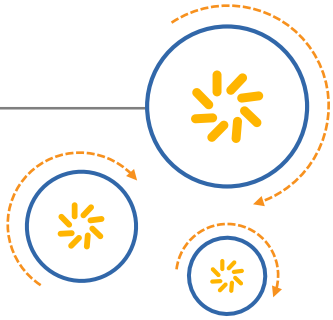
NOTICE REGARDING QUALCOMM ATHEROS, INC.

Effective June 2016, Qualcomm Atheros, Inc. (QCA) transferred certain of its assets, including substantially all of its products and services, to its parent corporation, Qualcomm Technologies, Inc. Qualcomm Technologies, Inc. is a wholly-owned subsidiary of Qualcomm Incorporated. Accordingly, references in this document to Qualcomm Atheros, Inc., Qualcomm Atheros, Atheros, QCA or similar references, should properly reference, and shall be read to reference, Qualcomm Technologies, Inc.

Qualcomm Atheros, Inc.



IPQ4019/IPQ4029 AP.DK04 ETSI Receiver Spurious Emissions Improvements

Application Note

80-Y9700-26 Rev. A

April 28, 2016

Qualcomm Atheros, Inc.
1700 Technology Drive
San Jose, CA 95110
U.S.A.

Revision history

Revision	Date	Description
A	April 2016	Initial release

Contents

1 Overview **4**

2 ETSI Receiver Spurious Emissions **5**

2.1 Definition 5
2.2 Limits 5

3 Test **6**

3.1 Test setup 6
3.2 Measure results 7
3.3 Failure analysis 9
3.4 Improvements 9
3.4.1 Solution 1 9
3.4.2 Solution 2 16

4 Conclusions **20**

Figures

Figure 3-1 Standard EN radiated test chamber 6
Figure 3-2 Receiver setting 7

Tables

Table 2-1 Spurious radiated emission limits 5

1 Overview

Using the measurement of “4.6 Receiver spurious emissions” section in ETSI EN 301 893 V1.8.1, the spur emission level of 3800 MHz will exceed the limitation 1 dB (limit = -46 dBm) and cannot pass the ETSI certification on AP.DK04 board.

To reduce the spur emission level, major improvements on AP.DK04 board come from:

- Adjust the location and shape of thermal pad
- Connect the thermal plate to board’s ground plane with 2 metal screws
- Add shielding case for IPQ4019/IPQ4029 or add absorber (S21>20 dB) on the top of IPQ4019/IPQ4029 chipset.

This document provides the background information on the ETSI receiver spurious emissions, measurement frequencies, compliance limits, test method and the test results achieved with board changes.

2 ETSI Receiver Spurious Emissions

2.1 Definition

In ETSI EN 301 893 V1.8.1 (2015-03), receiver spurious emissions are emissions at any frequency when the equipment is in receive mode.

2.2 Limits

Table 2-1 shows that the spurious emissions of the receiver cannot exceed the limits.

- In case of equipment with antenna connectors, these limits apply to emissions at the antenna port (conducted) and to the emissions radiated by the cabinet.
- In case of integral antenna equipment (without temporary antenna connectors), these limits apply to emissions radiated by the equipment.

Table 2-1 Spurious radiated emission limits

Frequency range	Maximum power	Measurement bandwidth
30 MHz to 1 GHz	-57 dBm	100 kHz
1 GHz to 26 GHz	-47 dBm	1 MHz

3 Test

3.1 Test setup

Figure 3-1 shows the standard EN radiated test chamber.

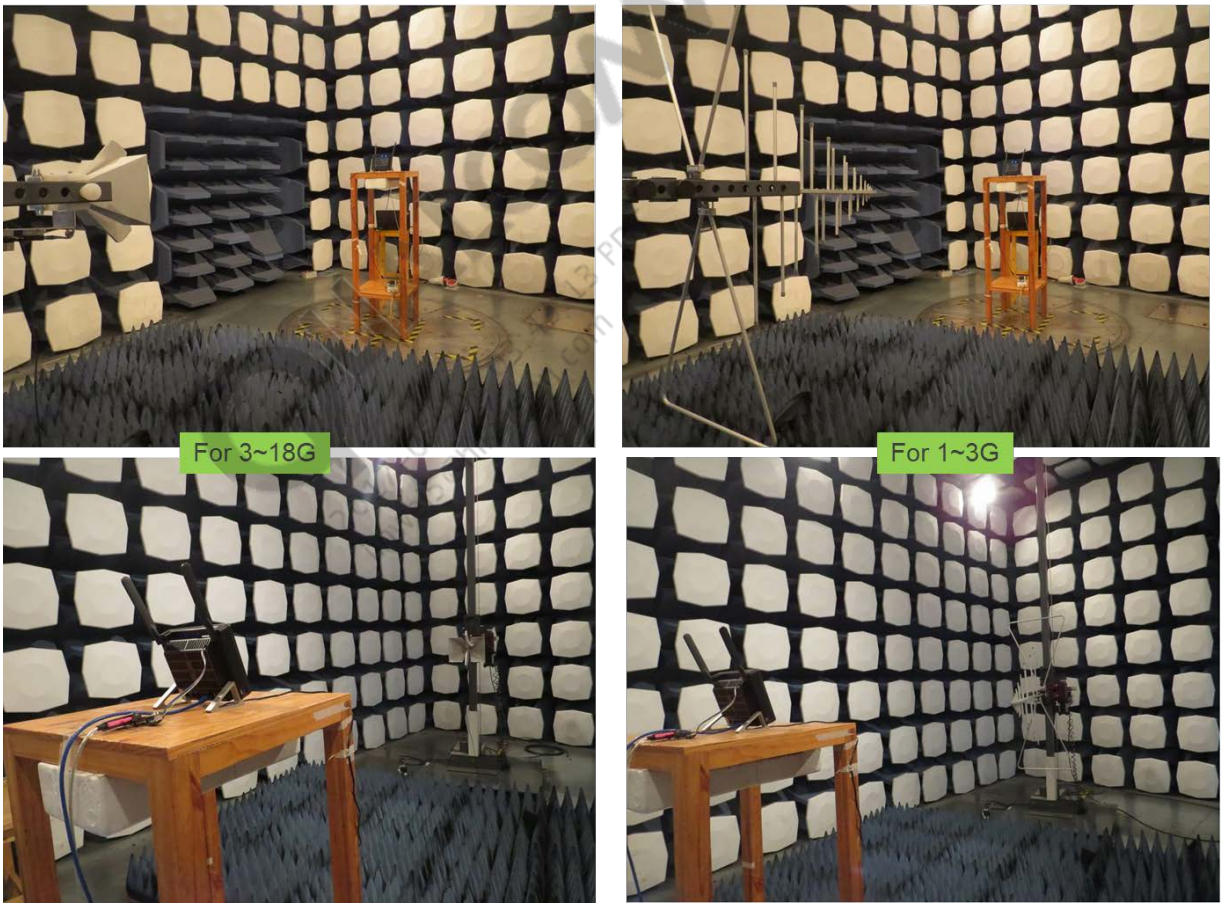


Figure 3-1 Standard EN radiated test chamber

Blackbox is DUT (AP.DK04). QRCT is used to set the receive mode on AP.DK04.

Figure 3-2 shows the QRCT receiver setting.

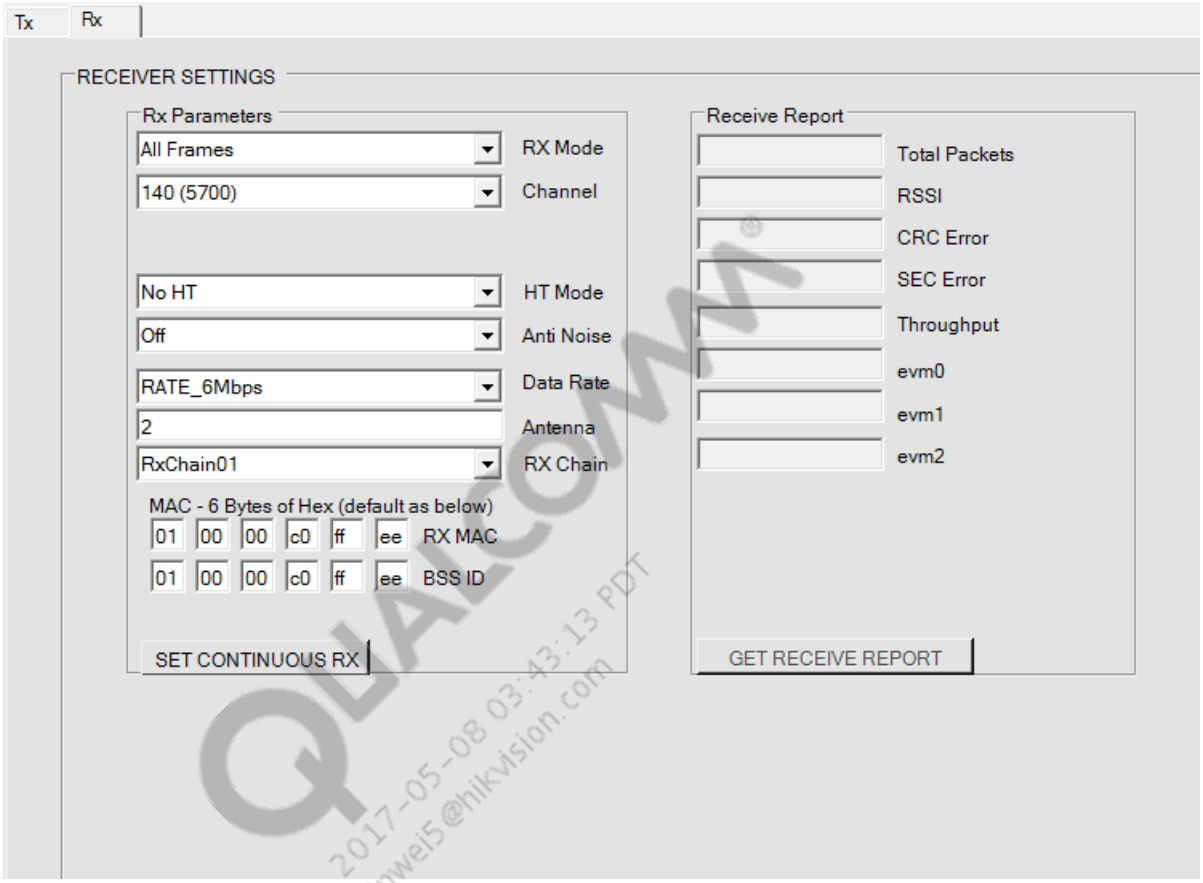
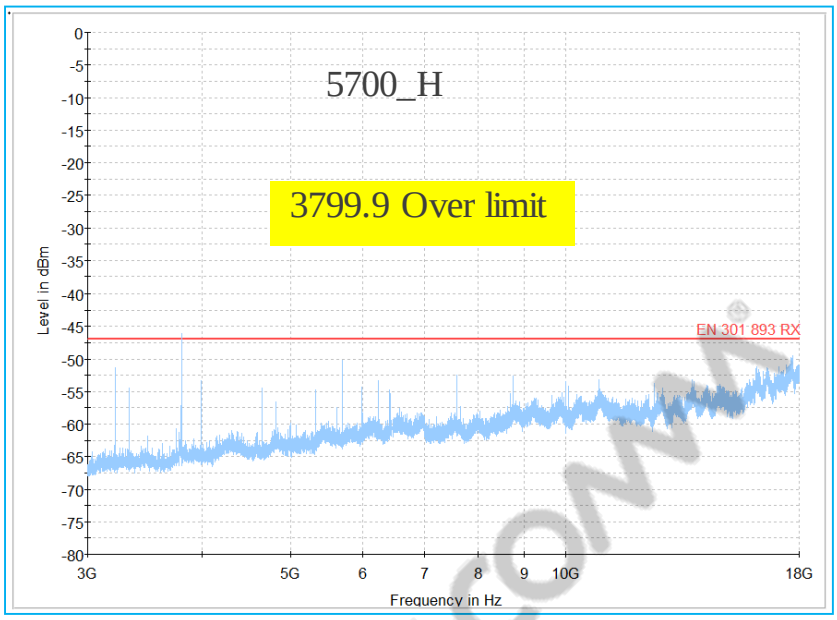


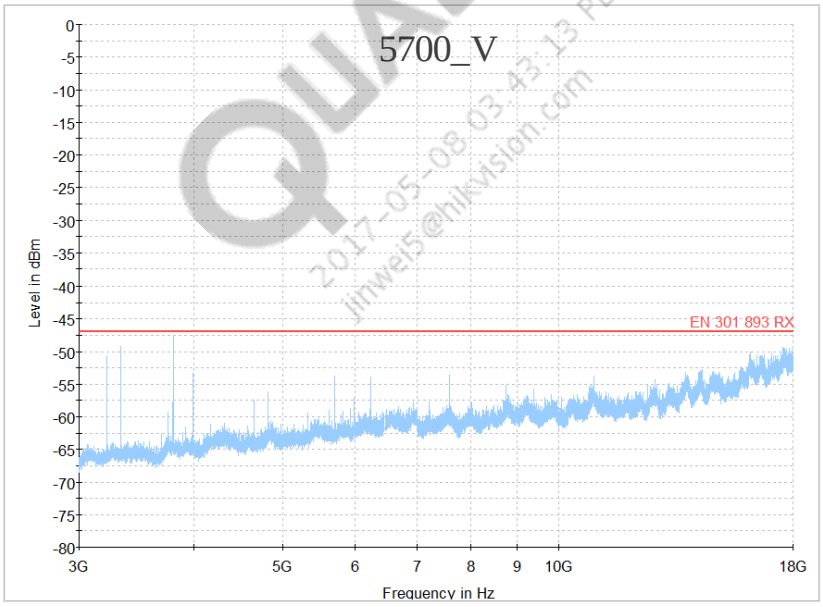
Figure 3-2 Receiver setting

3.2 Measure results

Default measure data on AP.DK04 without board changes.

Test Data File Name	Frequency (MHz)	Peak (dBm)	Margin (dB)	Degree	Pass or fail ETSI?
RSE_AP.DK04_WIFI 5G_5700_IDLE_3-18GHz_V_0414	3799.9	-47.60	0.60	45	Pass
	3330.0	-49.20	2.20	180	Pass
	3215.3	-50.60	3.60	0	Pass
RSE_AP.DK04_WIFI 5G_5700_IDLE_3-18GHz_H_0414	3799.9	-46.00	-1.00	45	Fail
	5700.0	-50.30	3.30	315	Pass
	3214.1	-51.30	4.30	90	Pass





3.3 Failure analysis

Removed heat plate, the spur level at 3800 MHz (as the following tables) can be reduced. All receiver spurious emissions can pass ETSI.

Frequency	Channel 36		Channel 64		Channel 100		Channel 140	
	H	V	H	V	H	V	H	V
3.453 GHz	/	/	—	—	—	—	—	—
6.906 GHz	/	/	—	—	—	—	—	—
3.546 GHz	—	—	/	/	—	—	—	—
7.093 GHz	—	—	/	/	—	—	—	—
3.666 GHz	—	—	—	—	-3.1	-5.19	—	—
7.222 GHz	—	—	—	—	/	/	—	—
3.799 GHz	—	—	—	—	—	—	-13.64	-13
7.599 GHz	—	—	—	—	—	—	/	/

1. No spur at 3.453 GHz, 6.906 GHz, 3.546 GHz, 7.093 GHz, 7.222 GHz and 7.599 GHz.
2. / means tested, but no spur; — means not tested.

The 3.8 GHz emission frequency is from IPQ4019/IPQ4029 chipset which is (2/3)*5700 MHz. Potential emission frequencies from Qualcomm Atheros chip (GHz): considering (2/3)*Fc, (4/3)*Fc, 2*Fc, 3*Fc.

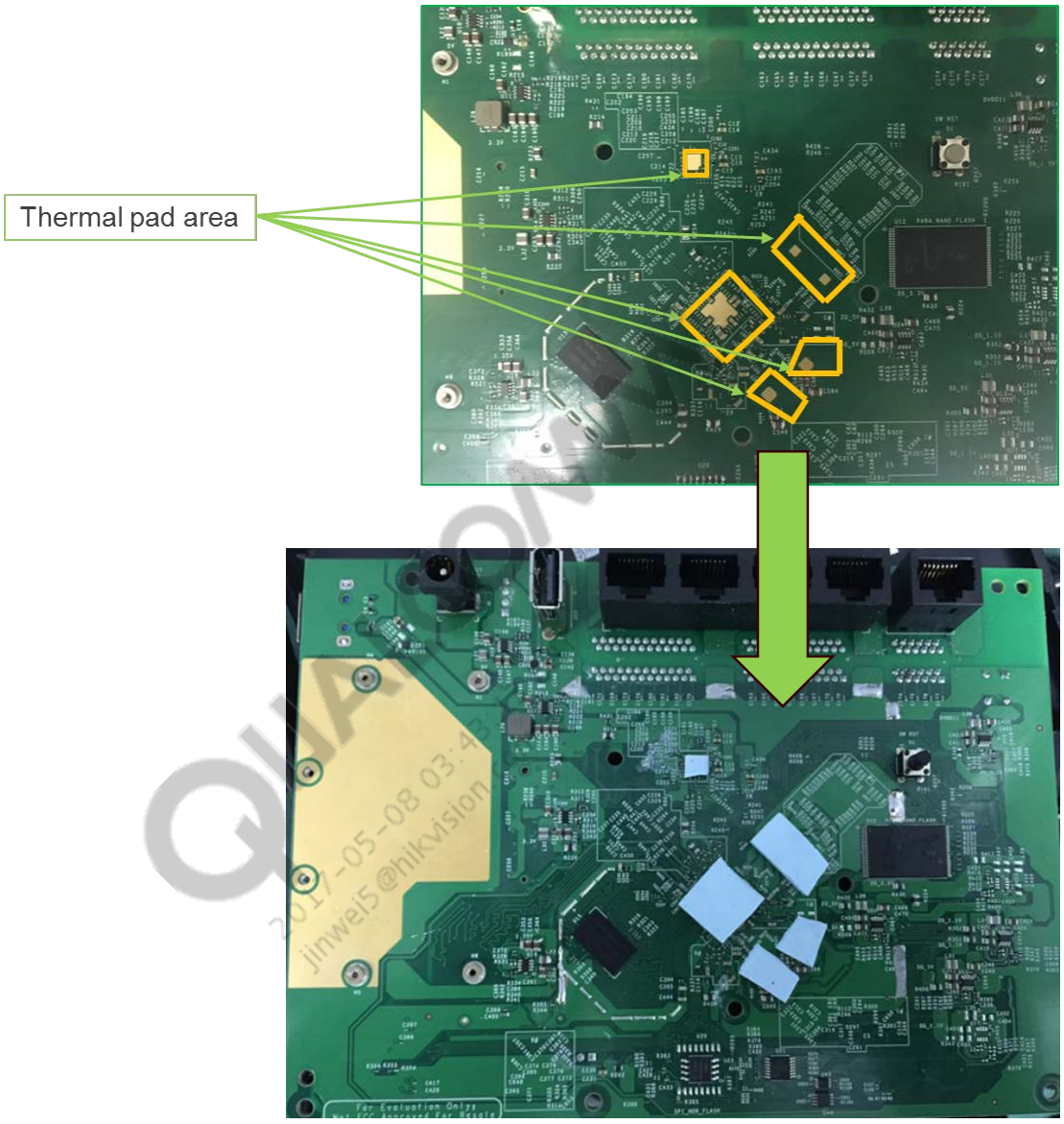
The spurious emission@3.8 GHz is getting worse when thermal plate and thermal pad are added on board.

3.4 Improvements

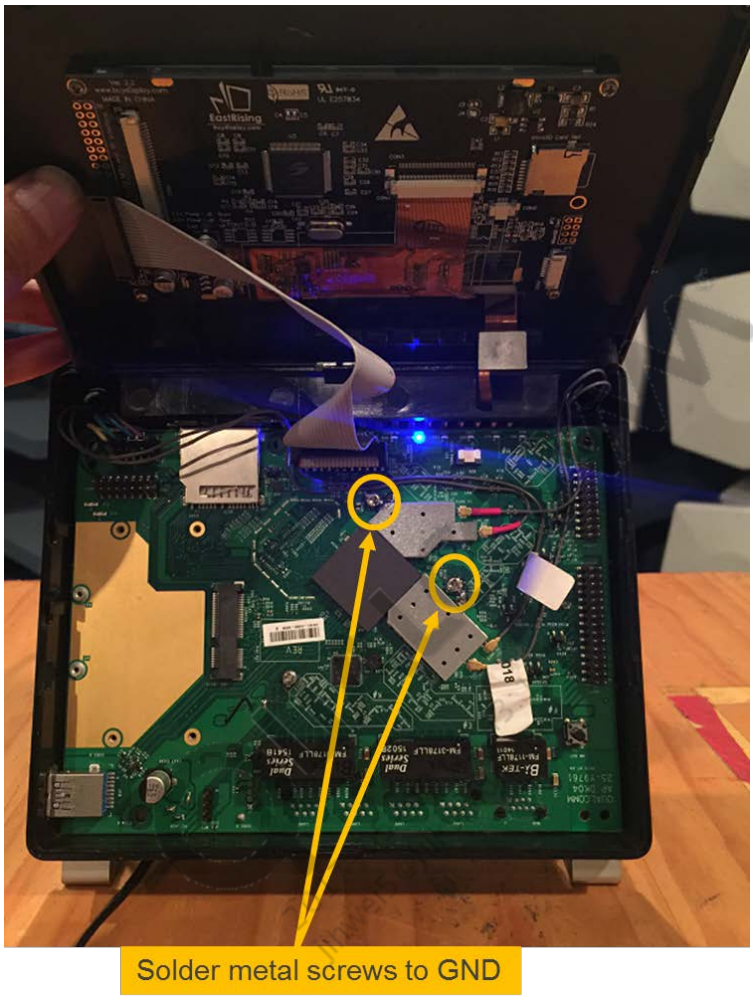
To PASS ETSI receive spurious emission, two optional solutions are introduced to fix spurious emission issue on AP.DK04.

3.4.1 Solution 1

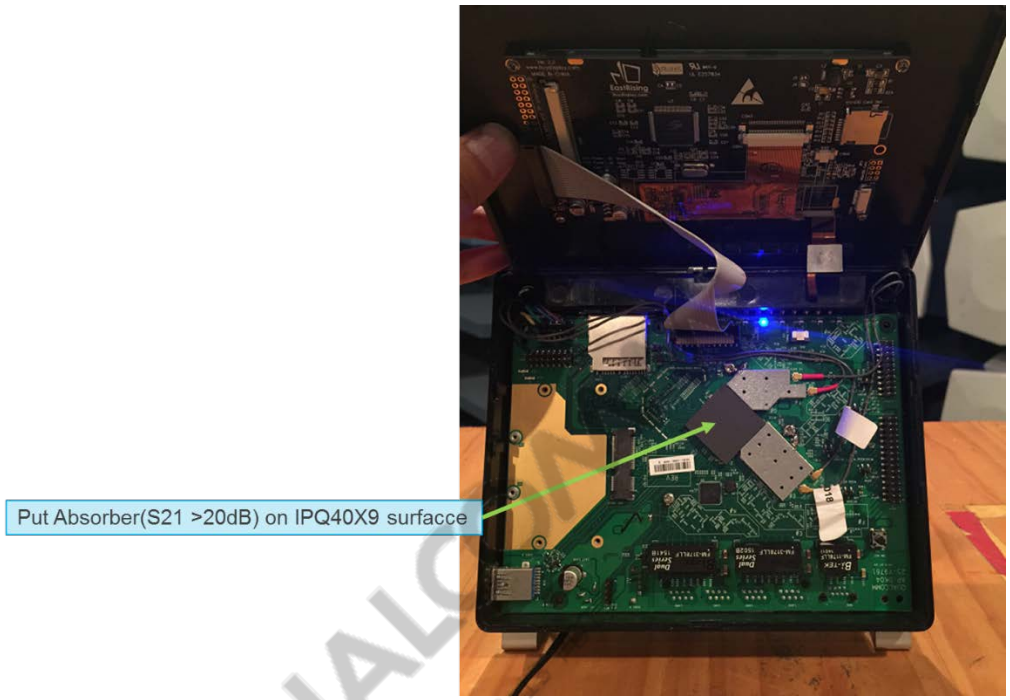
1. Change the location and shape of thermal pad.



2. Connect the thermal plate by soldering 2 metal screws to GND.



3. Put absorber on the surface of IPQ4019/IPQ4029 chipset.

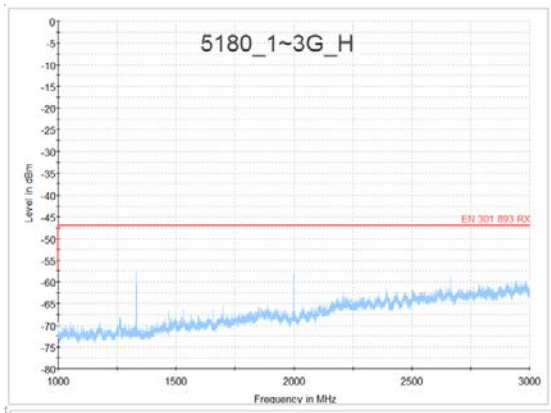


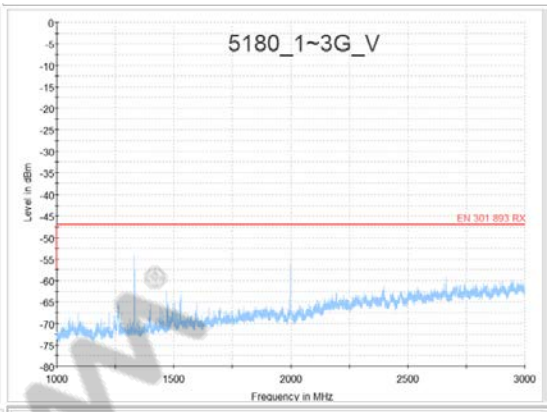
4. After above board changed, the receiver emission can pass ETSI with minimum margin 1.3 dB at 3.8 GHz.
   - Summary table - minimum margin is 1.3 dB at 3.8 GHz.

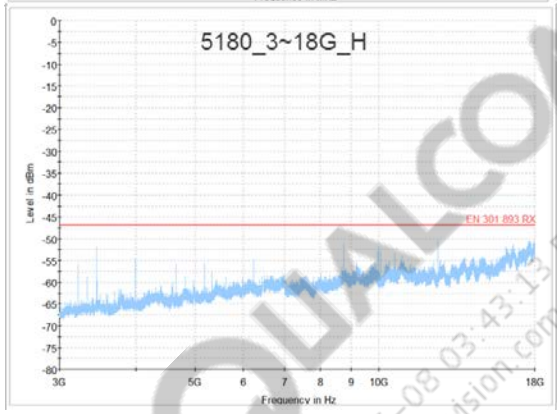
Test Data File Name	Frequency (MHz)	Peak (dBm)	Margin (dB)	Degree	Pass or fail ETSI?
RSE_AP.DK04_Solution1_WIFI 5G_5320_IDLE_3-18GHz_H_0414	3546.4	-50.12	3.12	225	Pass
	9937.1	-51.87	4.87	225	Pass
	12499.5	-50.36	3.36	225	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5320_IDLE_3-18GHz_V_0414	3329.6	-52.54	5.54	135	Pass
	3546.4	-50.76	3.76	180	Pass
	3996.0	-54.99	7.99	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5700_IDLE_3-18GHz_H_0414	3799.9	-48.30	1.30	270	Pass
	9937.5	-51.83	4.83	225	Pass
	12499.5	-49.96	2.96	225	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5700_IDLE_3-18GHz_V_0414	3330.0	-52.39	5.39	135	Pass
	3799.9	-52.08	5.08	270	Pass
	7600.1	-53.56	6.56	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5180_IDLE_3-18GHz_H_0414	3453.0	-51.95	4.95	225	Pass
	8749.9	-51.07	4.07	90	Pass
	12499.5	-50.58	3.58	315	Pass

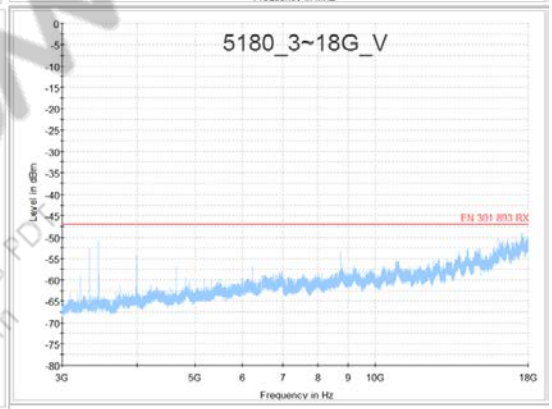
Test Data File Name	Frequency (MHz)	Peak (dBm)	Margin (dB)	Degree	Pass or fail ETSI?
RSE_AP.DK04_Solution1_WIFI 5G_5180_IDLE_3-18GHz_V_0414	3329.6	-52.83	5.83	180	Pass
	3453.0	-50.89	3.89	180	Pass
	3996.0	-54.20	7.20	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5500_IDLE_3-18GHz_H_0414	8749.9	-50.15	3.15	135	Pass
	9999.8	-51.52	4.52	225	Pass
	12499.9	-49.72	2.72	225	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5500_IDLE_3-18GHz_V_0414	3329.6	-53.01	6.01	180	Pass
	3663.8	-53.33	6.33	315	Pass
	3996.0	-54.27	7.27	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5500_IDLE_1-3GHz_H_0414	1331.8	-57.90	10.90	180	Pass
	1998.0	-58.50	11.50	180	Pass
	2664.0	-58.60	11.60	135	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5500_IDLE_1-3GHz_V_0414	1332.0	-54.40	7.40	180	Pass
	1998.0	-55.70	8.70	135	Pass
	2664.0	-60.50	13.50	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5700_IDLE_1-3GHz_H_0414	1332.0	-57.80	10.80	180	Pass
	1998.0	-58.50	11.50	180	Pass
	2664.8	-59.60	12.60	135	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5700_IDLE_1-3GHz_V_0414	1332.0	-54.30	7.30	180	Pass
	1998.0	-54.60	7.60	135	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5320_IDLE_1-3GHz_H_0414	1332.0	-57.90	10.90	180	Pass
	1998.0	-58.20	11.20	180	Pass
	2664.0	-58.80	11.80	135	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5320_IDLE_1-3GHz_V_0414	1332.0	-54.40	7.40	180	Pass
	1998.0	-56.00	9.00	135	Pass
	1493.8	-57.10	10.10	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5180_IDLE_1-3GHz_H_0414	1332.0	-57.80	10.80	180	Pass
	1998.0	-58.20	11.20	180	Pass
	2664.0	-58.60	11.60	135	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5180_IDLE_1-3GHz_V_0414	1332.0	-54.10	7.10	180	Pass
	1998.0	-56.10	9.10	135	Pass
	2664.0	-59.40	12.40	315	Pass

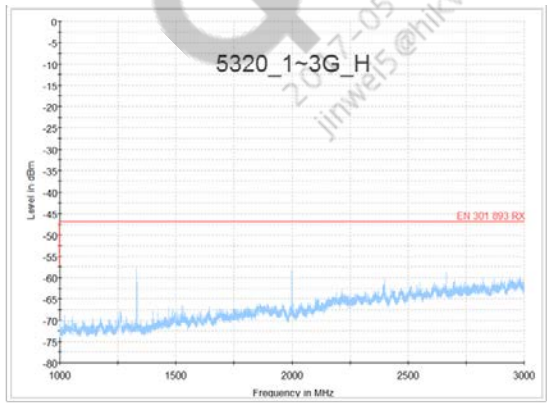
- Captured waveforms

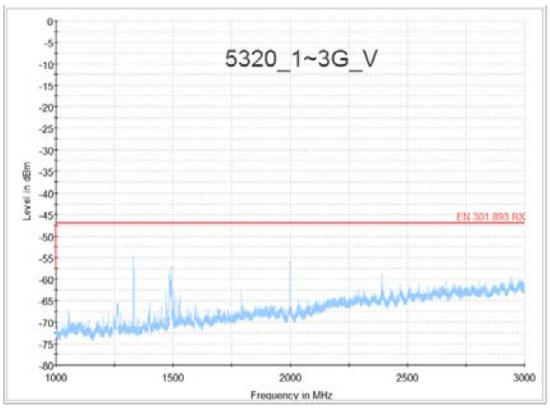


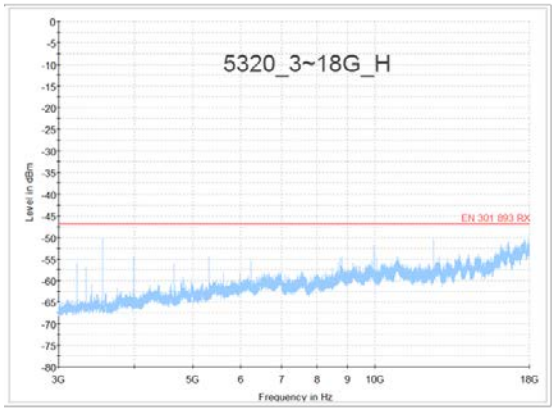


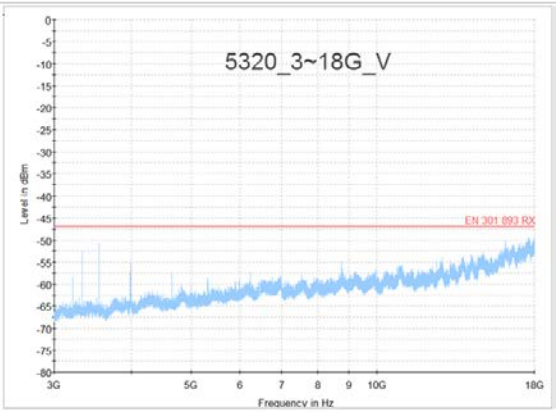


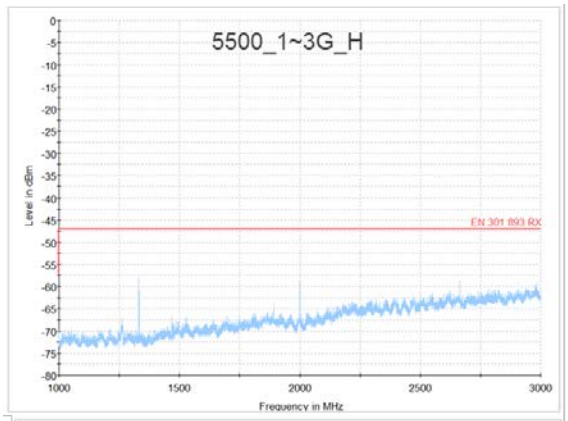


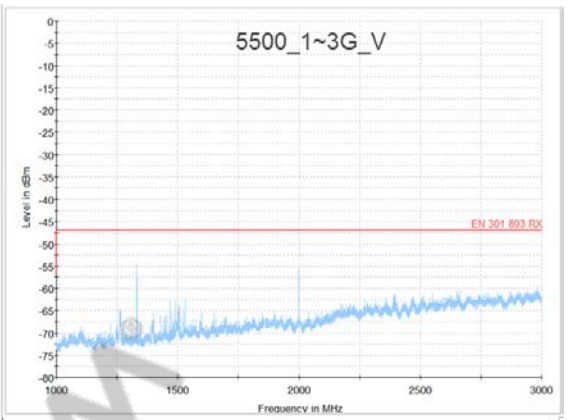


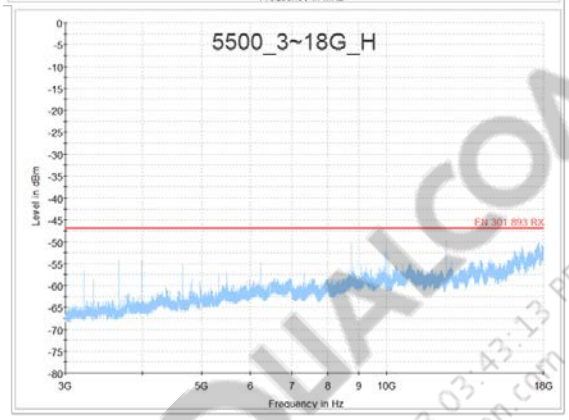


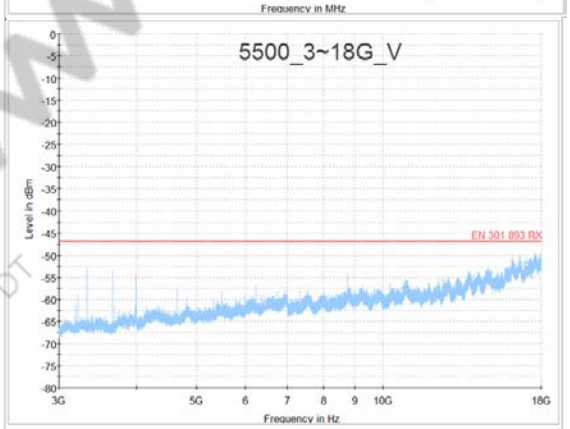


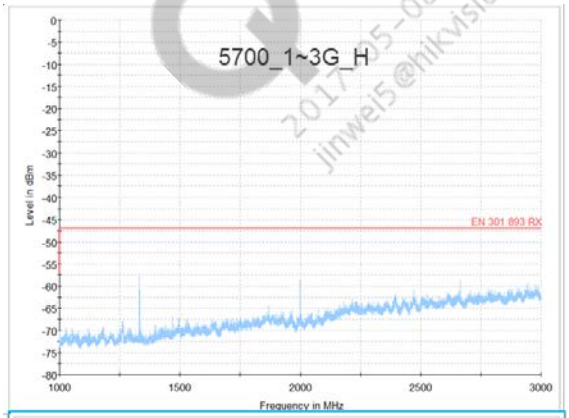


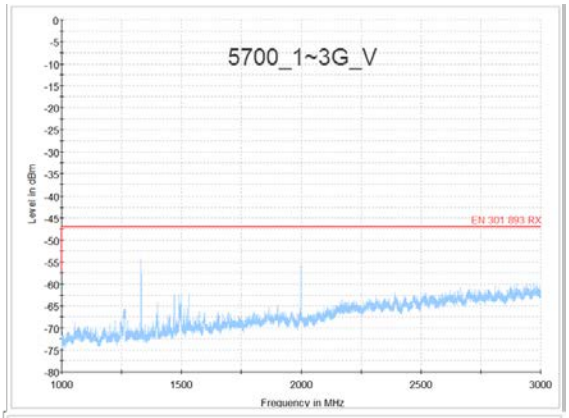


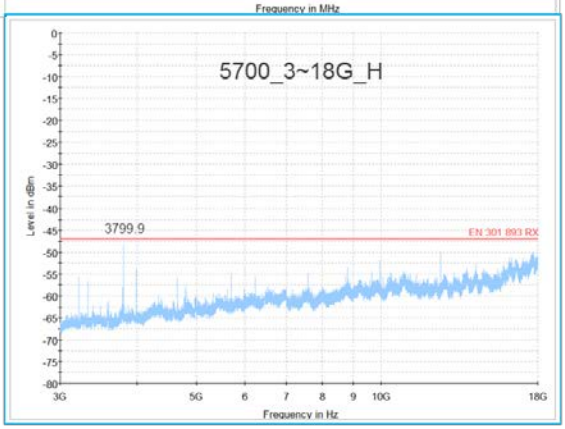


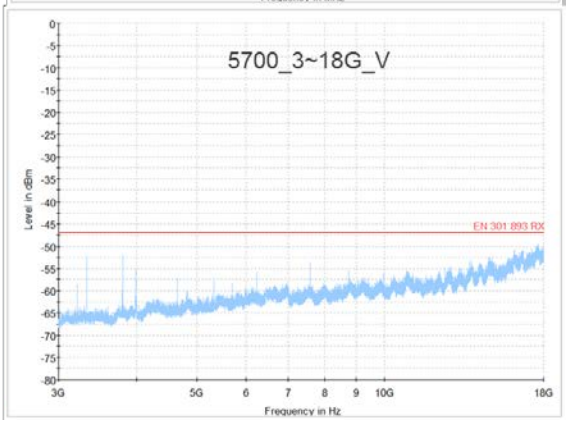






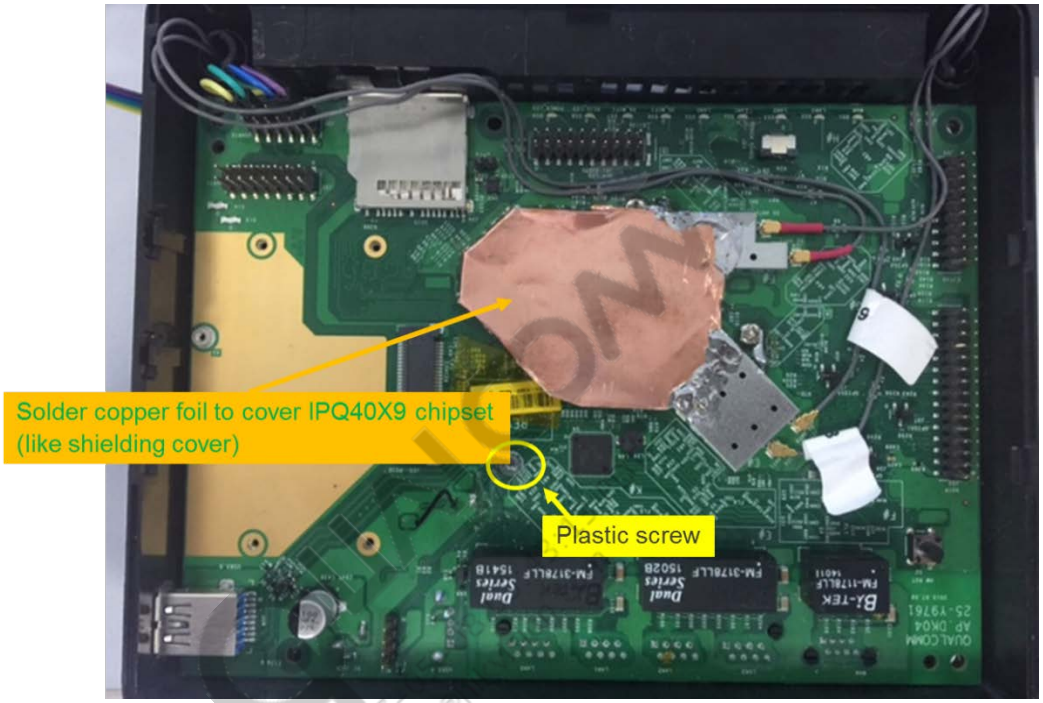






3.4.2 Solution 2

1. Change thermal pad, same as Solution 1.
2. Solder 2 metal screws to GND, same as Solution 1.
3. Solder copper foil to cover IPQ4019/IPQ4029 chipset as following.

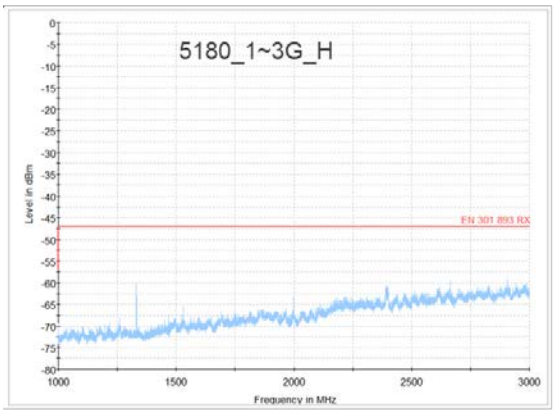


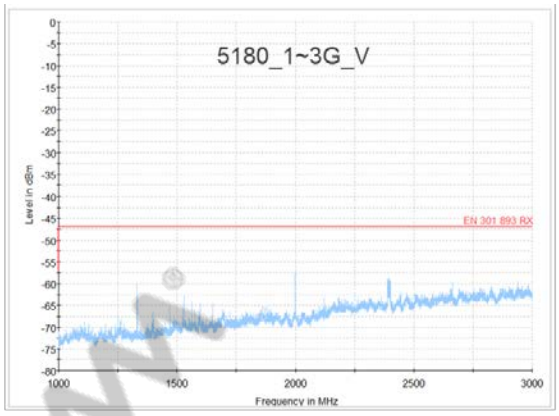
4. After above board changed, the receiver emission can pass ETSI with minimum margin 2.99 dB at 3.8 GHz.
   - Summary table - minimum margin is 2.99 dB at 3.8 GHz.

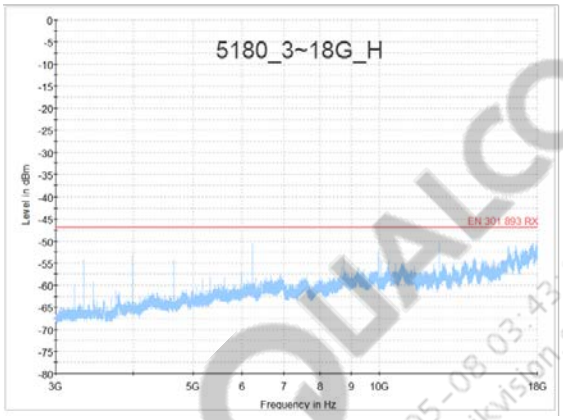
Test Data File Name	Frequency (MHz)	Peak (dBm)	Margin (dB)	Degree	Pass or fail ETSI?
RSE_AP.DK04_Solution2_WIFI 5G_5700_IDLE_3-18GHz_V_0420	3330.0	-53.14	6.14	315	Pass
	3799.9	-49.99	2.99	180	Pass
	3996.0	-53.41	6.41	180	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5700_IDLE_3-18GHz_H_0420	3799.9	-51.60	4.60	225	Pass
	6249.8	-50.58	3.58	225	Pass
	12499.5	-50.15	3.15	225	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5320_IDLE_3-18GHz_H_0420	3996.0	-53.50	6.50	225	Pass
	6249.8	-50.69	3.69	225	Pass
	12499.5	-50.77	3.77	225	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5320_IDLE_3-18GHz_V_0420	3329.6	-53.74	6.74	135	Pass
	3546.4	-52.54	5.54	180	Pass
	3996.0	-53.49	6.49	180	Pass

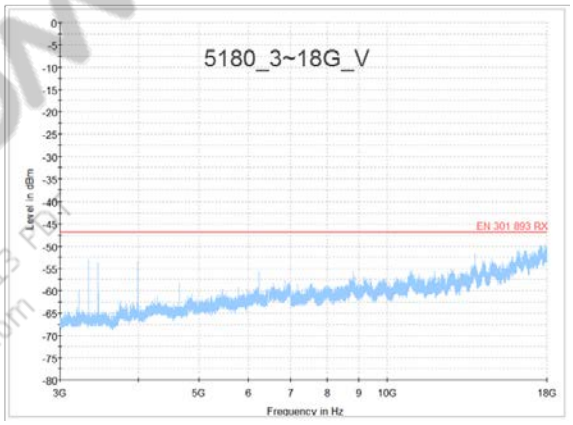
Test Data File Name	Frequency (MHz)	Peak (dBm)	Margin (dB)	Degree	Pass or fail ETSI?
RSE_AP.DK04_Solution2_WIFI 5G_5180_IDLE_3-18GHz_H_0420	3996.0	-53.10	6.10	225	Pass
	6249.8	-50.60	3.60	225	Pass
	12499.5	-50.36	3.36	225	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5180_IDLE_3-18GHz_V_0420	3329.6	-53.00	6.00	135	Pass
	3453.0	-53.77	6.77	180	Pass
	3996.0	-53.31	6.31	180	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5500_IDLE_3-18GHz_H_0420	3996.0	-54.00	7.00	225	Pass
	6249.8	-50.30	3.30	225	Pass
	12499.9	-50.14	3.14	225	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5500_IDLE_3-18GHz_V_0420	3329.6	-53.41	6.41	135	Pass
	3666.4	-53.66	6.66	180	Pass
	3996.0	-54.02	7.02	180	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5500_IDLE_1-3GHz_H_0420	1332.0	-59.98	12.98	180	Pass
	2399.5	-59.24	12.24	90	Pass
	2664.0	-58.91	11.91	225	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5500_IDLE_1-3GHz_V_0420	1332.0	-59.73	12.73	135	Pass
	1998.0	-58.19	11.19	225	Pass
	2393.3	-58.21	11.21	180	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5180_IDLE_1-3GHz_H_0420	1332.0	-60.05	13.05	180	Pass
	2393.5	-60.39	13.39	90	Pass
	2664.0	-59.57	12.57	225	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5180_IDLE_1-3GHz_V_0420	1331.8	-59.79	12.79	135	Pass
	1998.0	-57.64	10.64	225	Pass
	2392.3	-58.48	11.48	90	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5320_IDLE_1-3GHz_H_0420	1332.0	-59.97	12.97	180	Pass
	2394.0	-60.75	13.75	90	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5320_IDLE_1-3GHz_V_0420	1331.8	-59.96	12.96	135	Pass
	1998.0	-57.94	10.94	225	Pass
	2391.3	-57.32	10.32	180	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5700_IDLE_1-3GHz_H_0420	1331.8	-57.97	10.97	135	Pass
	2664.0	-58.96	11.96	180	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5700_IDLE_1-3GHz_V_0420	1332.0	-55.12	8.12	180	Pass
	2399.3	-56.52	9.52	180	Pass

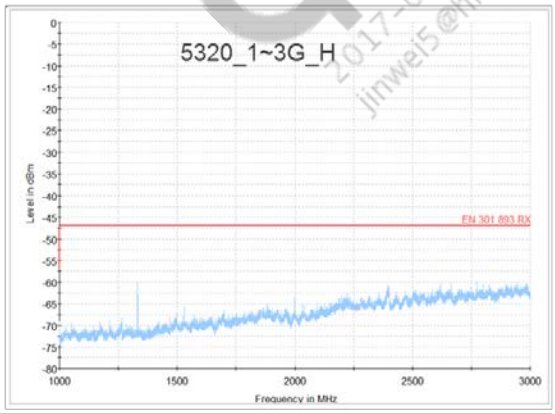
- Captured waveforms

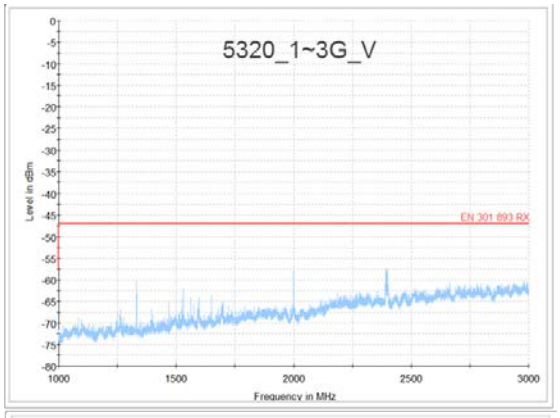


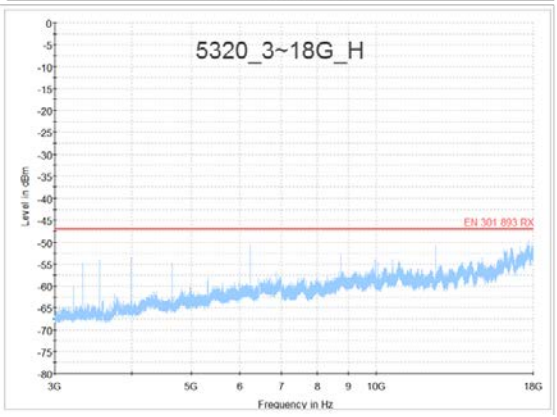


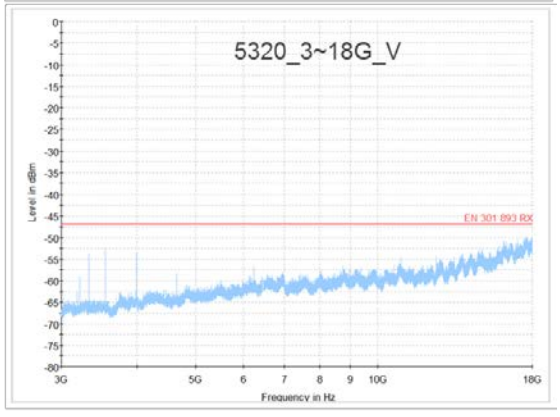


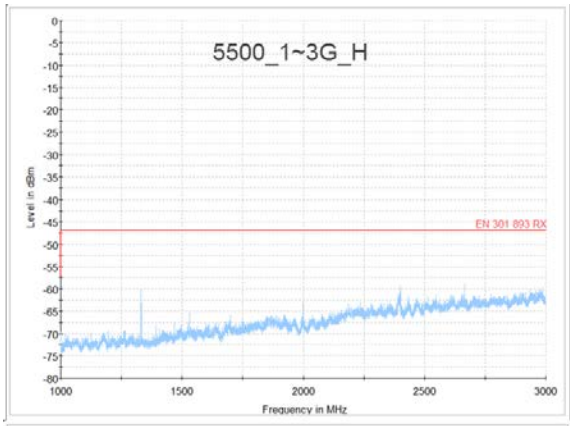


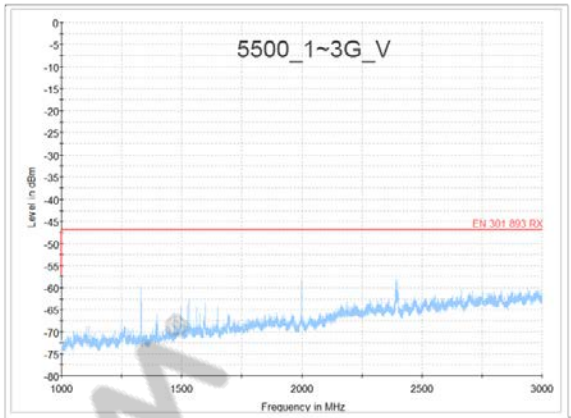


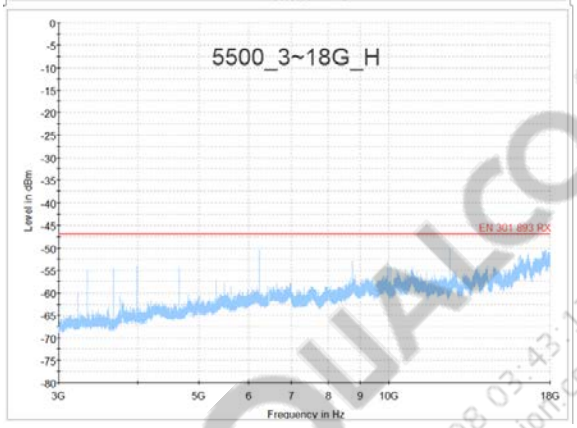


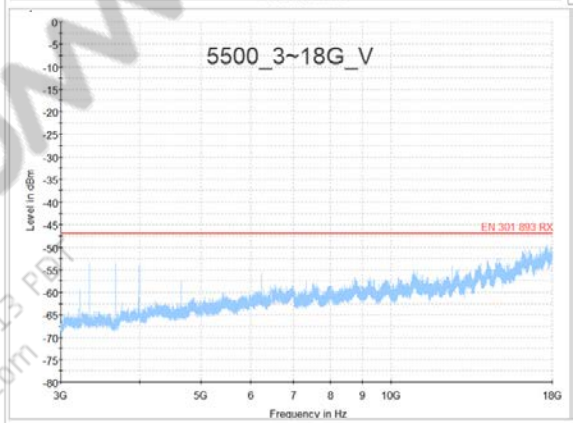


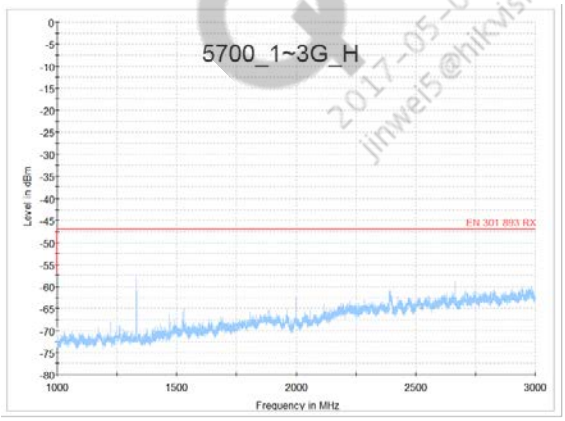


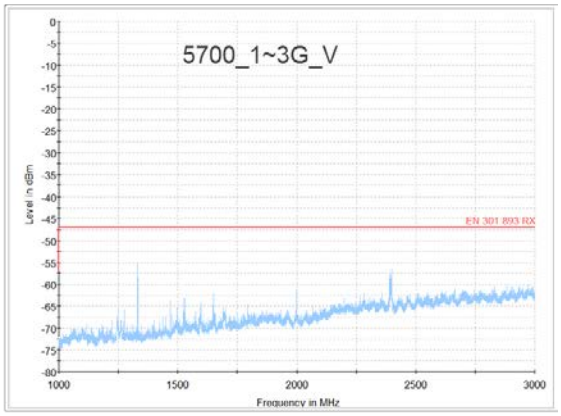


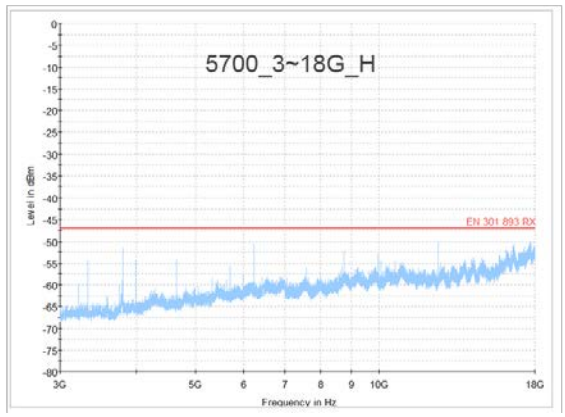


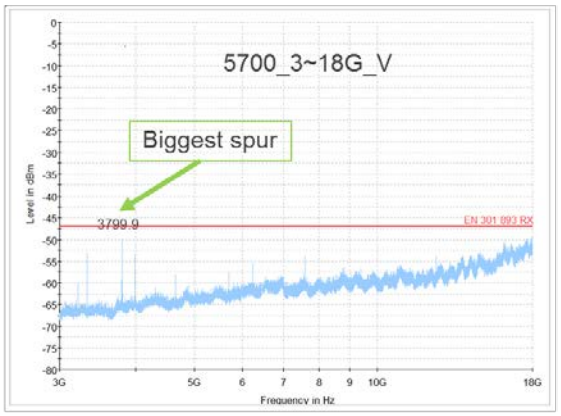












4 Conclusions

Following recommends are provided on customer board designs:

- Heat plate should be connected to Ground on PCB board. Note that GND touched point should be kept away from PSGMII bus and QCA8075.
- The area of thermal pad will slightly impact spur level. When failure occurs in ETSI receiver spurious emission, remove thermal pad to check the result again at first. Re-adjust thermal pad can be used as a possible solution.
- Shielding case is added for IPQ4019/IPQ4029 chipset. (This solution is recommended.) If shielding case cannot be added due to the board limitation, absorber (S21>20 dB) is recommended to be added on top of IPQ4019/IPQ4029.