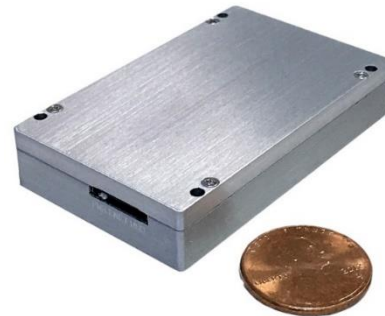


## Doodle Labs Smart Radio – RM-1370

### 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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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 – 1370 MHz Band

The 1370 MHz band ranges from 1350~1390 MHz. 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 1370 MHz have the ability to propagate further distances via two mechanisms: penetration and diffraction. Penetration refers to 1370 MHz waves ability to penetrate through building walls, vegetation and other obstacles. 1370 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 1370 MHz wave that it can go around an object such as a building or vegetation. 1370 MHz waves have smaller Fresnel zone.

The DoD operates telemetry systems in this band that are used to transmit and receive data from airborne vehicles at test and training ranges. Additionally, the DoD operates transportable tactical point-to point communication systems in the 1370 MHz band. These tactical communication systems are used for command and control networks for military ground forces. This is the only transmission media available to the Marine Corps with sufficient bandwidth to carry large quantities of critical data such as maps, overlays, intelligence pictures, and other data to the battlefield commanders. These systems are used within the United States for comprehensive and realistic training to maintain a high level of combat readiness. The DoD will continue to operate tactical transportable fixed point-to-point communication systems in this band for the foreseeable future.

### Doodle Labs Products for 1370 MHz Band

| Description   | Model No.  |
|---|------------|
| 1x1 COFDM Broadband Transceiver with miniPCIe interface | NM-1370-1G |
| 2x2 MIMO Broadband Transceiver with miniPCIe interface  | NM-1370-2H |
| 1x1 COFDM Smart Radio with Ethernet interface           | RM-1370-1G |
| 2x2 MIMO Smart Radio with Ethernet interface            | RM-1370-2H |

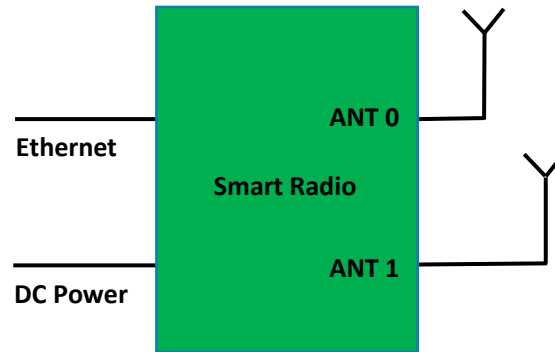
### System Integration

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.

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## Data Sheet

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



## Technical Specifications (1370 MHz Band)

| Model No.                           | RM-1370-1G   | RM-1370-2H   |
|-------------------------------------|--|--|
| Radio Configuration                 | 1x1 COFDM  | 2x2 MIMO   |
| Frequency Range                     | 1350-1370 MHz  |  |
| Channel Bandwidth                   | 5, 10, and 20 MHz  |  |
| Data Throughput (64 QAM, 20 MHz BW) | 50 Mbps  | 100 Mbps   |
| Operating Range (Indicative)        | 10 Km  | 20 Km  |
|                                     | 8 dBi antenna on both sides, 20 dBm fade margin, BPSK rate   |  |
| RF Power Output                     | 0.5W (27 dBm) @ BPSK<br>0.5W (27 dBm) @ 16QAM<br>125 mW (21 dBm) @ 64QAM   | 1W (30 dBm) @ BPSK<br>1W (30 dBm) @ 16QAM<br>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<br>-73 dBm @ 64QAM   | -95 dBm @ BPSK<br>-74 dBm @ 64QAM                                    |

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| Model No.                                  | RM-1370-1G   | RM-1370-2H   |
|--|--|--|
| 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<br>Extreme Reliability, IPC Class 2 standard with Class 3 options<br>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-1370-1G   | RM-1370-2H  |
|---|--|---|
| Power Consumption                                       | 6.3W @ Max power, in continuous data transfer mode<br>2.2W in continuous data receive mode<br>1W in Sleep mode | 9W @ Max power in continuous data transfer mode<br>3.4W in continuous data receive mode<br>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-1370-1G  | RM-1370-2H |
|---|---|------------|
| 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<br>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.