

# WLAN 11ax 信令测试指南 v3.0

此版本适用于 CMW500/270 BASE FW  $\geq$  3.7.150, WLAN FW  $\geq$  3.7.70;

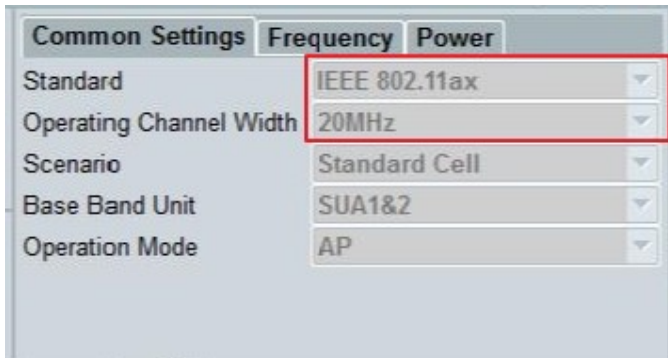
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# 1 信令连接

## 1.1 信令连接主要步骤

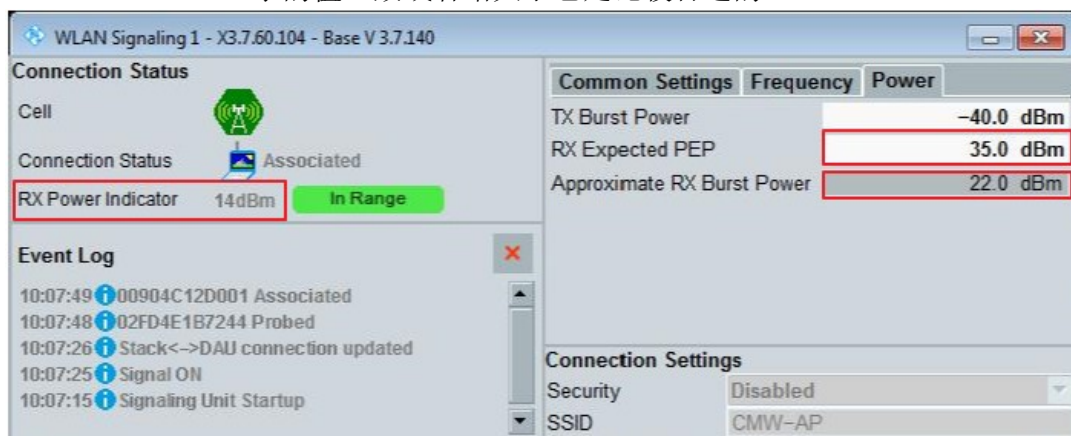
1. 按复位键“RESET”，选择 Global(all Instruments)，点击“Preset”。
2. 按 SIGNAL GEN 键后，选择 WLAN Signaling。
3. 在信令界面 Common Setting 下选择 Standard “IEEE 802.11ax”，在 Operating Chanel Width 下选择需要测试的带宽 20/40/80/160MHz（本文以 20Mhz 为例）。



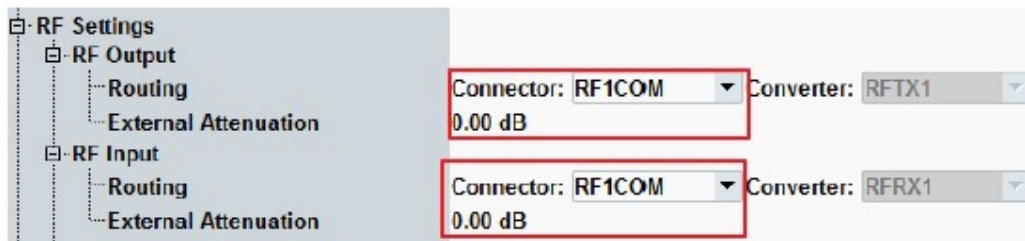
4. 在 Frequency 下选择 Center Frequency/Chanel 中心频率或者信道（本文以 36 信道为例）。



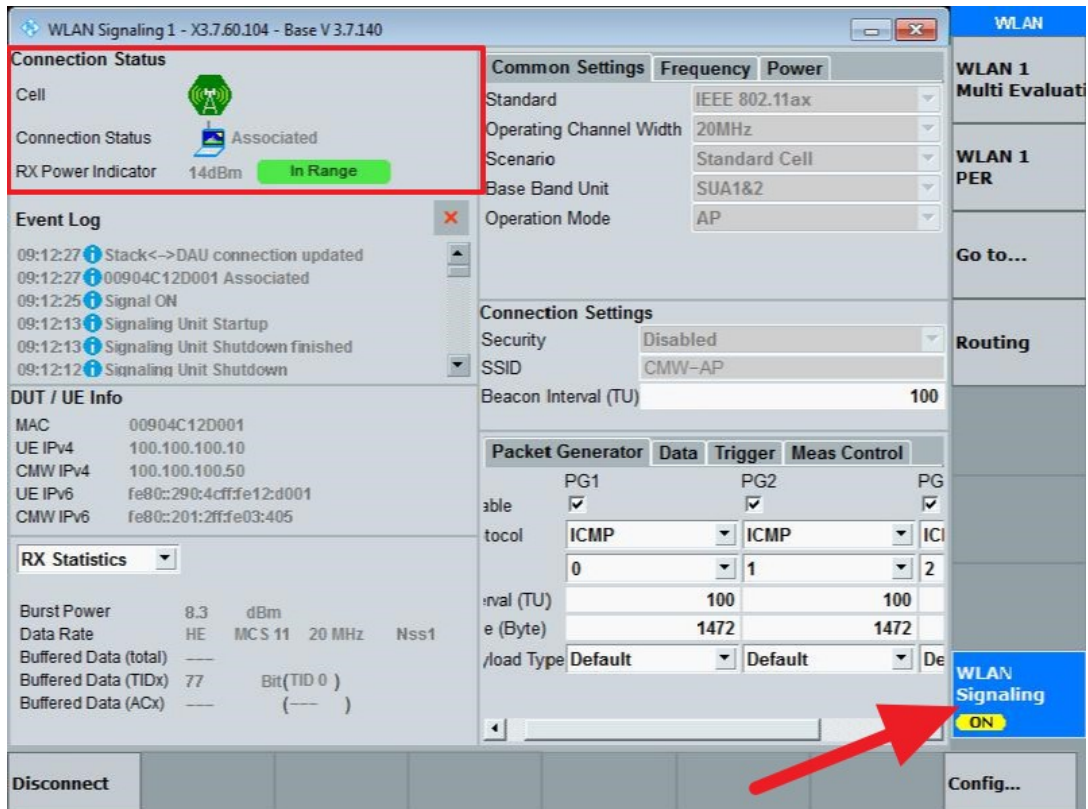
5. 在 Power 下设置合适的 Rx Expected PEP，一般传导下设置 30dbm，设置原则是调整 Rx Expected PEP 使 Approximate RX Burst Power 与左侧 RX Power Indicator 显示的值一致或者略大于它是比较合适的。



6. "Config" hotkey > "RF Settings" 下设置 RF 端口和 External Attenuation 外置线损。



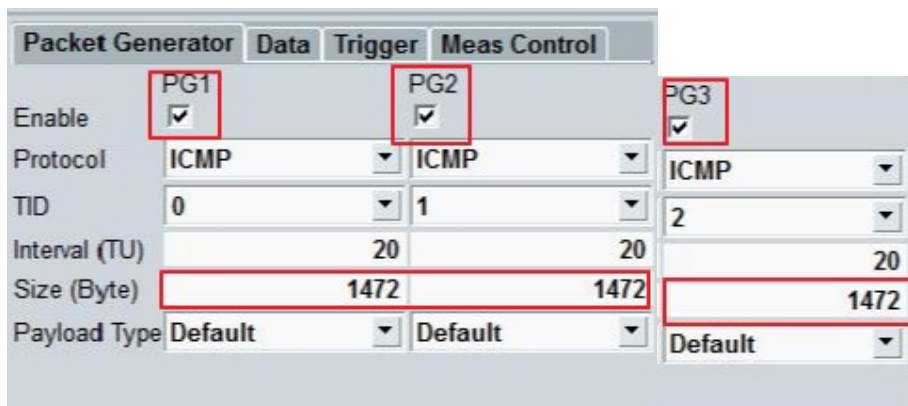
7. 打开 WLAN signaling -> ON, Connection Status 变为 Associated 后意味着连接成功。



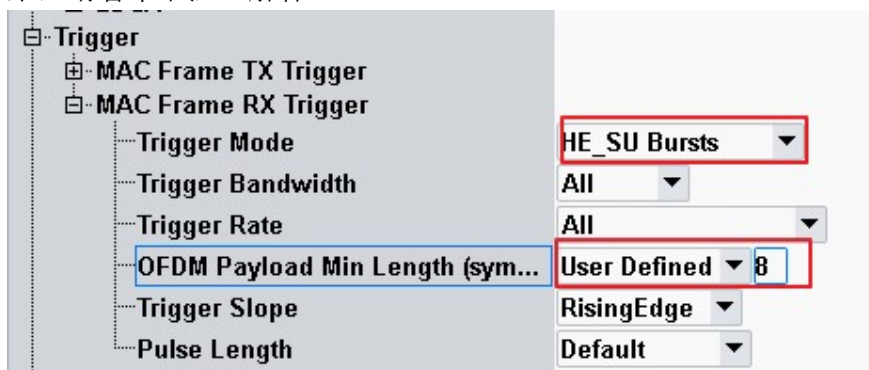
## 2 发射机测试

### 2.1 HE\_SU PDU 发射机测试

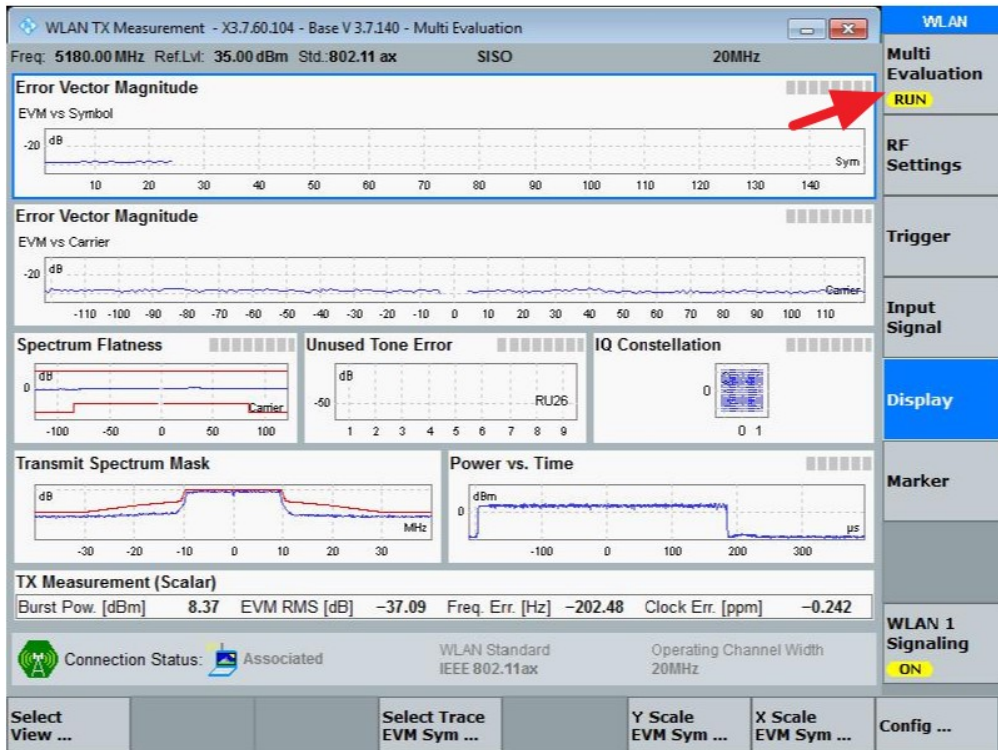
1. 在做发射机测试之前先把 PG1/2/3 都 勾上，Payload Size(Byte) 设置成最大 1472。



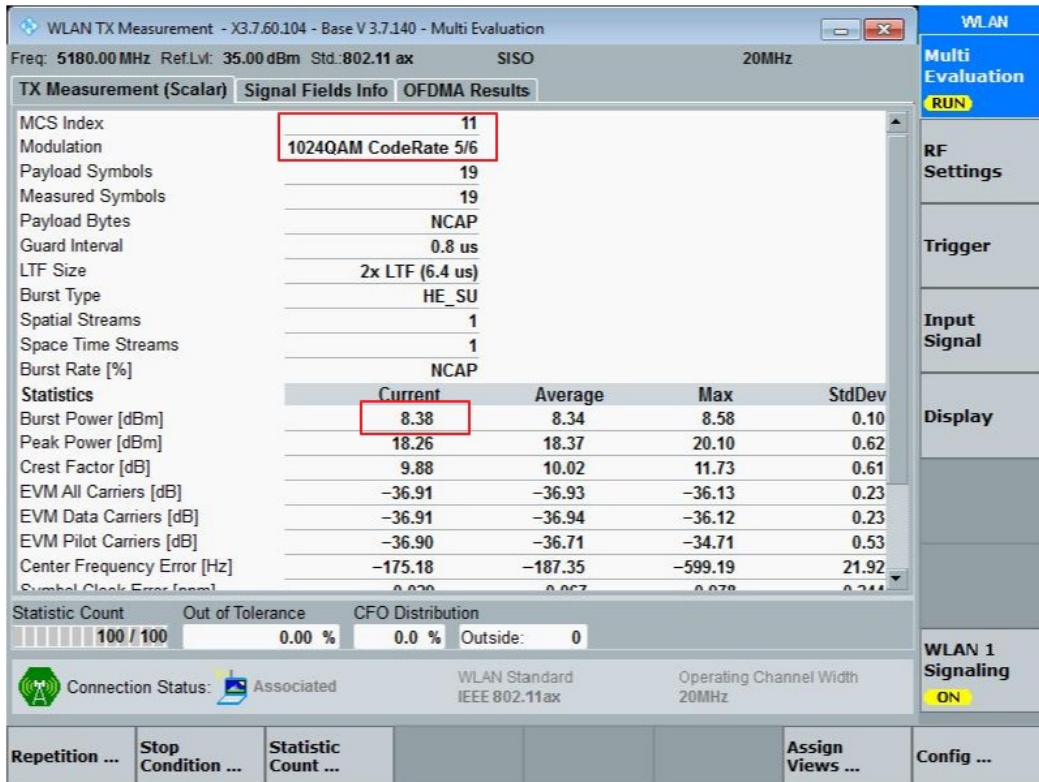
2. 按信令界面 config 进入 Trigger 设置 MAC Frame RX Trigger，选择 Trigger Mode → HE\_SU Bursts，设置对应的带宽和速率（也可以选择 ALL），设置 Min Length symbol 为 User Defined = 16（20MHz BW），如果测试大带宽 80/160 MHz BW 可以适当减少 min symbol length = 8 or 4 or 1；（此时可能测试界面会显示 payload symbol 小于 16 的情况，但实际上不影响射频测试结果，请看本节注 1 解释）



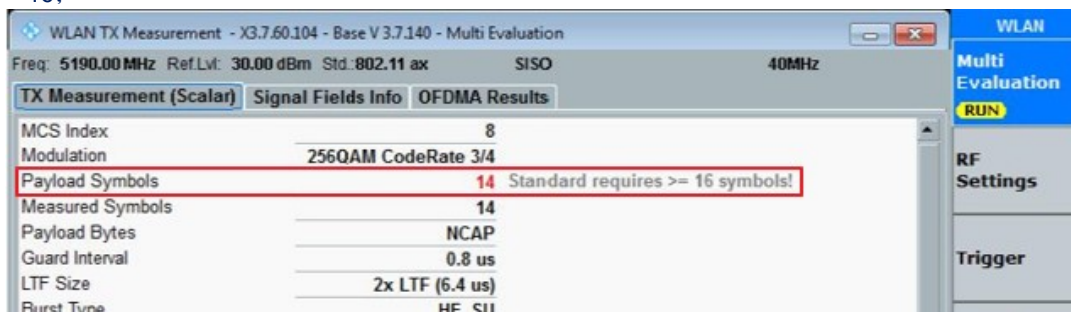
- 按信令界面右上角 WLAN 1 Multi Evaluation 进入测量界面，打开测量 Multi Evaluation ON。若测量无信号，请检查 Trigger 和 input signaling 是否正确。



- 可以通过 Display 按键选择 TX 具体测项，也可以直接双击进入每个测项的详细界面，如下图进入 TX Measurement 可以看到当前测试的 Burst Power, EVM, Frequency error, MCS 等。



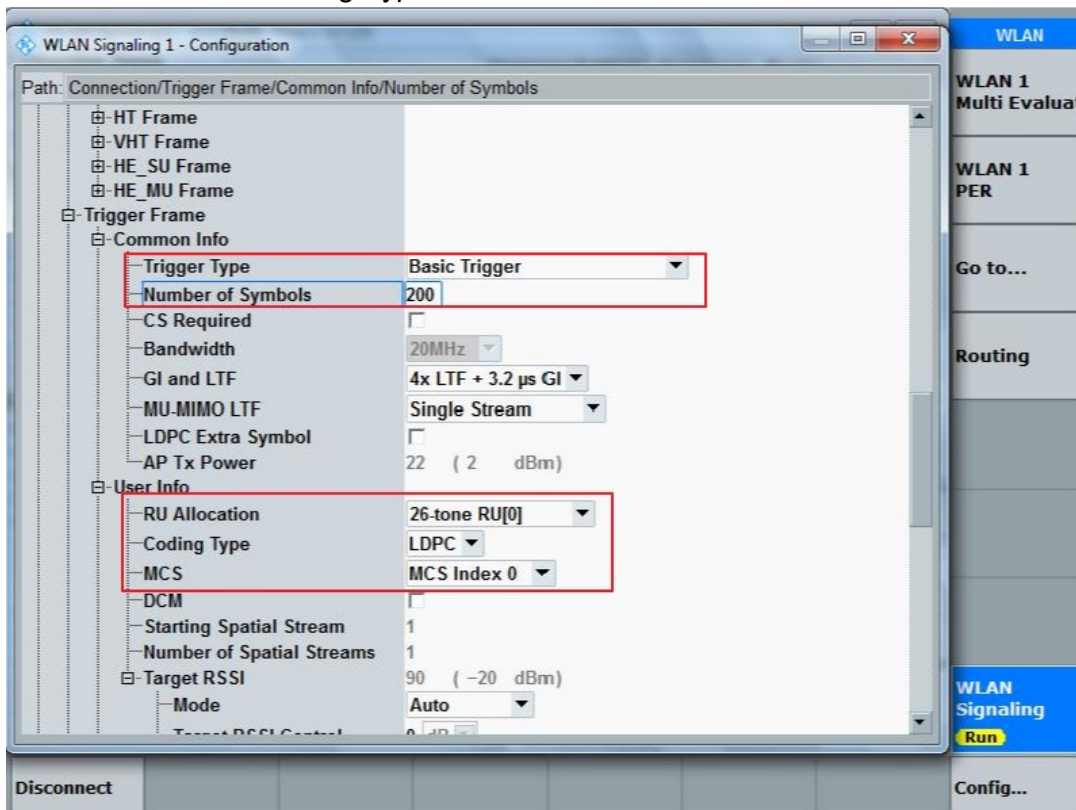
注 1: 当测试 11ac 或者 11ax 的大带宽 40/80/160Mhz 的时候, 有时会出现 Payload Symbol 小于 16 的情况, 这是因为大带宽高调制方式下, ICMP payload 最大为 1472 Bytes, 此时传这么多数据所用 symbol 数理论上就小于 16 个, 而且也没法再通过增加 payload size 来增加 symbol 数, 因此 CMW 设计了三个 PG 来尽可能快尽可能多的发 ICMP PING 包给 UE, 就像本节步骤 1 那样设置将三个 PG enable, payload size 都设置为最大 1472 Bytes, 减少三个 PG 发包间隔 Time Interval (TU) 比如都设置成 10, 如果还不满足大于 16symbol, 将 TU 设置成 0, 这时候 CMW 连续不断的发 PING 包, 只要 DUT 有足够的处理能力, 它会以同样的速率回包给 CMW。但此时不建议三个 PG TU 同时设置成 0, 用其中一个 PG 即可, 举例 PG1 enable, TU=0, Payload size = 1472, RX Frame Trigger 下 OFDM payload mini length = 16;



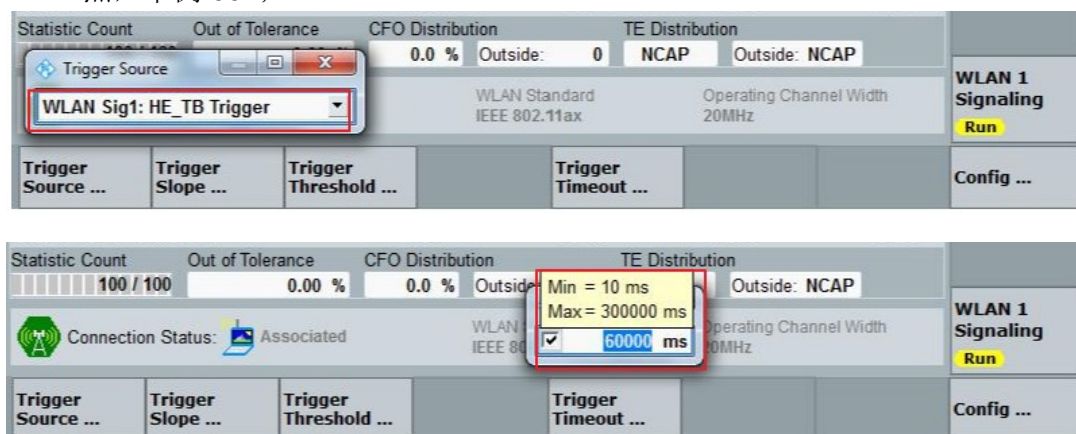
注 2: 有时候 EVM 测试结果差, 怎么调试 DUT 都无法改善, 可以尝试在测量界面的 Config > Modulation > Channel Estimation > payload, 据经验, 用 payload 做信道估计会比 preamble 测 EVM 好 2-3dB。IEEE 802.11 规定是用 Preamble 来做信道估计, 所以尽量还是用 preamble 来调试。

## 2.2 HE\_TB PDU 发射机测试

1. 设置 Trigger Frame, Trigger Type 为 Basic Trigger, Number of Symbols, Ru Allocation, Coding Type, MCS 等内容 (根据需要选择对应的参数);

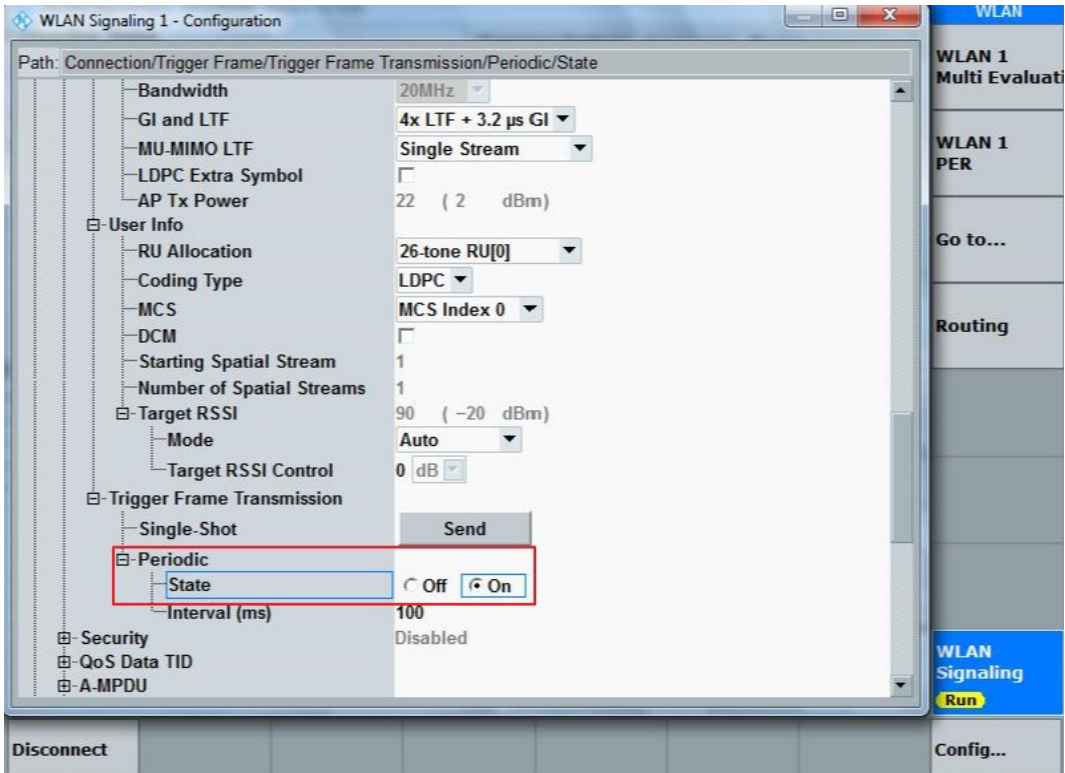


2. 在测量界面下设置 Trigger Source 为 HE\_TB Trigger, Trigger Timeout 设置长一点, 举例 60s;

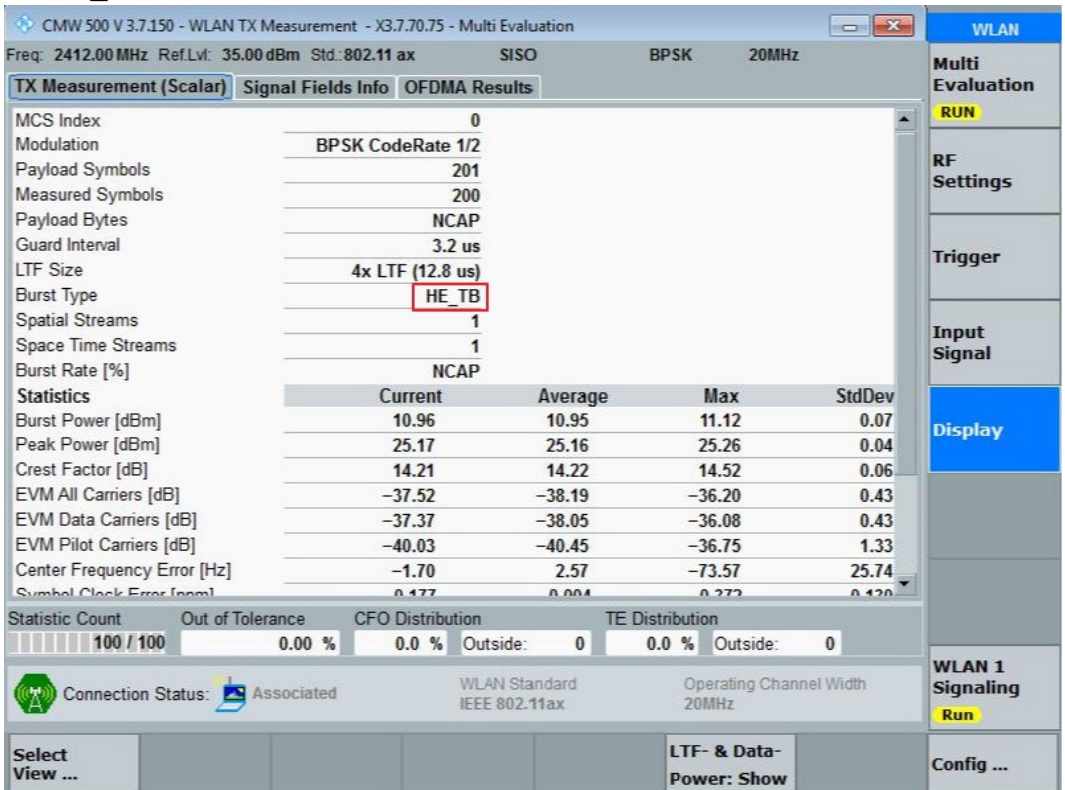




- 在进行测量前需要把 config 下 Trigger Frame Transmission → Periodic state 设置成 on 如下图所示，然后再回到 Multi Evaluation 下打开测量，当然同样在打开测量前需要把 PG on 先打开；



- HE\_TB PPDU 测试结果如下：



5. HE\_TB 的测试因具有 OFDMA 特性，因此多了 RU 的分配，多了 timing error 和 unused tone error，以及 OFDMA results。

CMW 500 V 3.7.150 - WLAN TX Measurement - X3.7.70.75 - Multi Evaluation

Freq: 2412.00 MHz Ref.Lvl: 35.00 dBm Std.:802.11 ax SISO BPSK 20MHz

TX Measurement (Scalar) Signal Fields Info OFDMA Results

Guard Interval: 3.2 µs  
LTF Size: 4x LTF (12.8 µs)  
Burst Type: HE\_TB  
Spatial Streams: 1  
Space Time Streams: 1  
Burst Rate [%]: NCAP

Statistics	Current	Average	Max	StdDev
Burst Power [dBm]	10.86	10.95	11.12	0.07
Peak Power [dBm]	25.17	25.16	25.26	0.04
Crest Factor [dB]	14.30	14.21	14.52	0.05
EVM All Carriers [dB]	-38.44	-38.17	-35.51	0.48
EVM Data Carriers [dB]	-38.32	-38.03	-35.40	0.48
EVM Pilot Carriers [dB]	-40.09	-40.33	-36.75	1.31
Center Frequency Error [Hz]	29.08	4.84	-73.57	25.72
Symbol Clock Error [ppm]	0.179	0.001	-0.372	0.127
Timing Error [µs]	0.237	0.232	0.287	0.030
IQ Offset [dB]	-61.60	-60.69	-58.05	1.32
DC Power [dBm]	-50.73	-49.75	-47.10	1.32
Gain Imbalance [dB]	NCAP	NCAP	NCAP	NCAP
Quadrature Error [°]	NCAP	NCAP	NCAP	NCAP

Statistic Count: 100 / 100 Out of Tolerance: 0.00 % CFO Distribution: 0.0 % Outside: 0 TE Distribution: 0.0 % Outside: 0

Connection Status: Associated WLAN Standard: IEEE 802.11ax Operating Channel Width: 20MHz

Select View ... LTF- & Data-Power: Show

CMW 500 V 3.7.150 - WLAN TX Measurement - X3.7.70.75 - Multi Evaluation

Freq: 2412.00 MHz Ref.Lvl: 35.00 dBm Std.:802.11 ax SISO BPSK 20MHz

Unused Tone Error

dB

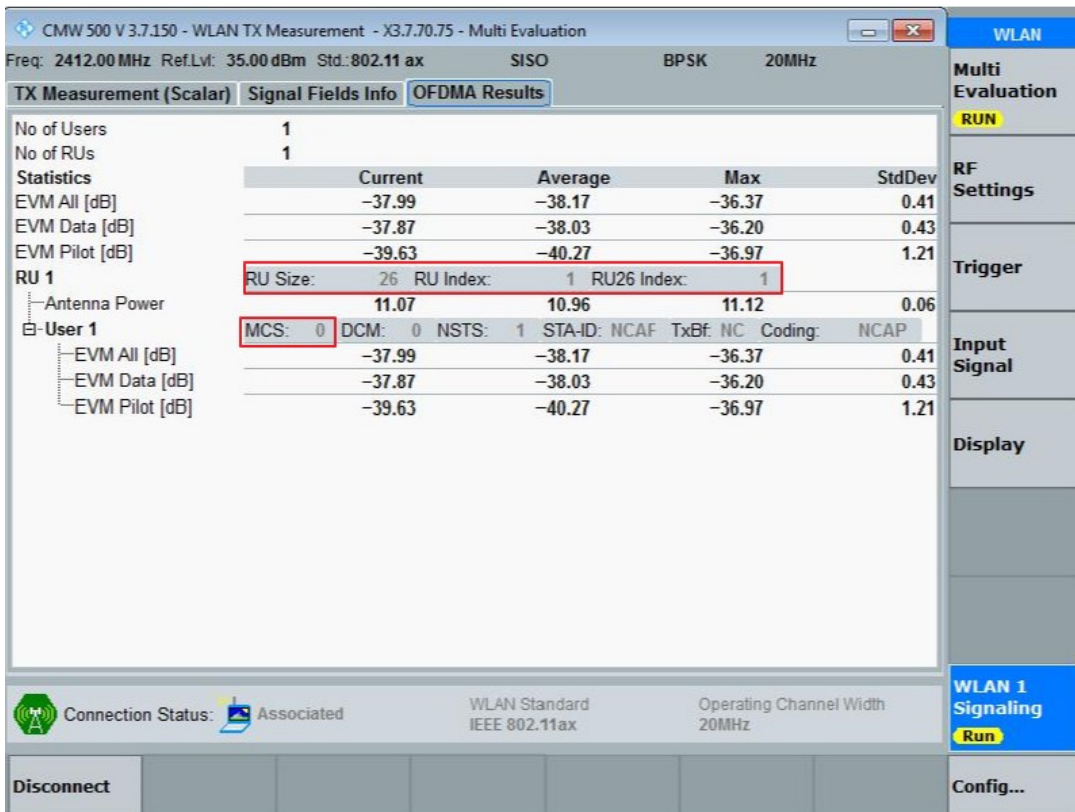
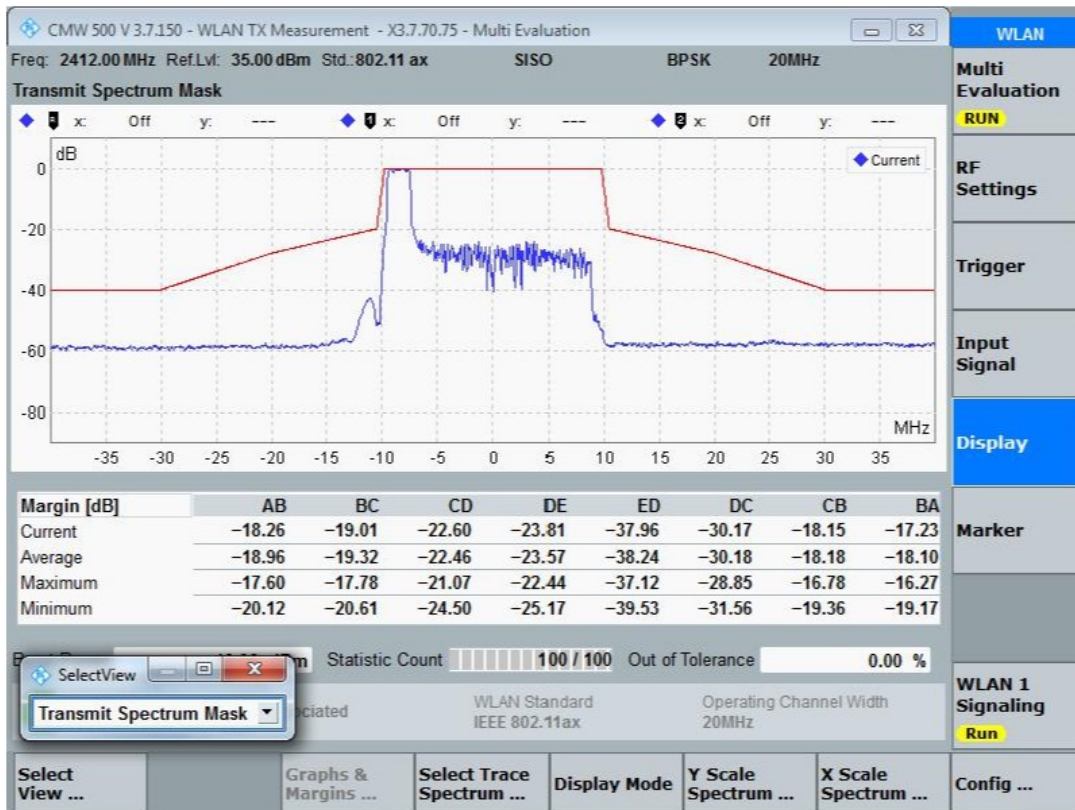
1 2 3 4 5 6 7 8 9

	Margin [dB]			Unused Tone Error [dB]		
	Current	Average	Maximum	Current	Average	Maximum
RU26 02	-37.4	-36.2	-35.2	-52.4	-51.2	-50.2
RU26 03	-31.2	-30.7	-30.2	-56.2	-55.7	-55.2
RU26 04	-21.8	-21.7	-21.3	-56.8	-56.7	-56.3
RU26 05	-22.2	-22.1	-21.7	-57.2	-57.1	-56.7
RU26 06	-22.6	-22.5	-22.2	-57.6	-57.5	-57.2
RU26 07	-22.5	-22.6	-22.2	-57.5	-57.6	-57.2
RU26 08	-22.5	-22.6	-22.3	-57.5	-57.6	-57.3
	-18.6	-18.6	-18.3	-53.5	-53.6	-53.3

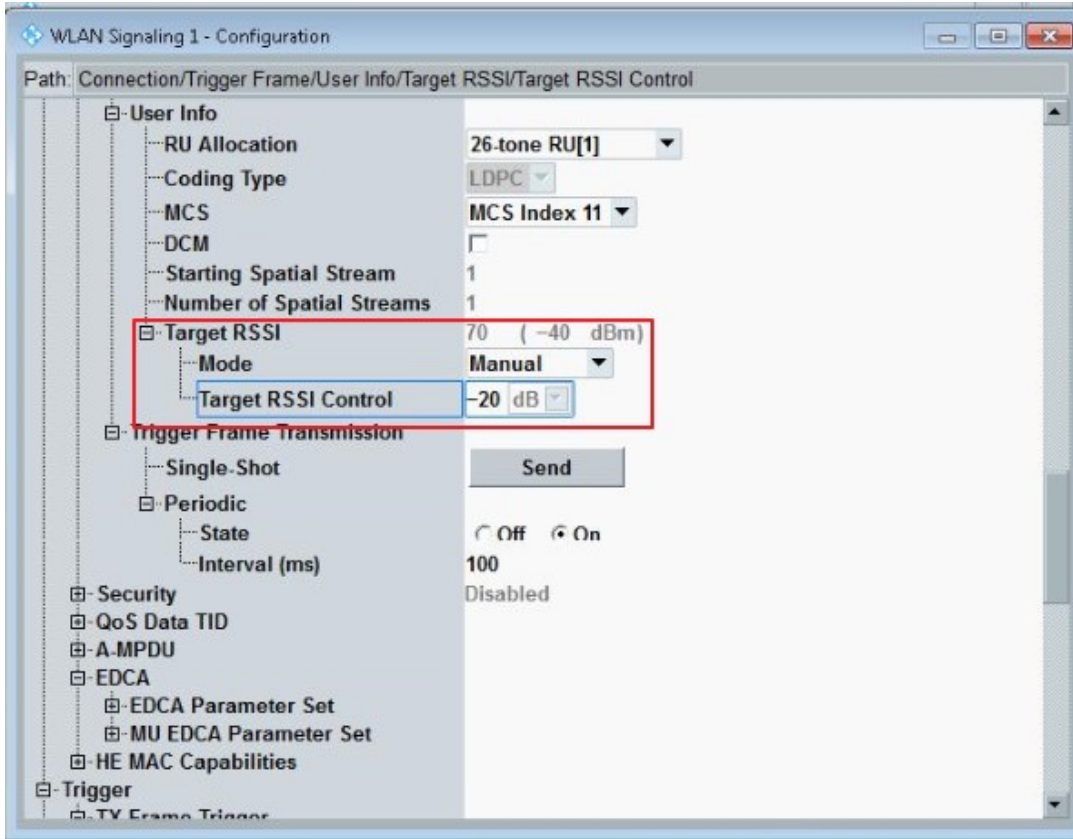
SelectView Unused Tone Error

WLAN Standard: IEEE 802.11ax Operating Channel Width: 20MHz

Select View ... Select Trace UTE ... Y Scale UTE ... X Scale UTE ...



6. 功率控制，11ax 通过 Target RSSI 来做功率控制，Mode 可以选择 Auto，Manual，max power 三种，如果选择 Manual 可以调整 Target RSSI Control 来调节 station 的发送功率，功率测量结果变化可在 TX measurement 下查看。



注 1：针对功率控制规范解释如下

### 27.3.15.2 Power pre-correction

Each STA that is scheduled in a triggering frame calculates the UL transmit power,  $T_{X_{PWR}}^{STA}$ , of the HE TB PPDU for the assigned HE-MCS using Equation (27-124).

$$T_{X_{PWR}}^{STA} = PL_{DL} + Target_{RSSI} \quad (27-124)$$

where

$PL_{DL}$  represents DL pathloss

$Target_{RSSI}$  represents the target receive signal power of the HE TB PPDU averaged over the AP's antenna connectors.  $Target_{RSSI}$  is the value, in dBm, indicated in the UL Target RSSI subfield of User Info field in Trigger frame or the TRS control field.

NOTE—A value of 127 in the UL Target RSSI subfield indicates that the HE TB PPDU is transmitted at its maximum transmit power for the assigned HE-MCS, and Equation (27-124) is not used.

Each STA computes  $PL_{DL}$  using Equation (27-125).

$$PL_{DL} = T_{X_{PWR}}^{AP} - DL_{RSSI} \quad (27-125)$$

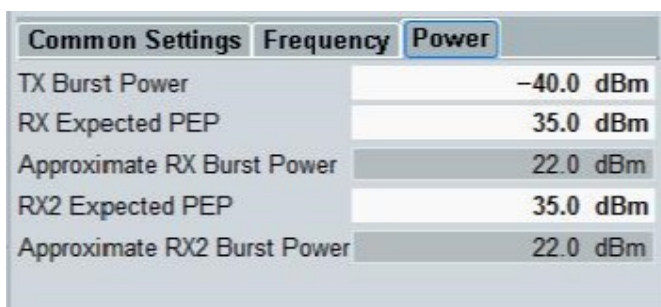
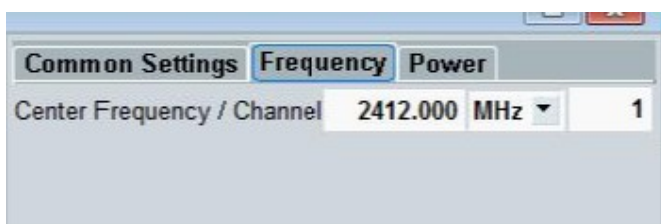
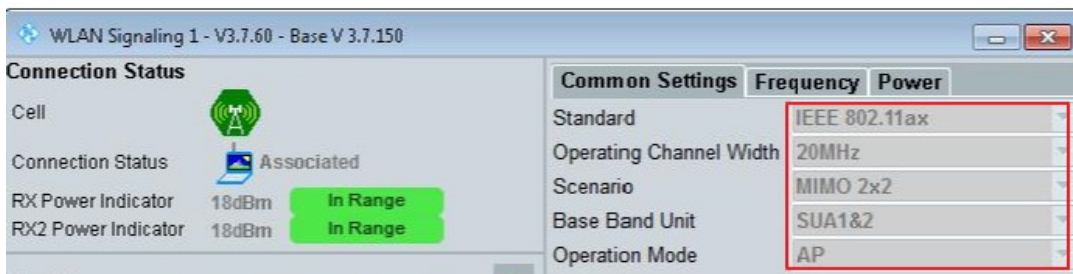
where

$T_{X_{PWR}}^{AP}$  is in dBm and represents the AP's transmission power and is equal to the value of the AP Tx Power subfield of the Common Info field in the Trigger frame, the encoding of which is specified in 9.3.1.22 (Trigger frame format) or the DL Tx Power subfield of the TRS Control field as specified in 9.2.4.6a.1 (TRS Control).

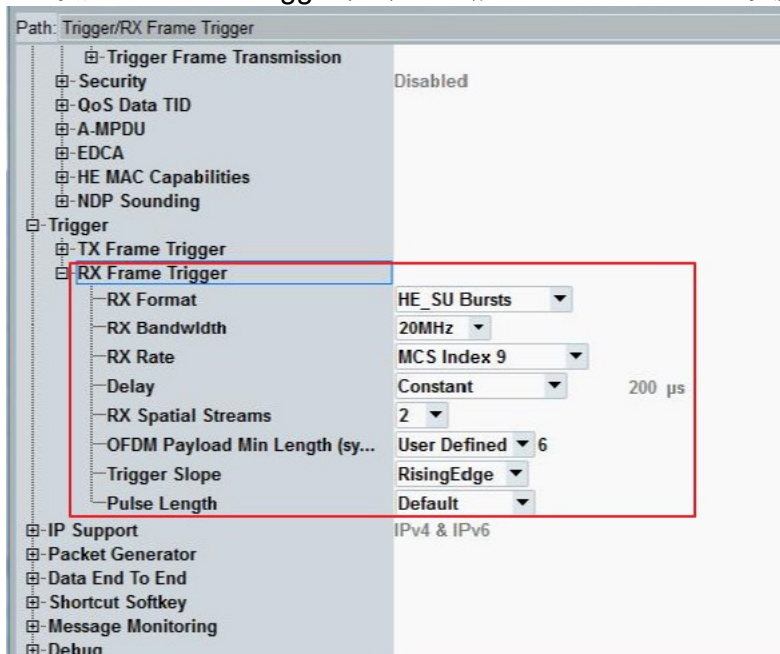
$DL_{RSSI}$  represents the RSSI at the antenna connector(s) of the STA of the triggering PPDU normalized to 20 MHz bandwidth.  $DL_{RSSI}$  in dBm is an average of the received power over the antennas on which the average  $PL_{DL}$  is being computed. If the triggering PPDU is a HT-mixed, VHT or HE PPDU, then the received power is measured from the fields prior to the HT-STF, VHT-STF or HE-STF, respectively.

## 2.3 信令 True MIMO 发射机测试

1. 基本信令设置，选择 2x2 MIMO 场景，设置频点和期望功率，设置原则跟 SISO 下一样；



2. 设置 RX frame trigger 如下，包括 RX format, MCS 以及空间流为 2；



3. 同样在测 TX 前将 PG ON 打开，测试结果如下，可以看到两路 TX 的 EVM, power 等结果。

WLAN TX Measurement - V3.7.60 - Base V 3.7.150 - Multi Evaluation

Freq: 2412.00 MHz Std.: 802.11 ax True MIMO 20MHz

TX Measurement (Scalar) Signal Fields Info OFDMA Results

Spatial Streams	2			
Space Time	2			
Data Symbols	12			
Statistics				
	Current	Average	Max	StdDev
EVM All [dB]	-37.85	-37.48	-35.92	0.46
EVM Data [dB]	-37.87	-37.47	-35.87	0.47
EVM Pilot [dB]	-37.44	-37.85	-36.73	0.42
Power Total [dBm]	19.08	19.03	19.14	0.04
Symbol Clock Error [ppm]	-3.244	-3.101	-3.788	0.241
Center Frequency Error [Hz]	-14792.17	-14969.41	-15896.59	425.49
Streams				
EVM All 1 [dB]	-37.58	-37.37	-35.46	0.51
EVM All 2 [dB]	-38.14	-37.60	-35.19	0.65
EVM Data 1 [dB]	-37.61	-37.36	-35.43	0.52
EVM Data 2 [dB]	-38.15	-37.58	-35.10	0.66
EVM Pilot 1 [dB]	-36.93	-37.52	-35.86	0.56
EVM Pilot 2 [dB]	-38.02	-38.21	-36.49	0.60
Antenna				
Burst Power 1 [dBm]	16.18	16.18	16.29	0.05

WLAN TX Measurement - V3.7.60 - Base V 3.7.150 - Multi Evaluation

Freq: 2412.00 MHz Std.: 802.11 ax True MIMO 20MHz

TX Measurement (Scalar) Signal Fields Info OFDMA Results

EVM All 2 [dB]	-37.58	-37.37	-35.46	0.51
EVM Data 1 [dB]	-35.26	-37.30	-34.96	0.59
EVM Data 2 [dB]	-37.64	-37.56	-35.10	0.65
EVM Pilot 1 [dB]	-37.65	-37.55	-35.86	0.55
EVM Pilot 2 [dB]	-38.86	-38.21	-36.49	0.60
Antenna				
Burst Power 1 [dBm]	16.15	16.18	16.29	0.05
Burst Power 2 [dBm]	15.90	15.85	16.03	0.05
Peak Power 1 [dBm]	25.74	25.67	26.68	0.36
Peak Power 2 [dBm]	25.32	25.30	26.47	0.39
Crest Factor 1 [dB]	9.59	9.49	10.51	0.35
Crest Factor 2 [dB]	9.42	9.45	10.61	0.38
IQ Offset 1 [dB]	-42.79	-42.98	-42.05	0.35
IQ Offset 2 [dB]	-46.17	-46.53	-44.71	0.69
DC Power 1 [dBm]	-26.63	-26.80	-25.88	0.36
DC Power 2 [dBm]	-30.27	-30.67	-28.94	0.69
Gain Imbalance 1 [dB]	0.00	0.00	-0.01	0.00
Gain Imbalance 2 [dB]	0.02	0.01	0.03	0.00
Quad. Error 1 [°]	0.41	0.38	0.46	0.03
Quad. Error 2 [°]	0.04	0.07	0.19	0.03

注 1: 此设置方法同样适合 11n 和 11ac 信令 true MIMO 测试;

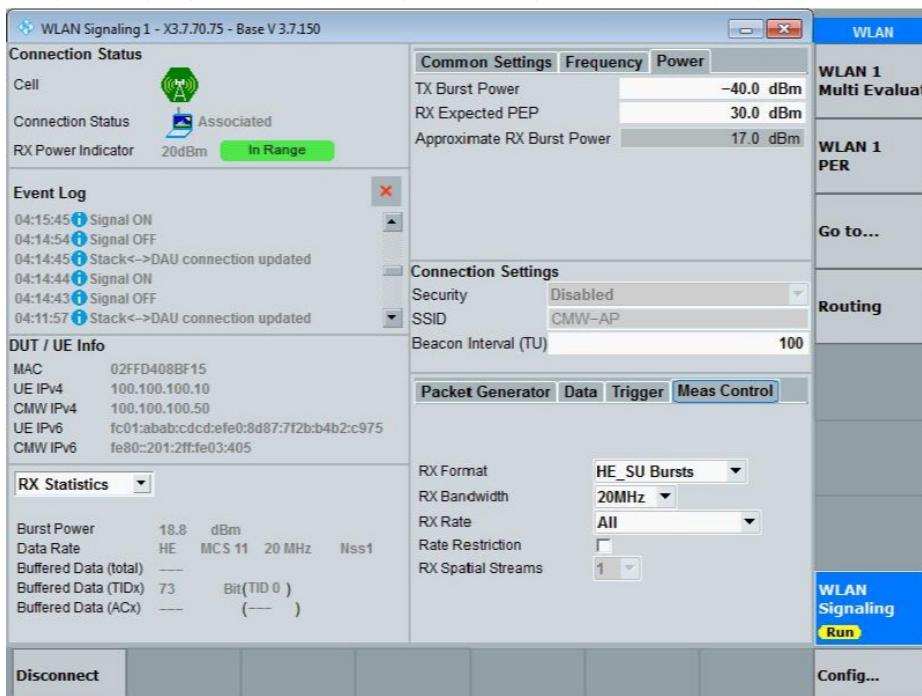
注 2: 硬件需要 1\*SUA(H500I)+2\*H570H+1\*MUA

注 3: 软件需要 KM654+KS657+KS670

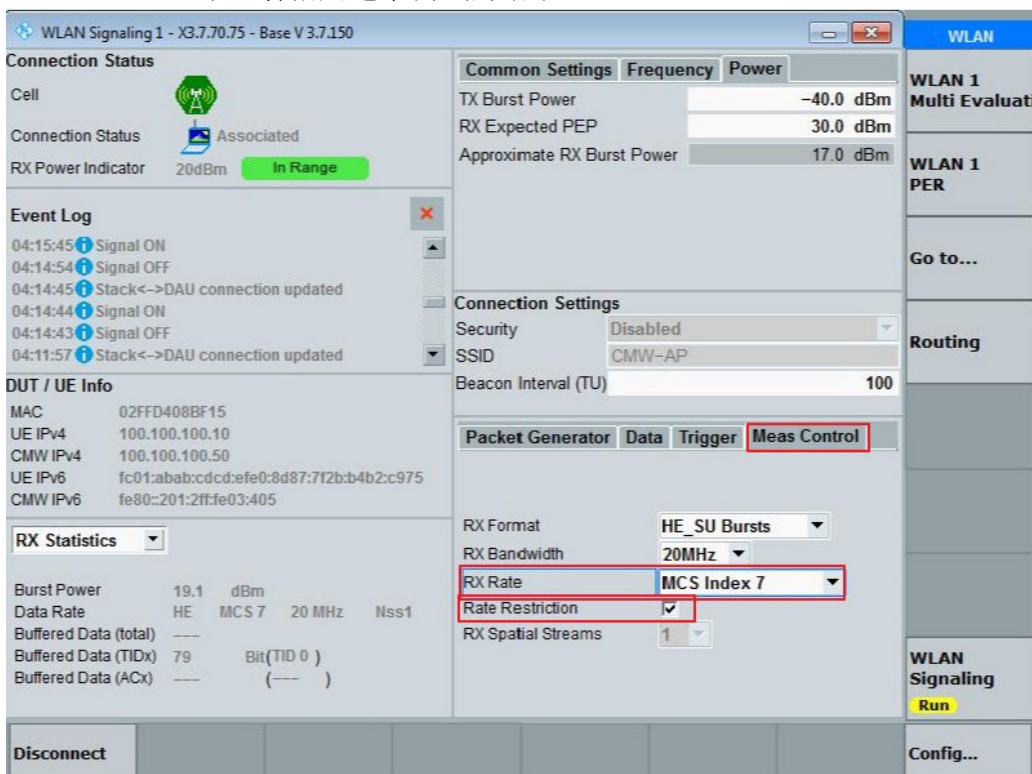
注 4: 11ax MU\_MIMO 需要 KS671

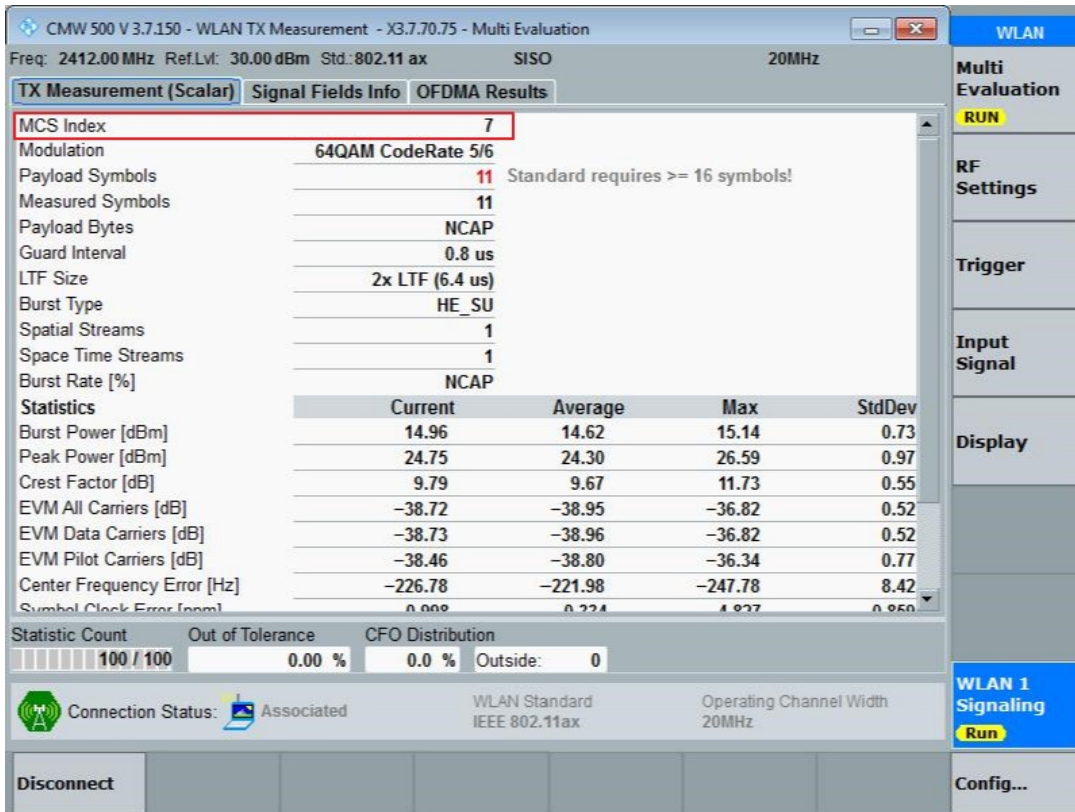
## 2.4 Rate Restriction 测试（指定速率测试）

1. 按常规信令连接的方法，将 11ax 速率自然协商到最高 MCS。



2. 在 Meas Control 下勾选 Rate Restriction，然后改变 RX Rate，然后再从 Multi Evaluation 下查看指定速率测试的结果。



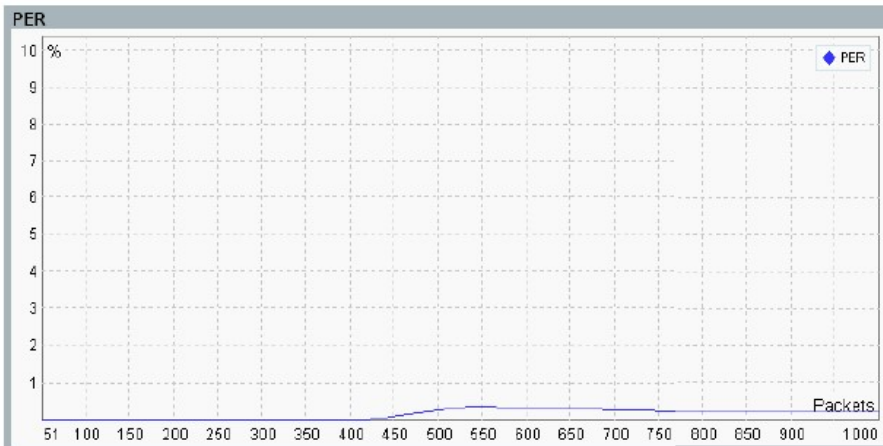


注 1: 此速率控制方法仅适用于 11ac 和 11ax, 无需重新信令断开在连接, 可以直接切 MCS 速率, 11a/b/g/n 还是原有的 support rate 下控制;

注 2: 因 UE 芯片平台众多, 每家平台的做法不尽一样, 因此 rate restriction 有一定的兼容适配性。

### 3 接收机测试

11ax 接收机测试与 11a/b/g/n/ac 测试方法一致, 进入 RX measurement, 设置 TX Burst Power Level (DL power), 在 PER setting 下面设置 GI, MCS, Coding type 和 Data Packets 个数, 打开 PER > ON, 读取 PER 结果。





具体设置要求和最小灵敏度指标见下图规范说明：

The requirements on receiver minimum input sensitivity in 27.3.20.2 (Receiver minimum input sensitivity), adjacent channel rejection in 27.3.20.3 (Adjacent channel rejection) and nonadjacent channel rejection in 27.3.20.4 (Nonadjacent channel rejection) apply to PPDU that meet all the following conditions:

- STBC is not used
- 0.8  $\mu$ s GI is used
- If the PPDU bandwidth is 20 MHz and the HE-MCS is less than 10, then BCC is used. Otherwise, LDPC is used.
- The PPDU is an HE SU PPDU

The packet error rate (PER) shall be less than 10% for a PSDU with the rate-dependent input levels listed in Table 27-51 (Receiver minimum input level sensitivity). The PSDU length shall be 2048 octets for BPSK modulation with DCM or 4096 octets for all other modulations.

Table 27-51—Receiver minimum input level sensitivity

Modulation		Rate (R)	Minimum sensitivity (20 MHz PPDU) (dBm)	Minimum sensitivity (40 MHz PPDU) (dBm)	Minimum sensitivity (80 MHz PPDU) (dBm)	Minimum sensitivity (160 MHz or 80+80 MHz PPDU) (dBm)
Without DCM	With DCM					
N/A	BPSK	1/2	-82	-79	-76	-73
BPSK	QPSK	1/2	-82	-79	-76	-73
QPSK	16-QAM	1/2	-79	-76	-73	-70
QPSK	16-QAM	3/4	-77	-74	-71	-68
16-QAM	N/A	1/2	-74	-71	-68	-65
16-QAM	N/A	3/4	-70	-67	-64	-61
64-QAM	N/A	2/3	-66	-63	-60	-57
64-QAM	N/A	3/4	-65	-62	-59	-56
64-QAM	N/A	5/6	-64	-61	-58	-55
256-QAM	N/A	3/4	-59	-56	-53	-50
256-QAM	N/A	5/6	-57	-54	-51	-48
1024-QAM	N/A	3/4	-54	-51	-48	-45
1024-QAM	N/A	5/6	-52	-49	-46	-43

详细步骤请参考：《CMW500 操作快速入门：WLAN 信令测试》

## 4 小结

本文主要介绍了 WLAN 11ax (WIFI 6) station 的信令测试方法，对 11ax 不同于传统技术的测试如 HE\_TB PPDU，信令 True MIMO，指定速率 Rate Restriction 功能等提供了详细的测试步骤，并且注明了测试注意事项。如对本文有任何疑问，请联系 [kai.hu@rohde-schwarz.com](mailto:kai.hu@rohde-schwarz.com) 或者当地 R&S 的技术支持。谢谢。