Wearable Smart Radio – 2400~2482 MHz (WiFi Band)

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 tactical 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 a teammate 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 standards-based 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 100 MHz and 6 GHz freq 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

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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 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

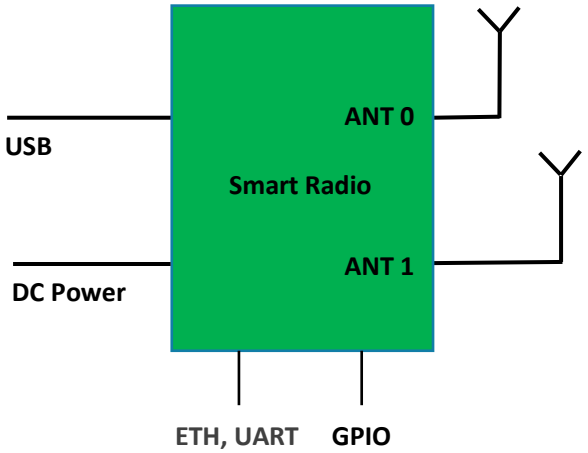
Band Introduction – 2400~2482 MHz ISM Band

The 2.4 GHz (WiFi) is a license free band globally. In the Americas, users are permitted to transmit up to 4W of (36 dBm) of power to achieve several kilometer long links for IIoT applications like drones and ground robots. In Europe and many other countries, the power is limited to 100mW (20 dBm).

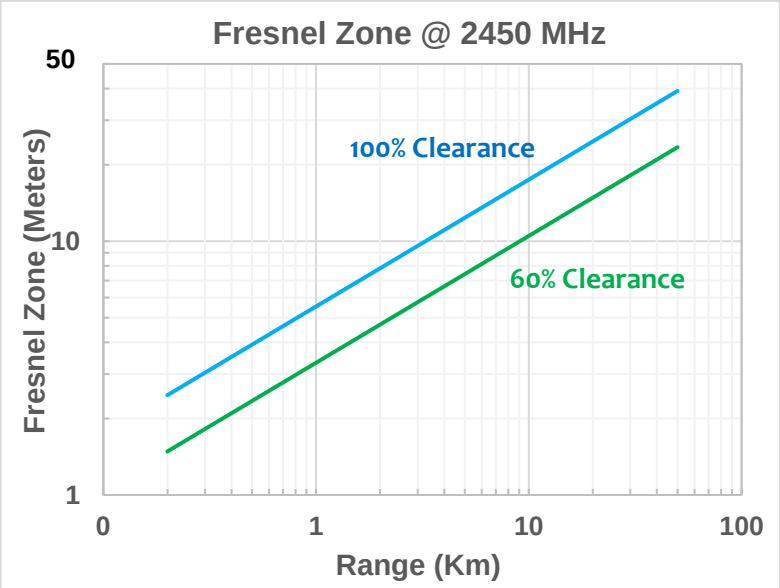
System Integration

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.

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.

Charts to be provided

a) **Embedded Antennas**
b) **Multi-polarized external antennas on the radio**
c) **High gain External Antennas**

Technical Specifications (2400~2482 MHz, WiFi band)

Model Category	Pro	Xtreme
ORDERING CODES		
Radio Configuration	2x2 MIMO	
Model # (Wearable)	RM-2450-2K-PW	RM-2450-2K-XW
Model # (OEM)	RM-2450-2K-PO	RM-2450-2K-XO
Evaluation Kit (Optional)	EK-2450-2K Includes: 2x Mesh Rider Antenna, External GPS Antenna, Breakout board, Cable, Mounting plate	
Design-In Documentation	https://www.doodlelabs.com/technologies/technical-library/	
PERFORMANCE OVERVIEW		
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 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)
Operating Modes	WiFi Radio: AP, Client Mesh Rider Radio: Mesh, WDS AP, WDS Client Bridged or Internet Gateway with NAT	
Command & Control channel	Ultra-Reliable Low Latency Channel (URLLC). Latency 1.5-10 ms	
Video Channel	Optimized video streaming with Unicast and Multicast transmission	

Model Category	Pro	Xtreme
MESH RIDER RF SPECIFICATIONS		
Protocol Compatibility (Long Range Mesh Rider)	Fully compatible with Wi-Fi (IEEE 802.11 a,n)	
Frequency Range	2400-2482 MHz	
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
Channel Sizes (Software Selectable)	10, 20 MHz	3, 5, 10, 20, 40 MHz
Radio Data Rate	Auto adapting Modulation Coding Scheme (MCS0-15)	
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 ±1 dBm	
Automatic Transmit Power Control (ATPC)	Intelligently adjusts the transmit power for very close range operation	
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

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WiFi HOTSPOT RF SPECIFICATIONS		
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 ±1 dBm	
Wireless Error Correction	FEC, ARQ	
NETWORKING SPECIFICATIONS		
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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HARDWARE SPECIFICATIONS		
Power Input	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	
Dimensions - Wearable	130 x 75 x 23 mm and 245 grams	
Dimensions - OEM	127 x 63 x 13 mm and 125 grams	
Mesh Rider Antenna Ports	2x Embedded Antennas	2x Embedded Antennas and 2x SMA-Female connector for External antennas
Host Interface	WiFi (2.4 GHz), USB-Device	+ Ethernet (100 Base-T), 1x UART (3.3V), USB-Host, and 1x GPIO port (2.62V)
Temperature range (Operating)	-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.	
Ingress Protection (Wearable)	IP62, Water spray falling at an angle of up to 15° from vertical.	
Shock and Vibration Resistance	Standard	Compliant to MIL-STD-810H for high shock and vibration
DC Power Consumption	• 9W @ Max Data Troughput • 7W @ Max Range • 3.5W in Rx mode • 0.5W in Standby mode	• 14W @ Max Data Troughput • 12W @ Max Range • 3.5W in Rx mode • 0.5W in Standby mode
Reliability	Standard	Extreme Reliability, IPC Class 2 standard with Class 3 options
Integrated GPS	NA	Simultaneous multiple constellations (GPS/Galileo/Glonass/BeiDou/QZSS), 1.5 meter CEP position accuracy, -163 dBm tracking sensitivity
GPS Antenna	NA	Embedded Antenna + SMA-Female connector for External antenna
Integrated Altimeter	NA	-698 to +11,775 m (20-bit), 1 Hz Refresh Rate. MPL3115A2

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Integrated Temp Monitor	NA	-40 – 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 (±6KV) for Contact Discharge and Level 4 (±15KV) 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	
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	

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ADDITIONAL MESH RIDER 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 -78 dBm @ MCS 15

Model Category	Pro	Xtreme
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 -70 dBm @ MCS 15	
Rx Sensitivity (40 MHz Channel BW)	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

Model Category	Pro	Xtreme
Receive Adjacent Channel Rejection (ACRR)	>34 dB @ MCS0 for 20 MHz channel (Typ)	
Receive Noise Figure	+4 dB	
Transmitter Adjacent Channel Leakage Ratio (ACLR)	-28 dBr (Fc ± ChBW)	
Transmitter Spurious Emission Suppression	-40 dBc	

* Specifications are subject to change without prior notice