

Doodle Labs Smart Radio – RM-2250

Advanced MIMO Mesh Router in a Tiny Form Factor

Smart Radio Overview



Embedded



External

The Smart Radio is an advanced 2x2 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 BII® technology (Broadband for Industrial IoT) 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/>

Key Features - Smart Radio Platform

PERFORMANCE RF

- Long range (field tested >100km) and high throughput (up to 100 Mbps)
- Interference resistant COFDM/MIMO 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
- Time Division Duplexing (TDD) for bi-directional traffic
- Resistant to high-power jamming signals
- 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

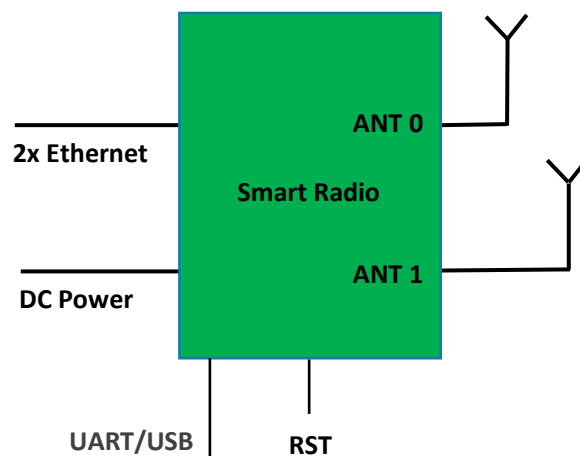
System Integration

The Smart Radio is an embedded module. It has been designed to be nearly plug and play. Only Ethernet, power supply (5.5~42V), and antenna connections are required for integration.

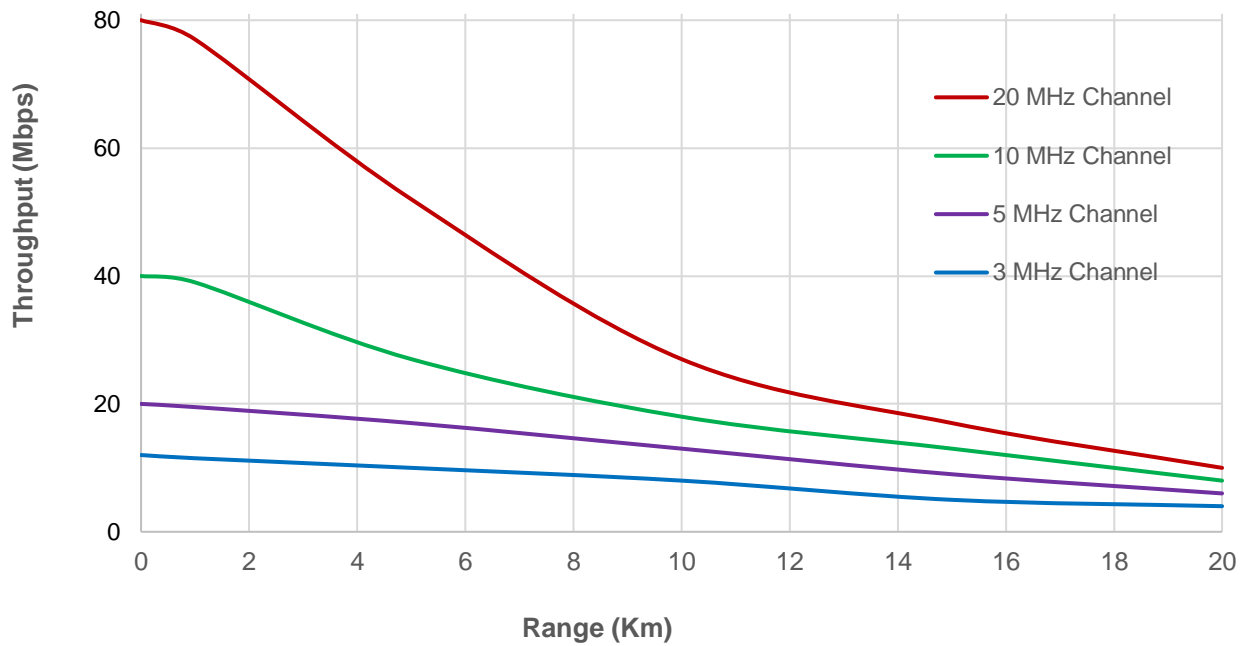
Doodle Labs provides following documents upon request: integration guide, 3D CAD model, mechanical drawing, cable drawing, and thermal map.

Doodle Labs provides extensive design-in documents at:

<https://www.doodlelabs.com/technologies/technical-library/>



Xtreme Link Performance (Indicative)



Link Configuration:

- 11 dBi antennas on both ends of the link.
- Cross-polarized H and V antennas for maximum diversity.
- > 15 dBm fade margin to account for changing RF conditions.

Technical Specifications (2200-2300 MHz Band)

Model Category	Xtreme
ORDERING CODES	
Radio Configuration	2x2 MIMO
Model # (Embedded) (v3 hardware)	RM-2250-2J-XM RM-2250-2J-XM-C
Model # (External) (v3 hardware)	RM-2250-2J-XE RM-2250-2J-XE-C
Model Options	Integrated GPS – add G suffix PoE (External only) – add O suffix
Evaluation Kit	EK-2250-2J (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)	>20 Km (Recommended), (Max field demonstrated range >100km)
Max Data Throughput at 10-meter range (Indicative)	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)
Interference Immunity	SAW filters for strong out of band noise immunity + Adjustable squelch for resistance against high-power jamming
Over the Air Data Encryption	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

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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.
RF SPECIFICATIONS	
Frequency Range	2200-2300 MHz
Channel Sizes (Software Selectable)	3, 5, 10, 20, 26, 40 MHz
Radio Data Rate (Modulation Coding Scheme – MCS)	Dynamic Link Auto Adaptation
RF Power Output (Typical) Each radio individually calibrated	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	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	±10 ppm max over life
Control for External Power Amp	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	
Mesh Router	Self-Forming/Self-Healing, Peer to Peer

Model Category	Xtreme
Multicast	High Rate
Custom Software Package Manager	OPKG
Device Management	SSH, RPC-JSON, 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
Integrate with 3rd Party Apps	Integrate with various apps e.g. ATAK, Q Ground Control, 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)
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
Temperature range (Operating)	Industrial: -40°C to +85°C, Commercial: -10°C to +65°C
	System's thermal design should ensure that the radio's case temperature is maintained within these specifications.

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Ingress Protection (Embedded)	IP 50 (Embedded), Dust Protected, No Liquids
Ingress Protection (External)	IP66 — Protected from high pressure water jets from any direction.
Shock and Vibration Resistance	Compliant to MIL-STD-202G for high shock and vibration
DC Power Consumption	<ul style="list-style-type: none"> • 10W @ Max RF power in UDP data Tx mode <ul style="list-style-type: none"> • 4W in data Rx mode • 1.2W in Sleep mode
Reliability	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	Yes
Humidity (Operating)	0% – 95% (Non-condensing)
Life Cycle Planning	Extended lifespan with 7 years guaranteed availability
REGULATORY INFORMATION	
FCC ID	NA
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	Xtreme
ADDITIONAL RF SPECIFICATIONS	
Radio Data Rates (Dynamic Per Packet 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)
Wireless Protocol	TDD with Carrier Sense Multiple Access with Collision Avoidance
Wireless Error Correction	FEC, ARQ
Freq Accuracy	±10 ppm Max over life
Antenna Signal Strength	-25 to -85 dBm (Recommended), Absolute Maximum=+12 dBm
Control for External Power Amp	DC biased signal over RF port
Receiver LNA Gain	>10 dB
Rx Sensitivity (3 MHz Channel BW)	-100 dBm @ MCS 0 -97 dBm @ MCS 1 -95 dBm @ MCS 2 -92 dBm @ MCS 3 -87 dBm @ MCS 4 -85 dBm @ MCS 5

Model Category	Xtreme
	<p>-82 dBm @ MCS 6</p> <p>-79 dBm @ MCS 7</p> <p>-97 dBm @ MCS 8</p> <p>-83 dBm @ MCS 9</p> <p>-91 dBm @ MCS 10</p> <p>-88 dBm @ MCS 11</p> <p>-84 dBm @ MCS 12</p> <p>-80 dBm @ MCS 13</p> <p>-79 dBm @ MCS 14</p> <p>-78 dBm @ MCS 15</p>
<p>Rx Sensitivity (5 MHz Channel BW)</p>	<p>-98 dBm @ MCS 0</p> <p>-95 dBm @ MCS 1</p> <p>-93 dBm @ MCS 2</p> <p>-90 dBm @ MCS 3</p> <p>-85 dBm @ MCS 4</p> <p>-83 dBm @ MCS 5</p> <p>-80 dBm @ MCS 6</p> <p>-77 dBm @ MCS 7</p> <p>-95 dBm @ MCS 8</p> <p>-91 dBm @ MCS 9</p> <p>-89 dBm @ MCS 10</p> <p>-85 dBm @ MCS 11</p> <p>-82 dBm @ MCS 12</p> <p>-78 dBm @ MCS 13</p> <p>-77 dBm @ MCS 14</p> <p>-76 dBm @ MCS 15</p>
<p>Rx Sensitivity (10 MHz Channel BW)</p>	<p>-96 dBm @ MCS 0</p> <p>-93 dBm @ MCS 1</p> <p>-91 dBm @ MCS 2</p> <p>-88 dBm @ MCS 3</p>

Model Category	Xtreme
	-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
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
Receive Adjacent Channel Rejection (ACR)	>18 dB @ 6 Mbps (Typ)

Model Category	Xtreme
Receive Alternate Channel Rejection (ALCR)	>35 dB @ 6 Mbps (Typ)
Receive Noise Figure	+4 dB
Transmitter Adjacent Channel Leakage Ratio (ACLR)	-28 dB _r (F _c ± ChBW)
Transmitter Spurious Emission Suppression	-55 dB _c

* Specifications are subject to change without prior notice.

Band Introduction – 2250 MHz Band

The 2250 MHz band ranges from 2200~2300 MHz. It is used exclusively by the Federal Government. Typical uses include military research, law enforcement video surveillance, control of robotic systems for explosive ordnance neutralization and disposal, testing of robotic ground vehicles and airborne mobile systems for air-to-ground video telemetry, air combat training systems, and unmanned aerial vehicles.