

## Doodle Labs Smart Radio – RM-4700

Advanced MIMO Mesh Router in a tiny Form Factor

### Smart Radio Overview

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 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
- 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 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 – 4.4~5.0 GHz C-Band

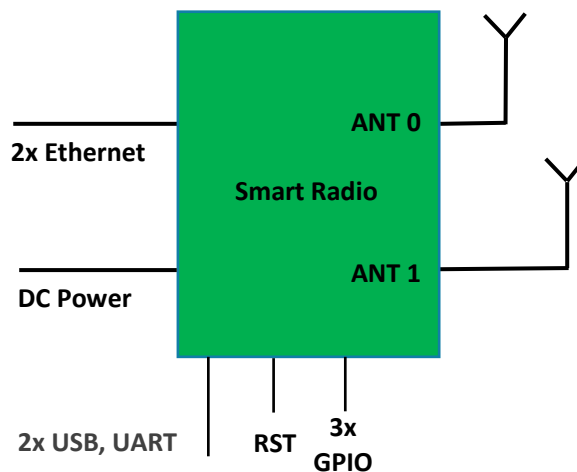
The 4.4 GHz C-band extends from 4400~5000 MHz. The C-band is used exclusively by the USA Federal Government and NATO allies. Federal & Homeland Security (DHS, DOJ), and Public Safety organizations use this band to satisfy many requirements for high capacity, multi-channel, fixed, and transportable point-to-point communications. The major functions of systems operating in this band are point-to-point communications, 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 data links supporting exchange of sensor data. These systems support tactical as well as training and administrative operations.

## System Integration

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

**Doodle Labs provides extensive design-in documents at:**

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



**Technical Specifications (4400-5000 MHz NATO Band)**

Model Category	Xtreme
<b>ORDERING CODES</b>	
Radio Configuration	2x2 MIMO, with 2x Ethernet, 2x USB, and 1x UART interfaces
Model # (Embedded)	RM-4700-2J-XM
Model # (External)	RM-4700-2J-XE
Integrated GPS (Optional)	-G suffix
Evaluation Kit	EK-4700-SR
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	>20 Km (Recommended), (Max field demonstrated range >100km)
Max Data Throughput at 10-meter range (Indicative)	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 (FIPS140-2, Level 2 compliant)	256-bit AES (12 Mbps max throughput) 128-bit AES (Full throughput)
Operating Modes	Mesh, AP, Client, Transparent WDS Bridge, Internet Gateway
Command & Control channel	Ultra-Reliable Low Latency Channel (URLLC). Latency (6 ms Min, 30 ms Typical)
Video Channel	Optimized video streaming with Unicast and Multicast transmission
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.
<b>RF SPECIFICATIONS</b>	
Frequency Range	4400-5000 MHz
Channel Sizes (Software Selectable)	3, 5, 10, 20, 40 MHz

Model Category	Xtreme
<b>Radio Data Rate (Modulation Coding Scheme – MCS)</b>	Dynamic Per Packet Link Auto Adaptation
<b>RF Power Output (Typ) Each radio individually calibrated</b>	1.0W (30 dBm), @ MCS 0,8 1.0W (30 dBm), @ MCS 3,11 0.3W (25 dBm), @ MCS 5,13 0.2W (23 dBm), @ MCS 7,15
<b>Antenna Signal Strength</b>	-25 to -85 dBm (Recommended), Absolute Maximum= +12 dBm
<b>Receiver LNA Gain</b>	>10 dB
<b>RF Power Control</b>	In 1 dBm steps, Tolerance ±1 dBm
<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>Control for External Power Amp</b>	DC biased signal over RF port
<b>Wireless Protocol</b>	TDD with Carrier Sense Multiple Access with Collision Avoidance
<b>Wireless Error Correction</b>	FEC, ARQ
<b>Frequency Accuracy</b>	±10 ppm max over life
<b>Automatic Transmit Power Control (ATPC)</b>	Automatic adjustment of Tx power based on signal level, which ensures optimal link health at both short and long distances
NETWORKING SPECIFICATIONS	
<b>Mesh</b>	Self-Forming/Self-Healing, Peer to Peer
<b>Custom Software Package Manager</b>	OPKG
<b>Radio Management</b>	LuCI Web Interface, and UCI command line interface and SNMP
<b>Network Access control</b>	Password, MAC #, IP #, Port filtering
<b>Network Security</b>	VPN, L2TP, GRE, STP
<b>Supported Protocols</b>	IPv6, QoS, DNS, HTTPS, IP, ICMP, NTP, DHCP, VLAN

<b>Software Upgrade</b>	Over the air software upgrade supported	
<b>HARDWARE SPECIFICATIONS</b>		
<b>Operating Voltage</b>	5.5~42V DC	
<b>DC Power Consumption</b>	<ul style="list-style-type: none"> <li>• 17.5W @ Max RF power in UDP data Tx mode</li> <li>• 12.5W @ 100mW (20 dBm) RF power in UDP data Tx mode</li> <li>• 8.7W in data Rx mode</li> <li>• 1.2W in Sleep mode</li> </ul>	
<b>Dimensions</b>	65 x 57 x 20 mm, 130 grams (Embedded)	148 x 137 x 58 mm, 540 grams (External)
<b>Antenna Connection</b>	2x MMCX-Female (Embedded)	2x SMA-Female (External)
<b>Host Interface</b>	2x Ethernet (100 Base-T), 1x UART (3.3V FT234XD chipset), and 2x USB 2.0 Hub ports	
<b>Temperature Range (Operating)</b>	-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</b>	IP 50 (Embedded) Dust Protected, No Liquids	IP67 (External) Immersion to 1 meter under water
<b>Shock and Vibration Resistance</b>	Compliant to MIL-STD-810H for high shock and vibration	
<b>Reliability</b>	Extreme Reliability, IPC Class 2 standard with Class 3 options	
<b>Integrated GPS (Optional)</b>	Simultaneous multiple constellations (GPS/Galileo/Glonass/BeiDou/QZSS), 1.5 meter CEP position accuracy, -163 dBm tracking sensitivity	
<b>Integrated CPU</b>	MIPS 24K, 540 MHz, 32MB Flash, 64MB DDR2 RAM	
<b>Temper Evident Seal</b>	Yes	
<b>MTBF</b>	>235k hours (25 years)	
<b>Humidity (Operating)</b>	0% – 95% (Non-condensing)	
<b>Life Cycle Planning</b>	Extended lifespan with 7 years guaranteed availability	
<b>REGULATORY INFORMATION</b>		
<b>J/F-12 Certification</b>	11929 (NTIA DD1494 available upon request)	
<b>Flammability Rating</b>	UL94 V-0 compliant	

<p><b>Regulatory Requirements</b></p>	<p>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.</p>
<p><b>RoHS/WEEE Compliance</b></p>	<p>Yes. 100% Recyclable/Biodegradable packaging</p>
<p><b>ADDITIONAL RF SPECIFICATIONS</b></p>	
<p><b>Radio Data Rates (Dynamic Per Packet Link Auto Adaptation)</b></p>	<p>MCS15 = 64QAM (5/6), 2x2 MIMO  MCS14 = 64 QAM (3/4), 2x2 MIMO  MCS13 = 64 QAM (2/3), 2x2 MIMO  MCS12 = 16QAM (3/4), 2x2 MIMO  MCS11 = 16QAM (1/2), 2x2 MIMO  MCS10 = QPSK (3/4), 2x2 MIMO  MCS9 = QPSK (1/2), 2x2 MIMO  MCS8 = BPSK (1/2), 2x2 MIMO</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>
<p><b>Rx Sensitivity (3 MHz Channel BW)</b></p>	<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</p> <p>-97 dBm @ MCS 8  -93 dBm @ MCS 9  -91 dBm @ MCS 10  -88 dBm @ MCS 11</p>

	<p>-84 dBm @ MCS 12                  -80 dBm @ MCS 13                  -79 dBm @ MCS 14                  -78 dBm @ MCS 15</p>
<p><b>Rx Sensitivity (5 MHz Channel BW)</b></p>	<p>-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</p>
<p><b>Rx Sensitivity (10 MHz Channel BW)</b></p>	<p>-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</p>



	-75 dBm @ MCS 14 -74 dBm @ MCS 15
<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 -71 dBm @ MCS 15
<b>Receive Adjacent Channel Rejection (ACR)</b>	>18 dB @ 6 Mbps (Typ)
<b>Receive Alternate Channel Rejection (ALCR)</b>	>35 dB @ 6 Mbps (Typ)
<b>Receive Noise Figure</b>	+4 dB
<b>Transmitter Adjacent Channel Leakage Ratio (ACLR)</b>	-28 dBr ( $F_c \pm ChBW$ )
<b>Transmitter Spurious Emission Suppression</b>	-55 dBc

\* Specifications are subject to change without prior notice.