Doodle Labs Smart Radio – RM-5800

Advanced MIMO Mesh Router in a tiny Form Factor

Smart Radio Overview

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, Cost), the Smart Radio is very popular for mobile IIoT (Industrial Internet of Things) applications like drones and autonomous vehicles 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, External and Pocketable 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)
- Interference resistant COFDM for robust link quality in difficult RF environments
- Exceptional Multipath and NrLOSMIMO 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 constructionto meet MIL-specs
- MIL-spec temp range (-40C to +85C)
- High quality, manufactured in ISO9001 and ISO14001 certified facilities
- COTS – Commercial off the Shelf
- Extended lifespan and availability

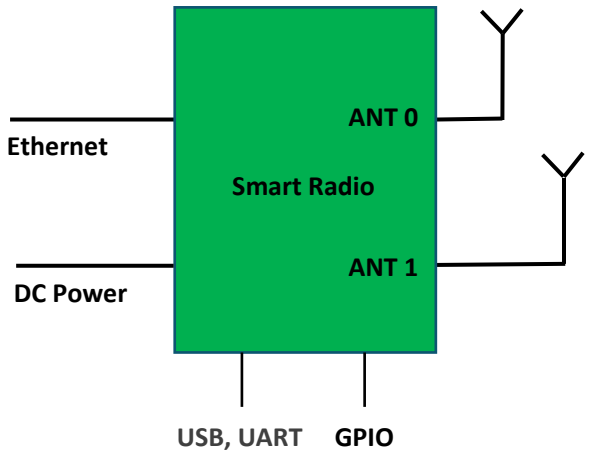
Band Introduction – 5725~5875 MHz ISM Band

The 5.8 GHz ISM Band ranges from 5735~5840 MHz. Due to it's globally unlicensed nature, the 5.8 GHz ISM band is popular for establishing wireless data links for Industrial IoT use cases. The major functions of systems operating in this band are point-to-point communications, video surveillance, control of robotic systems and unmanned aerial vehicles data links supporting exchange of sensor data.

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.

Doodle Labs provides extensive design-in documents at:
https://www.doodlelabs.com/technologies/technical-library/



Technical Specifications (5725-5875MHz ISMBand)

Model Category	Pro	Xtreme
ORDERING CODES		
Radio Configuration	2x2 MIMO, with 2x Ethernet, 2x USB and 1x UART interfaces	
Model # (Embedded)	RM-5800-2J-PM	RM-5800-2J-XM
Model # (External)	RM-5800-2J-PE	RM-5800-2J-XE
Integrated GPS (Optional)	-G suffix	
Evaluation Kit	EK-5800-SR	
Design-In Documentation	https://www.doodlelabs.com/technologies/technical-library/	
PERFORMANCE OVERVIEW		
Max Operating Range	>10 Km (Recommended)	>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)	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 (Full throughput)	256-bit AES (12 Mbps max throughput) (FIPS140-2, Level 2 compliant)
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	
RF SPECIFICATIONS		
Frequency Range	5735-5840 MHz	
Channel Sizes (Software Selectable)	10, 20MHz	3, 5, 10, 20, 40 MHz
Radio Data Rate (Modulation Coding Scheme – MCS)	Dynamic Link Auto Adaptation	

Model Category	Pro	Xtreme
RF Power Output (Typ) **Each radio individually calibrated**	400mW (26 dBm), @ MCS 0,8 200mW (23 dBm), @ MCS 3,11 125mW (21 dBm), @ MCS 5,13 100mW (20 dBm), @ MCS 7,15	800mW (29 dBm), @ MCS 0,8 400mW (26 dBm), @ MCS 3,11 250mW (24 dBm), @ MCS 5,13 0.200W (23 dBm), @ MCS 7,15
Antenna Signal Strength	-25 to -85 dBm (Recommended), Absolute Maximum=+12 dBm	
Receiver LNA Gain	>10 dB	
RF Power Control	In 1 dBm steps, Tolerance ±1 dBm	
Integrated Antenna Port Protection	Able to withstand open port;>10 KV (contact) and >15KV (open air discharge) as per IEC-61000-4-2	
Control for External Power Amp	NA	DC biased signal over RF port
Wireless Protocol	TDD with Carrier Sense Multiple Access with Collision Avoidance**(Not compatible with IEEE802.11 (WiFi)**	
Wireless Error Correction	FEC, ARQ	
Frequency Accuracy	±20 ppm max over life	±10 ppm max over life
Hardware RF Kill Function for Airborne Applications	Pin 4 of AUX connector (Embedded version only)	
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	Self-Forming/Self-Healing, Peer to Peer	
Custom Software Package Manager	OPKG	
Radio Management	LuCI Web Interface, and UCI command line interface	
Network Access control	Password, MAC #, IP #, Port filtering	
Network Security	VPN, L2TP, GRE, STP	
Supported Protocols	IPv6, QoS, DNS, HTTPS, IP, ICMP, NTP, DHCP, VLAN	
Software Upgrade	Over the air software upgrade supported	

Model Category	Pro	Xtreme
	HARDWARE SPECIFICATIONS	
Operating Voltage	5.5~42V DC	
DC Power Consumption	• 12W @ Max RF power in UDP data Tx mode • 9W @ 100mW (20 dBm) RF power in UDP data Tx mode • 2.5W in data Rx mode • 1.2W in Sleep mode	• 15W @ Max RF power in UDP data Tx mode • 10W @ 200mW (23 dBm) RF power in UDP data Tx mode • 2.5W in data Rx mode • 1.2W in Sleep mode
Dimensions	65 x 57 x 12 mm, 75 grams (Embedded) 148 x 137 x 58mm, 540 grams (External)	
Antenna Connection	2x MMCX-Female (Embedded) 2x SMA-Reverse (External)	
Host Interface	2x Ethernet (100 Base-T), 1x UART (3.3V FT234XD chipset), and 2x USB 2.0 Hubports	
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 (Embedded)	IP 50 (Embedded) Dust Protected, No Liquids	
Ingress Protection (External)	IP67 (External) Immersion to 1 meter under water	
Shock and Vibration Resistance	Standard	Compliant to MIL-STD-810H for high shock and vibration
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	
Temper Evident Seal	NA	Yes
MTBF	>235k hours (25 years)	

Model Category	Pro	Xtreme
Humidity (Operating)	0% – 95% (Non-condensing)	
Life Cycle Planning	Extended lifespan with 3 years guaranteed availability	Extended lifespan with up to 7 years guaranteed delivery
REGULATORY INFORMATION		
FCCID	2AG87RM-5800 (In process)	
Industry Canada (IC)	21411-RM5800 (In process)	
Flammability Rating	UL94 V-0 compliant	
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	
ADDITIONAL RF SPECIFICATIONS		
Radio Data Rates (Dynamic Per Packet Link Auto Adaptation)	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 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)		-100 dBm @ MCS 0 -97 dBm @ MCS 1 -95 dBm @ MCS 2 -92 dBm @ MCS 3 -87 dBm @ MCS 4

Model Category	Pro	Xtreme
		-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
Rx Sensitivity (5 MHz Channel BW)		-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	

Model Category	Pro	Xtreme
	-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	
Rx Sensitivity (40 MHz Channel BW)	-91 dBm @ MCS 0 -88 dBm @ MCS 1 -85 dBm @ MCS 2 -82 dBm @ MCS 3 -77 dBm @ MCS 4 -75 dBm @ MCS 5 -72 dBm @ MCS 6	

Model Category	Pro	Xtreme
	-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 -79 dBm @ MCS 14 -68 dBm @ MCS 15	
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.

IC statement

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic DevelopmentCanada’ s licence-exempt RSS(s). Operation is subject to the following two conditions:

(1) This device may not cause interference.

(2) This device must accept any interference, including interference that may cause undesired operation of the device.

The term “IC: “ before the certification/registration number only signifies that the Industry Canada technical specifications were met.

This product meets the applicable Industry Canada technical specifications.

Cet appareil contient des émetteurs / récepteurs exemptés de licence conformes aux RSS (RSS) d'Innovation, Sciences etDéveloppement économique Canada. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pasproduire de brouillage,et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme auxCNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes :

1)L'appareil ne doit pas produire de brouillage;

2)L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre lefonctionnement.

Please notice that if the ISED certification number is not visible when the module is installed inside another device, then theoutside of the device into which the module is installed o display a label referring to the enclosed module. This exteriorlabel can use wording such as the following: “Contains IC: 21411-RM5800” any similar wording that expresses the same meaningmay be used.

l'appareil hôte doit porter une étiquette donnant le numéro de certification du module d'Industrie Canada, précédé des mots «Contient un module d'émission », du mot « IC: 21411-RM5800 » ou d'une formulation similaireexprimant le même sens, comme suit

The device meets the exemption from the routine evaluation limits in section 2.5 of RSS 102 andcompliance with RSS-102 RF exposure, users can obtain Canadian information on RF exposure andcompliance.

Le dispositif rencontre l'exemption des limites courantes d'évaluation dans la section 2.5 de RSS 102 etla conformité

à l'expositionde RSS-102 rf, utilisateurs peut obtenir l'information canadienne surl'exposition et la conformité de rf.

This transmitter must not be co-located or operating in conjunction with any other antenna ortransmitter. This equipment should be installed and operated with a minimum distance of 20centimeters between the radiator and your body.

Cet émetteur ne doit pas être Co-placé ou ne fonctionnant en même temps qu'aucune autre antenne ouémetteur. Cet équipementdevrait être installé et actionné avec une distance minimum de 20 centimètres entre le radiateur et votre corps.

This radio transmitter IC: 21411-RM5800 has been approved by innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Antennas Information:

Antenna Type	Manufacturer	Model/Part No.	Gain (dBi)	Frequency Range (MHz)
External Antenna	San Jose Technology, Inc.	EEN-TX11	3dBi	2400-2500MHz/5150-5850MHz

FCC Statement

FCC standards: FCC CFR Title 47 Part 15 Subpart E Section 15.407: 2016
External Antenna with gain 3.0dBi

FCC Regulatory Compliance:
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.
Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.
If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
-- Reorient or relocate the receiving antenna.
-- Increase the separation between the equipment and receiver.
-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-- Consult the dealer or an experienced radio/TV technician for help.

Warning: changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

If power exceeds the limit and the distance(Over 20cm distance in actual use between the device and user) is compliance with the requirement

RF Exposure Compliance:
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator and any part of your body.

Notice to OEM integrator
If the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. The end product shall haves the words "Contains Transmitter Module FCC ID: 2AG87RM-5800".

The device must be professionally installed.
The intended use is generally not for the general public. It is generally for industry/commercial use.
The connector is within the transmitter enclosure and can only be accessed by disassembly of the transmitter that is not normally required. The user has no access to the connector.
Installation must be controlled. Installation requires special training.

Any company of the host device which installs this modular with unlimited modular approval should perform the test of radiated & conducted emission and spurious emission, etc. according to FCC part 15C: 15.407 and15.203 & 15.207, 15B Class B requirement, only if the tests result comply with FCC part 15C: 15.407 and 15.203 & 15.207, 15B Class B requirement, then the host can be sole legally.

When the module is installed inside another device, the user manual of the hose contain below
1) This device may not cause harmful interference.
2) This device must accept any interference received, including interference that may cause undesired operation