Planning	Extended lifespan with 3 years guaranteed availability	Extended lifespan with 7 years guaranteed availability
REGULATORY INFORMATION		
Europe (CE)	In Progress	
USA (FCC ID)	In Progress	
Industry Canada (IC)	In Progress	
Japan (MIC)	In Progress	
S. Korea (KC Mark)	In Progress	
Regulatory Requirements	Designed and verified to meet various regulatory requirements. Formal testing and approval are required for the Integrator's antenna type. The Integrator is responsible for obtaining all regulatory approvals in target markets for the finished product.	
RoHS/WEEE Compliance	Yes. 100% Recyclable/Biodegradable packaging	

Model Category	Pro	Xtreme
<b>ADDITIONAL MESH RIDER RF SPECIFICATIONS</b>		
<b>Radio Data Rates (Dynamic Link Auto Adaptation)</b>	<p>MCS15 = 64QAM (5/6)  MCS14 = 64 QAM (3/4)  MCS13 = 64 QAM (2/3)  MCS12 = 16QAM (3/4)  MCS11 = 16QAM (1/2)  MCS10 = QPSK (3/4)  MCS9 = QPSK (1/2)  MCS8 = BPSK (1/2)</p> <p>MCS7 = 64QAM (5/6)  MCS6 = 64 QAM (3/4)  MCS5 = 64 QAM (2/3)  MCS4 = 16QAM (3/4)  MCS3 = 16QAM (1/2)  MCS2 = QPSK (3/4)  MCS1 = QPSK (1/2)  MCS0 = BPSK (1/2)</p>	
<b>Rx Sensitivity (3 MHz Channel BW)</b>	NA	<p>-100 dBm @ MCS 0  -97 dBm @ MCS 1  -95 dBm @ MCS 2  -92 dBm @ MCS 3  -87 dBm @ MCS 4  -85 dBm @ MCS 5  -82 dBm @ MCS 6  -79 dBm @ MCS 7  -97 dBm @ MCS 8  -93 dBm @ MCS 9  -91 dBm @ MCS 10  -88 dBm @ MCS 11  -84 dBm @ MCS 12  -80 dBm @ MCS 13  -79 dBm @ MCS 14  -78 dBm @ MCS 15</p>

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Model Category	Pro	Xtreme
<b>Rx Sensitivity (5 MHz Channel BW)</b>	NA	-98 dBm @ MCS 0 -95 dBm @ MCS 1 -93 dBm @ MCS 2 -90 dBm @ MCS 3 -85 dBm @ MCS 4 -83 dBm @ MCS 5 -80 dBm @ MCS 6 -77 dBm @ MCS 7 -95 dBm @ MCS 8 -91 dBm @ MCS 9 -89 dBm @ MCS 10 -85 dBm @ MCS 11 -82 dBm @ MCS 12 -78 dBm @ MCS 13 -77 dBm @ MCS 14 -76 dBm @ MCS 15
<b>Rx Sensitivity (10 MHz Channel BW)</b>	-96 dBm @ MCS 0 -93 dBm @ MCS 1 -91 dBm @ MCS 2 -88 dBm @ MCS 3 -83 dBm @ MCS 4 -81 dBm @ MCS 5 -78 dBm @ MCS 6 -75 dBm @ MCS 7 -93 dBm @ MCS 8 -89 dBm @ MCS 9 -87 dBm @ MCS 10 -84 dBm @ MCS 11 -80 dBm @ MCS 12 -76 dBm @ MCS 13 -75 dBm @ MCS 14 -74 dBm @ MCS 15	

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Model Category	Pro	Xtreme
<b>Rx Sensitivity (20 MHz Channel BW)</b>	-93 dBm @ MCS 0 -90 dBm @ MCS 1 -88 dBm @ MCS 2 -85 dBm @ MCS 3 -80 dBm @ MCS 4 -78 dBm @ MCS 5 -75 dBm @ MCS 6 -72 dBm @ MCS 7 -90 dBm @ MCS 8 -86 dBm @ MCS 9 -84 dBm @ MCS 10 -81 dBm @ MCS 11 -77 dBm @ MCS 12 -73 dBm @ MCS 13 -72 dBm @ MCS 14 -70 dBm @ MCS 15	
<b>Rx Sensitivity (40 MHz Channel BW)</b>	NA	-90 dBm @ MCS 0 -87 dBm @ MCS 1 -85 dBm @ MCS 2 -82 dBm @ MCS 3 -77 dBm @ MCS 4 -75 dBm @ MCS 5 -72 dBm @ MCS 6 -69 dBm @ MCS 7 -87 dBm @ MCS 8 -83 dBm @ MCS 9 -81 dBm @ MCS 10 -78 dBm @ MCS 11 -74 dBm @ MCS 12 -70 dBm @ MCS 13 -69 dBm @ MCS 14 -66 dBm @ MCS 15

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<b>Receive Adjacent Channel Rejection (ACRR)</b>	>34 dB @ MCS0 for 20 MHz channel (Typ)	
<b>Receive Noise Figure</b>	+4 dB	
<b>Transmitter Adjacent Channel Leakage Ratio (ACLR)</b>	-28 dB <sub>r</sub> ( $F_c \pm ChBW$ )	
<b>Transmitter Spurious Emission Suppression</b>	-40 dB <sub>c</sub>	

\* Specifications are subject to change without prior notice