



INTEGRATION GUIDE

802.11ac Wave 2 2x2 Radio Module

Installation, Setup and Configuration

RM-WIFI-AC-2X2-HP-US, RM-WIFI-AC-2X2-HP-EU, RM-WIFI-AC-2X2-HP-CA

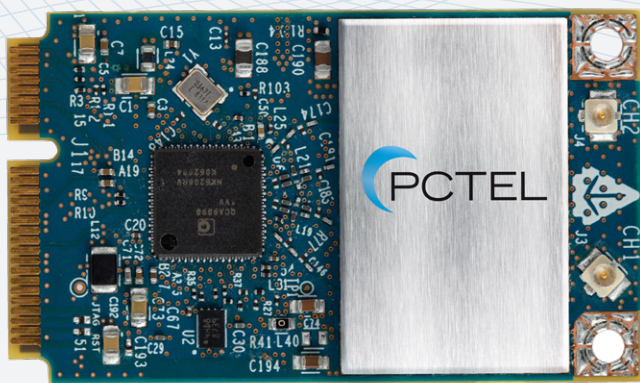


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Text Format Conventions

Monotype – Palatino Linotype MONOTYPE, Bold
[Command prompt, directories, files]

Courier New, Bold
[Console commands and input]

Terms and Abbreviations

SoC	System-on-Chip
OFDM	Orthogonal Frequency-division Multiplexing
MU-MIMO	Multi-User, Multiple Input, Multiple Output
DSSS	Direct Sequence Spread Spectrum
CCK	Complementary Code Keying
AMSDU	Aggregated MAC Service Data Unit
AMPDU	Aggregated MAC Protocol Data Unit

Referenced Documents

Document	Description	Version
PCTEL® RM-WIFI-AC-2x2-HP Datasheet	2x2, 802.11ac Wave 2 WiFi Radio Module	1.0

1. Overview

The PCTEL® RM-WIFI-AC-2x2-HP 802.11ac Wave 2 Radio Module is built in a standard mini-card format following the mini-PCIe interface standard. The radio module features true enterprise-class specifications including high TX output power and support for all 802.11ac channel definitions up to and including 80 MHz channels.

The radio module adheres to the PCI-SIG PCI Express Mini Card Specification 2.0 mechanical form factor with an electrical interface that meets the PCIe Specification 1.1. The small solution and low power consumption make this radio module ideal for integration into edge computers and other platforms.

This Integration Guide provides both hardware and software information needed to properly integrate the radio module into a host platform.

Additional information can be found in the PCTEL Industrial IoT Radio Module Datasheet.

2. Architecture

2.1. Product Description

The PCTEL RM-WIFI-AC-2x2-HP WiFi Radio Module is compliant with the IEEE 802.11ac Wave 2 standard. It is a single-band 5 GHz radio with 2 RF chains. An EEPROM memory is included for calibration information storage. There is no external volatile memory for application processing.

The Qualcomm Technology QCA9898 5 GHz WiFi radio transceiver chip provides the radio module functionality. An external power amplifier for each channel is provided to achieve high transmit power.

2.2. Block Diagram

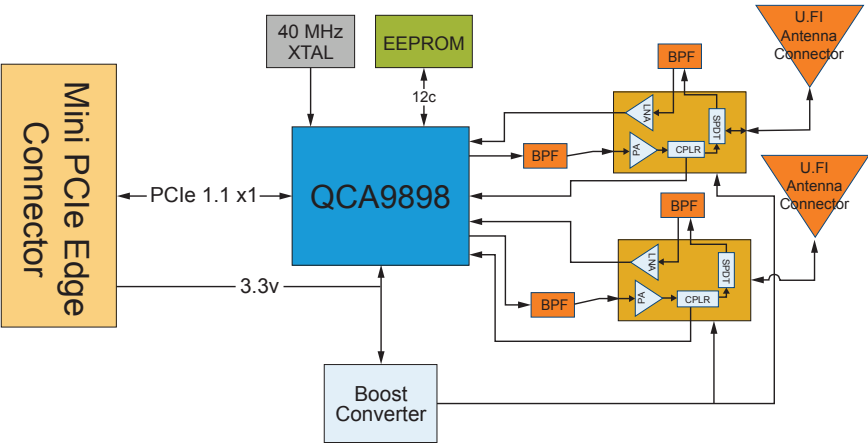


Figure 1. Block Diagram

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2.3. WiFi Features

- IEEE 802.11a/n/ac Wave 2 standards
- Capable of 2x2, two spatial stream communication
- Supports 20/40/80 MHz at 5 GHz
- Supports up to 256 QAM
- Data rates of up to 867 Mbps in 802.11ac 80 MHz channels using reduced (short) guard interval (SGI)
- Supports Multiuser MIMO (MU-MIMO) technology
- Supports Dynamic Frequency Selection (DFS) in required 5 GHz bands
- Maximal likelihood (ML) decoding
- Spatial multiplexing, cyclic-delay diversity (CDD), low-density parity check (LDPC), maximal ratio combining (MRC), and space-time block coding (STBC)
- AMSDU and AMPDU frame aggregation
- Compatible with software encryption of AES-CCMP at 128/256 bits or AES-GCMP at 128/256 bits
- Compatible with WEP, TKIP hardware encryption or WAPI hardware encryption
- PCIe 1.1 compliant communication to host processor

2.4. Hardware Overview

The PCTEL RM-WIFI-AC-2X2-HP Radio Module utilizes the Qualcomm QCA9898 SoC. The on-board EEPROM is used to store radio parameters. All communication is made over a single channel PCIe 1.1 interface.

The Radio Module requires a nominal 7 W [2.2 amps @ 3.3 VDC] of power from the system power supply.

2.5. Software Overview

The PCTEL radio module is supported in Linux OS systems by the standard Qualcomm Technology ath10k mac80211 wireless driver.

3. Connectors

3.1. WiFi Antenna (2)

- 50 Ω U.FL-style – 5 GHz (2)
- The two connectors, J3 and J4, are visible on the top side of the radio module.

3.2. PCIe

The radio module adheres to the PCI-SIG PCI Express Mini Card Specification 2.0 mechanical form factor with an electrical interface that meets the PCIe Specification 1.1. The connector pinout follows.

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Table 1. Mini PCIe connector pinout for the odd pins

Pin	Description	Legend	Direction on Radio
1	WAKE#	Open drain, active low signal. When the card supports wakeup, this signal is used to request that the system return from a sleep/suspended state to service a function-initiated event.	Input/Output
3	COEX1	Chip Power down control. Connected to CHP_PWD_L on the QCA 9898. Must be de-asserted after both 3.3 V power and 1.1 V power become stable.	
5	Unused		
7	CLKREQ#	Reference clock request signal	Output
9	GND		GND
11	REFCLK-	PCI Express differential reference clock (100 MHz)	Input
13	REFCLK+	PCI Express differential reference clock (100 MHz)	Input
15	GND		GND
Mechanical Key			
17	Unused		
19	Unused		
21	GND		GND
23	PERn0	PCI Express Rx- (Rx WRT host)	Output
25	PERp0	PCI Express Rx+ (Rx WRT host)	Output
27	GND		GND
29	GND		GND
31	PETn0	PCI Express Tx- (Tx WRT host)	Input
33	PETp0	PCI Express Tx+ (Tx WRT host)	Input
35	GND		GND
37	GND	PCIe Lane 2 GND	GND
39	Unused		
41	Unused		
43	GND	PCIe Lane 2 GND	GND
45	Reserved		
47	Reserved		
49	Reserved		
51	Reserved		

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Table 2. Mini PCIe connector pinout for the even pins

Pin	Description	Legend	Direction on Radio
2	3.3V		Power
4	GND		GND
6	Unused		
8	Unused		
10	Unused		
12	Unused		
14	Unused		
16	Unused		
Mechanical Key			
18	GND		GND
20	W_Disable1#	Active low signal. Used by the system to disable radio operation on cards that implement radio frequency applications. (This has been implemented on the PCTEL RM-WIFI-2x2-HP. Connected to GPIO18).	Input
22	PERST#	Functional Reset to the card	Input
24	3.3V		Power
26	GND		GND
28	Unused		
30	Unused		
32	Unused		
34	GND		GND
36	Unused		
38	Unused		
40	GND		GND
42	Unused		
44	LED_WLAN#	Open drain, active low signal for LED indication of status (Tied low for boot strap; connected to QCA 9898 GPIO017)	Output
46	Unused		
48	Unused		
50	GND		GND
52	3.3V		Power

4. Software Integration

4.1. Radio Module Firmware Installation

For reference, Linux OS information and device firmware information can be found in the following locations.

GitHub - kvalo/ath10k-firmware: Firmware files for ath10k, a mac80211 driver for Qualcomm 802.11ac devices

kernel/git/firmware/linux-firmware.git - Repository of firmware blobs for use with the Linux kernel

4.2. ath10k Driver Installation

The RM-WIFI-AC-2X2-HP radio module operates in a Linux OS environment. The proper driver, *ath10k* must be installed on the system to use the radio module successfully. The official version of the driver can be found at Kernel.org.

en:users:drivers:ath10k:firmware [Linux Wireless] (kernel.org)

4.3. ath10k Driver Configuration

The RM-WIFI-AC-2X2-HP can be configured through the *ath10k* driver. Details can be found at the following link at Kernel.org.

en:users:drivers:ath10k:configuration [Linux Wireless] (kernel.org)

4.4. Radio Module Configuration

The radio calibration information is stored in the radio module EEPROM. The RM-WIFI-AC-2X2-HP Power Table information is stored here. Also, the radio calibration information is installed in the EEPROM. The EEPROM is not user accessible.

4.5. Board Data File [BDF]

A Board Data File is needed to properly operate the RM-WIFI-AC-2X2-HP. This binary file contains important configuration and initialization information. This file is used by the *ath10k* driver in Linux systems. The RM-WIFI-AC-2X2-HP Radio Module requires a specific board data file that is not the default in the *ath10k* driver. The PCTEL BDF must be inserted into the correct Linux folder or built into the Linux code so that the BDF is properly loaded at boot.

The location of the board data file that gets loaded on boot for QCA9898-based radio cards is not always consistent in the Linux structure, but is likely to be found at:

/lib/firmware/ath10k/QCA9888/hw2.0/board-2.bin

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This can be verified by looking at the boot log or issuing the `dmesg` command and looking for lines that begin with *ath10k_pci*. The system needs to have the correct board data file at that location to pull the correct configuration and initialization information for the Radio Module to function.

Below is an example of the driver and the PCTEL board data file loading correctly.

root@OpenWrt:/# dmesg | grep ath10k

```
[ 15.869293] ath10k_pci 0000:05:00.0: enabling device (0140 -> 0142)
[ 15.876075] ath10k_pci 0000:05:00.0: pci irq legacy oper_irq_mode 1 irq_mode 0
reset_mode 0
[ 18.503626] ath10k_pci 0000:05:00.0: qca9888 hw2.0 target 0x01000000 chip_id
0x00000000 sub 0000:0000
[ 18.512911] ath10k_pci 0000:05:00.0: kconfig debug 0 debugfs 1 tracing 0 dfs 1
testmode 1
[ 18.530080] ath10k_pci 0000:05:00.0: firmware ver 10.4-3.9.0.2-00070 api 5
features no-p2p,mfp,peer-flow-ctrl,allows-mesh-bcast,no-ps crc32 a44e2231
[ 19.111055] ath10k_pci 0000:05:00.0: board_file api 1 bmi_id N/A crc32 74ac9ec2
[ 21.342454] ath10k_pci 0000:05:00.0: htt-ver 2.2 wmi-op 6 htt-op 4 cal otp max-sta
512 raw 0 hwcrypto 1
```

5. Mechanical

5.1. Form Factor

The image of the RM-WIFI-AC-2X2-HP-XX radio module shown below identifies the connectors and mounting holes used to integrate the module into other host systems.

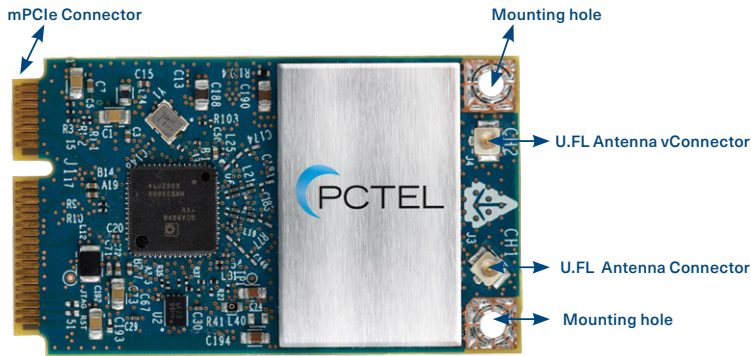


Figure 2. Radio Module

The board outline and dimensions for the Radio Module conforms to the PCI-SIG “PCI Express Mini Card Electromechanical Specification, Revision 2.0” and all superseding specifications. The outline conforms to the definition of the “Full Mini Card”, see Figure 3.

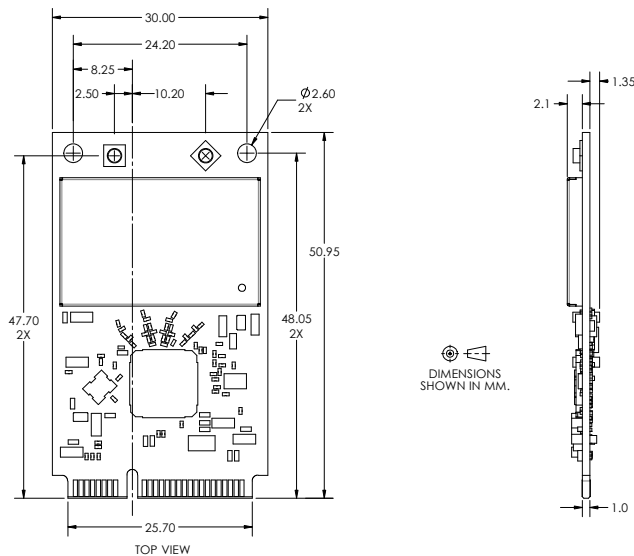


Figure 3. Dimensioned Drawing of the Radio Module

5.2 Mechanical Implementation

In order to deploy the RM-WIF-AC-2X2-HP-XX Radio Module in environments that will experience temperatures above 75 °C ambient, PCTEL requires that a properly sized thermal pad be installed between the bottom of the radio module and the host PCB. The thermal pad should cover most of the bottom of the Radio Module and be of appropriate thickness to fill in the gap between the Radio Module PCB and the host PCB as shown in Figure 4 and Figure 5 below.

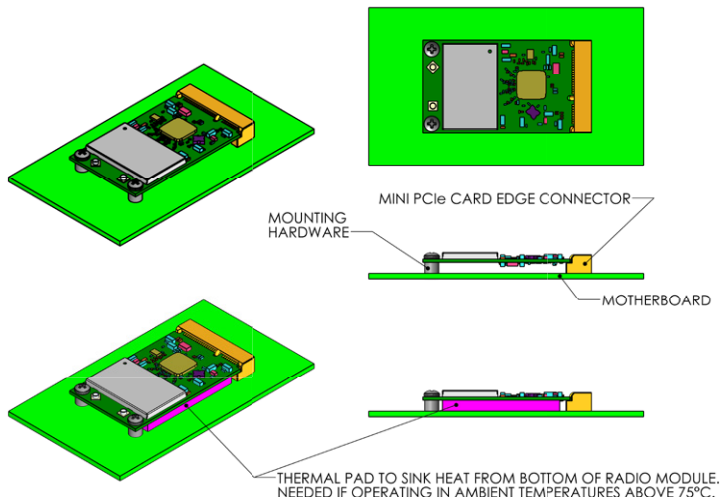


Figure 4. Typical Mounting Configurations Showing Installation of Thermal Pad

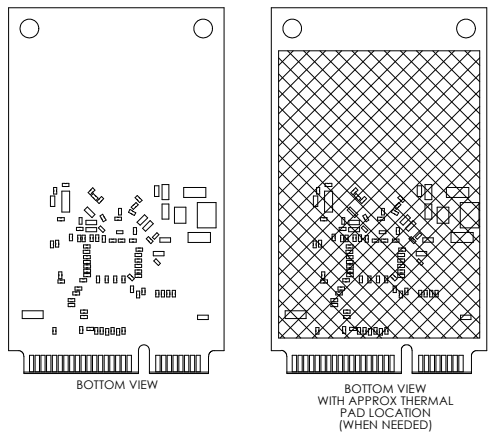


Figure 5. Bottom View of the Radio Module Showing Thermal Pad Coverage

6. Compliance

Safety	Radio Approvals	EMI and Susceptibility
IEC 62368-1	FCC Part 15.407	FCC Part 15.107, 15.109
UL/CSA 62368-1	EN 301 893	EN 301 489-1, 301 489-17
	RSS-210	ICES-003
	RSS-247	

Figure 6. Compliance

6.1. Manufacturer's Federal Communication Commission (FCC) Compliance Statements

Model: RM-WIFI-AC-2X2-HP-US

FCC ID: NYPRMWIFIAC2X2

Manufacturer:
PCTEL, Inc.
471 Brighton Dr.
Bloomington, IL 60108-3102
USA

To ensure regulatory compliance, when integrating the RM-WIFI-AC-2X2-HP-US radio module into a host device, it is required to meet the documentation and operational requirements set forth by the applicable regulatory agency. The following sections outline the information that must be considered and included in the user's guide and external labels for the host device that includes the RM-WIFI-AC-2X2-HP radio module.

6.1.1. Antenna Information

The RM-WIFI-AC-2X2-HP-US radio module has been designed and approved to operate with the antennas listed below.

Table 3. Approved Antennas

PCTEL Part Number	Description	Gain
		5150 - 5850 MHz
BOA51004NM	Heavy-Duty Omnidirectional Antenna	4 dBi
MPAMB24495804-RPSMA	Portable Omnidirectional Antenna	4 dBi
MHODB24490507NM-IP	Dual-Band High-Performance Omnidirectional Antenna	7 dBi
AEMH51PT155UFL	Circuit-board-based 5 GHz horizontally ploraised monopole with 155 mm U.FL pigtail cable	4.3 dBi
AED2451PT155UFL	Circuit-board-based dual-band dipole with 155 mm U.FL pigtail cable	2.8 dBi
AEMV2451PT155UFL	Bent metal dual -band monopole with 155mm U.FL pigtail cable	2.4 dBi
AEPV2451PT155UFL	Bent metal dual -band PIFA with 155mm U.FL pigtail cable	4.8 dBi

In addition, two antenna cables are required.

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Important Note: For use as a client device, (not DFS master), the integrator can choose or specify a different antenna of like type and equal or lesser gain as an antenna appearing in the above table and still maintain compliance. Reference FCC Part 15.204(c)(4) for further information on this topic.

Important Note: For use in a host system that is a DFS master, the minimum, net antenna gain allowed is 1.1 dBi, including all other cable loss. Any antenna/cable combination whose gain is lower than 1.1 dBi, including all other cable loss, is not approved for use with a DFS master device without additional testing and approval.

6.1.2. FCC Declaration of Conformity Statement

These paragraphs must be included in any end-user documentation.

This device complies with Part 15 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 of a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential or office environment. This equipment generates, uses, and radiates radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference. However, there is no guarantee that interference will not occur. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the distance between the equipment and receiver.
- Connect the equipment to an outlet on a circuit different from which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician

WARNING: This Part 15 radio device operates on a non-interference basis with other devices operating at this frequency when using PCTEL approved antennas. The Federal Communications Commission warns that any changes or modifications to this radio module not expressly approved by PCTEL, Inc. could void the user's authority to operate this device.

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6.1.3. FCC Radiation Exposure Statement

This paragraph must be included in any end-user documentation.

The PCTEL RM-WIFI-AC-2X2-HP-US has been evaluated for RF exposure for Humans in reference to ANSI C 95.1 (American National Standards Institute) limits. The evaluation was based on ANSI C 95.1 and FCC OET Bulletin 65C Rev 1.01. To comply with FCC's RF radiation exposure requirements, the antennas used for this device must be installed such that the minimum separation distance of 7.87 inches (20 cm) is maintained between the radiating elements (antennas) and any users or general bystanders at all times and the antennas must not be co-located or operating in conjunction with any other antennas or transmitters.

Further RF exposure reduction can be achieved if the product/antennas are kept as far as possible from the user's body or is set to a lower RF output power if such a function is available.

6.1.4. Factors Affecting Module Usage Related to FCC Compliance

The RM-WIFI-AC-2X2-HP-US radio module has been certified by the FCC under the rules for a Modular Transmitter. There are some considerations that are important for the end user or integrator of the module:

1. A module extends to the host manufacturer the ability to market an end-product without the burden of filing a certification application for the RM-WIFI-AC-2X2-HP-US, which has already been certified as a modular transmitter per FCC 15.407. It does not allow a host manufacturer or integrator the convenience to simply use the module without any further testing and evaluation. The combination of host + radio module must be evaluated for continued compliance in that specific configuration. It is the responsibility of the integrator to carry out the required host product verification testing. PCTEL can advise the integrator on test setup and utilities for the and test that require radio control.
2. The RM-WIFI-AC-2X2-HP-US has been certified with its shield in place on the top side of the circuit board. The shield cannot be removed.
3. Note that per FCC Part 15 rules pertaining to unlicensed transmitters, the host device must be equipped with a unique antenna connector. Compliance with 47 CFR 15.203 does not permit the use of standard connectors such as N, BNC, SMA, TNC, etc.
4. The modular transmitter has been tested to the following FCC rules:
 - a. FCC 15.212
 - b. FCC 15.407
 - c. KDB 447498
 - d. CFR 47 Part 1.1310

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5. The RM-WIFI-AC-2X2-HP-US radio module has been certified with the antennas listed in the table above. For use as a client device (DFS non-master), the integrator can choose or specify a different antenna of like type and equal or lesser gain as an antenna appearing in the above table and still maintain compliance. Reference FCC Part 15.204(c)(4) for further information on this topic. Note that the highest antenna gain used for approval is 7 dBi.
6. **Important Note:** For use in a host system that is a DFS master, the minimum, net antenna gain allowed is 1.1 dBi, including all other cable loss. Any antenna/cable combination whose gain is lower than 1.1 dBi, including all other cable loss, is not approved for use with a DFS master device without additional testing and approval. Note that the highest antenna gain used for approval is 7 dBi.
7. The transmitter module has been evaluated for RF exposure on its own and therefore should not be co-located with any other transmitter or antenna without further testing and approval.
8. If deployed in the USA, any end-product using the RM-WIFI-AC-2X2-HP-US radio module must be visibly labeled with the following:

Contains FCC ID: NYPRMWIFIAC2X2
9. The integrator or host manufacturer must not provide information to the end user regarding the installation or removal of this modular transmitter from the host device in the user's manual of the end-product.
10. Any end-user manual shall include all required regulatory information/warnings as shown in this manual.
11. Even though the PCTEL RM-WIFI-AC-2X2-HP-US radio module has been FCC certified, the host product (i.e., the integrated product of radio module + host device) needs to be evaluated for continued compliance in that specific configuration. Contact PCTEL for any tools that may be required for such an evaluation.
12. If any of these conditions cannot be met (for example by using a unique antenna type), then the FCC certification is no longer considered valid, and the FCC ID cannot be used on the host/final product. In these circumstances, the integrator of the module is responsible for the re-evaluation of the end-product (including the transmitter) and obtaining a separate FCC certification.

6.2. Manufacturer's Innovation, Science and Economic Development (ISED) Canada Compliance Statements

Model: RM-WIFI-AC-2X2-HP-CA

IC ID: 26854-RMWIFIAC2X2

Manufacturer:

PCTEL, Inc.

471 Brighton Dr.

Bloomington, IL 60108-3102 USA

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To ensure regulatory compliance, when integrating the RM-WIFI-AC-2X2-HP-CA radio module into a host device, it is required to meet the documentation and operational requirements set forth by the applicable regulatory agency. The following sections outline the information that must be considered and included in the user's guide and external labels for the host device that includes the RM-WIFI-AC-2X2-HP radio module.

6.2.1. Antenna Information

The radio transmitter (IC: 26854-RMWIFIA2X2) was approved by Innovation, Science and Economic Development (ISED) 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.

Le présent émetteur radio (IC: 26854-RMWIFIA2X2) a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.

Table 3. Approved Antennas

PCTEL Part Number	Description	Gain
		5150 - 5850 MHz
BOA51004NM	Heavy-Duty Omnidirectional Antenna	4 dBi
MPAMB24495804-RPSMA	Portable Omnidirectional Antenna	4 dBi
MHODB24490507NM-IP	Dual-Band High-Performance Omnidirectional Antenna	7 dBi
AEMH51PT155UFL	Circuit-board-based 5 GHz horizontally polarized monopole with 155 mm U.FL pigtail cable	4.3 dBi
AED2451PT155UFL	Circuit-board-based dual-band dipole with 155 mm U.FL pigtail cable	2.8 dBi
AEMV2451PT155UFL	Bent metal dual-band monopole with 155mm U.FL pigtail cable	2.4 dBi
AEPV2451PT155UFL	Bent metal dual-band PIFA with 155mm U.FL pigtail cable	4.8 dBi

In addition, two antenna cables are required.

Important Note: For use as a client device, (not DFS master), the integrator can choose or specify a different antenna of like type and equal or lesser gain as an antenna appearing in the above table and still maintain compliance.

Important Note: For use in a host system that is a DFS master, the minimum, net antenna gain allowed is 1.1 dBi, including all other cable loss. Any antenna/cable combination whose gain is lower than 1.1 dBi, including all other cable loss, is not approved for use with a DFS master device without additional testing and approval.

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6.2.2. ISED (Canada) Compliance Statement

The following paragraphs must be included in any end-user documentation.

This device contains license-exempt transmitters/receivers that comply with Innovation, Science and Economic Development Canada's license-exempt RSSs. 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.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR 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 le fonctionnement.*

6.2.3. ISED Canada Radiation Exposure Statement

These paragraphs must be included in any end-user documentation.

This transmitter/receiver has been evaluated for RF exposure for humans in reference to ANSI C 95.1 (American National Standards Institute) limits. This evaluation was based on RSS-102 Rev 5. To maintain compliance, the minimum separation distance for RM-WIFI-AC-2X2-HP-CA is 7.87 inches (20 cm) from users or general bystanders. Further RF exposure reduction can be achieved if the product/antennas are kept as far as possible from the user's body or is set to a lower RF output power if such a function is available.

Cet émetteur/récepteur a été évalué quant à l'exposition aux RF pour les personnes en référence aux limites ANSI C 95.1 (American National Standards Institute). Cette évaluation est basée sur la norme RSS-102 Rév 5. Pour maintenir la conformité, la distance minimale de séparation pour le RM-WIFI-AC-2X2-HP-CA est de 7,87 pouces (20 cm) par rapport aux personnes présentes. Une réduction supplémentaire de l'exposition aux RF peut être obtenue si le produit/les antennes sont maintenus aussi loin que possible du corps de l'utilisateur ou s'ils sont réglés sur une puissance de sortie RF inférieure, si une telle fonction est disponible.

6.2.4. Factors Affecting Module Usage Related to ISED Compliance

The RM-WIFI-AC-2X2-HP-CA radio module has been certified by the ISED under the rules for a Modular Transmitter. There are some considerations and limitations that are important for the end user or integrator of the module:

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1. A module extends to the host manufacturer the ability to market an end-product without the burden of filing a certification application for the RM-WIFI-AC-2X2-HP-CA, which has already been certified as a modular transmitter. It does not allow a host manufacturer or integrator the convenience to simply use the module without any further testing and evaluation. The combination of host + radio module must be evaluated for continued compliance in that specific configuration. It is the responsibility of the integrator to carry out the required host product verification testing. PCTEL can advise the integrator on test setup and utilities for the and test that require radio control.
2. The RM-WIFI-AC-2X2-HP-CA has been certified with its shield in place on the top side of the circuit board. The shield cannot be removed.
3. Note that per RSS-247 rules pertaining to unlicensed transmitters, the host device must be equipped with a unique antenna connector. Compliance with these rules does not permit the use of standard connectors such as N, BNC, SMA, TNC, etc.
4. The modular transmitter has been tested to the following ISED rules:
 - a. RSS 210
 - b. RSS 247
 - c. ICES-003, Issue 7
 - d. RSS 102, Rev 5
5. The RM-WIFI-AC-2X2-HP-CA radio module has been certified with the antennas listed in the table above. For use as a client device (DFS non-master), the integrator can choose or specify a different antenna of like type and equal or lesser gain as an antenna appearing in the above table and still maintain compliance. Reference FCC Part 15.204(c)(4) for further information on this topic. Note that the highest antenna gain used for approval is 7 dBi.
6. For use in a host system that is a DFS master, the minimum antenna gain allowed is 1.1 dBi. Any antenna whose gain is lower than 1.1 dBi is not approved for use with a DFS master device without additional testing and approval. Note that the highest antenna gain used for approval is 7 dBi.
7. The transmitter module has been evaluated for RF exposure on its own and therefore should not be co-located with any other transmitter or antenna without further testing and approval.
8. If deployed in Canada, any end-product using the RM-WIFI-AC-2X2-HP-CA radio module must be visibly labeled with the following:

Contains IC: 26854-RMWIFIAC2X2
9. The integrator or host manufacturer must not provide information to the end user regarding the installation or removal of this modular transmitter from the host device in the user's manual of the end-product.

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10. Any end-user manual shall include all required regulatory information/warnings as shown in this manual.
11. Even though the PCTEL RM-WIFI-AC-2X2-HP-CA radio module has been ISSED certified, the host product (i.e., the integrated product of radio module + host device) needs to be evaluated for continued compliance in that specific configuration. Contact PCTEL for any tools that may be required for such an evaluation.
12. If any of these conditions cannot be met (for example by using a unique antenna type), then the ISSED certification is no longer considered valid, and the IC number cannot be used on the host/final product. In these circumstances, the integrator of the module is responsible for the re-evaluation of the end-product (including the transmitter) and obtaining a separate ISSED certification.

6.2.4. Limites d'utilisation du module liées à la conformité ISSED

Le module radio RM-WIFI-AC-2X2-HP-CA a été certifié par l'ISSED selon les règles applicables aux émetteurs modulaires. Il existe certaines considérations et limitations qui sont importantes pour l'utilisateur final ou l'intégrateur du module:

1. *Un module offre au fabricant hôte la possibilité de commercialiser un produit final sans avoir à déposer une demande de certification pour le RM-WIFI-AC-2X2-HP-CA, qui a déjà été certifié en tant que transmetteur modulaire. Il ne permet pas au fabricant ou à l'intégrateur hôte d'utiliser simplement le module sans autre test ni évaluation. La combinaison hôte + module radio doit faire l'objet d'une évaluation de conformité continue dans cette configuration spécifique. Il est de la responsabilité de l'intégrateur d'effectuer les tests de vérification du produit hôte requis. PCTEL peut conseiller l'intégrateur sur la configuration des tests et les utilitaires pour les tests qui nécessitent une commande radio.*
2. *Le RM-WIFI-AC-2X2-HP-CA a été certifié avec son blindage en place sur la face supérieure de la carte de circuit imprimé. Le blindage ne peut pas être retiré.*
3. *Notez que selon les règles RSS-247 relatives aux émetteurs sans licence, le dispositif hôte doit être équipé d'un connecteur d'antenne unique. La conformité à ces règles ne permet pas l'utilisation de connecteurs standard tels que N, BNC, SMA, TNC, etc.*
4. *L'émetteur modulaire a été testé selon les règles ISDE suivantes :*
 - a. *RSS 210*
 - b. *RSS 24*
 - c. *ICES-003, version 7*
 - d. *RSS 102, rév 5*

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5. *Le module radio RM-WIFI-AC-2X2-HP-CA a été certifié avec les antennes indiquées dans le tableau ci-dessus. Pour une utilisation en tant que dispositif client (DFS non-maître), l'intégrateur peut choisir ou spécifier une antenne différente de même type et de gain égal ou inférieur à une antenne figurant dans le tableau ci-dessus et demeurer conforme. Reportez-vous à la partie 15.204(c)(4) de la FCC pour plus d'informations à ce sujet. Notez que le gain d'antenne le plus élevé utilisé pour l'approbation est de 7 dBi.*
6. *Pour une utilisation dans un système hôte qui est un maître DFS, le gain d'antenne minimum autorisé est de 1,1 dBi. Toute antenne dont le gain est inférieur à 1,1 dBi n'est pas approuvée pour une utilisation avec un dispositif maître DFS sans tests et approbation supplémentaires. Notez que le gain d'antenne le plus élevé utilisé pour l'approbation est de 7 dBi.*
7. *Le module émetteur a été évalué pour l'exposition RF tout seul et ne doit donc pas être co-localisé avec un autre émetteur ou antenne sans test et approbation supplémentaires.*
8. *S'il est déployé au Canada, tout produit final utilisant le module radio RM-WIFI-AC-2X2-HP-CA doit être visiblement étiqueté comme suit :*
Contient IC : 26854-RMWIFAC2X2
9. *L'intégrateur ou le fabricant hôte ne doit pas fournir d'informations à l'utilisateur final concernant l'installation ou le retrait de cet émetteur modulaire du dispositif hôte dans le manuel d'utilisation du produit final.*
10. *Tout manuel de l'utilisateur final doit inclure toutes les informations/avertissements réglementaires requis, comme indiqué dans ce manuel.*
11. *Même si le module radio RM-WIFI-AC-2X2-HP-CA de PCTEL a été certifié ISDE, le produit hôte (à voire le produit intégré du module radio + le dispositif hôte) doit être évalué pour une conformité continue dans cette configuration spécifique. Veuillez contacter PCTEL pour obtenir les outils nécessaires à une telle évaluation.*
12. *Si l'une de ces conditions ne peut pas être remplie (par exemple en utilisant un type d'antenne unique), la certification ISDE ne sera plus considérée comme valide, et le numéro IC ne pourra pas être utilisé sur le produit hôte/final. Dans ces circonstances, l'intégrateur du module est responsable de la réévaluation du produit final (y compris l'émetteur) et de l'obtention d'une certification ISDE distincte.*

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6.3. Manufacturer's European Union (EU) and United Kingdom (UK) Compliance Statements

6.3.1. EU and UK Declaration of Conformity

Manufacturer: PCTEL, Inc.

Model Number/Type: RM-WIFI-AC-2X2-HP-EU/WiFi Radio Module
(A WiFi Transceiver)

Description: 2 x 2, 802.11ac, 5 GHz, mPCIe radio module

EU Directives: Radio Equipment Directive 2014/53/EU, ROHS Directive 2011/65/EU + (EU)2015/863

Standards Considered, Full or In Part, used for presumption of conformity

- EN IEC 62368-1:2018-1:2020 + A11:2020
- EN 301 489-17, v3.2.4:2020-09
- EN 301 893, v2.2.1:2017-05
- EN 63000:2018
- EN 62479:2010

Declaration: PCTEL, Inc. declares under its sole responsibility that the Industrial IoT Radio Module, model RM-WIFI-AC-2x2-HP-EU, is in conformity with the Radio Equipment Directive 2014/53/EU and the ROHS Directive 2011/65/EU + (EU)2015/863.

Place of Issue:

PCTEL, Inc.
471 Brighton Dr.
Bloomingdale, IL 60108-3102 USA
Tel: 1-630-372-6800

Date of Issue: May 3, 2022

Name of Authorized Person: Stephen V. Saliga, Vice-President, Engineering

Signature of Authorized Person: 

To ensure regulatory compliance, when integrating the RM-WIFI-AC-2X2-HP radio module into a host device, it is required to meet the documentation and operational requirements set forth by the applicable regulatory agency. The following sections outline the information that must be considered and included in the user's guide and external labels for the host device that includes the RM-WIFI-AC-2X2-HP radio module.

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6.3.2. Antenna Information

This radio transmitter has been approved under RED 2014/53/EU to operate the antenna types listed below with the maximum gain indicated. The usage of different antennas in the final host device may need a new assessment of host conformity to RED 2014/53/EU.

Table 3. Approved Antennas

PCTEL Part Number	Description	Gain
		5150 - 5850 MHz
BOA51004NM	Heavy-Duty Omnidirectional Antenna	4 dBi
MPAMB24495804-RPSMA	Portable Omnidirectional Antenna	4 dBi
MHODB24490507NM-IP	Dual-Band High-Performance Omnidirectional Antenna	7 dBi
AEMH51PT155UFL	Circuit-board-based 5 GHz horizontally polarized monopole with 155 mm U.FL pigtail cable	4.3 dBi
AED2451PT155UFL	Circuit-board-based dual-band dipole with 155 mm U.FL pigtail cable	2.8 dBi
AEMV2451PT155UFL	Bent metal dual -band monopole with 155mm U.FL pigtail cable	2.4 dBi
AEPV2451PT155UFL	Bent metal dual -band PIFA with 155mm U.FL pigtail cable	4.8 dBi

In addition, two antenna cables are required.

6.3.3. European Union and UK Radiation Exposure Statement

This radio transmitter has been evaluated for RF exposure for humans in reference to ICNIRP (International Commission on Non-Ionizing Radiation Protection) limits. The evaluation was based on the EN 62479 in conjunction with IEEE C95.1. To maintain compliance, the minimum separation distance from the antennas is 7.87 inches (20 cm) from end users and general bystanders.

6.3.4. EU and UK Compliance Statement

Any integrator must include specific information in the user's guide for the device into which the RM-WIFI-AC-2X2-HP-EU is integrated. In addition to FCC and ISSED statements outlined above, the following Radio Equipment Directive (RED) statements must be added in their entirety and without modification into a prominent place in the end-user's documentation.

This device, RM-WIFI-AC-2X2-HP-EU complies with the essential requirements of the 2014/53/EU - Radio Equipment Directive (RED). The following test methods have been applied in order to prove presumption of conformity with the essential requirements of the 2014/53/EU - Radio Equipment Directive (RED):

- **EN 62368-1:2020 + A11:2020**
Safety requirements for audio/video, information, and technology equipment
- **EN 62479:2010**
RF Exposure

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- **EN 301 489-17 v3.2.4 (2020-09)**

Electromagnetic Compatibility (EMC) Standard for Radio Equipment and Services; Part 17: Specific Conditions for Broadband Data Transmission Systems; Harmonised Standard for Electromagnetic Compatibility

- **EN 301 893 v2.1.1 (2017-05)**

5 GHz RLAN; Harmonised Standard Covering the Essential Requirements of Article 3.2 of Directive 2014/53/EU

- **EU 2015/863 (ROHS 3)**

Declaration of Compliance – EU Directive 2015/863; Reduction of Hazardous Substances (ROHS)

This device is a 5 GHz wideband transmission system (transceiver), intended for use in all EU member states and the UK.

Dansk (Danish)	Hermed erklærer PCTEL, Inc., at denne 5 GHz modtager overholder de generelle krav og andre retningslinjer af direktiv 2014/53/EU.
Deutsch (German)	Hiermit erklärt PCTEL, Inc., dass dieser 5-GHz-Transceiver den grundlegenden Anforderungen und anderen relevanten Bestimmungen der Richtlinie 2014/53/EU entspricht.
English	Hereby, PCTEL, Inc., declares that this 5 GHz transceiver is in compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU.
Español (Spanish)	Por la presente, PCTEL, Inc., declara que este transceptor de 5 GHz cumple los requisitos esenciales y otras disposiciones pertinentes de la Directiva 2014/53/UE.
Français (French)	Par la présente, PCTEL, Inc, déclare que cet émetteur-récepteur 5 GHz est conforme aux exigences essentielles et autres dispositions pertinentes de la directive 2014/53/UE.
Italiano (Italian)	Con la presente, PCTEL, Inc. dichiara che questo ricetrasmittitore da 5 GHz è conforme ai requisiti essenziali e ad altre pertinenti disposizioni della direttiva 2014/53/UE.
Nederlands (Dutch)	Hierbij verklaart PCTEL, Inc. dat deze 5 GHz zendontvanger in overeenstemming is met de essentiële eisen en andere relevante bepalingen van de Richtlijn 2014/53/EU.
Norsk (Norwegian)	PCTEL, Inc. erklærer herved at denne 5 GHz-mottakeren samsvarer med de nødvendige kravene og andre relevante bestemmelser i direktiv 2014/53/EU.
Português (Portuguese)	A PCTEL, Inc. declara que este transceptor de 5 GHz está em conformidade com os requisitos essenciais e outras disposições relevantes da Diretiva 2014/53/UE.
Suomalainen (Finnish)	Täten PCTEL, Inc. ilmoittaa, että tämä 5 GHz:n lähetin-vastaanotin on yhdenmukainen direktiivin 2014/53/EU keskeisten vaatimusten ja muiden olennaisten säännösten kanssa.
Svenska (Swedish)	PCTEL, Inc. intygar härmed att denna 5 GHz-transceiver uppfyller de grundläggande kraven och andra relevanta bestämmelser i direktiv 2014/53/EU.

7. Safety Notices

This section lists the product safety notices for the RM-WIFI-AC-2X2-HP. Please follow all safety notices to ensure proper installation and operation.

- A.** Only trained and qualified personnel should be allowed to install, replace or service this product.
- B.** Before connecting the product to the power source, read all installation instructions.
- C.** Product installation must comply with all national and local electrical codes.
- D.** Do not install or remove the product, and do not connect or disconnect any cables or antennas during the time when lightning activity is present.
- E.** Product disposal should be handled in accordance with all laws and regulations.

Industrial IoT Product Usage

UPDATED AUGUST, 2021

THE PRODUCTS ARE NOT DESIGNED, MANUFACTURED, OR INTENDED FOR USE, ALONE OR WITH OTHER PRODUCTS, IN ANY APPLICATION REQUIRING FAIL-SAFE PERFORMANCE OF THE PRODUCTS AND/OR IN WHICH A MALFUNCTION OR A FAILURE OF THE PRODUCTS COULD LEAD TO DEATH, PERSONAL INJURY, OR SERIOUS PHYSICAL OR ENVIRONMENTAL DAMAGE, INCLUDING BUT NOT LIMITED TO (A) SURGICALLY IMPLANTED DEVICES, LIFE SUPPORT MACHINES, LIFE PRESERVING MEDICAL DEVICES OR SYSTEMS, OTHER MEDICAL AND SURGICAL APPLICATIONS, OR ANY DEVICES, MACHINES, SYSTEMS, PRODUCTS, OR PROCESSES REQUIRING APPROVAL, TESTING OR CERTIFICATION BY THE U.S. FOOD AND DRUG ADMINISTRATION OR A SIMILAR GOVERNMENTAL ENTITY; (B) AIR TRAFFIC CONTROL OR AIRCRAFT SYSTEMS; (C) CONTROL EQUIPMENT FOR NUCLEAR OR OTHER POWER GENERATION FACILITIES; OR (D) MISSILE, NUCLEAR, BIOLOGICAL, OR CHEMICAL WEAPONS, OR OTHER MILITARY APPLICATIONS (EACH A “**PROHIBITED USE**”).

ANY AND ALL PROHIBITED USE OF THE PRODUCTS IS STRICTLY PROHIBITED, AS IS ANY SALE OR RESALE OF THE PRODUCTS FOR A PROHIBITED USE. PCTEL SHALL HAVE NO LIABILITY FOR ANY USE OF THE PRODUCTS IN ANY MANNER FOR, OR IN CONNECTION WITH, A PROHIBITED USE. ANY SUCH USE SHALL VOID ANY WARRANTIES AND INDEMNITIES PROVIDED BY PCTEL, AS WELL AS ALL OTHER OBLIGATIONS OF PCTEL, INCLUDING, WITHOUT LIMITATION, WITH RESPECT TO SUPPORT. PCTEL SHALL NOT BE DEEMED TO HAVE CONSENTED TO OR APPROVED ANY PROHIBITED USE BY PROVIDING WARRANTY, SUPPORT, OR ANY OTHER SERVICE. ANY PARTY USING THE PRODUCTS IN A PROHIBITED USE SHALL INDEMNIFY AND HOLD HARMLESS PCTEL FROM ANY CLAIMS, LIABILITIES, AND EXPENSES ARISING IN CONNECTION WITH SUCH PROHIBITED USE.

This Integration Guide is subject to change. PCTEL legal terms and conditions apply. Please see <https://www.pctel.com/legalinfo/>

Need help?

For additional information on the RM-WIFI-AC-2X2-HP 802.11ac Wave 2 2x2 Radio Module, please contact

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PCTEL, Inc.

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