AN13006

Compliance and Certification Considerations

Rev. 2 — 17 August 2023 Application note

Document information

Information	Content
Keywords	FCC, ETSI, EMC/RF emissions, adaptivity, DFS
Abstract	Provides general guidance and tips on how to test products based on NXP Wi-Fi devices for regulatory compliance (FCC, ETSI, etc.).

1 Revision history

Revision history

Rev	Date	Description
v.2	17 August 2023	**Modifications**: • Section 2.1 "Reference documents": updated • Section 3 "Certification process overview": updated the list of typical standards • Section 5.1 "Related parameters": updated • Section 5.2 "Test preparation": updated • Section 5.3 "General test procedure": updated • Section 7 "Adjacent channel selectivity": added • Section 8 "Acronyms and abbreviations": updated
v.1	3 November 2020	Initial version

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2 Introduction

This application note provides general guidance to test products based on NXP devices for regulatory compliance with standards like FCC and ETSI.

Users of this document will work with the regulatory test labs and module vendors to achieve the certification of their product.

It is recommended to read this document prior to going to the lab for compliance testing.

2.1 Reference documents

Table 1. Reference documents

Document type	Descriptive title
Application note	AN13009 - Wi-Fi Tx Power Table Management in Linux
Application note	AN13756 - ETSI Adaptivity and Receiver Blocking Tests
User manual	UM11490 - Feature Configuration Guide for NXP-based Wireless Modules on i.MX 8M Quad EVK

2.2 Using certified modules

If your product contains a wireless module that has already been regulatory certified, ask your module vendor for the regulatory certification.

We also strongly recommend that you use the same antenna as the one used by your module vendor, or an antenna with lower gain. Doing so may reduce the testing needed to demonstrate compliance, which helps reduce cost and delays to the project schedule.

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3 Certification process overview

The regulatory certification is a multiple step process to be planned closely with the regulatory test lab.

Start by determining the countries in which you plan to market your product. Each country may have its own regulations that can affect:

- The allowable frequencies (channels) and channel bandwidths that your product may operate on.
- The maximum transmit power that is allowed for each channel.
- Specific requirements for each operating frequency/channel (for example, adaptivity or dynamic frequency selection (DFS)).
- Test schedule. Some certifications, like DFS can require more time to get certified.

Typical standards related to regulatory compliance include:

- FCC: Part 15C, Part 15E
- ETSI EN 300 328, ETSI EN 301 893, ETSI EN 301 489, ETSI EN 300 440

After determining the target certifications, work with the regulatory test lab to determine a test plan to demonstrate compliance with the relevant requirements.

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4 EMC/RF emissions

This section provides some guidance for EMC/RF emissions tests. These tests measure the emissions transmitted at the antenna to determine if they exceed regulatory limits. The limits and test conditions for these tests:

- Are defined in the regulatory domain (for example FCC versus ETSI).
- May vary with the frequency/channel of operation (for example, 2.4 GHz band requirements may be different from 5 GHz band requirements).
- May depend on antenna gain.

The regulatory requirements may restrict both in-band (for example, power spectral density) and out-of-band (for example, harmonics of the signal) emissions.

4.1 Related parameters

For EMC/RF emissions testing, the key parameter that can be adjusted to meet compliance requirements is the RF transmit power. In general, the goal of compliance testing is to determine the highest transmit power level that can be used that still meets regulatory requirements.

If the regulatory requirements still cannot be met after reducing the transmit power level, consider using an antenna with lower gain. If you are using a certified module, contact your module vendor for assistance.

4.2 Test preparation

Prior to going to the lab for compliance testing, work with the regulatory test lab to put together a test plan. The test plan is based on:

- The countries (regulatory domains) that you plan to get certified for
- The frequencies/channels of operation (for example, 2.4 GHz and/or 5 GHz bands)
- The channel bandwidths of operation (for example 20 MHz, 40 MHz, and/or 80 MHz)

The test plan includes test cases, which specify the following:

- Bands, channels, channel bandwidths
- Transmit power levels
- Data rates

If you are using a wireless module that is already certified, we recommend obtaining the power table from the module vendor. The power table includes information on transmit power levels that are compliant for the specific module design and relevant regulatory domain. This transmit power table can be the initial starting point for compliance testing for your product.

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4.3 General test procedure

The test procedures and limits are generally defined by the relevant regulatory standard issued by organizations such as FCC and ETSI. This section provides some general tips on how to configure the radio for these tests.

1. For each test case, configure the radio to the desired band, channel, channel bandwidth, transmit power level and data rate. Look up the transmit power level for that particular radio configuration in the module transmit power table.
2. Enable continuous transmission mode.
3. Measure the emissions as required by the relevant standard, and determine the margin compared to limits. If the test case fails, adjust the power setting down by 1 dB and measure again. Continue until the test case passes. Record the final power setting and margin for passing condition.
4. Repeat the above process for all test cases.

Examples of test commands are provided in the application note *AN13756 - ETSI Adaptivity and Receiver Blocking Tests* (Section 2.1).

4.4 After testing is completed

The Wi-Fi power table includes the allowable channels, and transmit power levels used in normal operation out in the field. The power table specifies the target transmit power level based on channel, channel bandwidth, and data rate.

During compliance testing, it is recommended to record the transmit power levels that meet regulatory requirements.

After compliance testing is completed, verify the entries in the power table to ensure that the correct channels and transmit power levels are used. Adjust the values if needed.

Refer to the application note *AN13009 – Wi-Fi TX Power Table Management in Linux* (Section 2.1) for guidance on how to update the power table.

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5 Adaptivity

ETSI EN300 328 and EN301 893 standards require adaptivity.

The adaptivity test confirms the ability of the radio to hold off transmitting when an interfering signal is present. Meeting this requirement proves that the radio can safely share the spectrum with other users.

For the 2.4 GHz band, if the transmit power is less than +10 dBm EIRP, the adaptivity requirements do not apply.

Note: *For applications using Bluetooth, reduce the transmit power to less than 10 dBm EIRP so that the adaptivity requirement does not apply.*

5.1 Related parameters

The key Wi-Fi radio parameter that can be adjusted to meet the adaptivity requirement is the ED-MAC threshold. The ED-MAC threshold determines the sensitivity of the radio to interfering signals.

One ED-MAC threshold is used for all 2.4 GHz channels and another threshold is used for all 5 GHz channels.

The ED-MAC threshold can be enabled or disabled.

The ED-MAC threshold may need to be tuned to pass the adaptivity test. However, you should avoid tuning the ED-MAC threshold to be sensitive, since doing so can impact performance.

Note: *Prior to testing adaptivity, ensure that you calibrated RSSI for accurate measurements. For more information, refer to the application note "Calibration Structure" for your device.*

5.2 Test preparation

Prior to going to the test lab, prepare a test plan and review the general test procedure in Section 5.3 to be familiar with the related commands.

The test requires that the unit under test (UUT) transmits data to a companion device. The purpose of the test is to demonstrate that the data transmissions are paused when an interfering signal is present. Therefore, it is recommended to have a companion device (such as an access point) and a tool to generate data traffic (such as iPerf) available for the test.

5.3 General test procedure

The ETSI standard generally defines the test procedures and limits. Refer to the application note *AN13756 – ETSI Adaptivity and Receiver Blocking Tests* (Section 2.1) for guidance to configure your device for adaptivity testing.

5.4 After testing is completed

If the ED-MAC threshold required tuning to pass the compliance test, it is important to log the passing value of the threshold. There is one ED-MAC threshold for the 2.4 GHz band, and one threshold for the 5 GHz band. If you tested multiple channels per band during the compliance test, choose the lowest passing value for that band.

The system software must then set the ED-MAC threshold when the product boots, to ensure compliance when the product is used in the field.

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6 DFS

FCC, ETSI, and other countries when operating on certain channels require dynamic frequency selection (DFS). DFS is a scheme that allows wireless networks to operate in certain bands used by radar systems. The requirements and test procedure can vary by country.

When a DFS controller detects radar on the current channel, it stops operating on that channel and moves to a new channel. The DFS controller is the role of the access point in a Wi-Fi network.

The DFS controller informs the DFS responders when a channel change is required. Examples of DFS responders are the stations, or the client devices in a Wi-Fi network.

DFS compliance testing is required to operate on channels that require DFS.

DFS responder operation is enabled by default in the firmware.

Work with the test lab to prepare a test plan prior to going to the lab for certification.

Note:

1. *DFS controller testing is not covered in this revision of the document.*
2. *Prior to testing DFS, ensure that you calibrated RSSI for accurate measurements. For more information, refer to the application note "Calibration Structure" for your device.*

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7 Adjacent channel selectivity

Adjacent channel selectivity is a requirement of ETSI EN 300 440. The requirement applies only to short range devices (SRD) operating from 1 GHz to 40 GHz. These devices are defined as Receiver Category 1 (highly reliable SRD communication media). Adjacent channel selectivity is a measure of the ability of the receiver to operate satisfactorily in the presence of a strong unwanted signal in an adjacent channel.

In EN 300 440 v2.1.1, the k value range is 0 dB < k < 40 dBm. In EN 300 440 v2.2.1, the k value range has been updated to -40 dB < k < 0 dB. If you declare your device as a Receiver Category 1 device, NXP recommends using EN 300 440 v2.2.1.

Note: *The adjacent channel selectivity requirement does not apply to Receiver Category 2 or Receiver Category 3 devices.*

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8 Acronyms and abbreviations

Table 2. Acronyms and abbreviations

Acronym	Definition
DFS	Dynamic frequency selection
ED-MAC	Energy detect - Media/medium access controller
EIRP	Effective isotropic radiated power
EMC	Electromagnetic compatibility
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
RF	Radio frequency
SRD	Short range device
UUT	Unit under test

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