

## Doodle Labs Smart Radio – RM-1690

### SWaP Optimized COFDM/MIMO Broadband Radio with Ethernet

### Smart Radio Overview

The Smart Radio is a tiny, full-featured broadband MIMO radio and a mesh router. It has an Ethernet interface to allow easy integration into any system. With up to 1W of RF power and 2x2 MIMO technology, the Smart Radio can transmit large amounts of data (e.g. 4K video) in real-time from over 20 km away. Doodle Labs' Smart Radio has been designed to allow OEMs to rapidly develop new Industrial IoT applications.



The Smart Radio's flexible frequency architecture can satisfy customers' requirements in any market or country. The Smart Radios are available in many frequency bands up to 4 GHz and have been designed to be interchangeable, allowing customers to switch the operating bands by simply swapping the radio.

### Key Features

#### PERFORMANCE RF

- Interference resistant COFDM for improved link quality in busy RF environments
- Adaptive radio modulations from DSSS up to 64QAM and continuous per packet optimization to maximize link performance in dynamic environments
- Software defined channel size of 5~20 MHz for efficient re-use of spectrum
- Software defined operating frequency band for global applications
- Exceptional Multipath and NLOS performance
- Convolutional Coding, Forward error correction (FEC), Ack-retransmits for robust data transmission over noisy spectrum
- Maximal Ratio Combining and beam forming for diversity antenna gain
- Spatial Multiplexing for enhanced throughput
- Space Time Block Coding for increased robustness
- Time Division Duplexing (TDD) for bi-directional traffic
- Distributed control with CSMA/CA to auto balance the network for

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## Data Sheet

asymmetric up/down traffic and throughput requirements of each node

- Long range (up to 20 km) with adjustable RF power to reduce interference
- Fast handoff for mobile applications

### **PERFORMANCE NETWORKING**

- High data throughput up to 100 Mbps
- Advanced QOS and multimedia traffic prioritizations for low latency Command and Control as well as 4K video streaming on the same link
- Self-healing/self-forming mesh router with high scalability
- Multiple network access and authentication methods
- Support for all topologies, including infrastructure, adhoc, PtP, PtmP, and Repeater modes
- Up to 128-bit AES encryption for over the air data
- Firewall - MAC/IP/protocol/port filtering for restricted access control
- Embedded network management GUI with diagnostics
- Supported Protocols - DNS, HTTP, HTTPS, IP, ICMP, NTP, TCP, UDP,

RADIUS, DHCP, VLAN, STP/RSTP, VPN, IPsec, L2TP, GRE

- 3 levels of software licenses to meet customer requirements

### **ADDITIONAL FEATURES**

- Very small size, weight, and power (SWaP) for mobile applications
- Ethernet interface to allow easy integration into various applications
- Available in 100 MHz – 4 GHz frequency range in form factor compatible models
- Rugged construction, Industrial temperature range (-40C to +85C)
- OTA firmware upgrade
- Field proven and deployed in critical applications where failure is not an option
- COTS – Commercial off the Shelf

### **TARGET APPLICATIONS**

- Unmanned Aerial Vehicles (Drones)
- Mobile robotics
- Wireless Ethernet extensions

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### Band Introduction – 1690 MHz Band

The 1690 MHz band ranges from 1670~1710 MHz. In 2014, the FCC in collaboration with NTIA reallocated the band to commercial wireless use. Operations in the 1690 MHz band consist of military tactical radio relay, air combat training systems, tracking, telemetry, and control data communications for control of spacecraft. Federal agencies and the military also use this band for law enforcement video surveillance and robotics, terrestrial telemetering operations for aircraft, missile flight testing, fixed point-to-point microwave relay communications and unmanned aerial systems.

This band's transmission characteristics make it desirable to achieve a good balance of range and penetration for mobile ground-based robots. The RF signals at 1690 MHz have the ability to propagate further distances via two mechanisms: penetration and diffraction. Penetration refers to 1690 MHz waves ability to penetrate through building walls, vegetation and other obstacles. 1690 MHz waves can go through multiple building walls making it an excellent choice for applications that do not have a direct line of sight between sender and receiver. Diffraction describes the characteristic of a 1690 MHz wave that it can go around an object such as a building or vegetation. 1690 MHz waves have smaller Fresnel zone.

### Doodle Labs Products for 1690 MHz Band

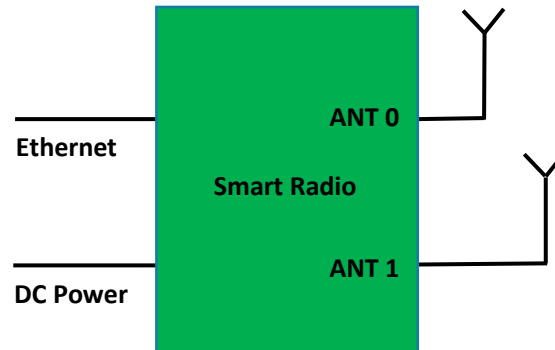
Description	Model No.
1x1 COFDM Broadband Transceiver with miniPCIe interface	NM-1690-1G
2x2 MIMO Broadband Transceiver with miniPCIe interface	NM-1690-2H
1x1 COFDM Smart Radio with Ethernet interface	RM-1690-1G
2x2 MIMO Smart Radio with Ethernet interface	RM-1690-2H

### System Integration

The Smart Radio is easy to integrate. Only the Ethernet, Power supply and Antenna connections are required. The Smart Radio integrates the CPU and optimized OpenWRT to free the systems developer from the details.

## Data Sheet

Doodle Labs provides following documents upon request - Integration Guide, 3D CAD model, Mechanical Drawing and Cable Drawing.



## Technical Specifications (1690 MHz Band)

Model No.	RM-1690-1G	RM-1690-2H
Radio Configuration	1x1 COFDM	2x2 MIMO
Frequency Range	1670-1710 MHz	
Channel Bandwidth	5, 10, and 20 MHz	
Data Throughput (64 QAM, 20 MHz BW)	50 Mbps	100 Mbps
Operating Range (Indicative)	8 Km	15 Km
	11 dBi antenna on both sides, 20 dBm fade margin, BPSK rate	
RF Power Output	0.5W (27 dBm) @ BPSK 0.5W (27 dBm) @ 16QAM 125 mW (21 dBm) @ 64QAM	1W (30 dBm) @ BPSK 1W (30 dBm) @ 16QAM 250 mW (25 dBm) @ 64QAM
RF Power Control	In 0.5 dBm steps. Accuracy of power calibration loop $\pm 2$ dBm. Each radio individually calibrated and tested.	
Rx Sensitivity (5 MHz Channel BW)	-92dBm @ BPSK -73 dBm @ 64QAM	-95 dBm @ BPSK -74 dBm @ 64QAM

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Model No.	RM-1690-1G	RM-1690-2H
Radio Data Rates (Dynamic Link Adaptation)	1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48 and 54 Mbps, MCS0-7	1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48 and 54 Mbps, MCS0-15
Wireless Protocol	TDD with Carrier Sense Multiple Access with Collision Avoidance	
Wireless Error Correction	FEC, ARQ	
Wireless Data Encryption	Up to 128-bit AES data encryption	
Special Features	Extended lifespan with many years' planned availability Extreme Reliability, IPC Class 2 standard with Class 3 options Compliant to MIL-STD-202G for high shock/vibration environments	
<b>SOFTWARE SPECIFICATIONS</b>		
Operating Modes	AP, Client and Adhoc modes to implement Access Point, PtP, PtmP, and Mesh networks	
Traffic Prioritization	Advanced QOS and multimedia traffic prioritizations for low latency Command and Control as well as 4K video streaming on the same link	
Mesh Router	Self-Forming/Self-Healing, Peer to Peer	
Firewall	MAC/IP/protocol/port filtering for restricted access control	
Supported Protocols	DNS, HTTP, HTTPS, IP, ICMP, NTP, TCP, UDP, RADIUS, DHCP, VLAN, STP/RSTP, VPN, IPsec, L2TP, GRE	
Software License	3 Levels of Software licenses to meet customer requirements. See separate Software datasheet for more details.	
<b>HARDWARE SPECIFICATIONS</b>		
Operating Voltage	5.5~40V DC	

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Model No.	RM-1690-1G	RM-1690-2H
Power Consumption	6.3W @ Max power, in continuous data transfer mode 2.2W in continuous data receive mode 1W in Sleep mode	9W @ Max power in continuous data transfer mode 3.4W in continuous data receive mode 1.2W in Sleep mode
Antenna Signal Strength	-35 to -85 dBm (Recommended), Absolute Maximum=+12 dBm	
Interference Immunity	SAW filters on RF and ANT ports for immunity against other high-power transmissions in the neighboring bands	
Integrated Antenna Port Protection	Able to withstand open port, >10 KV (contact) and >15KV (open air discharge) as per IEC-6100-4-2	
Receiver LNA Gain	>10 dB	
Receiver Adjacent Channel Rejection (ACR)	>18 dB @ 6 Mbps (Typ)	
Receiver Alternate Channel Rejection (ALCR)	>35 dB @ 6 Mbps (Typ)	
Receive chain Noise Figure	+6 dB	
Transmitter Adjacent Channel Leakage Power Ratio (ACLR)	45 dB ( $F_c \pm ChBW$ )	
Transmitter Spurious Emission Suppression	-55 dBc	
Freq Accuracy	$\pm 10$ ppm Max	
Integrated CPU	MIPS 24K, 540 MHz, 32MB Flash, 64MB DDR2 RAM	
Control for External Power Amp	DC biased signal over RF ports	
<b>PHYSICAL, ENVIRONMENTAL SPECIFICATIONS</b>		
Dimensions	37x57x11 mm, 40 grams	65x57x11 mm, 60 grams
Antenna Connection	1x MMCX-Female	2x MMCX-Female
Host Interface	Ethernet	

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Model No.	RM-1690-1G	RM-1690-2H
Cable Assembly	Initial samples Include the harness with DC power. Cable assembly drawing available upon request.	
Shield case temperature range (Operating)	-40°C to +85°C System's thermal design should ensure that the transceiver's case temperature is maintained within these specifications.	
Humidity (Operating)	0% – 95% (Non-condensing)	
<b>OTHER SPECIFICATIONS</b>		
MTBF	25 years	
NTIA	Supporting information for DD-1494 is available upon request	
Regulatory Requirements	Designed and Verified to meet various regulatory requirements. Formal testing and approval is required based on the Integrator's host platform and antenna type. The Integrator is also responsible for obtaining all required regulatory approvals in target markets for the finished product.	
RoHS/WEEE Compliance	Yes. 100% Recyclable/Biodegradable packaging	

\* Specifications are subject to change without prior notice.