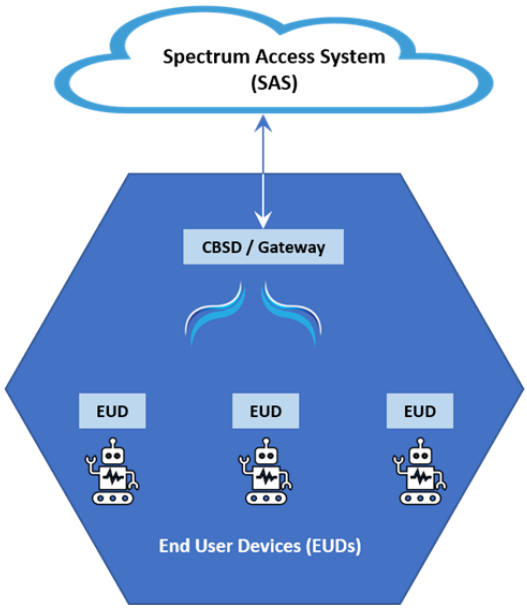
Embedded/External Mesh Rider® Radio – 3625-3700 MHz (CBRS Band)

Overview

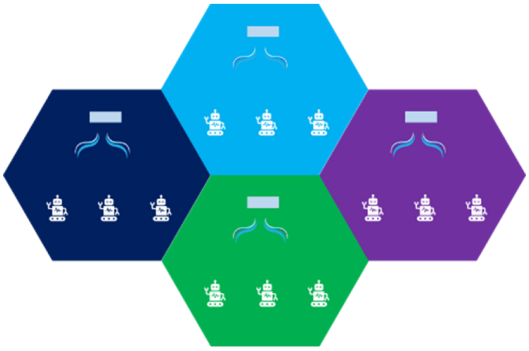
CBRS (Citizen's Broadband Radio Service) is a very large swath of newly released license free 3.5 GHz spectrum by FCC to promote the development of new applications. The FCC calls it an "Innovation band" with the intention that it will ignite the development of new use cases, like what WiFi did over 20 years ago. Because CBRS band's shared access is managed, it provides interference protection.

CBRS Anatomy

The figure shows the Point to Multi-Point Network architecture for the license free CBRS band. At power up, every CBSD (Citizens Broadband Radio Service Device) is required to contact the shared Spectrum Access System (SAS) over the Internet and receive operating parameters like the channel and the RF power limit. The SAS provides this authorization in accordance with other CBSDs operating in the area. The device category CBSD-A is defined for urban use cases and the high powered CBSD-B for rural-outdoor settings will be introduced in the future.



The FCC has authorized over 10 companies to operate the SAS. Doodle Labs has worked closely with Google SAS and Federated Wireless SAS to ensure the interoperability of our CBSD and pre-configure it to make this a turn-key operation. Once the CBSD receives authorization from the SAS, it can then instruct the downstream EUD (End User Device) to begin operation.



The CBRS topology is modeled after the cellular architecture. The SAS assigns non-overlapping/non-interfering channels to the adjacent cells. This greatly increases the ability to deploy large private networks without the worry of interference.

Mesh Rider® Radios for CBRS

The Mesh Rider® Radios for the 3.5 GHz CBRS band are advanced 2×2 MIMO mesh routers. The RM-3625 models are fully compliant to FCC Part 96 regulatory requirements. They provide all the building blocks to deploy license free, high performance and interference free private broadband networks. The CBRS Mesh Rider® Radios are available as CBSD/Gateway (Short Range CBSD-A and Rural CBSD-B), and EUD-A and EUD-B functions. The Gateways and EUDs are available in Embedded, External and Wearable form factors to meet application specific requirements.

Embedded

External

Wearable

Key Features - Mesh Rider® 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 bandwidth 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 channel/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
- FIPS Certified 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

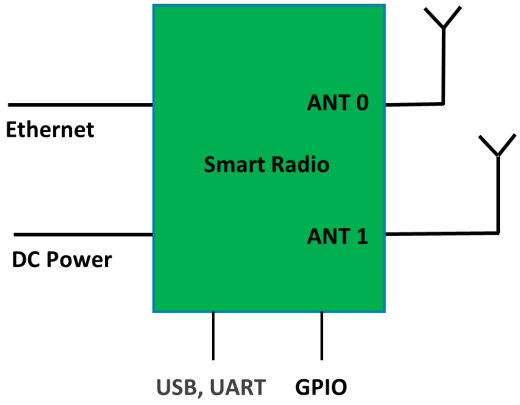
ADDITIONAL FEATURES

- 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

System Integration

The Mesh Rider® 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.



Technical Specifications (CBSD/Gateway)

Model Category	XTreme
ORDERING CODES	
Radio Configuration	2x2 MIMO
Model # (Embedded)	RM-3625-2J-SDB-MG (Industrial temp) RM-3625-2J-SDB-MG-C (Commercial temp)
Model # (External)	RM-3625-2J-SDB-EG (Industrial temp) RM-3625-2J-SDB-EG-C (Commercial temp)
Model options	Integrated GPS – add G suffix PoE (External only) – add O suffix
Evaluation Kit (Optional)	EK-3625-2J (Ethernet board for Embedded model)
Design-In Documentation	Doodle Labs Technical Library
PERFORMANCE OVERVIEW	
Data Throughput at 10-meter range with Attached 3 dBi Antennas (Indicative)	35 Mbps (10 MHz Channel)
Over the Air Data Encryption	128-bit AES (Full throughput) 256-bit AES (12 Mbps max throughput)
FIPS Certification (Optional)	FIPS 140-3
Operating Modes	Gateway/AP (CBSD-A), Rural Gateway/AP (CBSD-B), Transparent Client Bridge (EUD-A), Transparent Client Bridge (EUD-B)

Command & Control channel	Ultra-Reliable Low Latency Channel (URLLC). Latency 1.5-10 ms
Video Channel	Optimized video streaming with Unicast and Multicast transmission
RF SPECIFICATIONS	
Protocol Compatibility	Fully compatible with Doodle Labs Mesh Rider Waveform
Frequency Range	3550-3700 MHz (Supports GA and PAL users)
Advanced Band Filters	Dedicated SAW filters for high interference immunity
Max RF Power at SMA port (Software control) Each radio individually calibrated	1.0W (30 dBm) @ MCS 0,8 1.0W (30 dBm) @ MCS 3,11 0.4W (26 dBm) @ MCS 5,13 250mW (2 dBm) @MCS 7,15
Channel Sizes (Software Selectable)	3, 5, 10 MHz
Channel Aggregation	Up to 4 channels
Radio Data Rate	Auto adapting Modulation Coding Scheme (MCS0-15)
Antenna Signal Strength	-25 to -85 dBm (Recommended), Absolute Maximum= +12 dBm
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
Receive Noise Figure	+4 dB

Receive Adjacent Channel Rejection (ACRR)	34 dB @ MCS0 for 20 MHz channel (Typ)
Transmitter Adjacent Channel Leakage Ratio (ACLR)	< 28 dBr (Fc ± ChBW)
Transmitter Spurious Emission Suppression	< 55 dBc
Frequency Accuracy	±10 ppm max over life
Control for External Power Amp	DC biased signal over RF port
NETWORKING SPECIFICATIONS	
Mesh Router	Self-Forming/Self-Healing, Peer to Peer
Custom Software Package Manager	Image Builder, OPKG, ipk
Radio Management	Web GUI (HTTPs), SSH and JSON-RPC
Access control	Password, MAC, IP, Port filtering
Supported Protocols	IPv6, QoS, DNS, HTTPS, IP, ICMP, NTP, DHCP
Software Upgrade	Over the air software upgrade supported
HARDWARE SPECIFICATIONS	
Case Material	Aluminum (Embedded & External)
Power Input	6V - 42V DC **(EOL August 2022)** 6V - 32V DC External supports passive POE

DC Power Consumption	14W @ Max Data Throughput 5.6W in Rx mode 1.8W in Standby mode
Dimensions	65 x 57 x 12 mm, 78 grams (Embedded) 148 x 137 x 58 mm, 540 grams (External)
Mesh Rider Antenna Ports	2x MMCX-Female (Embedded) 2x SMA-Female (External)
Host Interface	2x Ethernet (100 Base-T), 1x UART (3.3V), 2x USB 2.0 Host, 2x GPIO (Embedded) 2x Ethernet (100 Base-T), 1x UART (RS232), 2x USB 2.0 Host, 2x GPIO (External)
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.*
Ingress Protection	IP 50 (Embedded), Dust Protected, No Liquids IP66 — Protected from high pressure water jets from any direction.
Relative Humidity	5% to 95% noncondensing
Shock and Vibration Resistance	Compliant to MIL-STD-810H for high shock and vibration
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 GPS Module with LNA	u-blox MAX-M8 series Concurrent GNSS Module (u-blox.com)

GPS Antenna	SMA-Female connector for external Passive antenna (External) MMCX-Female connector for external Passive antenna (Embedded) *(use of Active GPS antenna is not recommended)*
Integrated CPU	MIPS 24Kc, 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)
Life Cycle Planning	Extended lifespan with 7 years guaranteed availability
REGULATORY INFORMATION	
FCC ID	2AG87RM-3625
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

Technical Specifications (End User Device, EUD)

The Mesh Rider® Radios are available as lower cost End User Devices (EUD) to work with the CBSD/Gateway devices. The EUDs can interoperate with all CBSD options available. The table below shows only the specifications that are different than the CBSD specifications. This module can only operate in a host device acting as an end user device.

Model Category	XTreme
ORDERING CODES	
Radio Configuration	2x2 MIMO
Model # (Embedded)	RM-3625-2J-UDB-MG (Industrial temp) RM-3625-2J-UDB-MG-C (Commercial temp)
Model # (External)	RM-3625-2J-UDB-EG (Industrial temp)) RM-3625-2J-UDB-EG-C (Commercial temp)
Evaluation Kit (Optional)	EK-3625-2J (Ethernet board for Embedded model)
Design-In Documentation	Doodle Labs Technical Library
EUD SPECIFICATIONS	
Operating Modes	Transparent Client Bridge
RF Power Output (Typ)	23 dBm
DC Power Consumption	8.2 W @ 23 dBm 5.6 W @ RX 1.8 W @ standby
REGULATORY INFORMATION	
FCC ID	2AG87RM-3625 2AG87-RM3625
EXPORT INFORMATION	

ECCN Code	5A992
HS Code	85256010

Additional RF Specifications (Applies to all CBSD and EUD models)

Additional RF Specifications				
MCS Rate	**Modulation**	**Combined Output Power (dBm)**	**Sensitivity (dBm)**	**UDP Throughput (Mbps)**
0	BPSK (1/2)	30	-96	2.7
1	QPSK (1/2)	30	-93	5.3
2	QPSK (3/4)	30	-91	7.9
3	16-QAM (1/2)	30	-88	10.4
4	16-QAM (3/4)	27	-83	15.3
5	64-QAM (2/3)	26	-81	20.0
6	64-QAM (3/4)	25	-78	22.3
7	64-QAM (5/6)	24	-75	24.6
8	BPSK (1/2)	30	-93	5.3
9	QPSK (1/2)	30	-89	10.4
10	QPSK (3/4)	30	-87	15.2
11	16-QAM (1/2)	30	-84	19.9
12	16-QAM (3/4)	27	-80	28.6
13	64-QAM (2/3)	26	-76	36.7
14	64-QAM (3/4)	25	-75	40.5

15	64-QAM (5/6)	24	-74	44.2

Note 1: Performance based on 10-MHz bandwidth
Note 2: Sensitivity and throughput are approximately proportional to bandwidth.

FCC Statement

FCC Standards: FCC CFR Title 47 Part 96

External Antenna：

Antenna	Gain (dBi)	Cable Loss (dB)	True Gain (dBi)	Remark
1	9.5	2.71	6.79	Category A Device
2	18	2,71	15.29	Category B Device
3	3	0.63	2.37	End User Device

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. 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 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.

RF Exposure Compliance This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. The antenna used with this transmitter must be installed to provide a minimum separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi- transmitter product procedures.

Labeling and Notice to OEM Integrator If the FCC ID is not visible when the module is installed inside another device, then the outside of the finished product into which the module is installed must display a label referring to the enclosed module. This exterior label can use wording as follows:

For the RM-3625: Category A and Category B devices

Contains Transmitter Module FCC ID: 2AG87RM-3625 or

Contains FCC ID: 2AG87RM-3625

This transmitter operates as Category A and Category B CBSD. Category B CBSD is limited to professional installation and outdoor operations.