Anritsu envision : ensure

WLAN Product Design Guide

~Parts Selection~

Wireless Connectivity Test Set MT8862A

Contents

1 Introduction

It is necessary to consider various points when designing high-quality wireless LAN (WLAN) products; this guide explains what to consider to achieve the RF performance (signal quality) required to implement stable communications in any environment, as well as what WLAN module to choose.

2 Choosing Parts

The following lists a simple procedure for choosing parts.

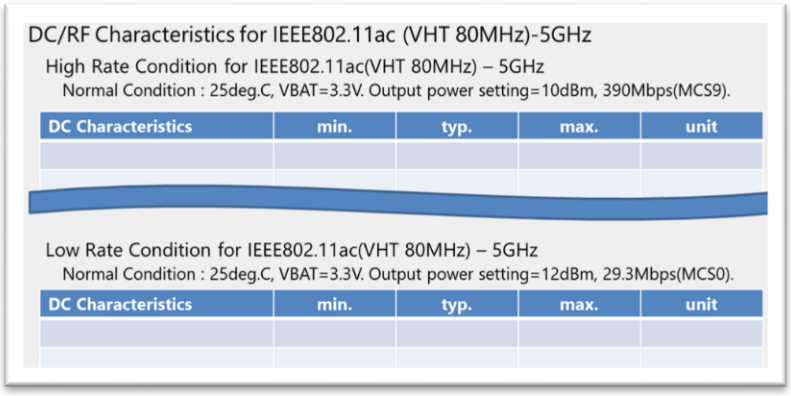
1. Determine the required performance.
2. Select WLAN modules meeting required performance.
3. Evaluate which is the best WLAN module from the candidates selected in step 2.

The next section explains the most-effective, objective evaluation methods.

3 Choosing Purchased Parts

3.1 Evaluating from Data Sheet

During the commercialization process, clarifying the required performance for the WLAN module which is implemented in the target product helps find WLAN modules meeting that performance as well as the evaluation requirements. To compare several WLAN modules, first, consider comparing data sheets. Some WLAN module data sheets are shown below.



DC/RF Characteristics for IEEE802.11ac (VHT 80MHz)-5GHz

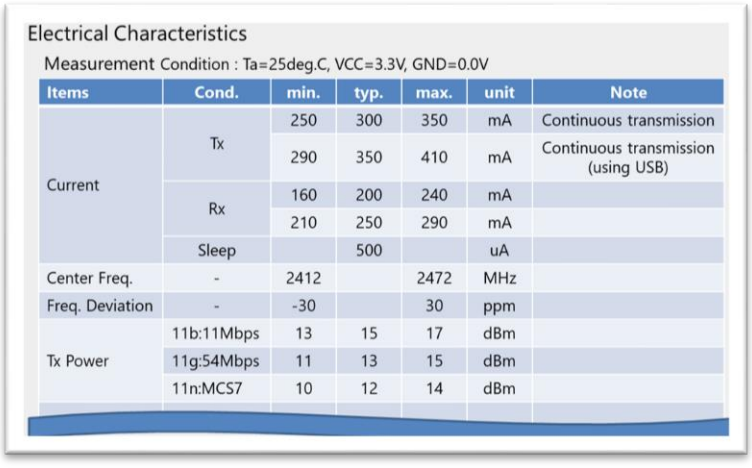
High Rate Condition for IEEE802.11ac(VHT 80MHz) – 5GHz
Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=10dBm, 390Mbps(MCS9).

DC Characteristics	min.	typ.	max.	unit

Low Rate Condition for IEEE802.11ac(VHT 80MHz) – 5GHz
Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=12dBm, 29.3Mbps(MCS0).

DC Characteristics	min.	typ.	max.	unit

Module A

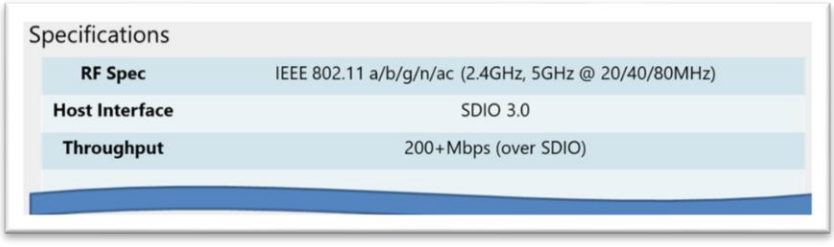


Electrical Characteristics

Measurement Condition : Ta=25deg.C, VCC=3.3V, GND=0.0V

Items	Cond.	min.	typ.	max.	unit	Note
Current	Tx	250	300	350	mA	Continuous transmission
		290	350	410	mA	Continuous transmission (using USB)
	Rx	160	200	240	mA	
		210	250	290	mA	
	Sleep		500		uA	
Center Freq.	-	2412		2472	MHz	
Freq. Deviation	-	-30		30	ppm	
Tx Power	11b:11Mbps	13	15	17	dBm	
	11g:54Mbps	11	13	15	dBm	
	11n:MCS7	10	12	14	dBm	

Module B



Specifications

RF Spec	IEEE 802.11 a/b/g/n/ac (2.4GHz, 5GHz @ 20/40/80MHz)
Host Interface	SDIO 3.0
Throughput	200+Mbps (over SDIO)

Module C

Fig. 1 Example of WLAN Module Data Sheets

Generally speaking, there are no fixed items in WLAN module data sheets for describing electrical performance. For example, Module A listed electrical specifications in each throughput performances. Module B describes only key specifications by Max throughput at each supported transmission method. And Module C publishes no items related to WLAN signal quality. Consequently, comparison of data sheets can be very difficult with different unstructured items scattered through the sheets. So what is the best way to compare WLAN modules?

3.2 Comparing Modules using WLAN Tester

Many WLAN modules can be pre-evaluated before purchase since they have an evaluation sample kit. Moreover, since the IEEEE 802.11 standard determining WLAN specifications describes the measurement methods and settings for evaluating signal quality, we recommend evaluation for each WLAN signal quality using an evaluation kit and WLAN tester by the IEEE 802.11 test item requirements.

Reference IEEE 802.11 Web page: http://www.ieee802.org/11/

It may give us an indication if you evaluate other modules using an evaluation kit and WLAN tester based on a data sheet with detailed parameters written like Module A. It is also good method is to make the comparative evaluation under the worst usage environment condition such as minimum Rx power from the access point and noise application. In any way, it is important to exclude external factors and to evaluate the signal quality quantitatively under the same conditions and settings.

There are two methods for evaluating the signal quality of WLAN products using a WLAN tester: the Direct Mode, and the Network Mode.

Direct Mode: In this mode, you shall set the DUT to signal reception condition or signal transmission conditions on Test Mode (DUT inspection mode for examining RF basic performance) for signal quality evaluation. The method and command to change to test mode depend on the DUT. In addition, some DUT may be necessary to replace with evaluation firmware for evaluation since it is not be able to change to test mode on regular firmware.

Network Mode: This mode measures signal quality (RF TRx characteristics) using standard WLAN protocol messages under the same conditions as at actual usage when a link is established with the WLAN product.

We recommend evaluation on the Network Mode because the Direct Mode requires device control, which requires specialist knowledge and expertise (learning in usage of chipset tools). Moreover, market requests evaluation at test environment as close as the actual usage environment.

Using a WLAN tester supporting the Network Mode supports quantitative measurement of signal quality under the same connection conditions as a wireless link with a regular Access Point (AP) (Fig. 2).

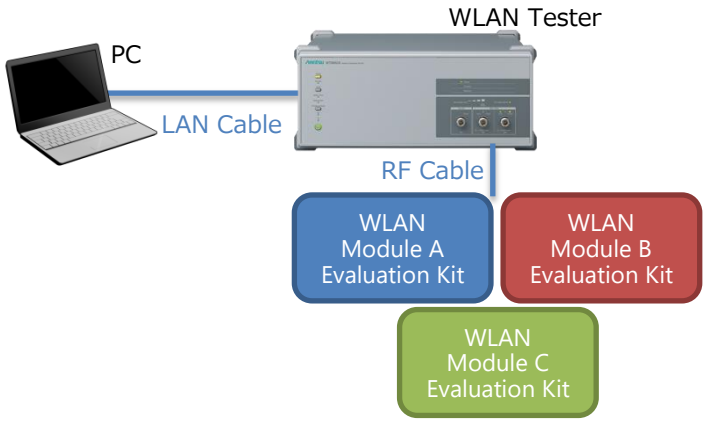


Fig. 2 Example of WLAN Tester and Module Connection

Column: What is IEEE 802.11?

WLAN is a wireless communications technology standardized by IEEE 802.11 defined by the Institute of Electrical and Electronics Engineers (IEEE). IEEE 802.11 describes RF standards and related test methods.
To ensure the quality of WLAN communications, basic measurement items and reference values related to transmission and reception tests are described in the standard; when a WLAN product meets these reference values, it is evaluated as having the required RF performance.

Column: Is it OK to evaluate by connection to Access Point?

The answer is no.
Even if a high IP throughput is measured when connected to a commercial Access Point, this does not confirm that there are no problems with signal quality (RF performance). IP throughput is not dependent only on RF performance but also changes greatly depending on the performance of the higher-layer protocol stack and the amount and type of sent and received data. Moreover, since the modulation method also changes according to the data rate, RF performance also changes accordingly.
Consequently, even when the RF performance has serious problems, they might be overlooked because the IP throughput result was unaffected by chance at the measurement instant or the throughput might have dropped under different conditions.
Furthermore, at wireless communications with a commercial Access point, there is no control of the data rate being used. When propagation conditions are ideal, generally, only the best signal rate supported by the Access Point and module is used. As a result, even when there is a transmit/receive problem at a specific data rate, discovering it is hard when using a commercial Access Point.
At first use of a module in various environments after product shipment, it may become apparent that the throughput is much lower than other modules. Avoiding this type of problem requires evaluation using a measuring instrument that can quantitatively capture the RF performance at each data rate.

3.3 Contents of Recommended Evaluation Test

The best objective test way is following the IEEE 802.11 measurement items. We recommend exhaustive data capture for each WLAN module with changing the parameters having a major impact on measured throughput and signal quality by IEEE 802.11 measurement items. This is because the signal performance of a WLAN product incorporating a WLAN module differs from that of a standalone WLAN module due to the effect of circuit patterns, antenna position, peripheral devices, etc.

Consequently, capturing exhaustive data on WLAN module signal performance at the design stage before assembly of the finished product will help to understand parts with degraded performance by performing the same measurements after assembly, and it simplifies product troubleshooting and performance improvements.

Recommended Test Contents:

We recommends executing the Tx and Rx performance tests while changing each MCS, channel, bandwidth, Tx power, etc by following the measurement items based on IEEE 802.11. The key IEEE 802.11a/b/g/n/ac measurement items are listed in the following tables.

☐ Tx Measurements

IEEE 802.11-2016

802.11a	802.11g	802.11n	802.11ac	Evaluation
17.3.9.2	18.4.7.2	19.3.18.3	N/A	Transmit power levels
17.3.9.3	18.4.7.3	19.3.18.1	21.3.17.1	Transmit spectrum mask
17.3.9.5	18.4.7.4	19.3.18.4	21.3.17.3	Transmit center frequency tolerance
17.3.9.6	18.4.7.5	19.3.18.6	21.3.17.3	Symbol clock frequency tolerance
17.3.9.7.2	17.3.9.7.2	19.3.18.7.2	21.3.17.4.2	Transmitter center frequency leakage
17.3.9.7.3	17.3.9.7.3	19.3.18.2	21.3.17.2	Transmitter spectral flatness
17.3.9.7.4	17.3.9.7.4	19.3.18.7.3	21.3.17.4.3	Transmitter constellation error
17.3.9.8	17.3.9.8	19.3.18.7.4	21.3.17.4.4	Transmitter modulation accuracy test
802.11b				**Evaluation**
16.3.7.2				Transmit power levels
N/A				Minimum transmitted power level
16.3.7.3				Transmit power level control
16.3.7.4				Transmit spectrum mask
16.3.7.5				Transmit center frequency tolerance
16.3.7.6				Chip clock frequency tolerance
16.3.7.7				Transmit power-on and power-down ramp
16.3.7.8				RF carrier suppression
16.3.7.9				Transmit modulation accuracy

☐ Rx Measurements

IEEE 802.11-2016

802.11a	802.11g	802.11n	802.11ac	Measurement
17.3.10.2	18.4.8.2	19.3.19.1	21.3.18.1	Receiver minimum input level sensitivity
17.3.10.3	18.4.8.3	19.3.19.2	21.3.18.2	Adjacent channel rejection
17.3.10.4	17.3.10.4	19.3.19.3	21.3.18.3	Nonadjacent channel rejection
17.3.10.5	18.4.8.4	19.3.19.4	21.3.18.4	Receiver maximum input level
802.11b				**Measurement**
16.3.8.2				Receiver minimum input level sensitivity
16.3.8.3				Receiver maximum input level
16.3.8.4				Receiver adjacent channel rejection

The parameters with a major impact on signal quality are transmission speed (MCS), bandwidth, and signal frequency (Channel). For one sample, these are defined in 11ac standard as follows:

MCS	MCS0 to MCS9 *1
Bandwidth	20 MHz, 40 MHz, 80 MHz, 160 MHz*2
Channel	20 MHz: Channels 36 to 169 (Total 26 channels) 40 MHz: Channels 36 to 165 (Total 13 channels) 80 MHz: Channels 36 to 149 (Total 6 channels)

*1: The MCS9 bandwidth settings are 40, 80, and 160 MHz only.
*2: The 160-MHz bandwidth is optional.

We recommend capturing as much RF performance data as possible at the module selection stage by making good use of the WLAN tester.

Overall	Standard	Data Rate	Channel	Transmit Power		Transmitter constellation error		Transmitter center frequency leakage			Center Frequency Tolerance						av
				ave (dBm)	max (dBm)	ave (dB)	max (dB)	ave (dB)	max (dB)	min (dB)	ave (Hz)	max (Hz)	min (Hz)	ave (ppm)	max (ppm)	min (ppm)	
PASS	11g	6Mbps	1	-20.22	-10.14	-30.3	-24.06	-40.19	-40.19	-40.19	-10,056	-10,056	-10,056	-4.2	-4.2	-4.2	
PASS	11g	6Mbps	6	-18.15	-7.56	-31.77	-24.09	-52.93	-52.93	-52.93	-10,121	-10,121	-10,121	-4.2	-4.2	-4.2	
PASS	11g	6Mbps	11	-19.74	-9.26	-32.33	-25.25	-40.84	-40.84	-40.84	-10,038	-10,038	-10,038	-4.1	-4.1	-4.1	
PASS	11g	6Mbps	13	-31.93	-21.22	-35.67	-29.67	-28.56	-28.56	-28.56	-10,323	-10,323	-10,323	-4.2	-4.2	-4.2	
PASS	11g	9Mbps	1	-23.21	-13.02	-33.76	-27.03	-37.03	-37.03	-37.03	-9,542	-9,542	-9,542	-4	-4	-4	
PASS	11g	9Mbps	6	-21.59	-12.03	-33	-26.18	-40.63	-40.63	-40.63	-10,290	-10,290	-10,290	-4.2	-4.2	-4.2	
PASS	11g	9Mbps	11	-21	-10.68	-32.19	-25.04	-35.77	-35.77	-35.77	-10,401	-10,401	-10,401	-4.2	-4.2	-4.2	
PASS	11g	9Mbps	13	-31.81	-21.38	-36.24	-29.94	-29.87	-29.87	-29.87	-10,249	-10,249	-10,249	-4.1	-4.1	-4.1	
PASS	11g	12Mbps	1	-21.89	-11.84	-33.28	-26.36	-41.13	-41.13	-41.13	-9,742	-9,742	-9,742	-4	-4	-4	
PASS	11g	12Mbps	6	-21.3	-11.43	-33.99	-27.62	-44.88	-44.88	-44.88	-10,331	-10,331	-10,331	-4.2	-4.2	-4.2	
PASS	11g	12Mbps	11	-19.84	-9.42	-31.48	-25.05	-37.01	-37.01	-37.01	-10,009	-10,009	-10,009	-4.1	-4.1	-4.1	
PASS	11g	12Mbps	13	-34.09	-23.88	-35.89	-30.12	-44.73	-44.73	-44.73	-10,423	-10,423	-10,423	-4.2	-4.2	-4.2	
PASS	11g	18Mbps	1	-22.95	-13.29	-35.66	-29.13	-41.02	-41.02	-41.02	-10,516	-10,516	-10,516	-4.4	-4.4	-4.4	
PASS	11g	18Mbps	6	-20.39	-9.75	-33.89	-27.64	-42.99	-42.99	-42.99	-9,924	-9,924	-9,924	-4.1	-4.1	-4.1	
PASS	11g	18Mbps	11	-20.65	-11.21	-32.3	-25.97	-47.47	-47.47	-47.47	-10,039	-10,039	-10,039	-4.1	-4.1	-4.1	
PASS	11g	18Mbps	13	-34.02	-24.02	-36.37	-29.96	-53.43	-53.43	-53.43	-10,216	-10,216	-10,216	-4.1	-4.1	-4.1	
PASS	11g	24Mbps	1	-21.42	-10.64	-34.25	-27.22	-47.42	-47.42	-47.42	-9,720	-9,720	-9,720	-4	-4	-4	
PASS	11g	24Mbps	6	-19.95	-9.1	-31.34	-24.46	-49	-49	-49	-10,260	-10,260	-10,260	-4.2	-4.2	-4.2	
PASS	11g	24Mbps	11	-19.01	-8.33	-32.55	-25.88	-51.67	-51.67	-51.67	-10,452	-10,452	-10,452	-4.2	-4.2	-4.2	
FAIL	11g	24Mbps	13	-33.96	-23.56	-35.69	-28.21	-29.53	-29.53	-29.53	-10,418	-10,418	-10,418	-4.2	-4.2	-4.2	
PASS	11g	36Mbps	1	-20.69	-10.26	-33.57	-26.79	-55.18	-55.18	-55.18	-9,671	-9,671	-9,671	-4	-4	-4	

Fig. 3 Example of Captured RF Performance Data at Various Settings

Column: Automatic Data Capture using Wireless Connectivity Test Set MT8862A

Although it is possible to cut the number of test items by cutting the usage conditions, measuring the RF performance for all supported connections takes an extremely long time. However, in this case, the measurement time can be cut greatly by using automation tools. The Anritsu Wireless Connectivity Test Set MT8862A is a WLAN tester using remote commands, so custom automation software can be created for the programming environment. In addition, we have sample scripts for some programming environments. Speak with Anritsu about the Wireless Connectivity Test Set MT8862A and available measurement tools.

Key Features of Wireless Connectivity Test Set MT8862A

- Network Mode Applications: Uses standard WLAN protocol messaging (WLAN signaling) to measure by establishing wireless link with WLAN product
- Supports also Direct Mode
- Supports IEEE 802.11a/b/g/n/ac
- 2x2MIMO Rx sensitivity and Tx power measurement functions
- Supports secure links (WEP, WPA-Personal, WPA2-Personal)
- Packet Error Rate (PER) measurement using ACK count, and bathtub curve generation for Rx measurements
- GUI controlled from Web browser without installing a control software.
- WLAN connection troubleshooting using Frame capture logs and analysis
- Supports IP TRx data exchange with external servers using built-in interface

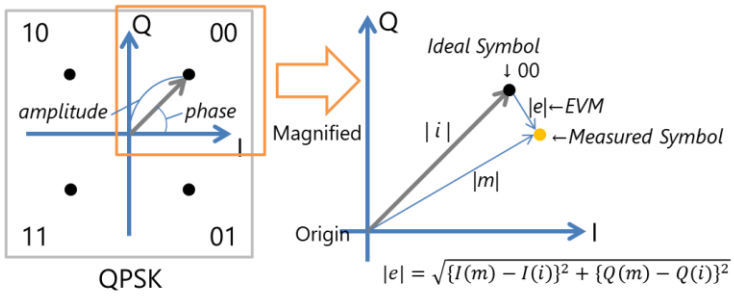
3.4 Deciding Which WLAN Module to Use

Choose the best WLAN module based on the obtained data, the module usage environment (amount of noise), usage application (TRx signal occurrence frequency, minimum required throughput) etc.
Read the following leaflets for an explanation of the obtained data and how to understand the measurement results.

- Evaluating WLAN Products Transmitter Characteristics - Introduction to WLAN Measuring Instruments -
- Evaluating WLAN Products Receiver Characteristics - Introduction to WLAN Measuring Instruments -

Column: How to view the Constellation? What is EVM?

Signal modulation and demodulation are performed for reducing the noise effects of noise and transmitting signal far away. The Constellation displays this data modulation.
Digital wireless modulation is composed of a combination of the Amplitude Modulation (AM) method for recognizing data using the signal amplitude, and the Phase Modulation method for recognizing data using the phase of the signal frequency.
As an example, using the QPSK method combining AM and Phase Modulation creates the following four conditions.
The Constellation expresses this phase and amplitude combination. In other words, it can recognize four data types (00, 01, 10, 11) using 2 bits of data.



In addition, the Constellation EVM (Error Vector Magnitude) quantifies the deviation (or error) of the modulation data points from the ideal positions.

Column: Channel Usage

Each country supports different channels. In addition, channel usage must be confirmed before product development because some channels have limited usage condition such as indoor use only.

Reference: List of WLAN channels en.wikipedia.org/wiki/List_of_WLAN_channels

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Specifications are subject to change without notice.

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Printed in Japan 2019-11 MJM No. MT8862A-E-F-1-(1.00)