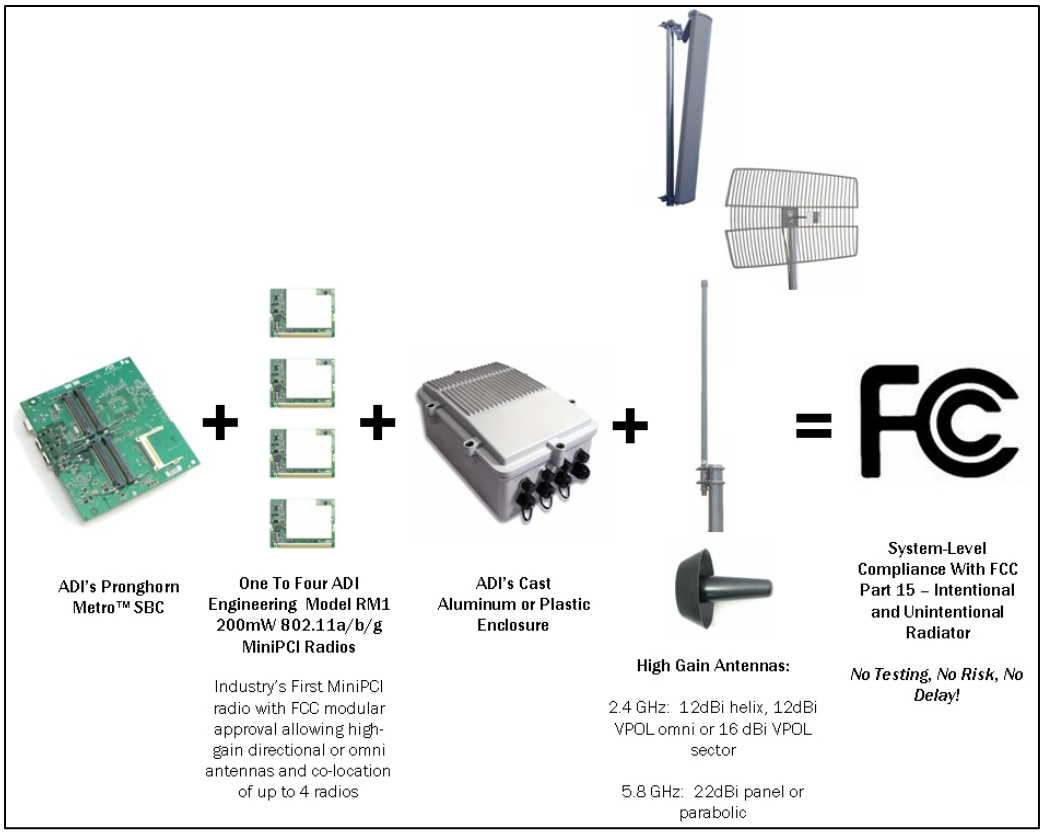
FCC Compliance of ADI Engineering Equipment for WISP and Metro Wireless Applications

Introduction

Open architecture hardware is commonplace in the WISP market, and is a growing trend for metro wireless. Service providers, OEMs and system integrators routinely build their own outdoor Wi-Fi systems using off-the-shelf wireless router boards, high-power MiniPCI radios, enclosures, antennas, and software of their choosing (commercial or open source). The benefits are clear: low equipment cost, easily upgradeable radio technology, flexibility, and easy customization of feature set by each service provider or OEM.

However, there is a major problem with this approach – currently available open architecture systems are almost always *illegal* under FCC Part 15 unless each service provider takes their equipment through full FCC certification – an expensive, time consuming and complex task. Few service providers comply – placing themselves at risk of network shutdown or fines by the FCC.

ADI recognizes the severity of this issue, and in partnership with system integrator partner aCure Technology is leading the market with an innovative and progressive solution that provides complete system-level Part 15 compliance for turnkey systems ADI builds or systems our customers build according to our assembly instructions.



The Certification Gap

Open architecture Wi-Fi systems with multiple radios, high gain antennas or software that allows operation on non-FCC frequencies are illegal under the FCC Part 15 rules. This may be a surprising statement to some, but there is a quickly growing recognition in the industry as to the severity of this problem. There are indications that the FCC may be increasing enforcement actions such as ordering the shutdown of non-compliant networks and levying fines. And there is certainly an inherent business value to WISPs, their investors and their customers knowing that the network is being operated in compliance with the law. It is becoming increasingly awkward for WISPs to build businesses based on illegal equipment.

The main cause of the problem is that module-level FCC certifications (if any) provided by the manufacturers of open architecture components are insufficient for real-world WISP and muni networks where high-gain directional antennas and multiple transmitters per node are needed. There is a "certification gap" between the commonly-available hardware that vendors sell and the certification requirements that WISPs and mesh operators must legally meet.

The modular Part 15 approvals for all 2.4 GHz MiniPCI radios currently on the market – even the higher-power ones marketed for outdoor use –don't include high-gain antennas multiple co-located transmitters, or any type of directional antenna. Simply placing more than one MiniPCI radio in a system or using an antenna type other than a low-gain omni is a clear violation of Part 15 requirements.

Most MiniPCI radios also respond to commands to operate on non-FCC frequencies.

Wireless router boards are another concern. Part 15 does not require any certification at all for unhoused CPU boards sold for professional integration into a larger system. Only the final system is regulated by Part 15. While it may be legal for wireless router board manufacturers, this practice simply passes a huge certification burden on to the integrator building the systems.

The bottom line is that lack of FCC certification has long been a "dirty little secret" of the open architecture hardware movement, with no good solution. System-level compliance has been a "no man's land" where the open architecture hardware vendors have no duty to provide modular certifications allowing typical WISP and muni usage. This certification gap has t dumped particularly difficult Part 15 compliance issues onto the individual WISPs, OEMs and system integrators – and often they are ill-prepared to handle them. There is no clear path forward, the technical challenges are numerous and complex, and therefore few open architecture systems are legal.

The market has gotten by thus far skirting the Part 15 rules, but with growth has come a new level of scrutiny from the FCC. And there has been no good solution – until now.

ADI's Strategy for System Level FCC Compliance

ADI and Australian mesh network operator aCure Technology with support from New Zealand metro wireless software provider RoamAD are leading the market with a progressive new strategy that provides complete system-level Part 15 compliance of open architecture hardware for WISP and muni wireless applications. Together, these companies are blazing a new trail to FCC compliance.

ADI and aCure have jointly obtained a complete system-level Part 15 approval for the Pronghorn Metro™ open architecture platform featuring up to four high-power ADI Engineering RM1 MiniPCI radio modules and high-gain antennas useful for outdoor WISP and muni applications.

This certification applies to turnkey systems from ADI or aCure as well as "do it yourself" systems built by WISPs, OEMs and system integrators using ADI's Pronghorn Metro™ SBC wireless router board and RM1 MiniPCI radios in accordance with our detailed system-level assembly instructions and bill of materials. Turnkey or DIY - either way, ADI and aCure have taken care of Part 15 compliance and you can rest assured that the final system is FCC certified with no further testing, expense or delay.

Our strategy is enabled by two key pillars:

1) FCC Part 15 Declaration of Conformity (DoC) for our Pronghorn Metro SBC wireless router board, and
2) ADI's new RM1 high-power Atheros sixth generation AR5006 chipset based 802.11 a/b/g MiniPCI radio module with enhanced modular Part 15 approval (FCC ID SNR-RM1). The RM1 is the only MiniPCI radio on the market with a modular FCC Part 15 approval allowing high-gain directional and omnidirectional antennas and co-location of up to four radios in a single piece of equipment.

Together, these pillars provide a clear path to certification with ADI equipment, regardless of whether ADI supplies turnkey systems or the service provider builds their own systems.

Muni networks based on ADI hardware running RoamAD metro wireless software were the initial beneficiary of the new certification, and RoamAD today remains the first and only DIY open architecture metro-scale wireless network solution that achieves FCC compliance. However, in recognition of the clear and fundamental benefits to the entire open architecture wireless community, ADI and aCure have structured our certification so that it does not depend on any specific software (more later in this document).

Features of FCC Certified System

The following summarizes the features of the certified Pronghorn Metro™ system:

- ADI's Pronghorn Metro™ SBC quad-radio wireless router board
    - Intel IXP425 at 533 MHz
    - Four MiniPCI slots
        - 6.5W continuous power availability each
        - All four can accommodate 80mm long MiniPCI radios
        - Each slot has independent power distribution and RF filtering to reduce interference
    - High-power Power Over Ethernet, with 1500VRMS isolation (48V and 24V options available)
    - Two 10/100 Ethernet ports, surge protected
    - One RS-232 port
    - -40 to +80C operating temperature range
    - RoHS compliant
- One to four ADI Engineering RM1 Atheros-based 802.11 a/b/g MiniPCI radios (200mW at 2.4 GHz, 80mW at 5.8 GHz)
- aCure/ADI custom cast aluminum enclosure, or off-the-shelf polycarbonate enclosure - with N-female antenna connectors
    - ADI's Pronghorn Metro SBC passes FCC regulations without shielding
- Optional lightning arrestors
- High-power Power Over Ethernet with 40W AC power supply and injector
- High-gain antennas:
    - 12dBi max gain at 2.4 GHz
    - 22dBi max gain at 5.8 GHz
    - Certified antenna types initially are circularly polarized helix at 2.4 GHz and panel for 5.8 GHz; This is currently being expanded to include omni and sector antennas in the 2.4 GHz band

How to Achieve FCC Compliance Using ADI Hardware

There are two paths to FCC compliance with ADI hardware:

- Buy turnkey systems pre-assembled by ADI or aCure, operated in accordance with the FCC approval

    – OR –

- Build your own systems using the ADI Engineering Pronghorn Metro™ SBC wireless router board and ADI Engineering RM1 radio modules in accordance with our detailed assembly instructions and bill of materials and operated in accordance with the FCC approval

To support the do it yourself market, ADI is developing detailed system assembly instructions, and we and our channel partners also provide the other system components (MiniPCI radios, enclosures, pigtails, etc.) required for a compliant system. Provided that our assembly and operation instructions are correctly followed and the exact materials specified in our bill of materials are used, customer-built systems will be legal under our Part 15 approval.

NOTE: The integrator bears all responsibility for correctly building the final system and any non-compliance that may result from failure to follow ADI's instructions.

Discussion of RM1 MiniPCI Radio with Enhanced Certifications

After extensive research and consultation with the FCC, ADI has learned that the biggest hurdle to FCC compliant open-architecture systems has been the lack of a 2.4 GHz MiniPCI radio with a modular Part 15 approval allowing for real-world WISP usage with high-gain antennas and radio co-location.

With a properly-approved radio module, FCC compliance of open architecture equipment is transformed from a difficult and expensive situation to a simple Part 15 modular transmitter scenario that integrates a pre-approved Part 15 modular transmitter with a pre-approved motherboard. This is analogous to adding a modularly approved Wi-Fi card to an FCC compliant notebook PC – the resultant composite system is FCC legal. The point of Part 15 modular transmitters is that they are self-contained and achieve compliance no matter what host system they are installed in. The benefit is that each additional system into which the radio module is integrated does not have to go through additional FCC testing. Provided that several important other requirements are met (more later in the software discussion), the resultant integrated system is FCC legal and does not require any additional FCC testing, certification, or filing.

The FCC is on record as stating to ADI that it is impossible for open architecture equipment using MiniPCI radios to be offered as a compliant DIY solution unless the MiniPCI radios have a modular approval allowing for their usage in the final system.

There have been cases in the past where OEMs have obtained FCC approval for a composite system consisting of a main board + standard MiniPCI radio + high gain antennas + enclosure, power supply and cables under a system-level FCC ID. While this avoids the need for a special MiniPCI radio with enhanced modular approval, the problem is that such an approval only allows the system to be sold or marketed as a complete, turnkey unit – hardware, and special software that enforces the limitations placed on radio operation to achieve compliance. The FCC has been quite clear that modular open architecture equipment offered on a DIY basis for integration by ADI's customers MUST use MiniPCI radios with a modular approval sufficient for usage in the final system. No such radios have existed – until now.

Based on this, ADI has made the commitment to enter the MiniPCI radio business – as the first and only supplier of MiniPCI radios with an enhanced modular Part 15 approval allowing high-gain antennas and radio co-location. This has been the key missing link in open architecture FCC compliant equipment, and ADI is excited to offer this path forward to the marketplace. ADI is about to launch our RM1 radio module (FCC ID SNR-RM1) as our initial offering.

ADI's approach to the RM1 is different than other 2.4 GHz MiniPCI radios. Other radio vendors focus on maximizing output power – as high as 600mW. But since the FCC strictly limits EIRP in the 2.4 GHz band to +36dBm, it is impossible to achieve compliance with a 600mW radio operating anywhere near full power when using high-gain antennas typical of real-world WISP networks. WISPs need directional antennas to manage interference to increase range and to decrease the number of access point sites. A 600mW radio at 2.4 GHz represents a large amount of wasted capability that cannot legally be used in most real-world applications.

(NOTE: This is true for access point use but a 600 mW radio CAN be legally used at the CPE end where the FCC 3:1 rule allows greater than +36dBm EIRP)

ADI has designed the RM1 to provide a clear path to system-level FCC compliance and to support real-world WISP usage. The RM1 offers the maximum legal access-point power at 2.4 GHz under the EIRP rules when used with its approved high-gain antennas. And the RM1's excellent receive performance is further improved with the approved high-gain antennas. The RM1 also takes the unique approach of automatically enforcing FCC compliance itself – even if software interacting with it attempts to setup non-FCC-compliant operation.

Key benefits of the RM1 include:

- Modular Part 15 approval allows the following antennas:
  - 2.4 GHz
    - 12 dBi helix
    - 12 dBi VPOL omni (being added currently)
    - 16 dBi VPOL sector (being added currently)
  - 5.8 GHz
    - 22 dBi panel/parabolic grid
- Modular approval allows one to four radios co-located in a single system
- Modular approval allows complete freedom in configuring all the co-located radios between 802.11 b/g and 802.11a operation
- The RM1 automatically enforces FCC compliance – commands issued to the RM1 that would result in violation of FCC rules are ignored. This means that no special software is required for compliance – the presence of non-FCC country code options in the wireless software interacting with the RM1 does not impact FCC compliance.
- ADI is open to adding additional antenna types and gains to our certification at customer request.

Preliminary specifications for the RM1 are as follows (subject to change prior to launch):

Wireless Standards	IEEE 802.11a/b/g
Frequency Bands	802.11a: 5.725-5.825 GHz 802.11b/g: 2.4-2.484 GHz
Maximum Approved Conducted Transmit Power	22.5dBm, 802.11b 15.5dBm, 802.11g 12.4dBm, 802.11a
Approved Antenna Types and Gains	2.4 GHz: 12dBi (+/- 1.5 dBi) helix currently - 12dBi VPOL omni & 16dBi VPOL sector being added to our approval prior to RM1 launch 5.8 GHz: 22dBi panel, 22dBi parabolic grid ADI is able to add antennas to the certification upon customer request
Maximum Approved EIRP (Allowing for antenna gain tolerance)	2.4 GHz: 36dBm 5.8 GHz: 36dBm -4-
Receive Sensitivity (Typical, measured at antenna connector. Effective receive sensitivity is higher by the amount of antenna gain)	802.11a: -90dBm @ 6Mbps, -74dBm @ 54Mbps 802.11g: -92dBm @ 6Mbps, -76dBm @ 54Mbps 802.11b: -96dBm @ 1Mbps, -92dBm @ 11Mbps

Wireless Chipset	Atheros AR5006
Other Features	• Complete IEEE 802.1x client support with EAP-TLS, EAP-TTLS supplicants • 802.11e standards supported for Wireless Multimedia Enhancement QoS • Two U.FL antenna connectors • FCC approval allows OEM and OEM-Integrator usage • Advanced Security Features: o WEP o WPA: AES, 64, 128, 512-WEP with shared key authentication, TKIP o WPA2 (IEEE 802.11i) o 802.1x support for LEAP/PEAP • Support for 802.11e: QOS support for wireless multimedia enhancements • Advanced Power Management features • Supports eXtended Range technology • Automatically enforces FCC compliant operation – commends that would establish non FCC compliant country codes, transmit powers or frequencies are ignored

Figure 1: ADI's RM1 MiniPCI Radio with Enhanced FCC Part 15 Modular Approval

Country Code Settings and Software Considerations for Compliance

There is quite a bit of confusion in the marketplace about software requirements for FCC compliant open architecture systems. Most wireless software offers user-selectable country code settings which would violate FCC rules if chosen. Compliant equipment must not allow users to configure it for non-compliant operation.

The FCC rules governing Part 15 modular transmitters clearly indicate that the intent is for the modular transmitter to achieve compliance without any dependency on the system it is installed in. Unfortunately, the status quo in the industry has been that many MiniPCI Part 15 modular transmitters respond to software commands (country code settings, power settings, channel settings) that result in violation of the FCC rules. The result is that compliance issues spill over onto the application software running on the wireless router board.

Until now, compliant systems had to use special versions of software that eliminated all non-FCC country code configuration options available to users. This puts application layer software (OSI layer 7) in the awkward role of managing an RF PHY layer issue (OSI layer 1). Software providers are also burdened with supporting special FCC compliant versions of their code. In ADI's opinion, this is a huge step backward.

ADI's approach is different, and simpler. The RM1 radio module automatically guarantees compliance regardless of what the application software running on the wireless router board may do. Commands that request the RM1 implement country codes, frequency selections or transmit power levels in violation of the FCC rules are simply ignored.

This means that ADI's approach achieves compliance without special software. Even if the application software offers non-FCC country code options, the RM1 ignores all commands that would result in non-compliance.

System Labeling Requirements

Compliant systems built according to ADI's assembly instructions will be labeled as follows. The integrator is responsible for printing and installing these labels on the outside of the enclosure.

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.

Tested to comply with FCC standards

FOR HOME OR OFFICE USE

Model [Integrator Model Name Here]
Contains Transmitter Module
FCC ID: SNR-RM1

Allowable Variances Under ADI's FCC Approval

Our FCC approval depends on our bill of materials and instructions for assembly and operation being followed exactly. Deviations will render the final system non-compliant. ADI's very quiet board design achieves full compliance without shielding. The result is that while ADI does offer a very nice enclosure for our board, the integrator can use an enclosure of their choosing and still achieve compliance.

There is also some latitude on antennas. Antennas of the same type as those in the certified system and of lesser or equal gain may be used. ADI and aCure are adding more antenna types to the certification currently.

ADI is open to discussing additions or modifications to our certification to suit specific customer requirements. Please contact ADI to discuss specific custom needs.

Figure 2: ADI/aCure Cast Aluminum Case for Pronghorn Metro

About ADI Engineering, Inc.

ADI Engineering, Inc. is a leading provider of reference platforms, engineering and manufacturing services supporting embedded Intel Architecture and Intel XScale technology. ADI also is a leading provider of semi-custom OEM Wi-Fi equipment and metro wireless hardware platforms and wireless router boards.

Founded in 1990, ADI is a privately held company with corporate offices and R&D facilities in Charlottesville, Virginia and manufacturing facilities in the US and Asia. ADI is an Associate member of the Intel Communications Alliance (intel.com/go/ica). For more information about ADI Engineering, please visit www.adiengineering.com or call (434) 978-2888.

About aCure Technology Pty Ltd

aCure Technology, founded in 2003 with the aim of providing superior technical support for LAN and WAN networks, obtained a carriers license in Perth in order to deliver an open metropolitan hot zone in the city central business district. This has been enhanced with Wi-Fi consulting services and the manufacture and sales of high performance turnkey mesh hardware solutions to OEM and WISP providers, internationally. For more information, visit www.acure.com.au or call +61 8 9201 9151.

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