Application Note

Anritsu envision : ensure

Wireless LAN Product Evaluation Guide

～Certification Guide～

Wireless Connectivity Test Set MT8862A

Table of Contents

1. Introduction

This Wireless LAN Product Certification Guide is an easy-to-understand explanation for new designers of wireless LAN (WLAN hereafter) products and covers key points in designing and developing these products. This guide is the fourth volume following the third Product Design and Development Volume and describes certification required for shipping completed WLAN products to market.

Various standards and regulations have been decided to establish WLAN product functions and safety. Obtaining certification requires evaluating the WLAN product in accordance with certification tests determined for each standard and regulation to assure the product complies with the standards. The standard and regulations are composed of the IEEE802.11 standard on communications, the Wi-Fi Alliance certification for assuring interconnectivity between peers, and mainly national regulations for certifying prevention of radio interference between electronic equipment. These standards cover the obligatory and optional requirements for acquiring certification of WLAN products. This document explains the required regulatory certification, which is obligatory and closely related to WLAN product communications performance.

Although certification applies to completed products, failure to pass compliance tests at the design stage leads to risk of problems, such as repeated design changes and testing, higher development costs, and delayed commercial release schedule. Performing the same evaluations early in the development stage as at certification testing should reduce the risk of disrupted business plans.

2. Wireless LAN Product Standards and Certification

Wireless LAN product standards have been described previously in volumes 1 through 3 of the guides but are summarized again in this guide explaining the need to obtain certification.

2.1 IEEE 802.11 Standards

Generally, these standards determine required WLAN product performance and functions and following the recommendations facilitates establishment of communications between WLAN products. However, there are currently no specified certification tests for assessing whether the device implementation satisfies the IEEE802.11 standards. This lack of a certification scheme based on IEEE802.11 has caused many problems in the past, such as inability to establish connections between WLAN products from different vendors.

2.2 Wi-Fi Alliance Certification

This certification is related to assuring interconnectivity between WLAN products. Rather than using a simulator or other test equipment for evaluation,the DUT*1 is tested against a WLAN product chosen as the reference product to confirm proper connection and function. Obtaining Wi-Fi Alliance certification guarantees interconnectivity with other Wi-Fi Alliance-certified products. Only test organizations approved by the Wi-Fi Alliance can run certification tests. Acquisition of Wi-Fi certification is optional and not required by law.

*1: DUT Device Under Test

2.3 Regulatory Certification

Regulatory certification includes various regulations based on the following different viewpoints but this explanation focuses on (1) Radio Spectrum Use, which is strongly related to wireless communications performance.

(1) Radio Spectrum Use
(2) Electro Magnetic Compatibility (EMC)
(3) Safety (Protects users from injuries)

The range of frequencies that can be used for radio communications, broadcasting, etc., is restricted, but even so, radio waves typically interfere with each other when propagating with attenuation simultaneously in the same free space. Since radio interference crosses international boundaries, radio frequencies are managed internationally by the International Telecommunication Union Radiocommunications (ITU-R) section and each country controls its radio spectrum use based on these ITU-R rules.

WLAN products uses radio waves in the 2.4, 5, and 6 GHz bands, but these bands are also used by other products. Different nations have established different standards for various reasons, such as coexistence in the same band. Sale and use of WLAN products in respective countries is not permitted unless the product vendor can prove that its products satisfy these standards. Sale and use of products not meeting the standards runs the risk of prosecution in accordance with national laws.

Since the rules are established by each country, it is necessary to prove that a developed WLAN product satisfies the legal regulations of the shipping-destination countries. However, not all countries enforce their own standards, and there are many cases where countries will approve sale of products if they meet the US or EU-approved standard values.

□ **List of Regulatory Agencies**

Japan: Ministry of Internal Affairs and Communications (MIC)
USA: Federal Communications Commission (FCC)
EU: European Telecommunications Standards Institute (ETSI)
China: State Radio Regulation of China (SRRC)
S. Korea: Korea Communication Commission (KCC)
Taiwan: National Communications Commission (NCC)

Nationally approved regulatory testing must be performed fairly and approved by the organization setting the qualification conditions.

When obtaining certification, generally, since some third-party company is assigned the task of performing the regulatory testing, product developers often think that there is no necessity to prepare the same regulatory in-house test environment. However, as mentioned previously, since regulatory tests are performed by outside organizations at the final product development stage, if the tests are failed at this stage, it may sometimes be necessary to start development over again.
To prevent this situation, the same evaluations as performed at the regulatory testing are often performed at the early development stage using a so-called equivalent pre-compliance test before the actual certification test.

The next section provides a simple explanation of the regulation contents and differences in Japan, the USA and the EU.

3. Differences in Radio Spectrum Usage Policies in Japan, USA, and EU

This section presents some parameters and standard values for the main regulatory targets using the example of the 5 GHz band in the three frequency bands and notes the differences between each.

As described in the explanation of regulatory certification, the purpose of these regulations is to mainly prevent radio-wave interference. As a result, WLAN products are operated in the approved frequency range at the approved power; the purpose of these tests is to certify that non-approved radio waves are not being output.

The 5 GHz band uses different frequency ranges in each country and region. Additionally, the 5 GHz band is split into several sub-bands each of which has an approved transmission (Tx) power that may also depend on the device; the required test contents may also be different.

3.1 Frequency Ranges

The following figure shows the relationship between MIC, FCC, and ETSI-approved sub-bands and frequencies in the 5 GHz band.

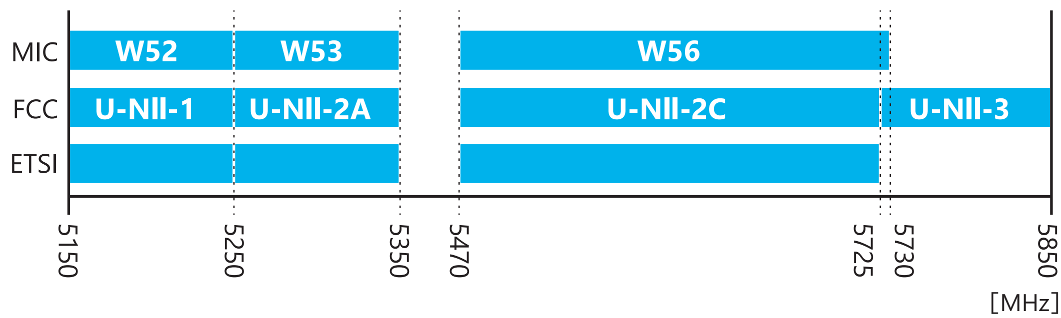


Fig. 1: Relationship Between National Approved Sub-bands & Frequencies in 5-GHz Band

3.2 Restrictions on Transmission Power

The following table shows the Tx power values regulated by MIC, FCC and ETSI. These tables have been created by Anritsu to show the values and output conditions for each sub-band.

□ MIC

Table 1: Japan MIC Tx Power Regulated Values

Frequency Range [MHz]	5150 to 5250	5250 to 5550	5470 to 5730
RF Output Power [dBm]	na	na	na
Power Density [mW/MHz]	OFDM 20 MHz BW: 10 OFDM 40 MHz BW: 5 OFDM 80 MHz BW: 2.5 OFDM 160 MHz BW: 1.25 Allowed deivation +20%, –80%		OFDM 20 MHz BW: 10 OFDM 40 MHz BW: 5 OFDM 80 MHz BW: 2.5 OFDM 160 MHz BW: 1.25 Allowed deviation +50%, –50%
DFS	No	Yes	Yes

□ FCC

Table 2: USA FCC Tx Power Regulated Values

Frequency Range [MHz]		5150 to 5250	5250 to 5550	5470 to 5725	5725 to 5850
RF Output Power [dBm]	Master device	30	24 or 11 + 10 log B		30
	Client device	24	whichever is lower (B= –26 dB emission BW)		
Power Density	Master device	17 dB/MHz	11 dBm/MHz		30 dBm/500 kHz
	Client device	11 dBm/MHz			
DFS		No	Yes		No

□ ETSI

Table 3: EU ETSI Tx Power Regulated Values

Frequency Range [MHz]		5150 to 5250	5250 to 5550	5470 to 5725
RF Output Power [dBm] (E.I.R.P*)	With TPC*	23	23	30
	Without TPC	20/23	20/23	27
Power Density [dBm/MHz] (E.I.R.P)	With TPC	10	10	10
	Without TPC	7/10	7/10	14 Excludig client with on DFS
DFS		No	Yes	Yes

EIRP: Equivalent Isotropic Radiation Power
TPC: Transmit Power Control

3.3 Weather Radar Interference Countermeasures

The 5 GHz band is also used by weather radar to detect rainfall. Since weather radar has high public benefit, it has higher-priority usage than wireless LAN, and WLAN products using the 5250 to 5350 MHz and 5470 to 5725 MHz frequencies (regulated by MIC up to 5730 MHz) are required to have passed a test of the Dynamic Frequency Selection (DFS) function to prevent interference with weather, shipping, and aerospace radar. When the DFS function detects the weather radar reference level, it stops the WLAN product using that frequency and switches to another unused frequency to prevent the risk of interference.

The DFS frequency ranges do not differ greatly between each regulation, but the pulse patterns emitted by weather radar are not identical and there are various types, which are defined separately for the regulatory tests by MIC, FCC, and ETSI. To obtain each regulatory certificate, it is necessary to test and verify the conformity of the procedure, reference values, and test pulse patterns.

4. Regulatory Certification Test Items

The following tables list the regulatory test items determined by each regulatory body. Some of the tests are common to each of the three agencies, but some are unique to a specific regulation; it is important to clarify shipping destination beforehand when preparing for the certification test.

Table 4: FCC, MIC, and ETSI Regulatory Test Items

MIC Wireless Infrastructure Regulations Article 19 Section
Frequency Tolerance
Occupied Frequency Bandwidth
Spurious/Unwanted Emissions
RF Output Power/Tolerance
Adjacent Channel Leakage Power
Receiver Spurious Emissions
Interference Blocking Function
Transmission Burst Length
Transmit Power Control (TPC) Function
Carrier Sense Function
Dynamic Frequency Selection Function (DFS, 5.3 GHz-Band)
Dynamic Frequency Selection Function (DFS, 5.6 GHz-Band)

FCC Rule Part 15 Subpart E
26 dB Bandwidth
6 dB Bandwidth
Maximum Conducted Output Power
Maximum Power Spectral Density
Dynamic Frequency Selection
Undesirable Emissions
General Field Strength Limits (Restricted Bands and Radiated Emission Limits)

ETSI EN301 893 v2.1.1
Nominal Centre frequencies
Nominal Channel Bandwidth and Occupied Channel Bandwidth
RF Output Power, Transmit Power Control
Power Density
Transmitter unwanted emissions
Receiver spurious emissions
Dynamic Frequency Selection (DFS)
Adaptivity (Channel Access Mechanism)
Receiver Blocking
User Access Restrictions
Geo-location capability

The next section explains some of the typical measurement items required by the above-described regulatory tests. However, be sure to refer to the latest version of each standard when actually performing measurements and confirm the exact required measurement conditions.

4.1 Transmission Tests

4.1.1 Frequency Tolerance/Center Frequency

The radio-wave output from the WLAN product is tested to confirm that the transmission frequency satisfies the standards. If the transmission frequency is out-of-specification, the WLAN product may be unable to communicate with its opposite partner, and additionally this out-of-specification radio wave may interfere with other WLAN channels and wireless systems to possibly cause communication problems.

The transmission frequency is output from the WLAN product set to the test mode*2 as an unmodulated wave at the frequency determined by the standard, and either a frequency counter or the frequency counter function of a spectrum analyzer is used to confirm the frequency. Additionally, the difference in the observed frequency and the frequency determined by the standard is assessed to confirm whether it is within the tolerance determined by the standard. However, since some WLAN products cannot output unmodulated waves, there are also substitute methods where the modulated waveform is observed using a spectrum analyzer to determine whether the center frequency meets the required standard.

*2: Mode for forcibly outputting test signal without communication partner

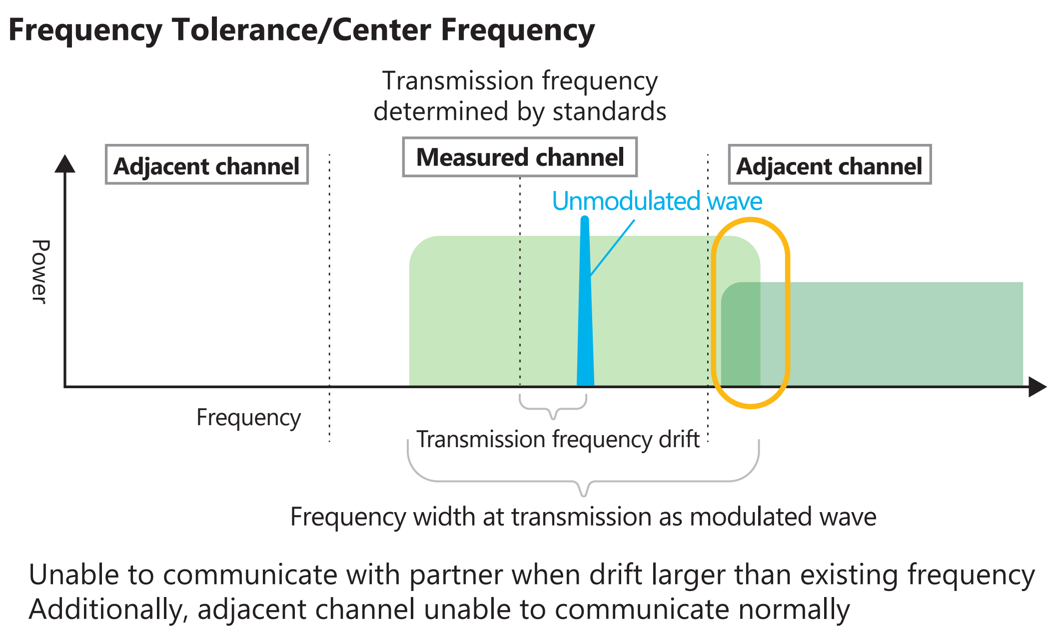


Fig. 2: Frequency Measurement Diagram

□ Required Test Instruments: Frequency Counter, Spectrum Analyzer

<Test Setup Example>

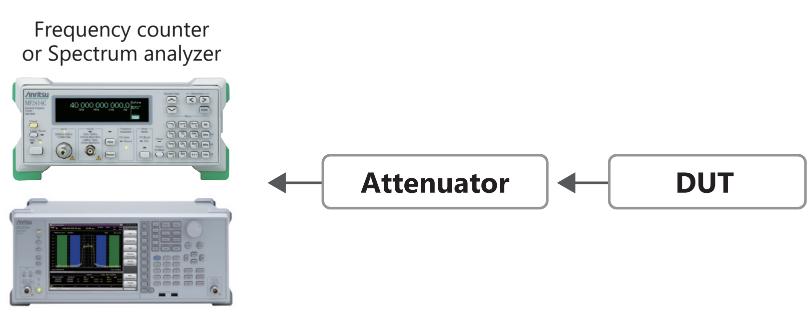


Fig. 3: Frequency Test Block Diagram

4.1.2 RF Output Power/Tolerance

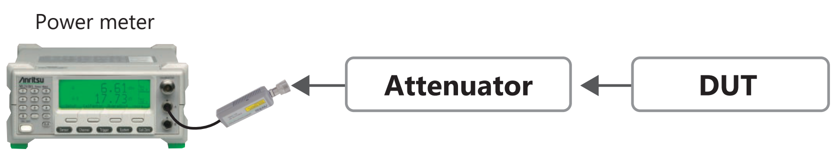
The power of the radio-wave output from the WLAN product is measured to confirm that it is in line with the standard requirements. If the Output Power exceeds the standard, the excess power may prevent normal communication with its communication partner or with other nearby WLAN products on the same channel. Furthermore, leakage of the radio wave into adjacent channels, or the presence of large spurious power may interfere with other WLAN channels and wireless systems to possibly cause communication problems.

The Output Power is measured using a power meter, spectrum analyzer, and oscilloscope to confirm that the output from the WLAN product set to the test mode satisfies the signal conditions determined by the standard. The ETSI standard requires use of an oscilloscope and power meter together to monitor the WLAN product duty cycle. Furthermore, the spectrum analyzer and power meter must also be used together when measuring the power density per MHz as outlined in Japan MIC regulations. The power upper limit differs according to whether or not the WLAN product has the Transmit Power Control (TPC) function.

□ Required Test Instruments: Power Meter, Spectrum Analyzer, Oscilloscope

<Test Setup Example>

■ **Power meter usage example**



■ **Spectrum analyzer and power meter usage example**

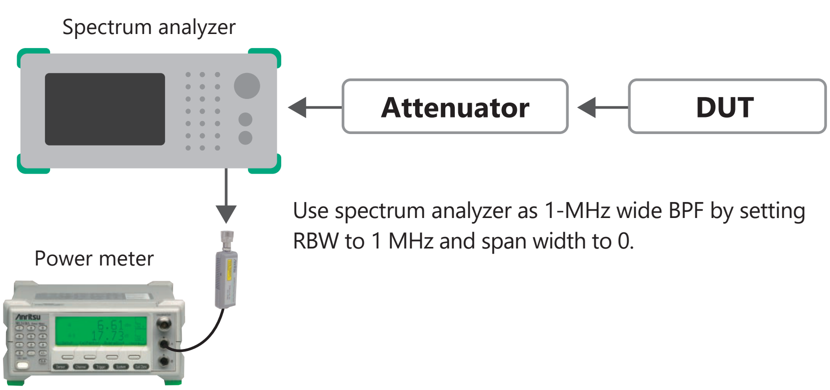


Fig. 4: RF Output Power/Tolerance Test Block Diagram

4.1.3 Occupied Frequency Bandwidth

The radio-wave output from the WLAN product is measured to confirm that it is in the frequency width determined by the standard. There are various values for this frequency width due to differences in WLAN product standards. If the output is in a frequency band outside the standard, the signal may interfere with other WLAN channels and wireless systems to possibly cause communication problems.

The occupied frequency bandwidth is measured using a spectrum analyzer to confirm that the signal occupied-frequency band output from the WLAN product set to the test mode satisfies the standards. The latest spectrum analyzers have a built-in function for measuring occupied frequency bandwidth, which measures the frequency band including a fixed proportion of the output power (e.g 99% or 90%).

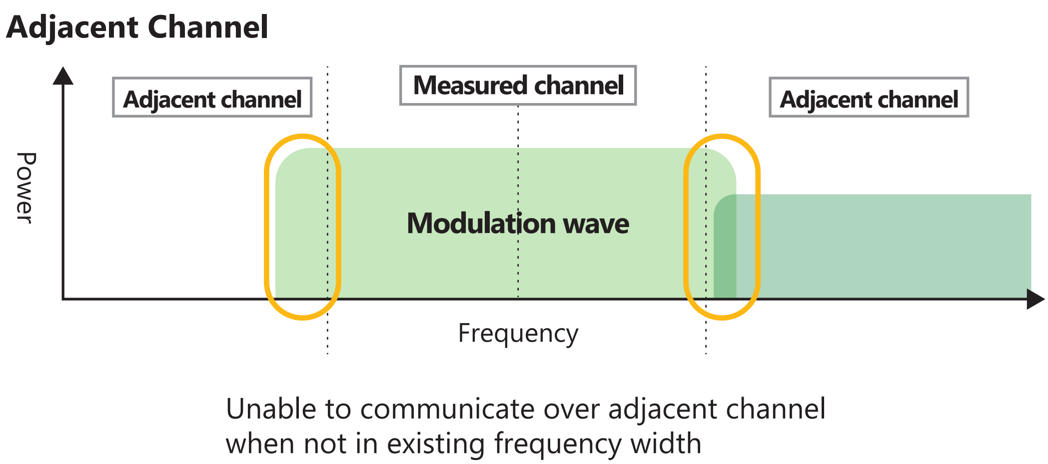


Fig. 5: Occupied Bandwidth Diagram

□ Required Test Instruments: Spectrum Analyzer

<Setup Example>

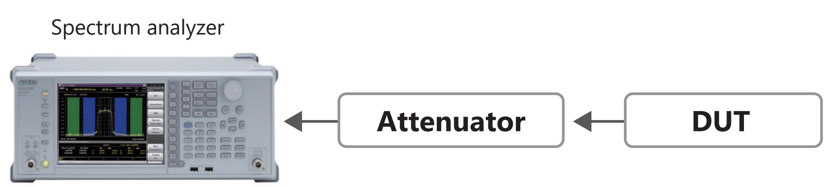


Fig. 6: Occupied Bandwidth Test Block Diagram

4.1.4 Spurious/Unwanted Emissions

This test measures the power of the spurious output from the WLAN product to confirm that it is not greater than the permitted value. Spurious is generated unintentionally at frequencies above and below the WLAN- product operating frequency and these radio waves are not necessary for communications. In particular, spurious can be large at frequencies that are integer multiples (2 or 3 times) the operating frequency. When the spurious value is large, the signal may interfere with other WLAN channels and wireless systems to possibly cause communication problems.

Spurious is measured using a spectrum analyzer to confirm that the output from the WLAN product set to the test mode satisfies the signal conditions determined by the standard. The upper limit for permitted spurious strength is determined for each standard and each observed frequency band. ETSI and MIC specify an upper measurement frequency of 13 GHz for 2.4 GHz WLAN products, while the FCC specifies 26 GHz. For 5.3 GHz and 5.6 GHz WLAN products, ETSI and MIC specify an upper limit of 26 GHz, while the FCC specifies 40 GHz. Moreover, the FCC also specifies 40 GHz for the new 6 GHz band (≤7.125 GHz)_ WLAN products being introduced in the US.

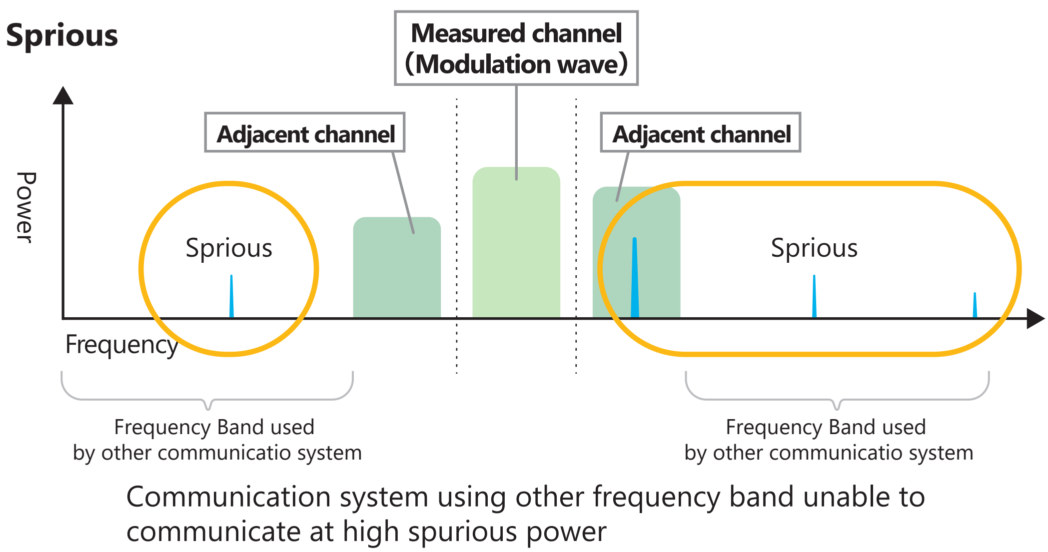


Fig. 7: Spurious Diagram

□ Required Test Instruments: Spectrum Analyzer

<Setup Example>

Fig. 8: Spurious Test Block Diagram

4.1.5 Adjacent Channel Leakage Power

This test measures whether and to what degree radio waves leaking from the WLAN product set to output over a predetermined frequency width are leaking into adjacent channels and whether this leakage is less than the permitted value. If the power of the leaking radio waves is large, there is a risk of interference with adjacent channels and possible communication problems.

First, the signal defined in the standards is output from the WLAN product set to the test mode. Then, this output signal is received by a spectrum analyzer, which measures the adjacent channel leakage power. The latest spectrum analyzers have a built-in function for measuring adjacent channel leakage power.

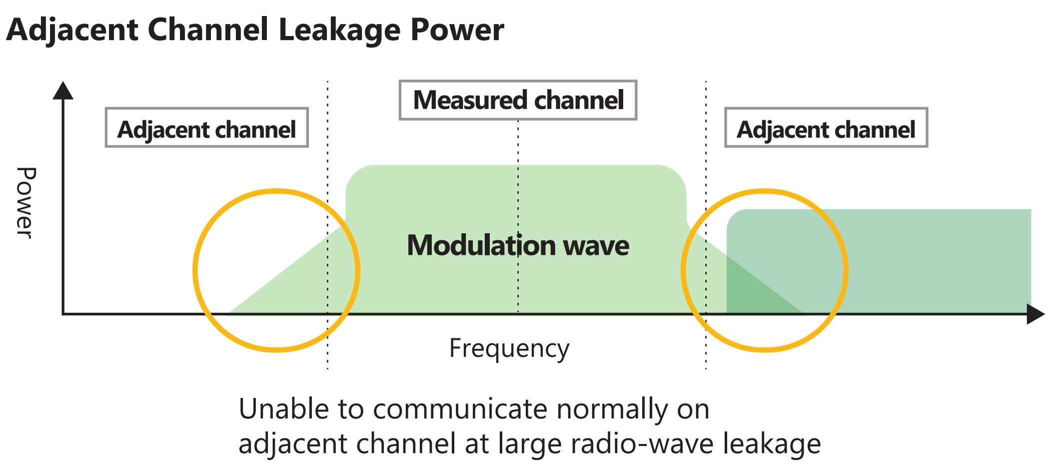


Fig. 9: Adjacent Channel Leakage Power Diagram

□ Required Test Instruments: Spectrum Analyzer

<Setup Example>

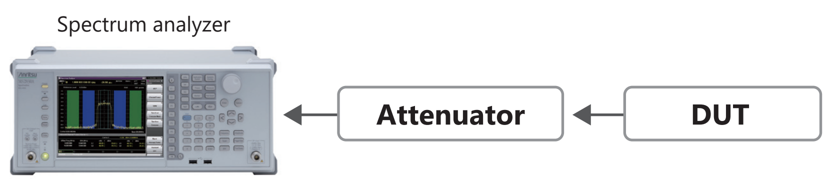


Fig. 10: Adjacent Channel Leakage Power Block Diagram

4.1.6 Receiver Spurious Emissions

This test measures whether the power of the spurious output from a WLAN product while this product is receiving a signal is less than the permitted value. Normally, there should be no output of radio waves while receiving. If radio waves are being output, in addition to the risk of being unable to receive normally, there is a risk of the emitted radio waves interfering with other channels and wireless systems to possibly cause communication problems.

Receiver spurious emissions are measured using a spectrum analyzer. As with spurious measurement, the permitted receiver spurious emissions upper limit is determined for each standard. ETSI and MIC specify an upper measurement frequency of 13 GHz for 2.4 GHz WLAN products, while the FCC specifies 26 GHz. For 5.3 GHz and 5.6 GHz WLAN products, ETSI and MIC specify an upper limit of 26 GHz, while the FCC specifies 40 GHz. Moreover, the FCC also specifies 40 GHz for the new 6 GHz band (≤7.125 GHz) WLAN products being introduced in the US.

□ Required Test Instruments: Spectrum Analyzer

<Setup Example>

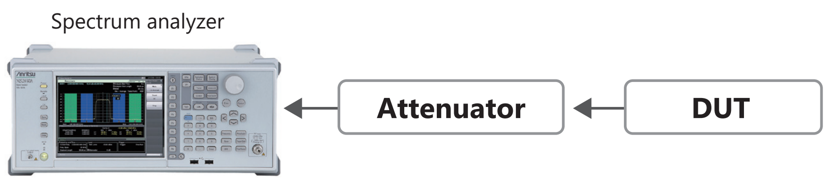


Fig. 11: Receiver Spurious Emissions Diagram

4.1.7 Dynamic Frequency Selection (DFS)

This test detects whether a WLAN product outputting 5.3 GHz and 5.6 GHz band radio waves can detect radio waves used by weather, shipping, and aerospace radar to stop signal output. The operation of the function is confirmed by outputting a signal for the WLAN product from a signal generator simulating a radar signal. The DFS function is possessed mainly by access points (AP) for WLAN products.

The simulated radar signals are in the 5.3 GHz and 5.6 GHz bands and the test details are determined by each standard. The simulated radar signal is output from the signal generator to the DUT while the DUT and external tester or partner device receiving the signal are communicating. A spectrum analyzer is used to confirm whether the waveform of the signal output from the DUT is extinguished to confirm operation of the DFS function. The number of tests and pass criteria are determined by each standard.

□ Required Test Instruments: Spectrum Analyzer, Signal Generator

<Setup Example>

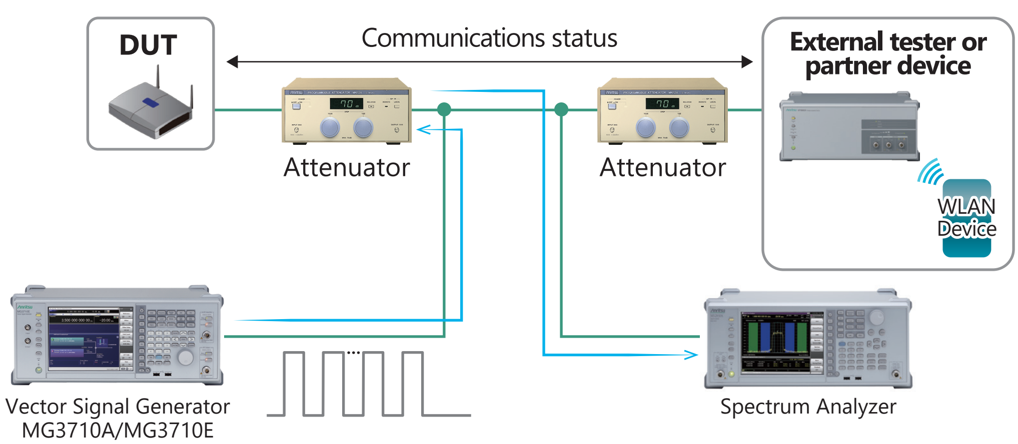


Fig. 12: DFS Test System Block Diagram

4.2 Reception Test

4.2.1 Receiver Blocking

Out of the three MIC, FCC, and ETSI regulatory agencies only ETSI defines a specific test for receiver blocking.

Generally, radio-wave frequency usage regulations are determined for radio transmissions, but this test item determines the performance that should be satisfied by the DUT receiver. The required reception performance demands that the WLAN signal from the partner device can be received by eliminating the effect of interference at a frequency adjacent to the frequency used by the WLAN frequency. The test pass/fail evaluation index is the same packet error rate (PER) reception measurement item used in the third Product Design and Development Volume; successful certification requires a PER or 10% or less under a constant interference-signal condition.

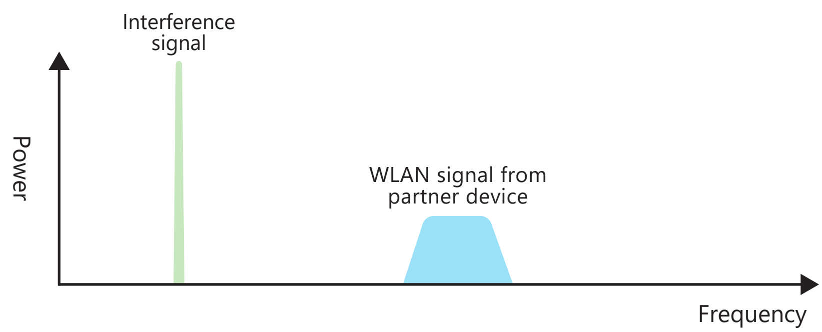


Fig. 13: Receiver Blocking Diagram

□ Required Test Instruments: WLAN Tester, Signal Generator

<Setup Example>

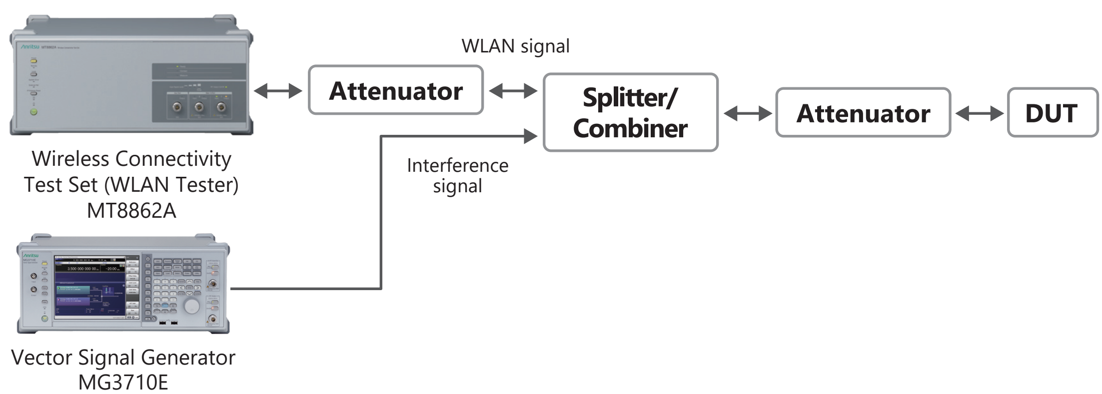


Fig. 14: Receiver Blocking Test Block Diagram

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2103

Printed in Japan 02/APR/2021 ddcm/CDT Catalog No. MT8862A-E-F-4-(1.00)