Doodle Labs Smart Radio – RM-915
Advanced MIMO Mesh Router in a Tiny Form Factor

Smart Radio Overview

Embedded   **External**   **Wearable**

The Smart Radio is an advanced 2×2 MIMO mesh router designed for easy plug & play integration. The tiny module carries all bi-directional communication (e.g. Telemetry, Video) in a single high-speed broadband RF channel.

Due to its very low SWaP-C (Space, Weight and Power and Cost), the Smart Radio is very popular for mobile IIoT (Industrial Internet of Things) applications like drones, autonomous vehicles, and mobile robotics applications across various industries.

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, the Ultra Reliable Low Latency Channel (URLLC) transports important command and control data over the wireless link, while a concurrent video-optimized streaming channel carries crystal clear 4K video.

The Smart Radio is available in many frequency bands between 100 MHz and 6 GHz in form-factor compatible models. This allows customers to switch the operating band by simply swapping radio module, avoiding costly re-design efforts when expanding to new markets that require new frequencies. The Smart Radio is available in embedded and external form factors.

For more information, please visit: https://doodlelabs.com/smart-radio/

Samples available on Mouser: https://www.mouser.com/search/refine.aspx?N=4248121056

Key Features - Smart Radio Platform

PERFORMANCE RF

- Long range (field tested >100km) and high throughput (up to 100 Mbps)

- Interferen/ 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 continuous 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; FIPS-2, Level 2 compliant

- 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 (SWaP-C) 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 3rd 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 – 900 MHz ISM Band

The 900 MHz band is also known as the 33-centimeter band. RF signals at 900 MHz can penetrate through building walls, vegetation, and other obstacles. 900 MHz signals can also go around objects by refraction. Due to these transmission characteristics, broadband communication in the 900 MHz band achieves a good balance of range, penetration, and throughput.

The 900 MHz band is license-free in large parts of the world: all of ITU's region 2 (23 countries in Americas) and some additional countries like Australia, New Zealand and South Korea. In the USA, like WiFi, FCC Part 15 certified radios are permitted for unlicensed operation.
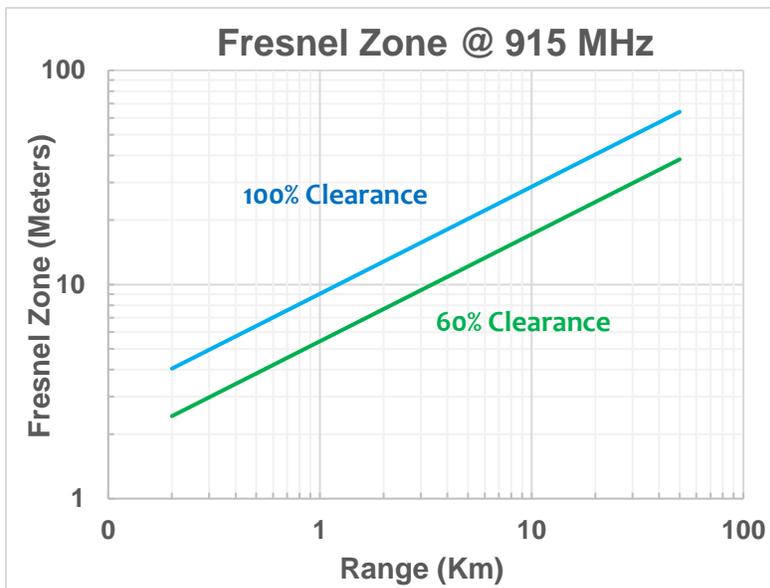
System Integration

The Smart Radio has been designed to be nearly plug and play. Only Ethernet/USB, power supply, and antenna connections are required for integration.

Visit Doodle Labs Technical Library for extensive design-in documents.
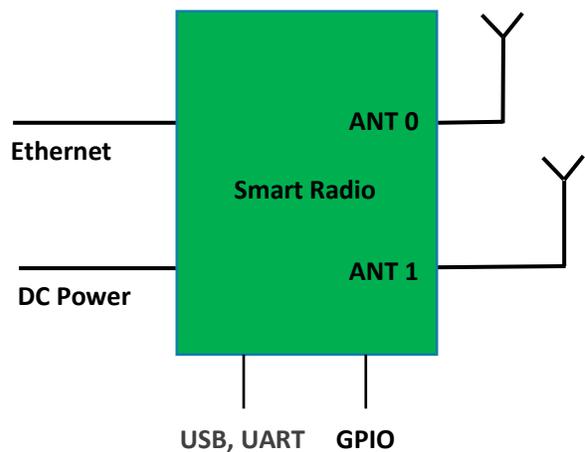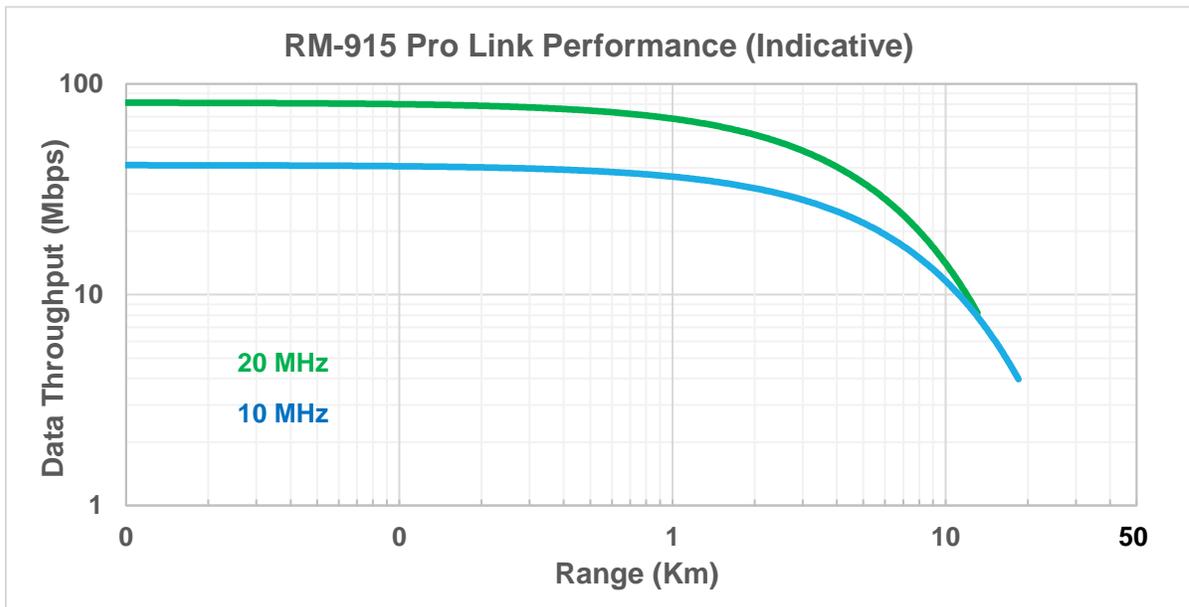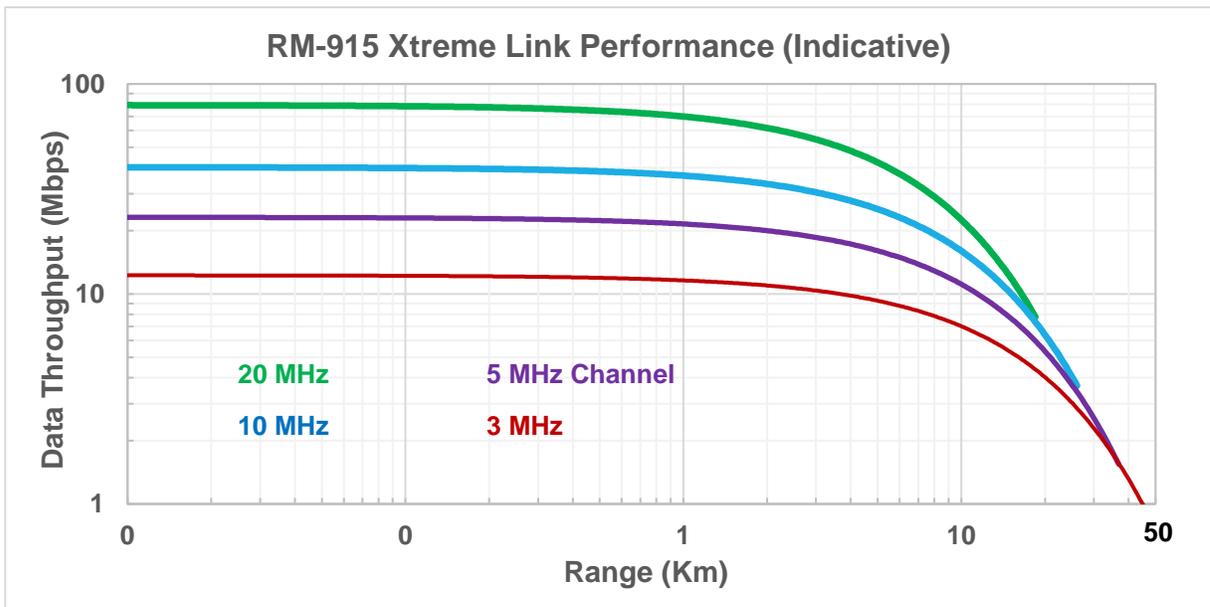
Fresnel Zone Clearance

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.

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

Link Distance

Smart Radio's Mesh Rider waveform has been field tested for >100km. The link distance depends on many factors, mainly Antenna gain, Line of Sight obstructions, Fresnel Zone clearance and environmental noise conditions. The charts below give an indication of radio's performance in a typical configuration. Refer to the App Note – Optimizing the Link Distance for more details.

Remote Antenna = 3 dBi, Control Station Antenna = 6 dBi,

Fade Margin = 10 dBm, Fresnel Zone 60% Clearance

RM-915 Xtreme Link Performance (Indicative)

20 MHz   5 MHz Channel

10 MHz   3 MHz

RM-915 Pro Link Performance (Indicative)

20 MHz

10 MHz

Technical Specifications (RM-915)

Model Category	Pro	Xtreme
ORDERING CODES		
Radio Configuration	2x2 MIMO	
Model # **(v3 hardware)**	RM-915-2J-PM (Embedded) RM-915-2J-PE (External)	RM-915-2J-XM (Embedded) RM-915-2J-XE (External)
Model # (Wearable)	RM-915-2K-PW	RM-915-2K-XW
Model Options	Integrated GPS – add G suffix PoE (External only) – add O suffix	
Evaluation Kit	EK-915-2J (Breakout board for Embedded model)	
Design-In Documentation	https://www.doodlelabs.com/technologies/technical-library/	
PERFORMANCE OVERVIEW		
Protocol (Waveform)	Mesh Rider (Not compatible with IEEE 802.11)	
Max Operating Range (Indicative)	Up to 10 Km	>20 Km (Recommended), (Max field demonstrated range >100km)
Max Data Throughput at 10-meter range (Indicative)	60 Mbps (20 MHz Channel) 30 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) (FIPS140-2, Level 2 compliant)
Operating Modes	Mesh, Relay, Routed Client, AP, Transparent Bridge, Internet Gateway	
Command & Control channel	Ultra-Reliable Low Latency Channel (URLLC). Latency 3-30 ms	
Video Channel	Optimized video streaming with Unicast and Multicast transmission	
Spectrum Scan	Automatic spectrum scan on boot up.	

Mesh Automatic Transmit Power Control (M-ATPC)	Intelligently adjusts the transmit output power based on signal strength. Allows the Smart Radios to be utilized in a widely dispersed and dynamic mesh.

Model Category	Pro	Xtreme
RF SPECIFICATIONS		
Frequency Range	902-928 MHz Channel plans available for all countries in Americas, Australia, New Zealand, and China	
Channel Sizes (Software Selectable)	5, 10, 20 MHz	3, 5, 10, 20, 26, 40 MHz
Radio Data Rate (Modulation Coding Scheme – MCS)	Dynamic Link Auto Adaptation	
RF Power Output (Typ) **Each radio individually calibrated**	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
Antenna Signal Strength	-25 to -85 dBm (Recommended), Absolute Maximum= +12 dBm	
Receiver LNA Gain	>10 dB	
RF Power Control	27 dBm	30-33 dBm
Integrated Antenna Port Protection	Able to withstand open port, >10 KV (contact) and >15KV (open air discharge) as per IEC-61000-4-2	
Wireless Error Correction	FEC, ARQ	
Frequency Accuracy	±20 ppm max over life	±10 ppm max over life
Control for External Power Amp	NA	DC biased signal over RF port
Automatic Transmit Power Control (ATPC)	Automatic adjustment of Tx power based on signal level, which ensures optimal link health at both short and long distances	
NETWORKING SPECIFICATIONS		

Model Category	Pro	Xtreme
Mesh Router	Self-Forming/Self-Healing, Peer to Peer	
Video Multicast	High Rate	
Custom Software Package Manager	OPKG	
Device Management	SSH, RPC-JSON, SNMP, UCI, GUI	
Access control	Password, MAC, IP, Port filtering	
Network Security	VPN, L2TP, GRE, STP	
Supported Protocols	IPv6, QoS, DNS, HTTPS, IP, ICMP, NTP, DHCP, VLAN	
Integrate with 3rd Party Apps	Integrate with various apps e.g. ATAK, QGroundControl, and more	
Software Upgrade	Over the air software upgrade supported	
HARDWARE SPECIFICATIONS		
Case Material	N/A (OEM) Aluminum (Embedded & External)	
Operating Voltage	6~42V DC Passive PoE (External only)	
Dimensions	65 x 57 x 12 mm, 62 grams (Embedded) 148 x 137 x 58 mm, 540 grams (External) 130 x 73.5 x 20 mm, 150 grams (Wearable)	
Interfaces	2x RJ45, UART, USB, 2x GPIO	
Antenna Connection	2x MMCX-Female (Embedded) 2x SMA-Female (External)	
Host Interface (Embedded)	2x Ethernet (100 Base-T) and UART (3.3V FT234XD chipset) OR USB 2.0 Hub	
Host Interface (External)	2x Ethernet (100 Base-T), 1x UART (3.3V FT234XD chipset), and 2x USB 2.0 Hub ports	
Host Interface (Wearable)	USB Power + Data Connector (USB-C Slave), USB Host (USB-C), AUX connector (Ethernet, UART and GPIO), SMA Connectors for External Antennas	
	-40°C to +70°C	-40°C to +85°C

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Model Category	Pro	Xtreme
Temperature range (Operating)	System's thermal design should ensure that the radio's case temperature is maintained within these specifications.	
Ingress Protection (Embedded)	IP 50 (Embedded), Dust Protected, No Liquids	
Ingress Protection (External)	IP66 (External), Protected against strong jets of water.	
Ingress Protection (Wearable)	IP 50 (Wearable), Dust Protected, No Liquids	
Shock and Vibration Resistance	Standard	Compliant to MIL-STD-810H for high shock and vibration
DC Power Consumption	• 8.5W @ Max RF power in UDP data Tx mode • 3.4W in data Rx mode • 1.2W in Sleep mode	• 9W @ Max RF power in UDP data Tx mode • 3.4W in data Rx mode • 1.2W in Sleep mode
Reliability	Standard	Extreme Reliability, IPC Class 2 standard with Class 3 options
Integrated GPS (Optional)	Simultaneous multiple constellations (GPS/Galileo/Glonass/BeiDou/QZSS), 1.5 meter CEP position accuracy, -163 dBm tracking sensitivity	
Integrated CPU	MIPS 24K, 540 MHz, 32MB Flash, 64MB DDR2 RAM	
MTBF	>235k hours (25 years)	
Temper Evident Seal	NA	Yes
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		
J/F-12 Certification	11929 (NTIA DD1494 available upon request)	
FCC ID	2AG87RM-915-2H	
Industry Canada (IC)	21411-RM9152H	
ANATEL	Compliant	
Regulatory Requirements	Designed and verified to meet various regulatory requirements. Formal testing and approval are required for the Integrator's antenna type. The	

Model Category	Pro	Xtreme
	Integrator is responsible for obtaining all regulatory approvals in target markets for the finished product.	
RoHS/WEEE Compliance	Yes. 100% Recyclable/Biodegradable packaging	
ADDITIONAL RF SPECIFICATIONS		
Radio Data Rates (Dynamic Link Auto Adaptation)	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) 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)	
Rx Sensitivity (3 MHz Channel BW)	NA	-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

Model Category	Pro	Xtreme
		-78 dBm @ MCS 15
Rx Sensitivity (5 MHz Channel BW)	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
Rx Sensitivity (10 MHz Channel BW)	-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	

Model Category	Pro	Xtreme
Rx Sensitivity (20 MHz Channel BW)	-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 -71 dBm @ MCS 15	
Rx Sensitivity (26 MHz Channel BW)	NA	-92 dBm @ MCS 0 -89 dBm @ MCS 1 -87 dBm @ MCS 2 -84 dBm @ MCS 3 -79 dBm @ MCS 4 -77 dBm @ MCS 5 -74 dBm @ MCS 6 -71 dBm @ MCS 7 -89 dBm @ MCS 8 -85 dBm @ MCS 9 -83 dBm @ MCS 10 -80 dBm @ MCS 11 -76 dBm @ MCS 12 -72 dBm @ MCS 13 -71 dBm @ MCS 14 -70 dBm @ MCS 15

Model Category	Pro	Xtreme
Receive Adjacent Channel Rejection (ACR)	>18 dB @ 6 Mbps (Typ)	
Receive Alternate Chanel Rejection (ALCR)	>35 dB @ 6 Mbps (Typ)	
Receive Noise Figure	+4 dB	
Transmitter Adjacent Channel Leakage Ratio (ACLR)	-28 dBr (Fc ± ChBW)	
Transmitter Spurious Emission Suppression	-55 dBc	

* Specifications are subject to change without prior notice

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