On the other hand, customers are increasingly wanting to 

"Compare our products"  
"Compare with other makers’ products"

in terms of WLAN performance and functions. This is the Benchmark Test.

As these backgrounds, if the transmitter and receiver performance of finished products with built-in WLAN modules is not confirmed, there is increasing risk of the following complaints from customers using these products, which makes advance comparative evaluation very important.

- After I traded-in for a better model, my connection speed is slower than before.
- Company B’s products are slower than Company A’s.
- I can connect with Company C’s product but Company D’s are difficult to connect and get dropped easily.

“WLAN performance is different between WLAN modules and finished products, making finished-product evaluation very important.”
Confirming Finished Product Transmitter and Receiver Performance

Under Close-to-Live Operation Conditions (Network Mode)

The MT8862A supports Network Mode for evaluating the wireless quality of finished WLAN products under close-to-live operation conditions. It evaluates transmitter and receiver performance using simple connections realizing general WLAN communications procedures.

Wired Connection

Control PC

LAN

TRx Signals

WLAN mounted device

MT8862A

Over The Air (OTA) Connection

Control PC

Radio Anechoic Chamber

LAN

Rx Signal

Tx Signal

WLAN mounted device

MT8862A

The DUT communications conditions are controlled by the MT8862A to perform quantitative evaluations with good reproducibility.

- Communications standards (11a/b/g/n/ac)
- Transmission Rate (54 Mbps, etc.)
- Channels (Frequency)*1

Evaluation Items Using MT8862A

Tx Performance: Power, Modulation Accuracy (EVM*2), etc.
Rx Performance: Rx Sensitivity (PER*3)

*1: Controlled by MT8862A in Access Point mode
*2: EVM = Error Vector Magnitude
*3: PER = Packet Error Rate

These materials introduce comparative evaluation of transmitter and receiver characteristics for a “product” with built-in WLAN communications functions. First, they introduce examples 1, 2, and 3 for benchmarking the modulation accuracy (EVM) transmitter characteristic.

What is modulation accuracy (EVM)?

The figures on the right show examples of 64QAM constellation screens.

For 64QAM, the number of symbol points is 8 x 8 on the vertical and horizontal axes. Error Vector Magnitude (EVM) is an index expressing the difference between theoretical and actual symbol points as a percentage.

Symbol points with good modulation accuracy are each focused at one point whereas they are diffused when the modulation accuracy is poor. A product with poor modulation accuracy does not receive signals correctly and the communications speed may decrease with more dropped connections.

Symbol point Examples of Constellation Screens (From Example 1)

<table>
<thead>
<tr>
<th>Symbol point</th>
<th>Good example</th>
<th>Bad example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulation accuracy EVM rms</td>
<td>Company E (2) 1.8%</td>
<td>Company F 9.5%</td>
</tr>
</tbody>
</table>

Transmitter Characteristics Benchmark Example 1: Performance Differences with Product Orientation

Transmitter characteristics may be degraded due to the positioning of the internal antennas when the product orientation is changed. In example 1, the product suffers changing modulation accuracy as the product orientation changes.

EVM : 11g, 54Mbps, 1ch(2412MHz)

Companies B, D, E (1), and F
Modulation accuracy tends to change with product orientation due to changes in the Rx level caused by the antenna positioning.

Companies A (1) and (2), C, and E (2):
Modulation accuracy is stable (2% to 3% change) with changes in product orientation and the transmitter characteristics are excellent.
Transmitter Characteristics Benchmark Example 2: Performance Differences due to Transmission Rate = Changes in Modulation Method

It is important to confirm each modulation accuracy when changing the transmission rate and modulation method. In example 2, some products are stable at all transmission rates but others suffer changing modulation accuracy when the transmission rate changes.

![Graph showing EVM vs. Throughput for different transmission rates and companies (A, B, C, D, E, F).]

- **Companies B, D, E (2) and F:** Modulation accuracy changes with transmission rate and some are degraded by almost 10%.
- **Company E (2):** Modulation accuracy is excellent at 54 Mbps but degrades as transmission rates drop and is about 5% worse at 6 Mbps.
- **Companies A (1), A (2), C and E (1):** Modulation accuracy is stable (2% to 3% change) and does not drop with transmission rate, supporting excellent transmitter characteristics.

Transmitter Characteristics Benchmark Example 3: Performance Differences Due to Channel = Frequency

Changing the equipment channel and frequency affects modulation accuracy due to the frequency characteristics performance. In example 3, the modulation accuracy of some products is stable even when the channel is changed but other products suffer changes in modulation accuracy with channel changes.

![Graph showing EVM vs. Channel (1, 6, 11) for different companies (A, B, C, D, E, F).]

- **Companies B, D, E (1) and F:** Modulation accuracy changes with channel/frequency. There are two groups: one group with degraded modulation accuracy at higher frequencies, and a second group with degraded modulation accuracy at lower frequencies.
- **Companies A (1), A (2), C, and E (2):** Modulation accuracy is stable (2% to 3% change) and does not drop with channel/frequency, supporting excellent transmitter characteristics.

Transmitter Performance Summary

Some products experience changes in modulation accuracy with changes in product orientation, transmission rate/modulation method, and channel/frequency. The examples in this document help clarify the excellent transmitter characteristics of products from Companies A (1) and A (2), and C.
Conclusion

Benchmark tests are important not only for comparison with other manufacturers’ products but also for in-house evaluations of old and new models, comparison at different design stages, comparison between different production lots, etc., to quantitatively evaluate the transmitter and receiver performance of finished products with high reproducibility. These types of evaluations reduce the risks of WLAN performance problems, such as poor and dropped connections, as well as low connection speeds, helping reduce negative effects on sales, service, and brand image.

Receiver Characteristics Benchmark Example

It is important to confirm the receiver characteristics of finished products with built in WLAN modules. This example confirms differences in receiver sensitivity levels between products.

Receiver Performance Summary

Not only receiver sensitivity level but also increases in error rates (trends) change with product. The example in this document clearly demonstrates the excellent receiver characteristics of products from Companies D and E (1).

Confirming Transmitter and Receiver Performance of Finished Products with Security Functions

Measurements of finished products with Security <MX886200-020  WLAN Security Function>

The MT8862A can connect and perform measurements without disabling the WLAN product security settings.

- WLAN IEEE802.11a/b/g/n/ac (2.4/5-GHz bands) [Access Points/Stations]
- WEP, WPA-Personal, WPA2-Personal
- The MT8862A simulates Access Points (AP) and Stations (STA).

The security function is required in the following evaluation scenarios.

- At final shipping evaluation with security function enabled
- When product can be set to security either as AP or STA and requires evaluation for both security functions

Conclusion

The recommended MT8862A configuration for evaluating the transmitter and receiver performance of previously described conducted WLAN products is listed in the following table.

Ordering Information

The next section introduces a comparison example for the packet error rate (PER\(^4\)) as receiver characteristic.

\(^4\): PER = Packet Error Rate

<table>
<thead>
<tr>
<th>Model</th>
<th>Name</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT8862A</td>
<td>Wireless Connectivity Test Set</td>
<td>Main Unit</td>
</tr>
<tr>
<td>MT8862A-001</td>
<td>RF Frequency 2.4 GHz, 5 GHz(^5)</td>
<td>Required Option</td>
</tr>
<tr>
<td>MX886200A</td>
<td>WLAN Measurement Software(^6)</td>
<td>Software for IEEE 802.11b/g/a/n TRx evaluation</td>
</tr>
<tr>
<td>MX886200A-001</td>
<td>WLAN 802.11ac Option(^7)</td>
<td>Software for IEEE 802.11ac TRx evaluation</td>
</tr>
<tr>
<td>MX886200A-020</td>
<td>WLAN Security Function(^7)</td>
<td>Supports WEP, WPA-Personal, and WPA2-Personal</td>
</tr>
</tbody>
</table>

\(^5\) Requires MT8862A; \(^6\) Requires MT8862A-001; \(^7\) Requires MX886200A

Company B: This product suffers errors at a higher level than other companies’ products and has poor receiver performance. In other words, it has a narrow range in which it can receive, which probably causes longer communications times.

Companies D and E (1): These companies’ products can receive at lower levels than other companies. In particular, Company D has the most excellent receiver performance since its product can receive at lower levels than levels where Company E starts to occur errors.