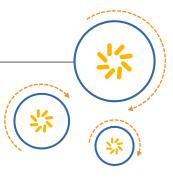
NOTICE REGARDING QUALCOMM ATHEROS, INC.

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

Confidential and Proprietary – Qualcomm Atheros, Inc.

NO PUBLIC DISCLOSURE PERMITTED: Please report postings of this document on public servers or websites to: DocCtrlAgent@qualcomm.com.

Restricted Distribution: Not to be distributed to anyone who is not an employee of either Qualcomm Atheros, Inc. or its affiliated companies without the express approval of Qualcomm Configuration Management.

Not to be used, copied, reproduced, or modified in whole or in part, nor its contents revealed in any manner to others without the express written permission of Qualcomm Atheros, Inc.

Qualcomm is a trademark of Qualcomm Incorporated, registered in the United States and other countries. Other product and brand names may be trademarks or registered trademarks of their respective owners.

This technical data may be subject to U.S. and international export, re-export, or transfer ("export") laws. Diversion contrary to U.S. and international law is strictly prohibited.

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

Revision history

Revision	Date	Description
А	April 2016	Initial release



Contents

1 Overview	
2 ETSI Receiver Spurious Emissions	5
2.1 Definition	5
2.2 Limits	5
3 Test	6
3.1 Test setup	
3.2 Measure results	
3.3 Failure analysis	
3.4 Improvements	
3.4.1 Solution 1	9
3.4.1 Solution 1	16
4 Conclusions	
4 Conclusions	20
V5 W	
03.70	
Figures	
Figure 3-1 Standard EN radiated test chamber	
El 0.400 LIEN EN LINE	
Figure 3-1 Standard EN radiated test chamber	
Figure 3-2 Receiver setting	
<i>y</i> .	
Tables	
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.

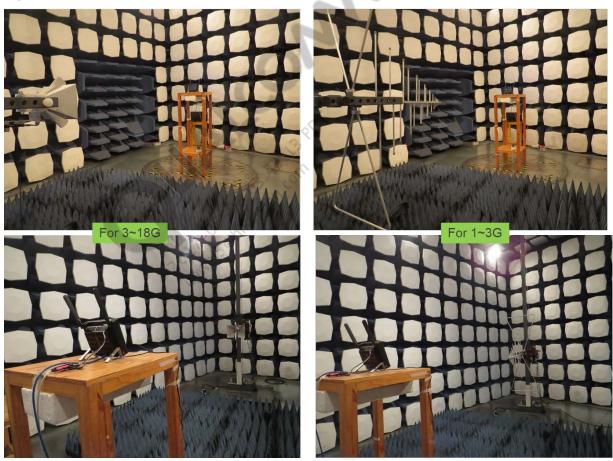


Figure 3-1 Standard EN radiated test chamber

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

Figure 3-2 shows the QRCT receiver setting.

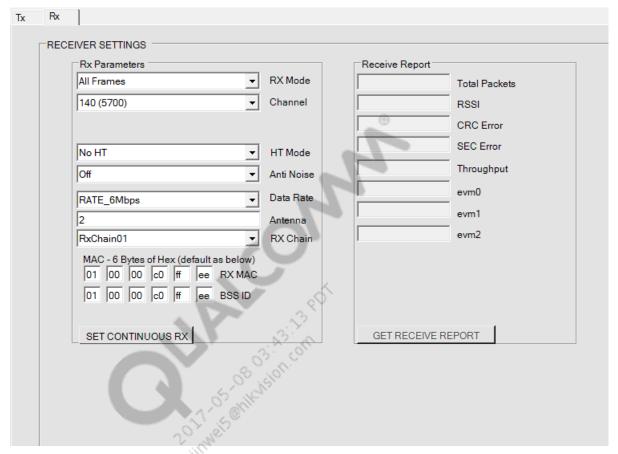
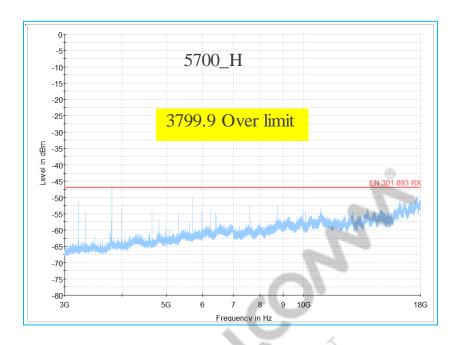


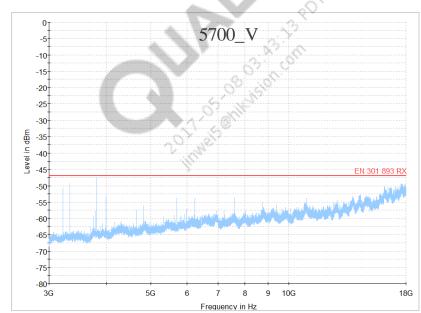
Figure 3-2 Receiver setting

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	3799.9	-47.60	0.60	45	Pass
5G_5700_IDLE_3-	3330.0	-49.20	2.20	180	Pass
18GHz_V_0414	3215.3	-50.60	3.60	0	Pass
RSE AP.DK04 WIFI	3799.9	-46.00	-1.00	45	Fail
5G_5700_IDLE_3-	5700.0	-50.30	3.30	315	Pass
18GHz_H_0414	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	Chanr	nel 36 Channel 64		Channel 100		Channel 140		
	Н	V	Н	V	Ĥ	V	Н	V
3.453 GHz	/	/	_				_	_
6.906 GHz	/	/	_	67	_		_	_
3.546 GHz	_	_	/	/	_	_	_	_
7.093 GHz	_	_		1	_	_	_	_
3.666 GHz	_	-		_	-3.1	-5.19	_	_
7.222 GHz	_	-	<u> </u>	_	/	/	_	_
3.799 GHz	- 1			♦ ○	_	_	-13.64	-13
7.599 GHz	-	_	3	_	_	_	/	/

^{1.} No spur at 3.453 GHz, 6.906 GHz, 3.546 GHz, 7.093 GHz, 7.222 GHz and 7.599 GHz.

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.

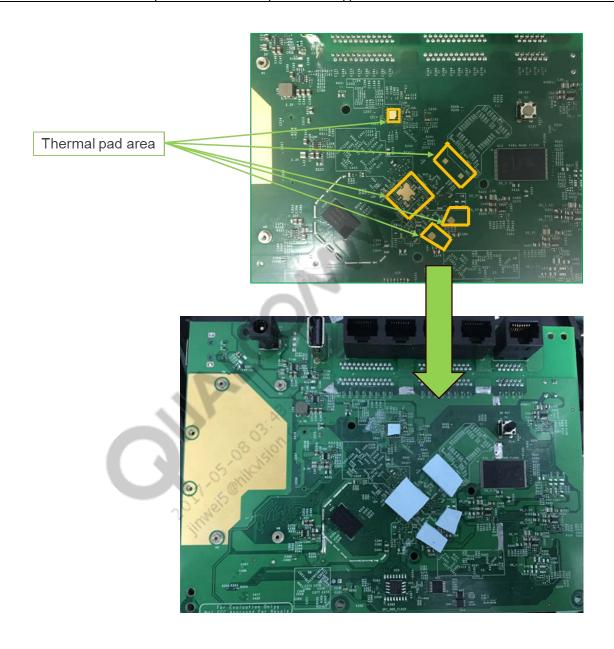
3.4 Improvements

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

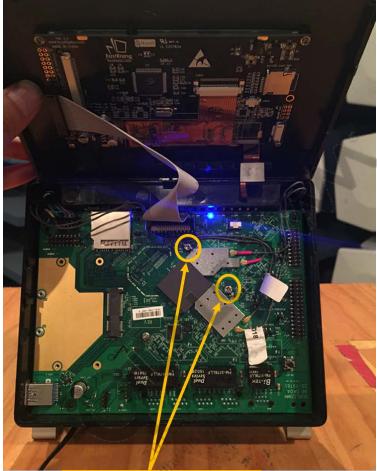
3.4.1 Solution 1

1. Change the location and shape of thermal pad.

^{2. /} means tested, but no spur; — means not tested.



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



Solder metal screws to GND

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



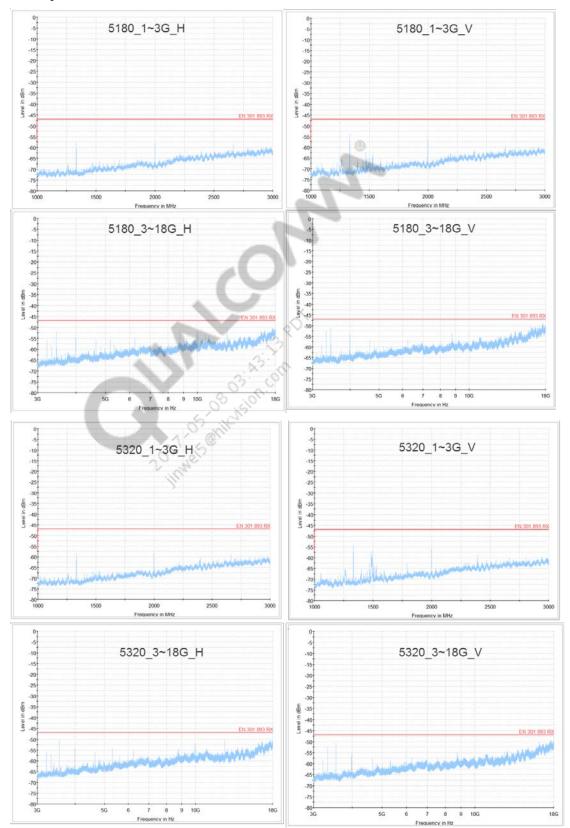
Put Absorber(S21 >20dB) on IPQ40X9 surfacce

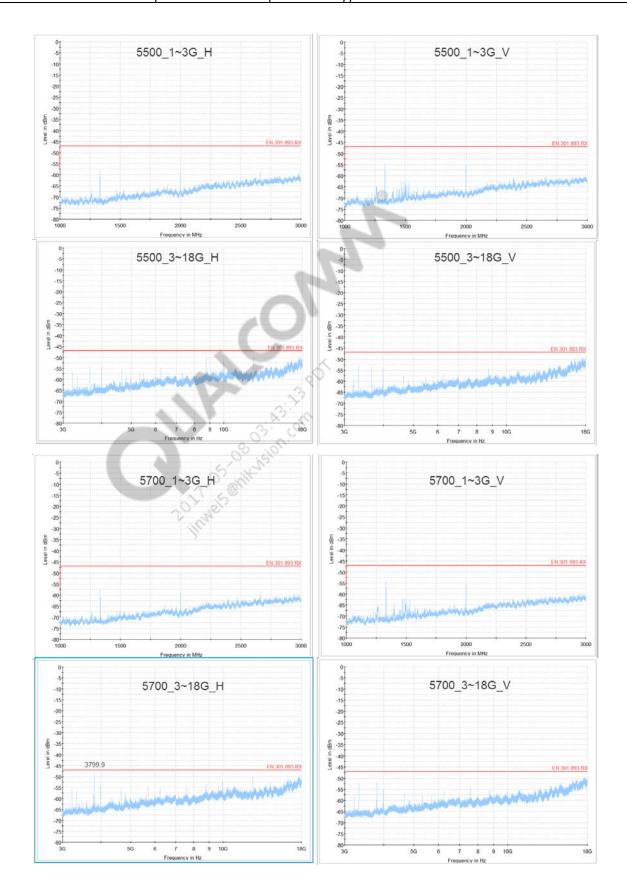
- 4. After above board changed, the receiver emission can pass ETSI with minimum margin 1.3 dB at 3.8 GHz.
 - $\hfill\Box$ Summary table minimum margin is 1.3 dB at 3.8 GHz.

Test Data File Name	Frequency (MHz)	Peak (dBm)	Margin (dB)	Degree	Pass or fail
					ETSI?
	3546.4	-50.12	3.12	225	Pass
RSE_AP.DK04_Solution1_WIFI 5G 5320 IDLE 3-18GHz H 0414	9937.1	-51.87	4.87	225	Pass
	12499.5	-50.36	3.36	225	Pass
	3329.6	-52.54	5.54	135	Pass
RSE_AP.DK04_Solution1_WIFI 5G 5320 IDLE 3-18GHz V 0414	3546.4	-50.76	3.76	180	Pass
	3996.0	-54.99	7.99	180	Pass
	3799.9	-48.30	1.30	270	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5700_IDLE_3-18GHz_H_0414	9937.5	-51.83	4.83	225	Pass
	12499.5	-49.96	2.96	225	Pass
	3330.0	-52.39	5.39	135	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5700_IDLE_3-18GHz_V_0414	3799.9	-52.08	5.08	270	Pass
	7600.1	-53.56	6.56	180	Pass
	3453.0	-51.95	4.95	225	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5180_IDLE_3-18GHz_H_0414	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?
	3329.6	-52.83	5.83	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5180_IDLE_3-18GHz_V_0414	3453.0	-50.89	3.89	180	Pass
00_0100_1B22_0 100112_V_0111	3996.0	-54.20	7.20	180	Pass
	8749.9	-50.15	3.15	135	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5500_IDLE_3-18GHz_H_0414	9999.8	-51.52	4.52	225	Pass
00_0000_1522_0 100112_11_0111	12499.9	-49.72	2.72	225	Pass
	3329.6	-53.01	6.01	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5500_IDLE_3-18GHz_V_0414	3663.8	-53.33	6.33	315	Pass
30_0000_IDEE_0 100112_V_0414	3996.0	-54.27	7.27	180	Pass
	1331.8	-57.90	10.90	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5500_IDLE_1-3GHz_H_0414	1998.0	-58.50	11.50	180	Pass
00_0000_ib2t_1 00/i2_i1_0111	2664.0	-58.60	11.60	135	Pass
	1332.0	-54.40	7.40	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5500_IDLE_1-3GHz_V_0414	1998.0	-55.70	8.70	135	Pass
00_0000_1022_1 00112_1_0111	2664.0	-60.50	13.50	180	Pass
13.	1332.0	-57.80	10.80	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5700_IDLE_1-3GHz_H_0414	1998.0	-58.50	11.50	180	Pass
00_0700_022_700112_700713	2664.8	-59.60	12.60	135	Pass
RSE_AP.DK04_Solution1_WIFI	1332.0	-54.30	7.30	180	Pass
5G_5700_IDLE_1-3GHz_V_0414	1998.0	-54.60	7.60	135	Pass
S. 70°.	1332.0	-57.90	10.90	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5320_IDLE_1-3GHz_H_0414	1998.0	-58.20	11.20	180	Pass
00_0020_1522_1 00112_11_0111	2664.0	-58.80	11.80	135	Pass
	1332.0	-54.40	7.40	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5320_IDLE_1-3GHz_V_0414	1998.0	-56.00	9.00	135	Pass
00_0020_1022_1 00112_1_01111	1493.8	-57.10	10.10	180	Pass
	1332.0	-57.80	10.80	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G_5180_IDLE_1-3GHz_H_0414	1998.0	-58.20	11.20	180	Pass
00_0.002_20020	2664.0	-58.60	11.60	135	Pass
	1332.0	-54.10	7.10	180	Pass
RSE_AP.DK04_Solution1_WIFI 5G 5180 IDLE 1-3GHz V 0414	1998.0	-56.10	9.10	135	Pass
	2664.0	-59.40	12.40	315	Pass

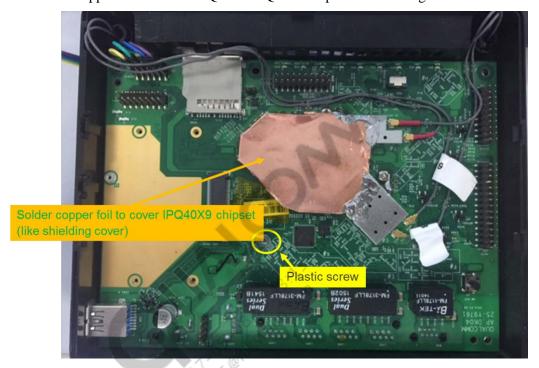
□ Captured waveforms





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.

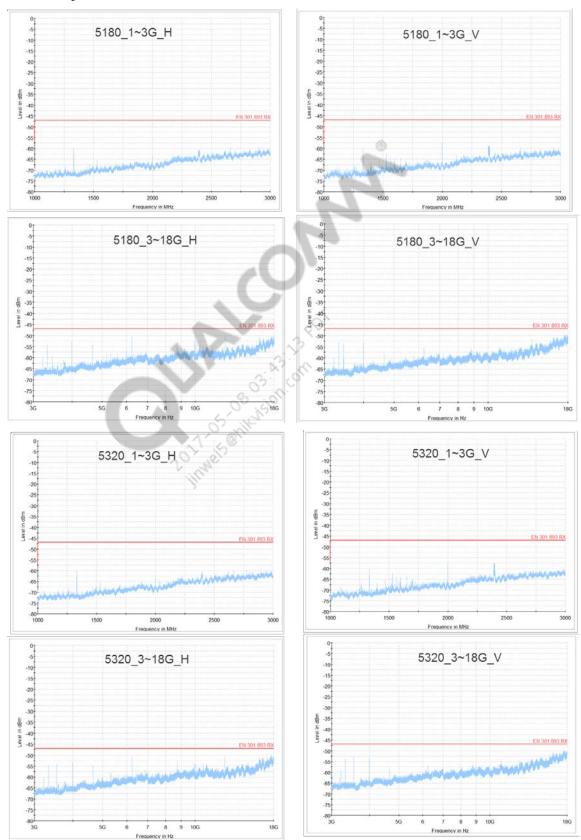


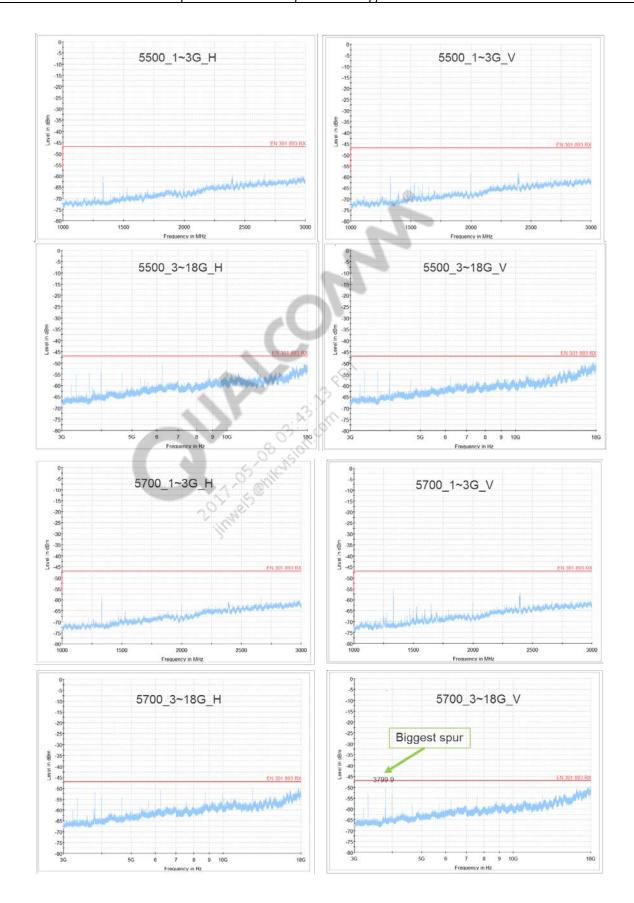
- 4. After above board changed, the receiver emission can pass ETSI with minimum margin 2.99 dB at 3.8 GHz.
 - □ Summary table minimum margin is 2.99 dB at 3.8 GHz.

Test Data File Name	Frequency (MHz)	Peak (dBm)	Margin (dB)	Degree	Pass or fail ETSI?
	3330.0	-53.14	6.14	315	Pass
RSE_AP.DK04_Solution2_WIFI 5G 5700 IDLE 3-18GHz V 0420	3799.9	-49.99	2.99	180	Pass
00_0700D22_0 1007.12_v_0120	3996.0	-53.41	6.41	180	Pass
	3799.9	-51.60	4.60	225	Pass
RSE_AP.DK04_Solution2_WIFI 5G 5700 IDLE 3-18GHz H 0420	6249.8	-50.58	3.58	225	Pass
00_0,00222_0 .0020 .20	12499.5	-50.15	3.15	225	Pass
	3996.0	-53.50	6.50	225	Pass
RSE_AP.DK04_Solution2_WIFI 5G 5320 IDLE 3-18GHz H 0420	6249.8	-50.69	3.69	225	Pass
00_0020_1322_0 100112_11_0 120	12499.5	-50.77	3.77	225	Pass
	3329.6	-53.74	6.74	135	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5320_IDLE_3-18GHz_V_0420	3546.4	-52.54	5.54	180	Pass
00_0020D22_0 100112_v_0120	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
30_0100_IDEE_0 100H2_H_0420	12499.5	-50.36	3.36	225	Pass
	3329.6	-53.00	6.00	135	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5180_IDLE_3-18GHz_V_0420	3453.0	-53.77	6.77	180	Pass
30_3100_IDEE_3-100H2_V_0420	3996.0	-53.31	6.31	180	Pass
	3996.0	-54.00	7.00	225	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5500_IDLE_3-18GHz_H_0420	6249.8	-50.30	3.30	225	Pass
30_0000_IDEE_0=100112_11_0420	12499.9	-50.14	3.14	225	Pass
	3329.6	-53.41	6.41	135	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5500_IDLE_3-18GHz_V_0420	3666.4	-53.66	6.66	180	Pass
30_0000_IDEE_0 100112_V_0420	3996.0	-54.02	7.02	180	Pass
	1332.0	-59.98	12.98	180	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5500_IDLE_1-3GHz_H_0420	2399.5	-59.24	12.24	90	Pass
00_0000_IDEE_1 00112_11_0420	2664.0	-58.91	11.91	225	Pass
23.	1332.0	-59.73	12.73	135	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5500_IDLE_1-3GHz_V_0420	1998.0	-58.19	11.19	225	Pass
00_0000_D22_1 00112_V_0120	2393.3	-58.21	11.21	180	Pass
OS "Ilea,	1332.0	-60.05	13.05	180	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5180_IDLE_1-3GHz_H_0420	2393.5	-60.39	13.39	90	Pass
7	2664.0	-59.57	12.57	225	Pass
111	1331.8	-59.79	12.79	135	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5180_IDLE_1-3GHz_V_0420	1998.0	-57.64	10.64	225	Pass
00_0100_1522_1 00112_1_0120	2392.3	-58.48	11.48	90	Pass
RSE_AP.DK04_Solution2_WIFI	1332.0	-59.97	12.97	180	Pass
5G_5320_IDLE_1-3GHz_H_0420	2394.0	-60.75	13.75	90	Pass
	1331.8	-59.96	12.96	135	Pass
RSE_AP.DK04_Solution2_WIFI 5G_5320_IDLE_1-3GHz_V_0420	1998.0	-57.94	10.94	225	Pass
00_0020522_1 00112_v_0120	2391.3	-57.32	10.32	180	Pass
RSE_AP.DK04_Solution2_WIFI	1331.8	-57.97	10.97	135	Pass
5G_5700_IDLE_1-3GHz_H_0420	2664.0	-58.96	11.96	180	Pass
RSE_AP.DK04_Solution2_WIFI	1332.0	-55.12	8.12	180	Pass
5G_5700_IDLE_1-3GHz_V_0420	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.