RF TEST REPORT

Report No.: 16050028-FCC-R2

Supersede Report No.: N/A

Applicant	Quectel Wireless Solutions Co., Ltd.
Product Name	Wifi& BT Module
Model No.	FC20
Serial No.	N/A
Test Standard	FCC Part 15.407: 2016, KDB905462 D02 v02 ; ANSI C63.10: 2013
Test Date	February 07 to March 02, 2017
Issue Date	March 03, 2017
Test Result	☑ Pass ☐ Fail
Equipment complied with the specification	☑
Equipment did not comply with the specification	☐

Leen Yang	David Huang	
Leen Yang Test Engineer	David Huang Checked By	

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Test result presented in this test report is applicable to the tested sample only

Issued by:

SIEMIC (SHENZHEN-CHINA) LABORATORIES

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Laboratories Introduction

SIEMIC, headquartered in the heart of Silicon Valley, with superior facilities in US and Asia, is one of the leading independent testing and certification facilities providing customers with one-stop shop services for Compliance Testing and Global Certifications.

In addition to testing and certification, SIEMIC provides initial design reviews and compliance management throughout a project. Our extensive experience with China, Asia Pacific, North America, European, and International compliance requirements, assures the fastest, most cost effective way to attain regulatory compliance for the global markets.

Accreditations for Conformity Assessment

Country/Region	Scope
USA	EMC, RF/Wireless, SAR, Telecom
Canada	EMC, RF/Wireless, SAR, Telecom
Taiwan	EMC, RF, Telecom, SAR, Safety
Hong Kong	RF/Wireless, SAR, Telecom
Australia	EMC, RF, Telecom, SAR, Safety
Korea	EMI, EMS, RF, SAR, Telecom, Safety
Japan	EMI, RF/Wireless, SAR, Telecom
Singapore	EMC, RF, SAR, Telecom
Europe	EMC, RF, SAR, Telecom, Safety

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1. Report Revision History

Report No.	Report Version	Description	Issue Date
16050028-FCC-R2	NONE	Original	March 03, 2017

2. Customer information

Applicant Name	Quectel Wireless Solutions Co., Ltd.
Applicant Add	RM501,Building 13,No.99 TianZhou Road,Xuhui District,Shanghai,China
Manufacturer	Quectel Wireless Solutions Co., Ltd.
Manufacturer Add	RM501,Building 13,No.99 TianZhou Road,Xuhui District,Shanghai,China

3. Test site information

Lab performing tests	SIEMIC (Shenzhen-China) LABORATORIES
Lab Address	Zone A, Floor 1, Building 2 Wan Ye Long Technology Park South Side of Zhoushi Road, Bao' an District, Shenzhen, Guangdong China 518108
FCC Test Site No.	718246
IC Test Site No.	4842E-1
Test Software	Radiated Emission Program-To Shenzhen v2.0

4. Equipment under Test (EUT) Information

Description of EUT:	Wifi& BT Module
Main Model:	FC20
Serial Model:	N/A
Date EUT received:	February 06, 2017
Test Date(s):	February 07 to March 02, 2017
Equipment Category :	NII
Antenna Gain:	Bluetooth/BLE: 3dBi WIFI(2.4G): 3 dBi WIFI(5150-5250MHz): 3 dBi WIFI(5250-5350MHz): 3 dBi WIFI(5470-5725MHz): 3 dBi WIFI(5725-5850MHz): 3 dBi **(Note: The radio module will be sold without antenna, this antenna only used limited to ERP/EIRP or radiated spurious emission test.)**
Antenna type :	Fixed External antenna
Type of Modulation:	Bluetooth: GFSK, π /4DQPSK, 8DPSK BLE: GFSK 802.11b: DSSS 802.11g/n20/n40/ac20/ac40/ac80: OFDM
Input Power:	Main supply voltage: 3.3V, 500mA IO supply voltage: 1.8V

Number of Channels:	WIFI :802.11b/g/n(20M): 11CH WIFI :802.11n(40M): 7CH WIFI :802.11ac20: 24CH WIFI :802.11ac40: 12CH WIFI :802.11ac80: 6CH Bluetooth: 79CH BLE: 40CH
RF Operating Frequency (ies):	WIFI: 802.11b/g/n(20M): 2412-2462 MHz(TX/RX) WIFI: 802.11n(40M): 2422-2452 MHz(TX/RX) 802.11ac 20: 5180-5240 MHz; 5260-5320 MHz; 5500-5700 MHz; 5745-5825 MHz； (TX/RX) 802.11ac 40: 5190-5230 MHz; 5270-5310 MHz; 5510-5710 MHz; 5755-5795 MHz；(TX/RX) 802.11ac 80: 5210 MHz; 5290 MHz; 5530-5690 MHz; 5775 MHz；(TX/RX) Bluetooth& BLE: 2402-2480 MHz
Max. Output Power:	5150-5250MHz: 802.11ac(20M): 12.16dBm 802.11ac(40M): 11.50dBm 802.11ac(80M): 10.68dBm 5250-5350MHz: 802.11ac(20M): 12.21dBm 802.11ac(40M): 11.42dBm 802.11ac(80M): 10.77dBm 5470-5725MHz: 802.11ac(20M): 11.10dBm 802.11ac(40M): 11.06dBm 802.11ac(80M): 10.86dBm 5725-5850MHz: 802.11ac(20M): 11.25dBm 802.11ac(40M): 9.93dBm 802.11ac(80M): 9.74dBm
Port:	N/A
Trade Name :	Quectel
FCC ID:	XMR201703FC20

5. Test Summary

The product was tested in accordance with the following specifications.

All testing has been performed according to below product classification:

FCC Rules	Description of Test	Result
§15.407 (i), §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.407 (a)(1)	DTS (99%&26 dB) CHANNEL BANDWIDTH	Compliance
§15.407 (e)	DTS (99%&6 dB) CHANNEL BANDWIDTH	Compliance
§15.407(a/1/2)	Conducted Maximum Output Power	Compliance
§15.407(a/1/2)	Peak Power Spectral Density	Compliance
§15.407(a)(6)	Peak Power Excursion	Compliance
§15.207 (a),	AC Power Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(b/1/2/3/6)	Radiated Spurious Emissions & Unwanted Emissions into Restricted Frequency Bands	Compliance
47CFR15.407 (h)	In-Service Monitoring - Channel Move Time	Compliance
47CFR15.407 (h)	In-Service Monitoring - Channel Closing Transmission Time	Compliance

Measurement Uncertainty

Emissions		
Test Item	**Description**	**Uncertainty**
Radiated Spurious Emissions & Unwanted Emissions into Restricted Frequency Bands	Confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2 (for EUTs < 0.5m X 0.5m X 0.5m)	+5.6dB/-4.5dB
-	-	-

6. Measurements, Examination And Derived Results

6.1 §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited.
The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

a. Antenna must be permanently attached to the unit.

b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.
And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Connector Construction

The EUT has 1 antenna:
An non-standard and Reverse polarity interface attached Fixed External antenna for Bluetooth/BLE/2.4G WIFI/5G WIFI, the gain is 3dBi for Bluetooth/BLE/2.4G WIFI, the gain is 3dBi for 5150-5250MHz/5250-5350MHz/5470-5725 MHz / 5725-2850MHz MHz 5G WIFI.

Result: Pass

6.2 §15.407(a)-DTS (99% &26 dB) Channel Bandwidth

1. Conducted Measurement

   EUT was set for low, mid, high channel with modulated mode and highest RF output power.

   The spectrum analyzer was connected to the antenna terminal.

2. Environmental Conditions

Temperature	22°C
Relative Humidity	53%
Atmospheric Pressure	1010mbar

3. Conducted Emissions Measurement Uncertainty

   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 30MHz – 40GHz is ±1.5dB.

4. Test date : February 13&09, 2017

   Tested By : Leen Yang

Standard Requirement:

None; for reporting purposes only.

Procedures:

99% Bandwidth:

1. Set center frequency to the nominal EUT channel center frequency
2. Set span = 1.5 times to 5.0 times the OBW.
3. Set RBW = 1 % to 5 % of the OBW
4. he video bandwidth (VBW) ≥ 3 x RBW.
5. Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used
6. Use the 99 % power bandwidth function of the instrument (if available)
7. If the instrument does not have a 99 % power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 % of the total is reached; that

frequency is recorded as the lower frequency. The process is repeated until 99.5 % of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the

difference between these two frequencies.

Emission Bandwidth (EBW)

1) Set RBW = approximately 1% of the emission bandwidth.
2) Set the VBW > RBW.
3) Detector = Peak.
4) Trace mode = max hold.
5) Measure the maximum width of the emission that is 26 dB down from the maximum of the emission. Compare this with the RBW setting of the analyzer. Readjust

Test Result: Pass.

Please refer to the following tables and plots.

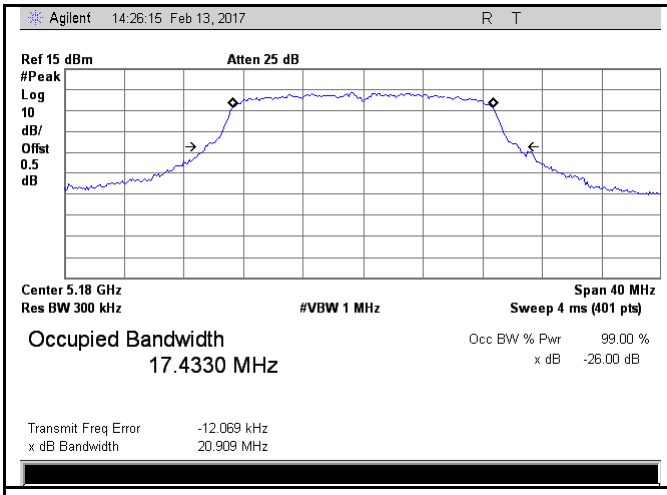
Measurement result

Test mode	Freq Band (MHz)	CH	Freq (MHz)	99% Bandwidth (MHz)	26dB Bandwidth (MHz)
802.11ac (20M)	5150-5250	Low	5180	17.4330	20.909
		Middle	5220	17.4215	20.661
		High	5240	17.4206	20.630
	5250-5350	Low	5260	17.4407	20.646
		Middle	5300	17.3947	20.820
		High	5320	17.4115	20.752
	5470-5725	Low	5500	17.4249	20.838
		Mid	5600	17.4107	20.645
		High	5700	17.4340	20.891
	5725-5850	Low	5745	17.4433	20.835
		Mid	5785	17.4541	20.023
		High	5825	17.4553	20.789
802.1ac (40M)	5150-5250	Low	5190	36.0520	42.023
		High	5230	36.0063	41.569
	5250-5350	Low	5270	35.9989	41.874
		High	5310	36.0111	42.021
	5470-5725	Low	5510	36.0151	41.991
		Mid	5590	35.9629	41.695
		High	5670	35.9684	41.718
		Straddle	5710	36.0555	41.996
	5725-5850	Low	5755	35.0257	41.858
		High	5795	35.9862	41.946
802.11ac (80M)	5150-5250	One	5210	75.2098	85.699
	5250-5350	One	5290	75.2531	85.205
	5470-5725	Low	5530	75.2074	85.434
		High	5610	75.1406	85.239
		Straddle	5690	75.2728	85.251
	5725-5850	One	5775	75.3226	85.851

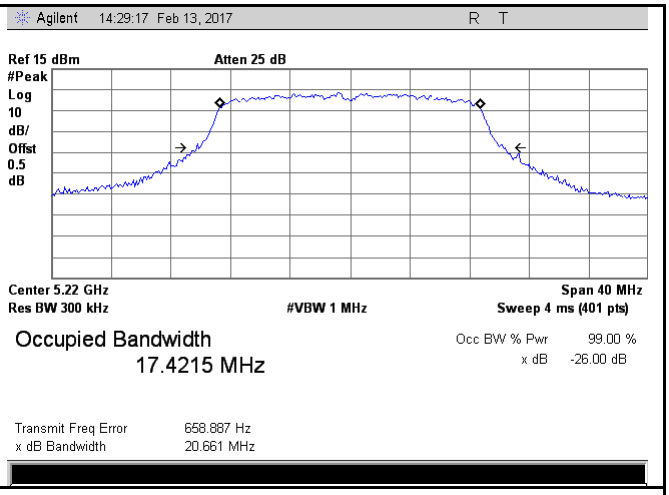
Test Plots

Bandwidth measurement result

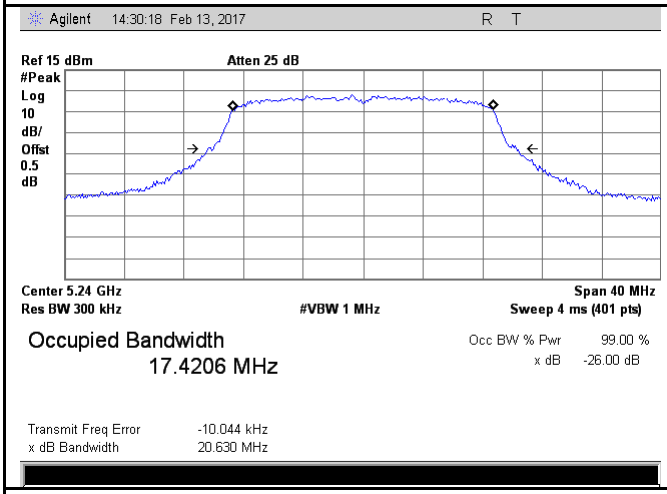
802.11ac (20M)



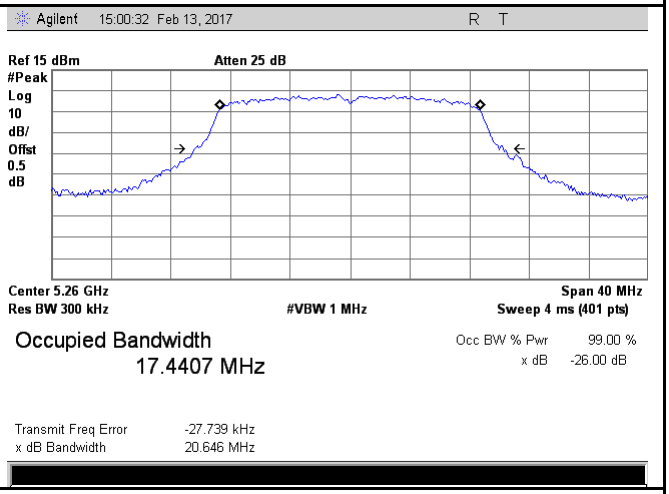
5150-5250MHz Bandwidth - Low CH 5180



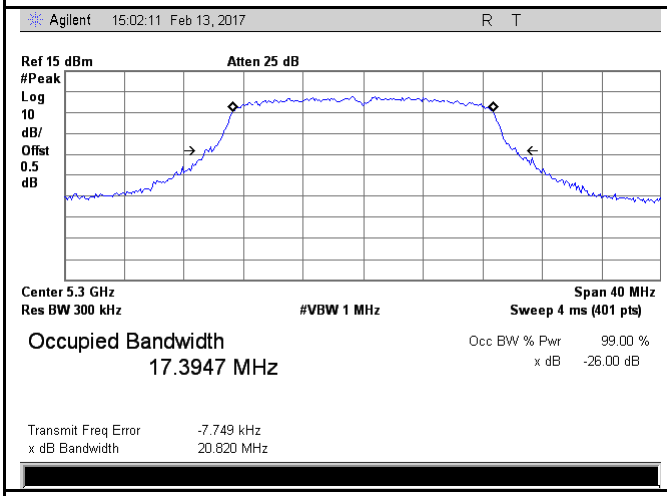
5150-5250MHz Bandwidth - Middle CH 5220



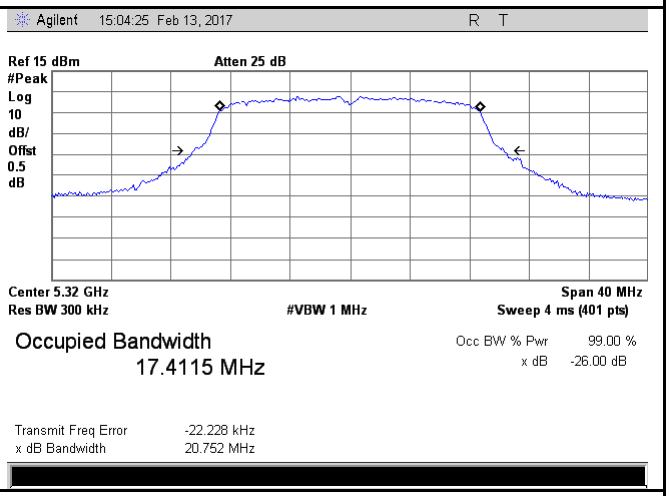
5150-5250MHz Bandwidth - High CH 5240



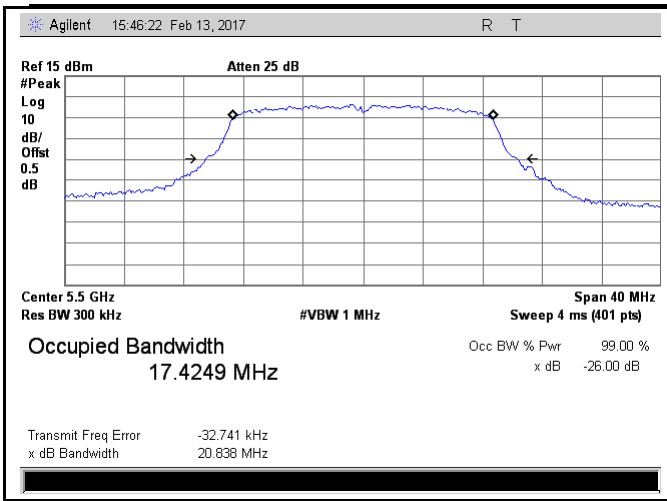
5250-5350MHz Bandwidth - Low CH 5260



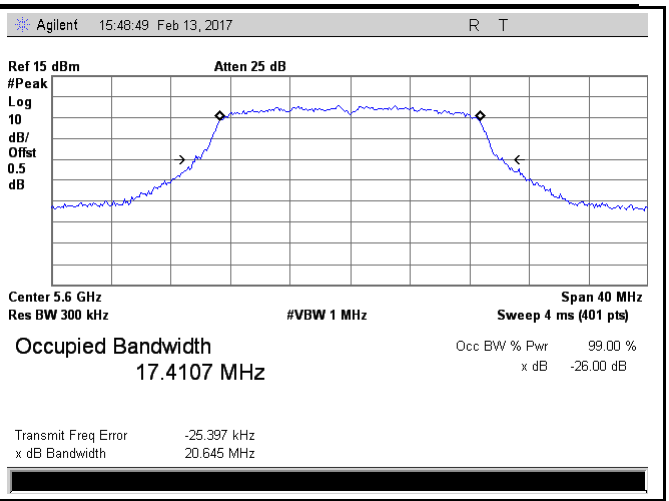
5250-5350MHz Bandwidth - Middle CH 5300



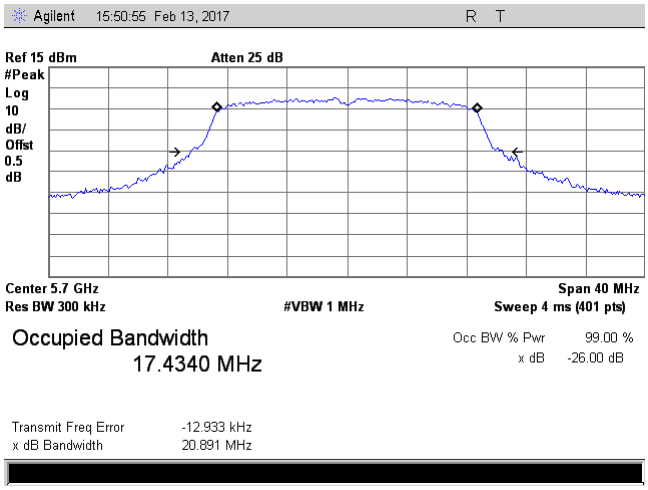
5250-5350MHz Bandwidth - High CH 5320



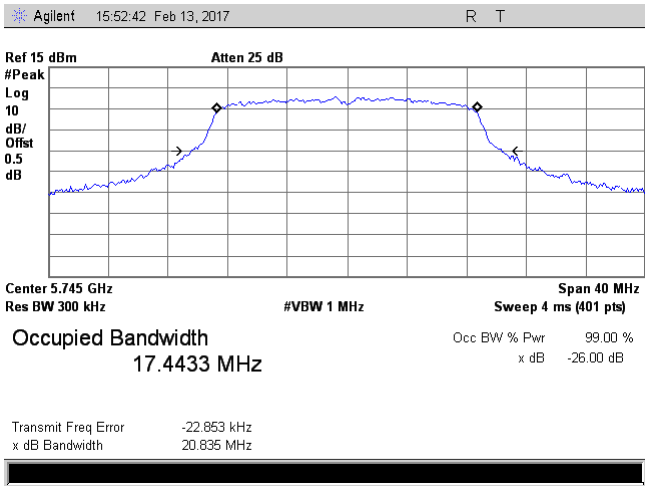
5470-5725MHz Bandwidth - Low CH 5500



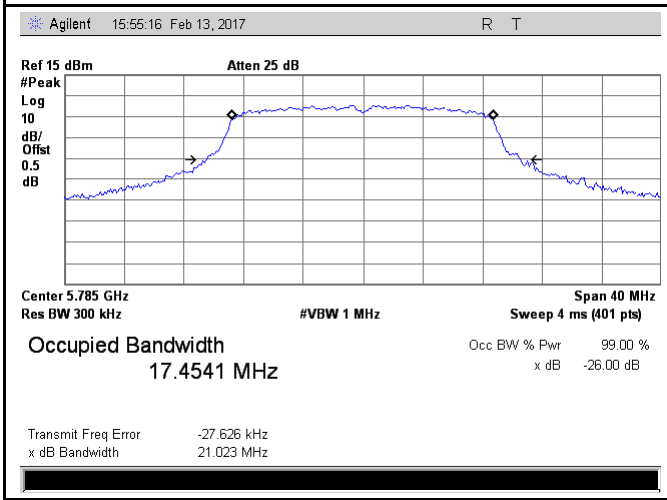
5470-5725MHz Bandwidth - Mid CH 5600



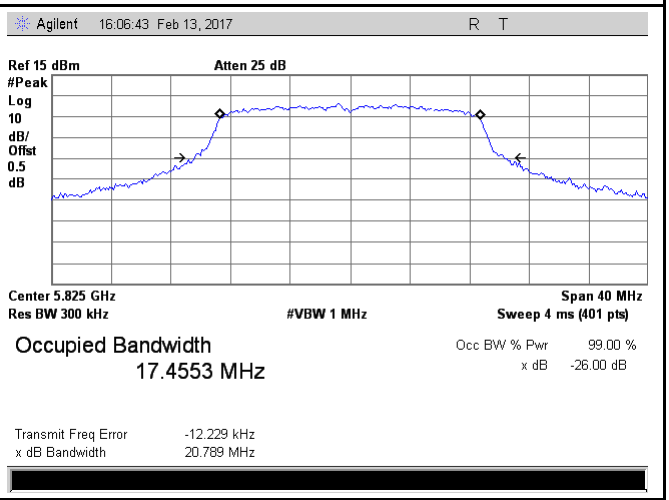
5470-5725MHz Bandwidth - High CH 5700



5725-5850MHz Bandwidth - Low CH 5745

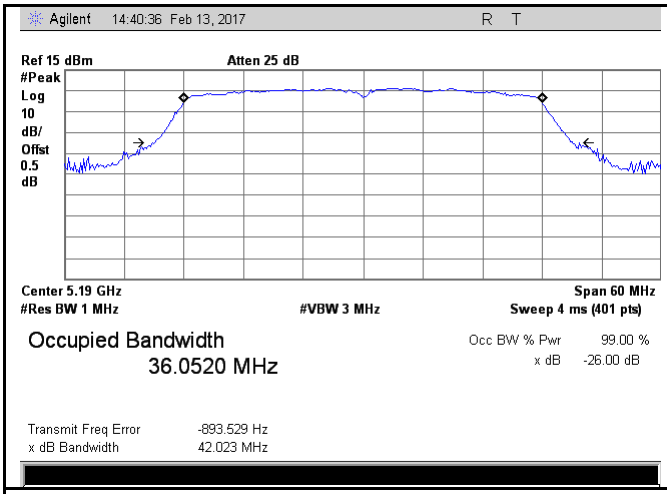


5725-5850MHz Bandwidth - Mid CH 5785

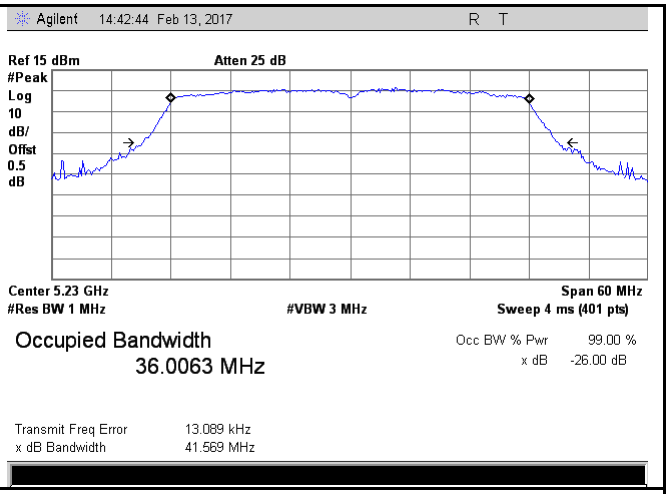


5725-5850MHz Bandwidth - High CH 5825

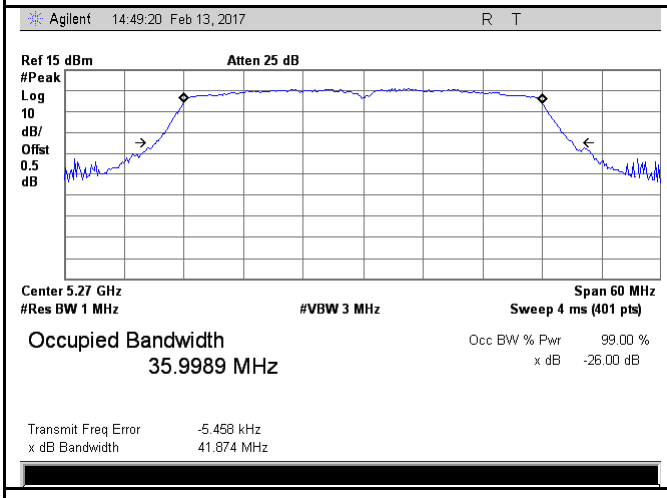
802.11ac (40M)



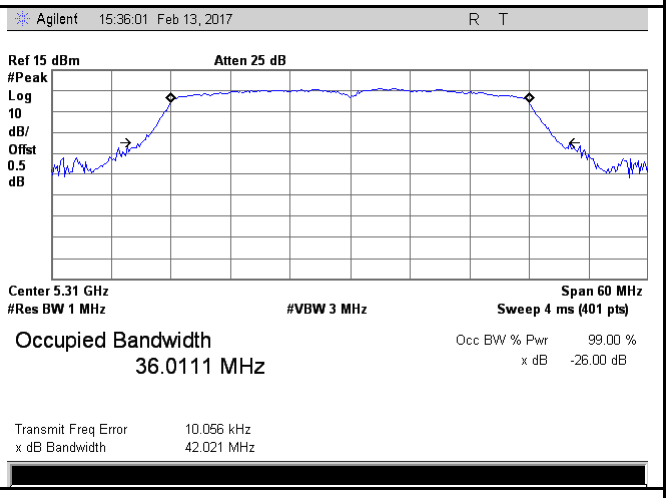
5150-5250MHz Bandwidth - Low CH 5190



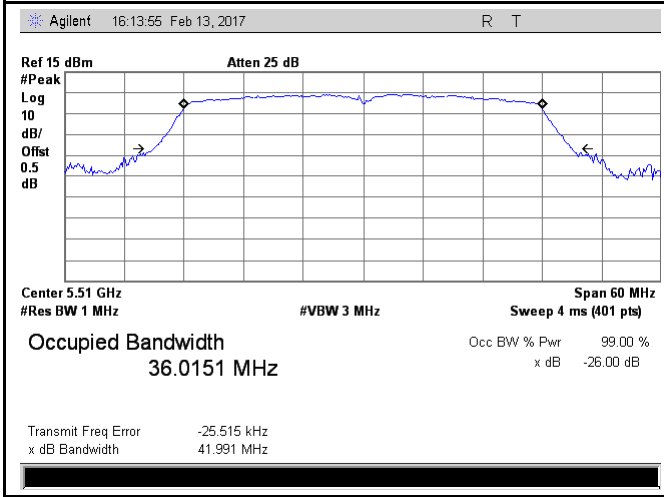
5150-5250MHz Bandwidth - High CH 5230



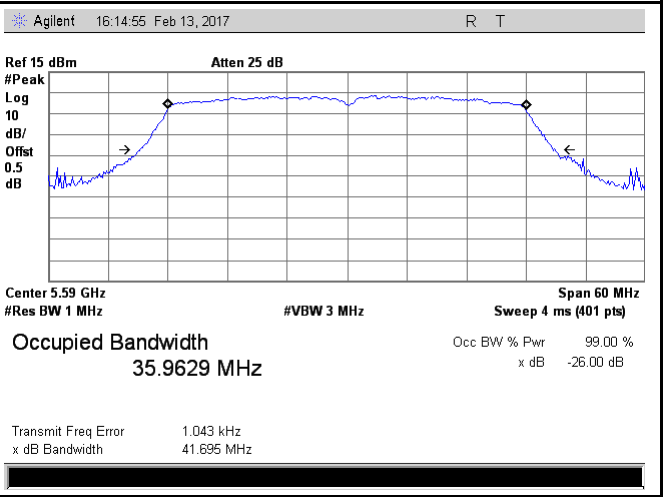
5250-5350MHz Bandwidth - Low CH 5270



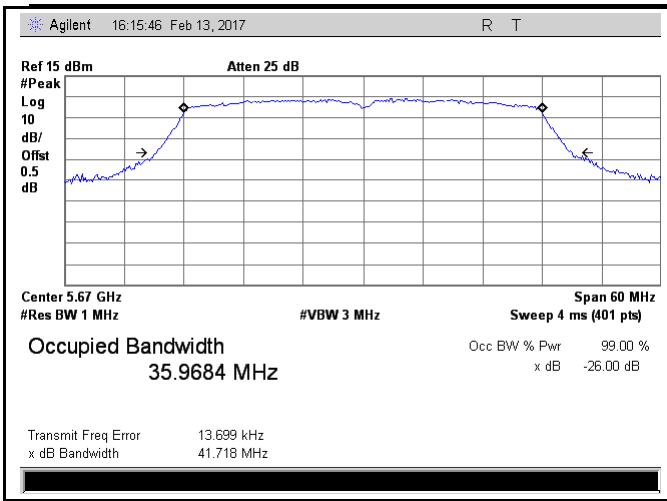
5250-5350MHz Bandwidth - High CH 5310



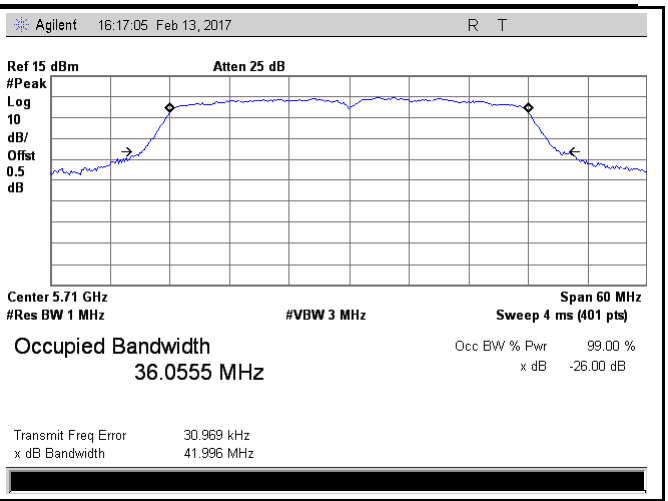
5470-5725MHz Bandwidth - Low CH 5510



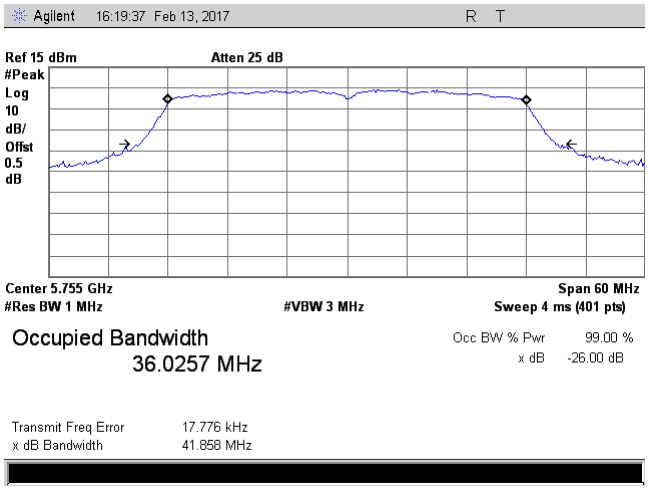
5470-5725MHz Bandwidth - Mid CH 5590



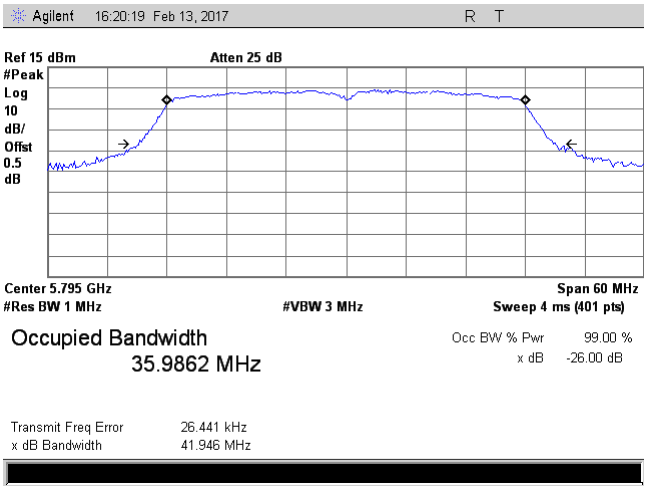
5470-5725MHz Bandwidth - High CH 5670



5470-5725MHz Bandwidth - Straddle CH 5710

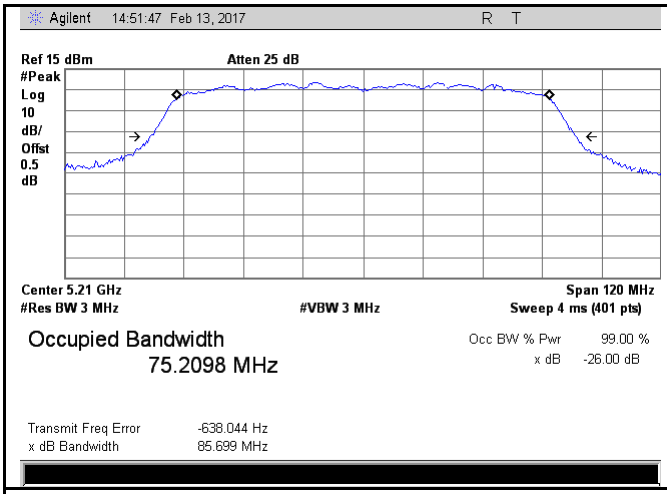


5725-5850MHz Bandwidth- Low CH 5755

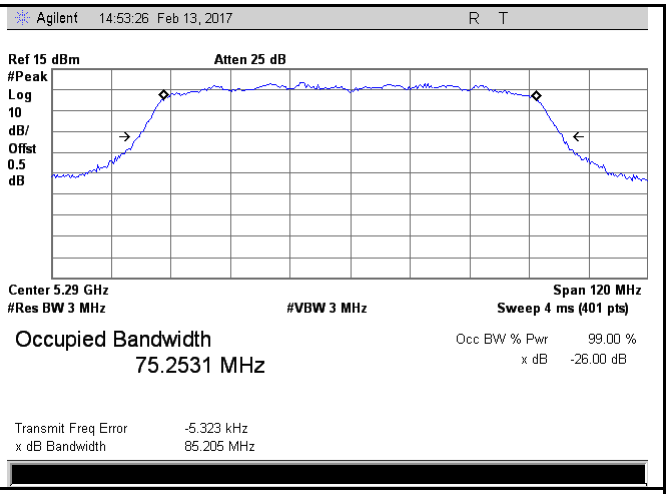


5725-5850MHz Bandwidth- High CH 5795

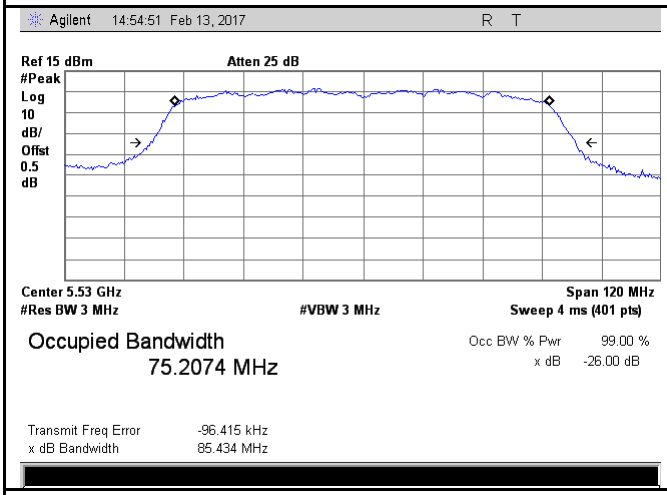
802.11ac (80M)



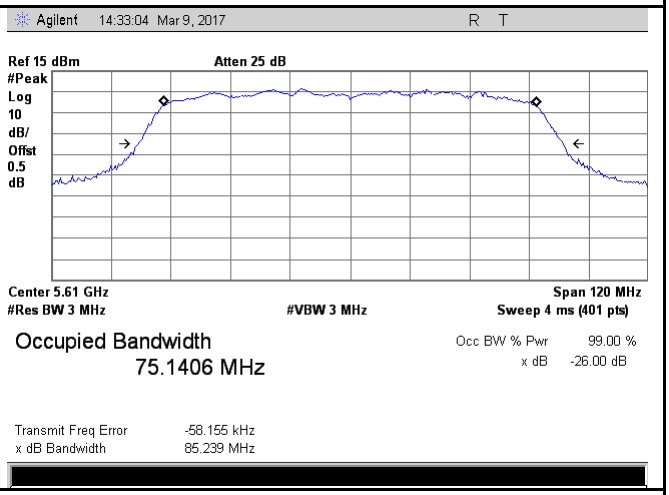
5150-5250MHz Bandwidth - One CH 5210



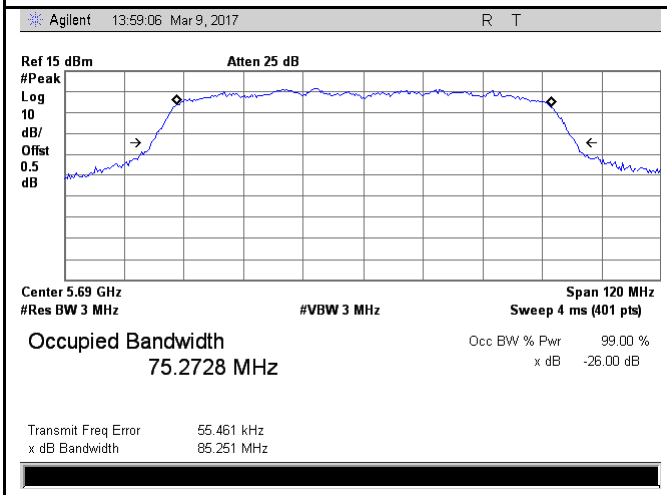
5250-5350MHz Bandwidth - Low CH 5290



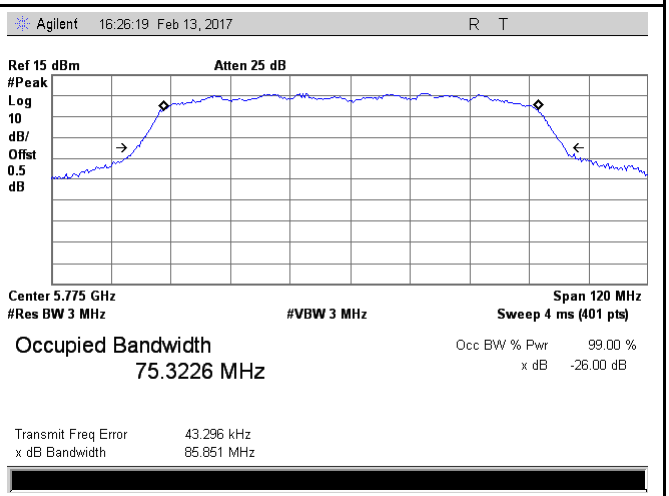
5470-5725MHz Bandwidth - Low CH 5530



5470-5725MHz Bandwidth - High CH 5610



5470-5725MHz Bandwidth - Straddle CH 5690



5725-5850MHz Bandwidth - One CH 5775

6.3 §15.407(a)-DTS (99% &6 dB) Channel Bandwidth

1. Conducted Measurement

   EUT was set for low, mid, high channel with modulated mode and highest RF output power.

   The spectrum analyzer was connected to the antenna terminal.

2. Environmental Conditions

Temperature	23℃
Relative Humidity	53%
Atmospheric Pressure	1012mbar

3. Conducted Emissions Measurement Uncertainty

   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 30MHz – 40GHz is ±1.5dB.

4. Test date : March 09, 2017

   Tested By : Leen Yang

Standard Requirement:

Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

Procedures:

99% &6 dB Bandwidth:

Section 15.407(e) specifies the minimum 6 dB emission bandwidth of at least 500 KHz for the band 5.715-5.85 GHz. The following procedure shall be used for measuring this bandwidth:

a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 × RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Note: The automatic bandwidth measurement capability of a spectrum analyzer or EMI receiver may be employed if it implements the functionality described above.

Emission Bandwidth (EBW)

1) Set RBW = approximately 1% of the emission bandwidth.

2) Set the VBW > RBW.

3) Detector = Peak.

4) Trace mode = max hold.

5) Measure the maximum width of the emission that is 26 dB down from the maximum of the emission. Compare this with the RBW setting of the analyzer. Readjust

Test Result: Pass.

Please refer to the following tables and plots.

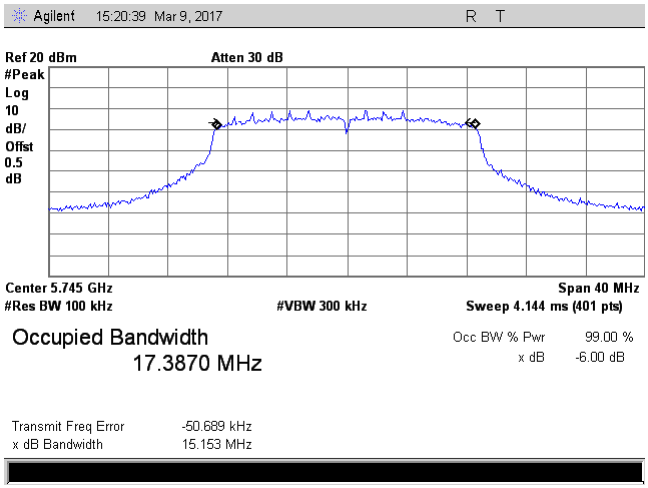
Measurement result

Test mode	Freq Band (MHz)	CH	Freq (MHz)	6dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
802.1ac (20M)	5725-5850	Low	5745	15.153	17.3870
		Mid	5785	15.486	17.3811
		High	5825	15.158	17.3903
802.1ac (40M)	5725-5850	Low	5755	35.284	35.6673
		High	5795	33.974	35.6884
802.1ac (80M)	5725-5850	One	5775	75.328	74.8610

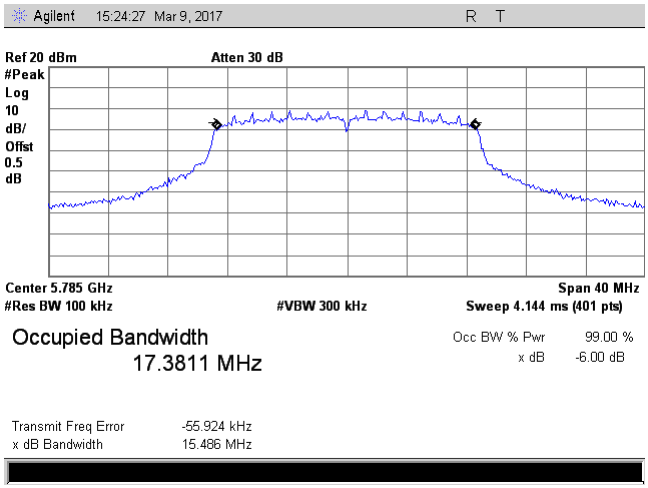
Test Plots (Bandwidth measurement result)

5725-5850MHz

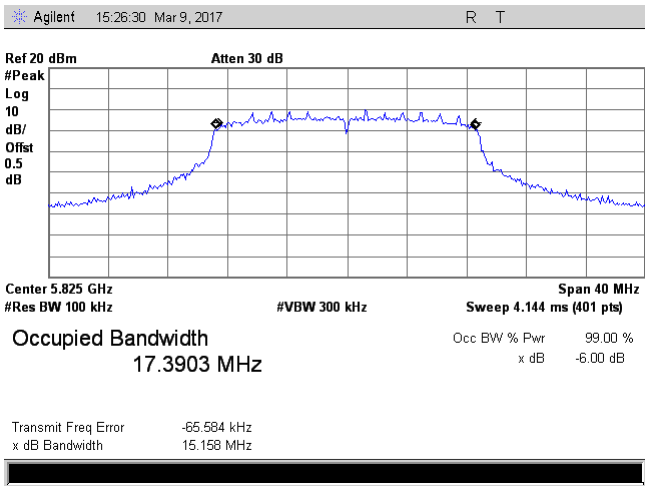
802.1ac (20M)



5725-5850MHz Bandwidth - Low CH 5745

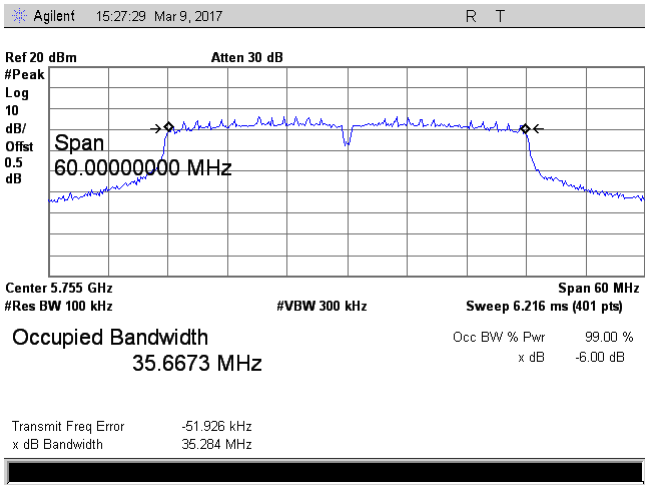


5725-5850MHz Bandwidth - Mid CH 5785

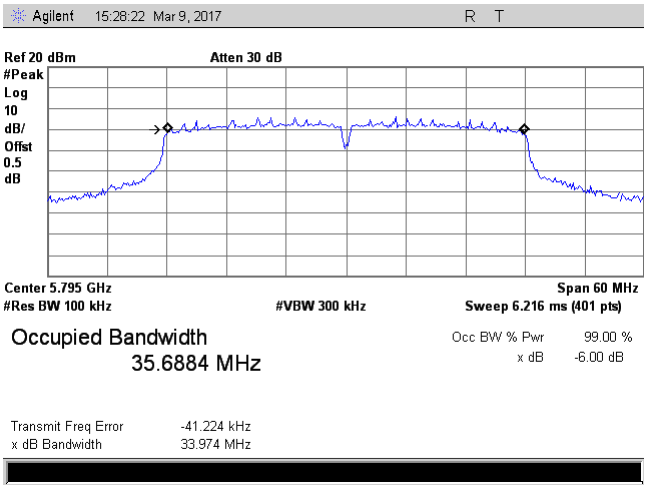


5725-5850MHz Bandwidth - High CH 5825

802.1ac (40M)

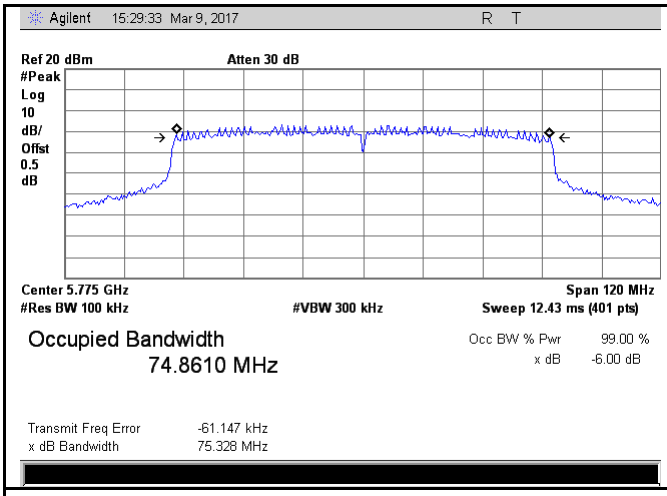


5725-5850MHz Bandwidth - Low CH 5755



5725-5850MHz Bandwidth - Low CH 5975

802.1ac (80M)



5725-5850MHz Bandwidth - One CH 5775

6.4 §15.407(a)-Conducted Maximum Output Power

1. Conducted Measurement
   EUT was set for low, mid, high channel with modulated mode and highest RF output power.
   The spectrum analyzer was connected to the antenna terminal.
2. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 30MHz – 40GHz is ±1.5dB.
3. Environmental Conditions

Temperature	22°C
Relative Humidity	53%
Atmospheric Pressure	1010mbar

4. Test date : February 13&March 09, 2017

   Tested By : Leen Yang

Standard Requirement:

For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. f transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of

operation shall not exceed 1 W.

If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Procedures:

Measurement Procedure Maximum conducted output power:

Maximum conducted output power may be measured using a spectrum analyzer/EMI receiver or an RF power meter.

1. Device Configuration

If possible, configure or modify the operation of the EUT so that it transmits continuously at its maximum power control level (see section II.B.).

a) The intent is to test at 100 percent duty cycle; however a small reduction in duty cycle (to no lower than 98 percent) is permitted if required by the EUT for amplitude control purposes. Manufacturers are expected to provide software to the test lab to permit such continuous operation.

b) If continuous transmission (or at least 98 percent duty cycle) cannot be achieved due to hardware limitations (e.g., overheating), the EUT shall be operated at its maximum power control level with the transmit duration as long as possible and the duty cycle as high as possible.

2. Measurement using a Power Meter (PM)

a) Method PM (Measurement using an RF average power meter):

(i) Measurements may be performed using a wideband RF power meter with a thermocouple detector or equivalent if all of the conditions listed below are satisfied.

- The EUT is configured to transmit continuously or to transmit with a constant duty cycle.
- At all times when the EUT is transmitting, it must be transmitting at its maximum power control level.

• The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

(ii) If the transmitter does not transmit continuously, measure the duty cycle, x, of the transmitter output signal as described in section II.B.
(iii) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
(iv) Adjust the measurement in dBm by adding 10 log(1/x) where x is the duty cycle (e.g., 10

log(1/0.25) if the duty cycle is 25 percent).

Test Result: Pass.

Please refer to the following tables and plots:

Output Power measurement result

Test mode	Freq Band (MHz)	CH	Frequency (MHz)	Conducted Power (dBm)	Duty factor (dB)	Conducted Power with D.F(dBm)	Limit (dBm)	Result
802.11ac (20M)	5150-5250	Low	5180	11.98	0.18	12.16	30	Pass
		Middle	5200	11.74	0.18	11.92	30	Pass
		High	5240	11.69	0.18	11.87	30	Pass
	5250-5350	Low	5260	11.95	0.18	12.13	23.98	Pass
		Middle	5300	12.03	0.18	12.21	23.98	Pass
		High	5320	11.79	0.18	11.97	23.98	Pass
	5470-5725	Low	5500	10.92	0.18	11.10	23.98	Pass
		Mid	5600	10.86	0.18	11.04	23.98	Pass
		High	5700	10.92	0.18	11.10	23.98	Pass
	5725-5850	Low	5745	11.07	0.18	11.25	30	Pass
		Mid	5785	11.00	0.18	11.18	30	Pass
		High	5825	11.05	0.18	11.23	30	Pass
802.1ac (40M)	5150-5250	Low	5190	10.90	0.36	11.26	30	Pass
		High	5230	11.14	0.36	11.50	30	Pass
	5250-5350	Low	5270	11.06	0.36	11.42	23.98	Pass
		High	5310	10.89	0.36	11.25	23.98	Pass
	5470-5725	Low	5510	10.70	0.36	11.06	23.98	Pass
		Mid	5590	10.45	0.36	10.81	23.98	Pass
		High	5670	10.54	0.36	10.90	23.98	Pass
		Straggle	5710	10.54	0.36	10.90	23.98	Pass
	5725-5850	Low	5755	9.49	0.36	9.85	30	Pass
		High	5795	9.57	0.36	9.93	30	Pass

802.11ac (80M)	5150-5250	One	5210	9.97	0.71	10.68	30	Pass
	5250-5350	One	5290	10.06	0.71	10.77	23.98	Pass
	5470-5725	Low	5530	10.15	0.71	10.86	23.98	Pass
		High	5610	9.89	0.71	10.60	23.98	Pass
		Straddle	5690	9.69	0.71	10.40	23.98	Pass
	5725-5850	One	5775	9.03	0.71	9.74	30	Pass

Note 1: Duty factor=10log(1/x), where x is the duty cycle.
For 20 MHz bandwidth, the duty cycle is 96%;
For 40 MHz bandwidth, the duty cycle is 92%;
For 80 MHz bandwidth, the duty cycle is 85%;

Note 2: The FC20 will be sold without antenna, it is no requirement that The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm) for an outdoor access point operating in the band 5.15-5.25 GHz,.

6.5 §15.407(a) - Power Spectral Density

1. Conducted Measurement

   EUT was set for low, mid, high channel with modulated mode and highest RF output power.

   The spectrum analyzer was connected to the antenna terminal.

2. Environmental Conditions

Temperature	22°C
Relative Humidity	55%
Atmospheric Pressure	1013mbar

3. Conducted Emissions Measurement Uncertainty

   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 30MHz – 40GHz is ±1.5dB.

4. Test date : February 15&March 09, 2017

   Tested By : Leen Yang

Standard Requirement:

The maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

The maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

The maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional

gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII
device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Procedures:

The rules requires " maximum power spectral density" measurements where the intent is to measure the maximum value of the time average of the power spectral density measured during a period of continuous transmission.

1. Create an average power spectrum for the EUT operating mode being tested by following the instructions in section II.E.2. for measuring maximum conducted output power using a spectrum analyzer or EMI receiver: select the appropriate test method (SA-1, SA-2, SA-3, or alternatives to each) and apply it up to, but not including, the step labeled, " Compute power…" . (This procedure is required even if the maximum conducted output power measurement was performed using a power meter, method PM.)

2. Use the peak search function on the instrument to find the peak of the spectrum and record its value.

3. Make the following adjustments to the peak value of the spectrum, if applicable:

a) If Method SA-2 or SA-2 Alternative was used, add 10 log(1/x), where x is the duty cycle, to the peak of the spectrum.

b) If Method SA-3 Alternative was used and the linear mode was used in step II.E.2.g)(viii), add 1 dB to the final result to compensate for the difference between linear averaging and power averaging.

4. The result is the Maximum PSD over 1 MHz reference bandwidth.

5. For devices operating in the bands 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.47-5.725 GHz, the above procedures make use of 1 MHz RBW to satisfy directly the 1 MHz reference bandwidth specified in § 15.407(a)(5). For devices operating in the band 5.725-5.85 GHz, the rules specify a measurement bandwidth of 500 kHz. Many spectrum analyzers do not have 500 kHz RBW, thus a narrower RBW may need to be used. The rules permit the use of a RBWs less than 1 MHz, or 500 kHz, " provided that the measured power is integrated over the full reference bandwidth" to show the total power over the specified measurement bandwidth (i.e., 1 MHz, or 500 kHz). If measurements are performed using a reduced resolution bandwidth (< 1 MHz, or < 500 kHz) and

integrated over 1 MHz, or 500 KHz bandwidth, the following adjustments to the procedures apply:

a) Set RBW ≥ 1/T, where T is defined in section II.B.I.a).

b) Set VBW ≥ 3 RBW.

c) If measurement bandwidth of Maximum PSD is specified in 500 kHz, add 10log(500kHz/RBW) to the measured result, whereas RBW (< 500 KHz) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.

d) If measurement bandwidth of Maximum PSD is specified in 1 MHz, add 10log(1MHz/RBW) to the measured result, whereas RBW (< 1 MHz) is the reduced resolution bandwidth of spectrum analyzer set during measurement.

e) Care must be taken to ensure that the measurements are performed during a period of continuous transmission or are corrected upward for duty cycle.

Note: As a practical matter, it is recommended to use reduced RBW of 100 KHz for the sections 5.c) and 5.d) above, since RBW=100 KHZ is available on nearly all spectrum analyzers.

Test Result: Pass.

Please refer to the following tables and plots.

Power Spectral Density measurement result

Test mode	Freq Band (MHz)	CH	Frequency (MHz)	Measured PSD (dBm)	Duty cycle factor (dB)	PSD (dBm)	Limit (dBm)	Result
802.11ac (20M)	5150-5250	Low	5180	9.172	0.18	9.35	17	Pass
		Middle	5220	9.160	0.18	9.34	17	Pass
		High	5240	8.721	0.18	8.90	17	Pass
	5250-5350	Low	5260	8.660	0.18	8.84	11	Pass
		Middle	5300	8.418	0.18	8.60	11	Pass
		High	5320	8.359	0.18	8.54	11	Pass
	5470-5725	Low	5500	7.355	0.18	7.54	11	Pass
		Mid	5600	7.023	0.18	7.20	11	Pass
		High	5700	6.243	0.18	6.42	11	Pass
	5725-5850	Low	5745	6.449	0.18	6.63	30	Pass
		Mid	5785	6.567	0.18	6.75	30	Pass
		High	5825	7.303	0.18	7.48	30	Pass
802.1ac (40M)	5150-5250	Low	5190	6.291	0.36	6.65	17	Pass
		High	5230	6.229	0.36	6.59	17	Pass
	5250-5350	Low	5270	6.296	0.36	6.66	11	Pass
		High	5310	6.049	0.36	6.41	11	Pass
	5470-5725	Low	5510	3.886	0.36	4.25	11	Pass
		Mid	5590	4.015	0.36	4.38	11	Pass
		High	5670	4.103	0.36	4.46	11	Pass
		Straggle	5710	4.352	0.36	4.71	11	Pass
	5725-5850	Low	5755	3.762	0.36	4.12	30	Pass
		High	5795	4.172	0.36	4.53	30	Pass

802.11ac (80M)	5150-5250	One	5210	9.661	0.71	10.37	17	Pass
	5250-5350	One	5290	8.530	0.71	9.24	11	Pass
	5470-5725	Low	5530	0.313	0.71	1.023	11	Pass
		High	5610	-0.168	0.71	0.542	11	Pass
		Straggle	5690	0.268	0.71	0.978	11	Pass
	5725-5850	One	5775	3.762	0.71	4.47	30	Pass

Note: Duty factor=10log(1/x), where x is the duty cycle.

For 20 MHz bandwidth, the duty cycle is 96%;

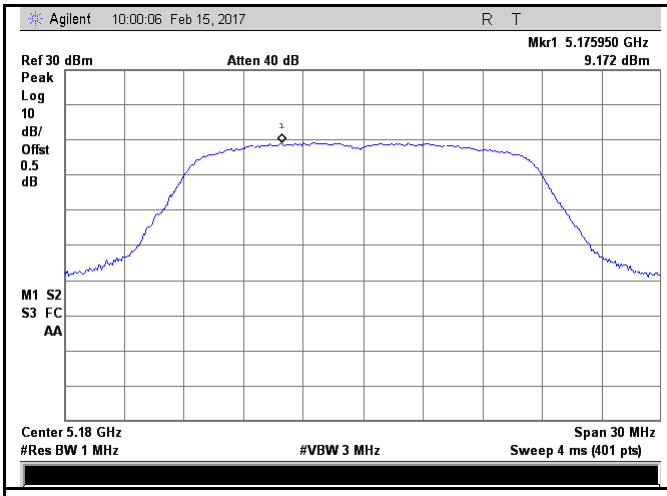
For 40 MHz bandwidth, the duty cycle is 92%;

For 80 MHz bandwidth, the duty cycle is 85%;

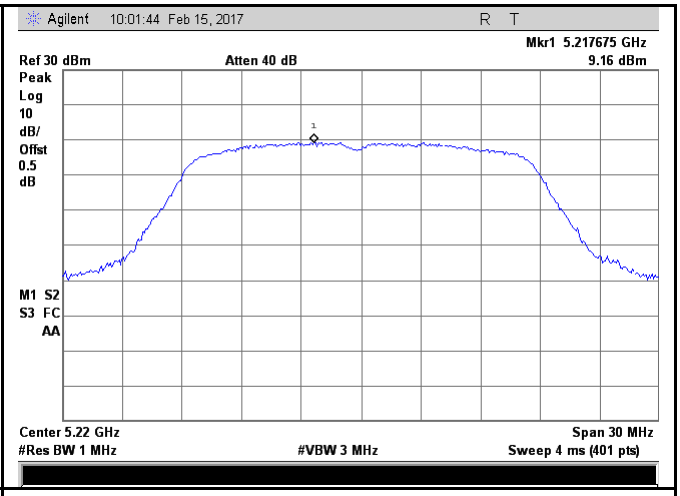
Test Plots

Power Spectral Density measurement result Test Plots

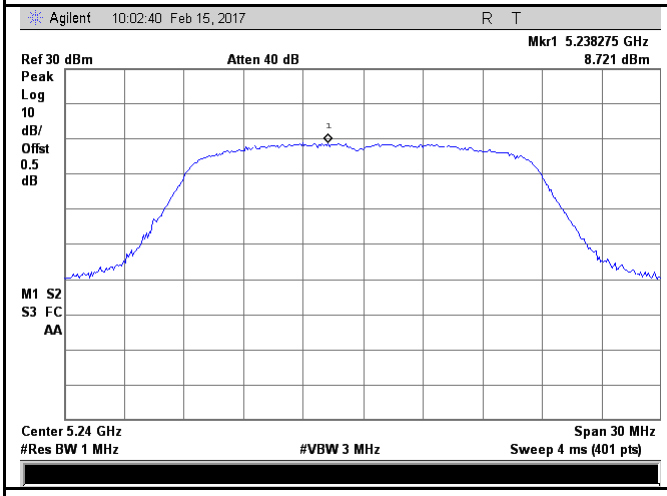
802.11ac (20M)



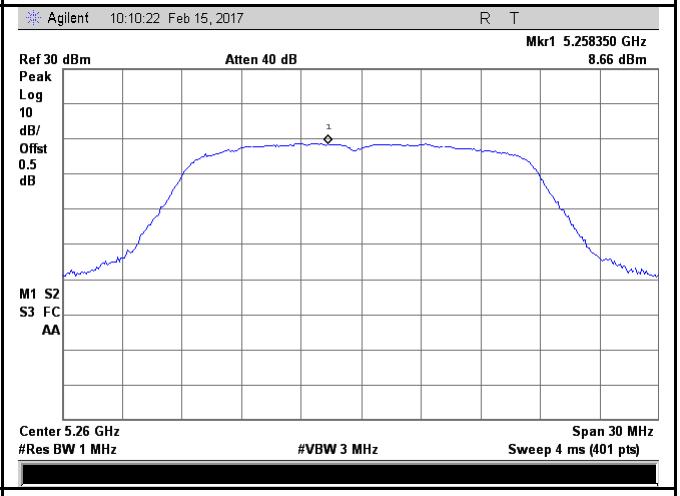
5150-5250MHz PSD - Low CH 5180



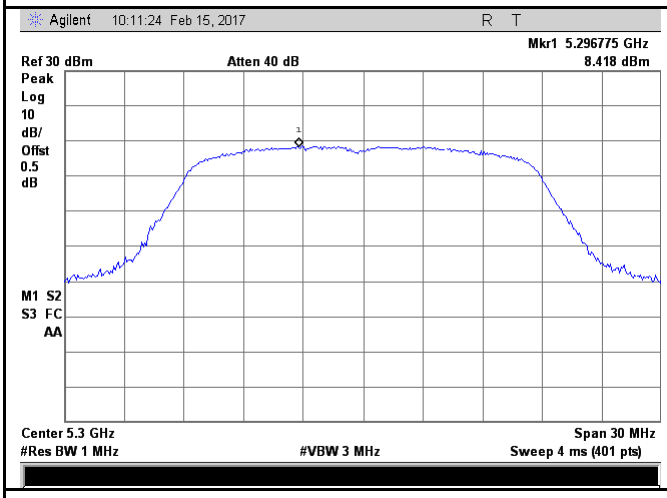
5150-5250MHz PSD - Middle CH 5220



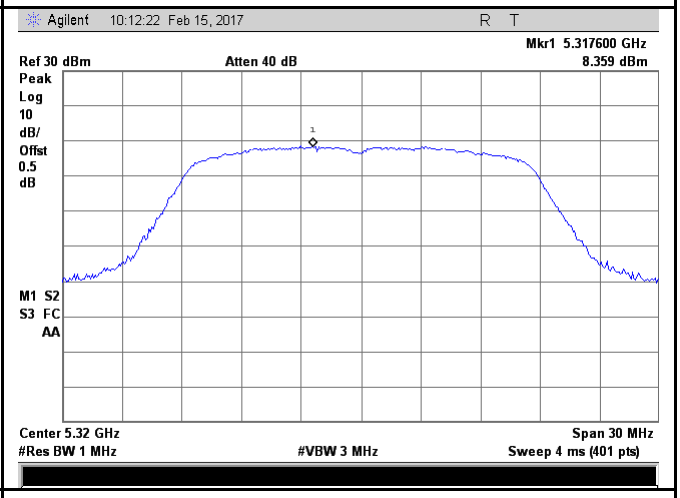
5150-5250MHz PSD - High CH 5240



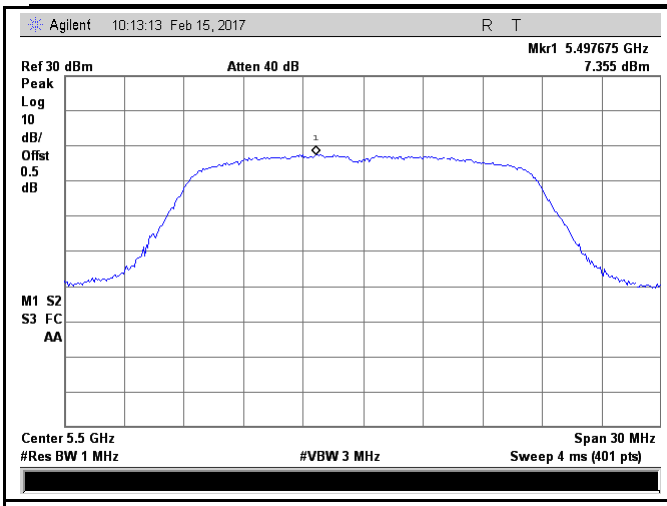
5250-5350MHz PSD - Low CH 5260



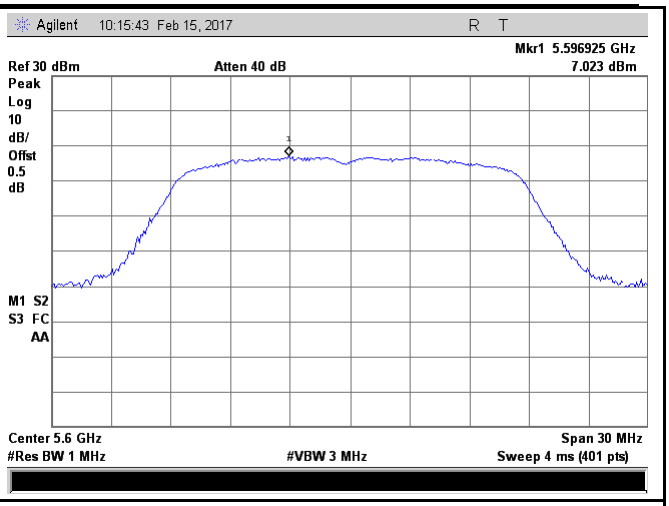
5250-5350MHz PSD - Middle CH 5300



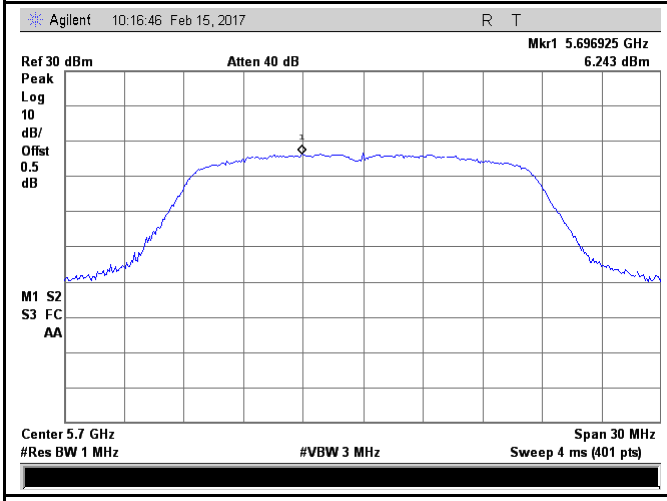
5250-5350MHz PSD - High CH 5320



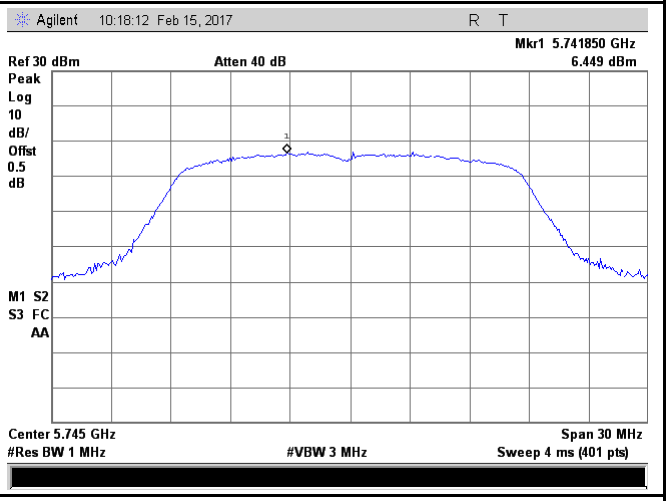
5470-5725MHz PSD - Low CH 5500



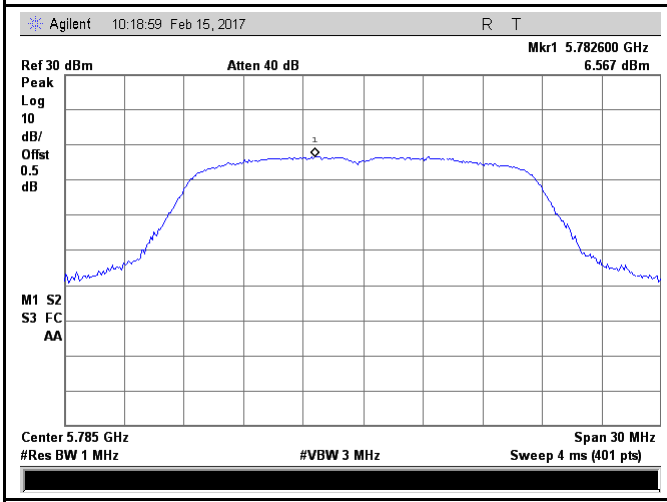
5470-5725MHz PSD - Mid CH 5600



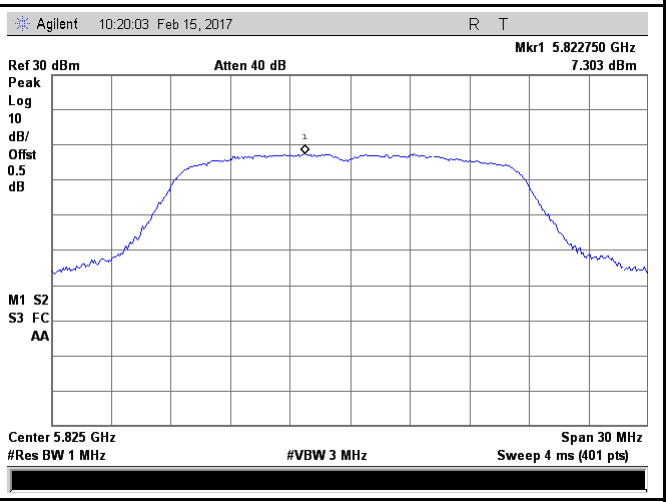
5470-5725MHz PSD - High CH 5700



5725-5850MHz PSD - Low CH 5745

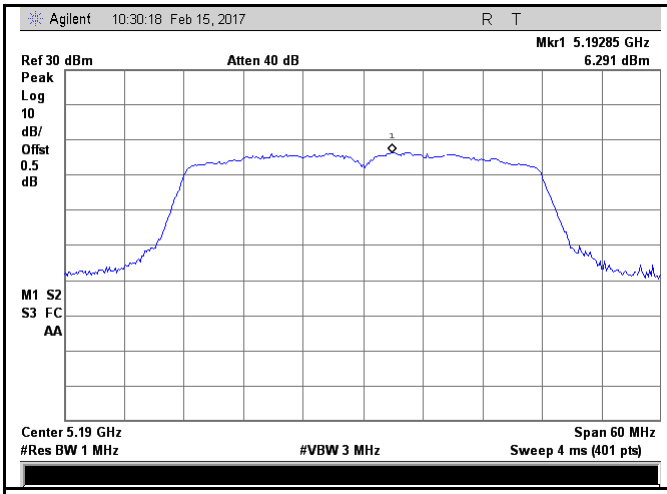


5725-5850MHz PSD - Mid CH 5785

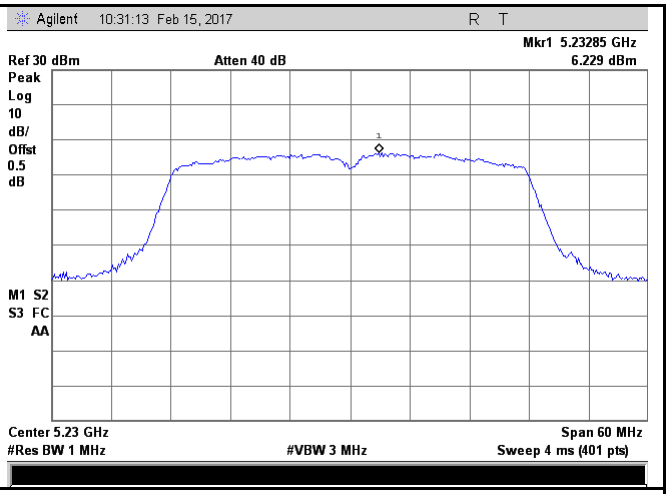


5725-5850MHz PSD - High CH 5825

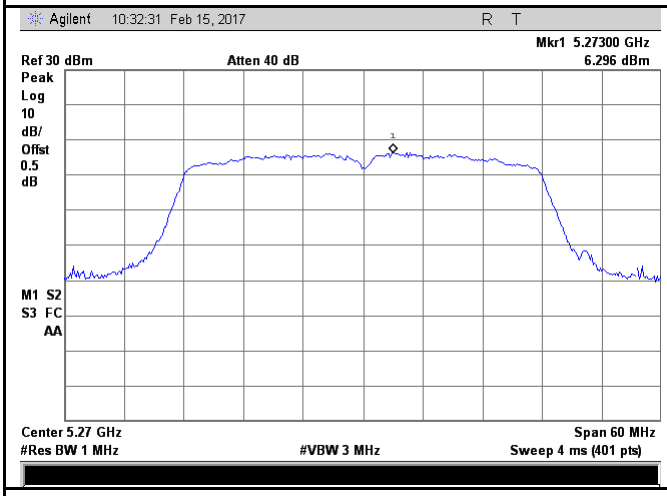
802.11ac (40M)



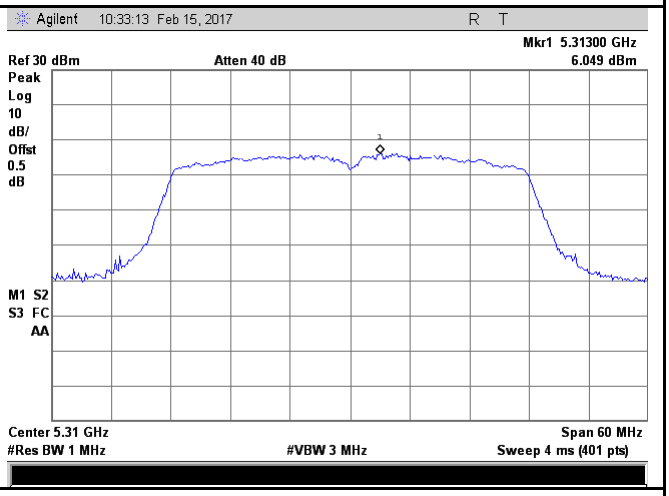
5150-5250MHz PSD - Low CH 5190



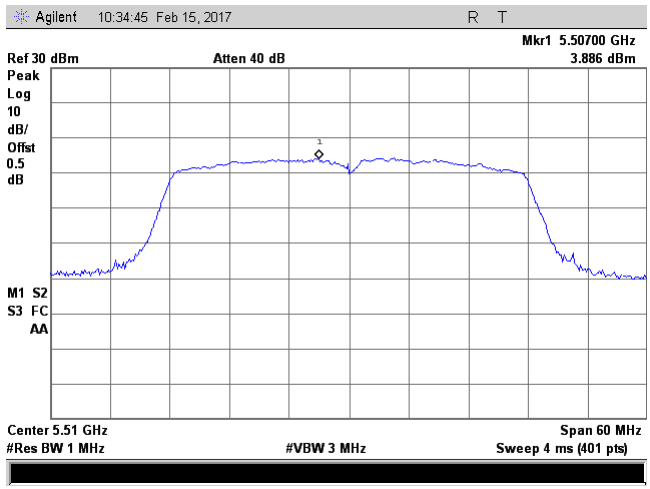
5150-5250MHz PSD - High CH 5230



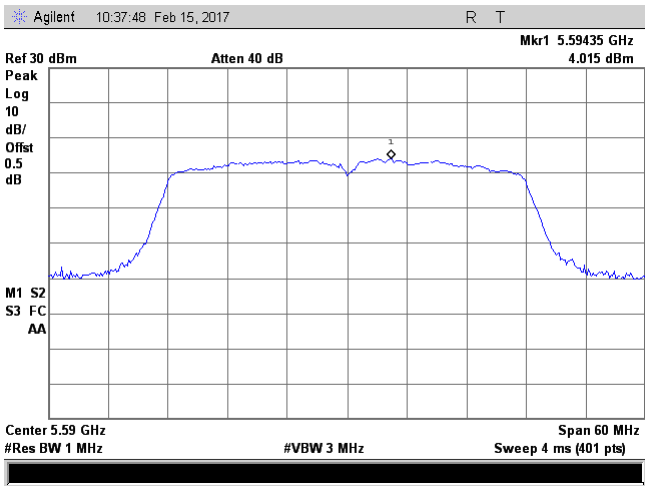
5250-5350MHz PSD - Low CH 5270



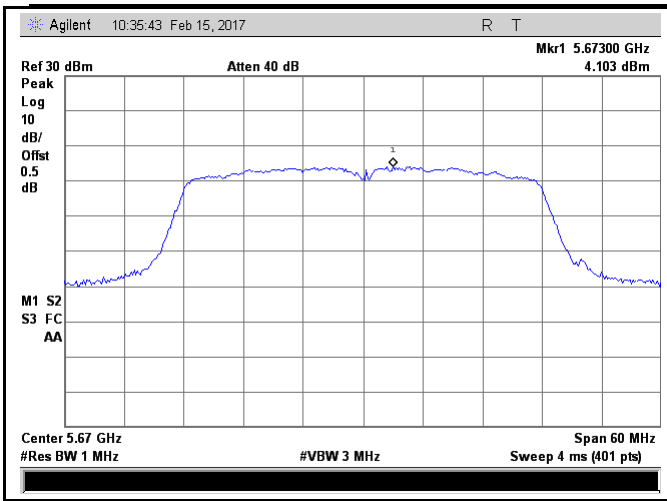
5250-5350MHz PSD - High CH 5310



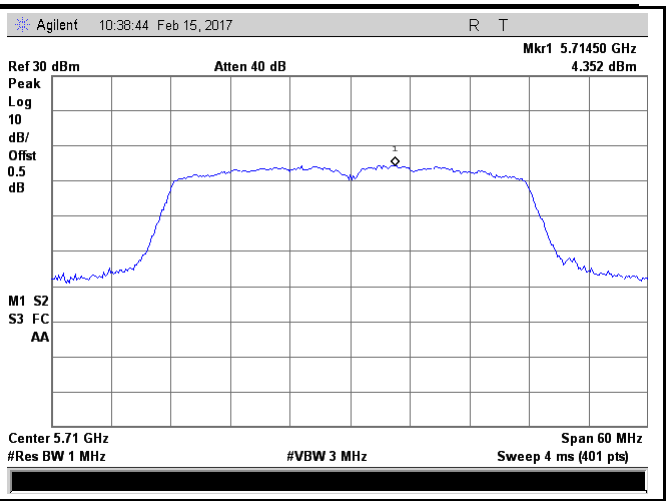
5470-5725MHz PSD - Low CH 5510



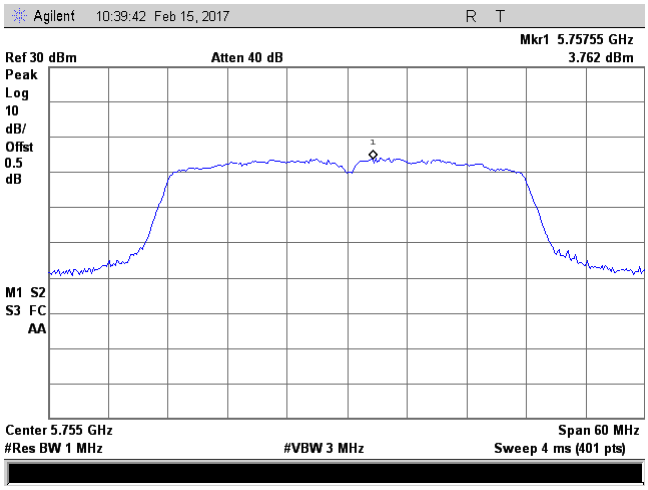
5470-5725MHz PSD - Mid CH 5590



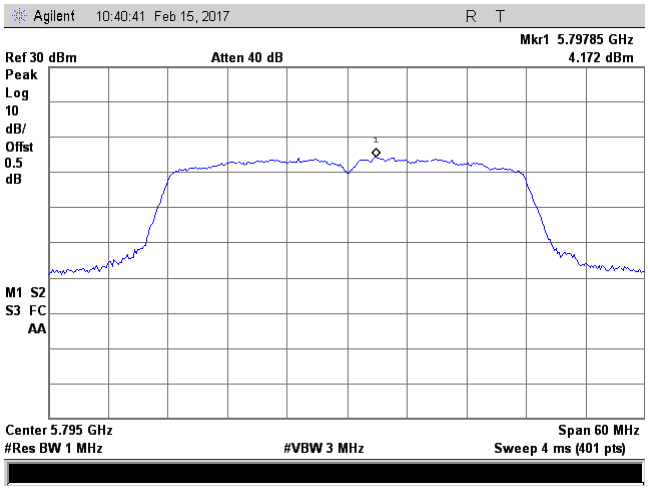
5470-5725MHz PSD - High CH 5670



5470-5725MHz PSD - Straddle CH 5710

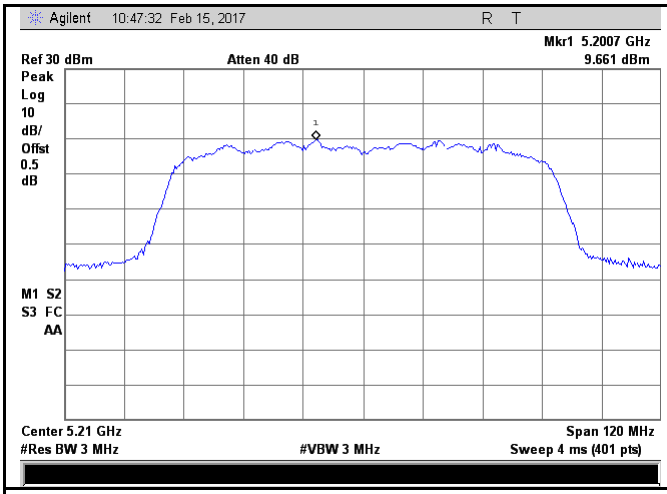


5725-5850MHz PSD - Low CH 5755

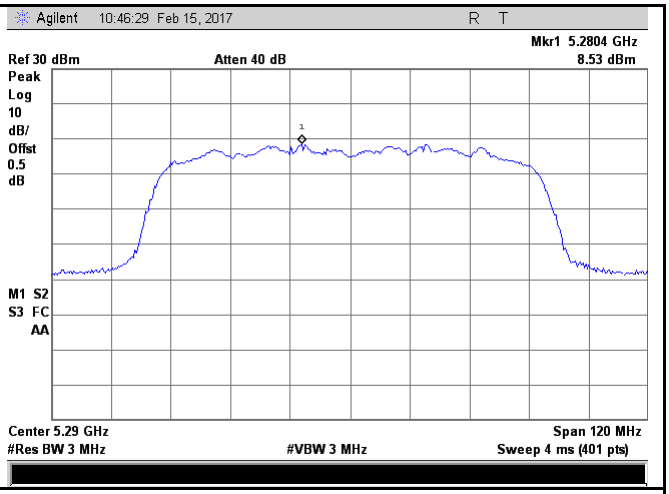


5725-5850MHz PSD - High CH 5795

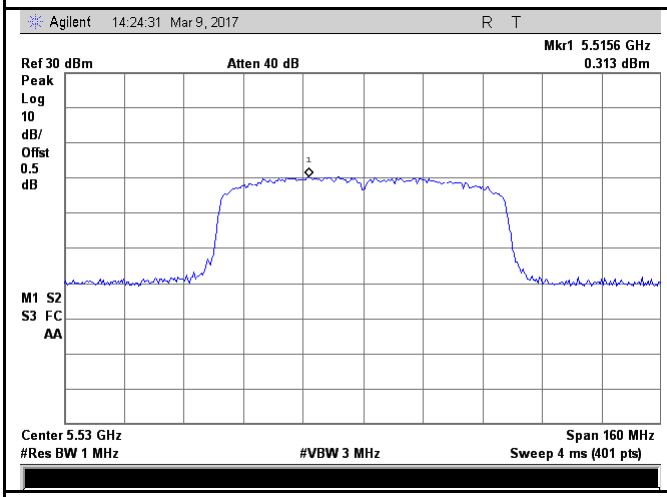
802.11ac (80M)



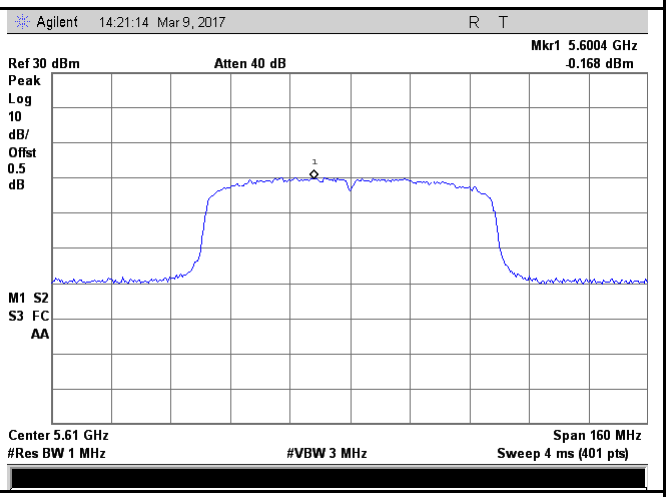
5150-5250MHz PSD - One CH 5210



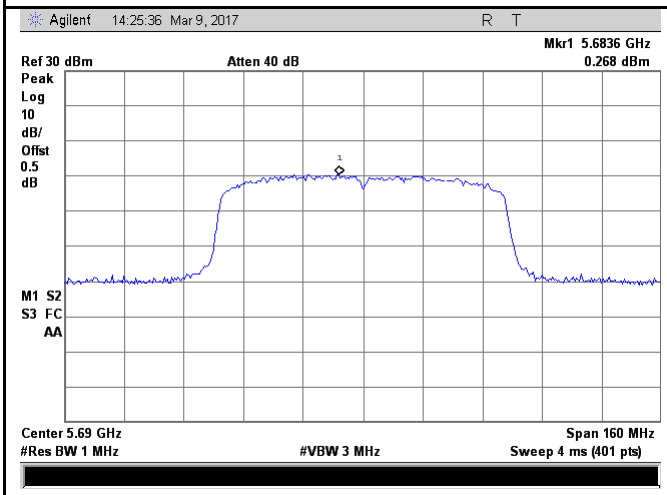
5250-5350MHz PSD - One CH 5290



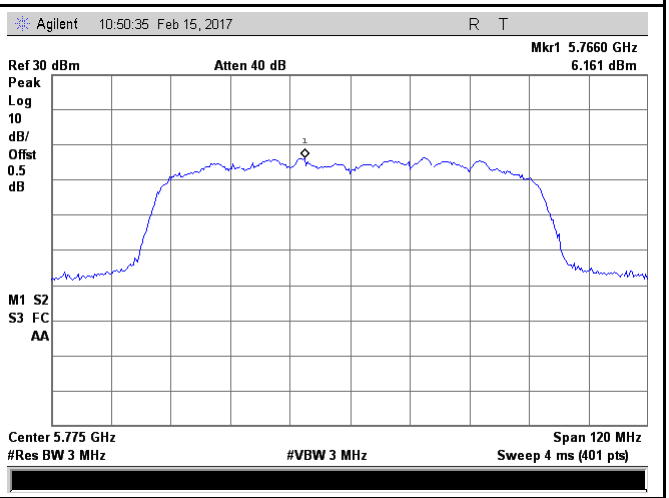
5470-5725MHz PSD - One CH 5530



5470-5725MHz PSD - One CH 5610



5470-5725MHz PSD - Straddle CH 5690



5725-5850MHz PSD - One CH 5775

6.6 §15.407(1) and b(4) Band-Edge

1. Conducted Measurement

   EUT was set for low, mid, high channel with modulated mode and highest RF output power.

   The spectrum analyzer was connected to the antenna terminal.

2. Environmental Conditions

Temperature	22°C
Relative Humidity	55%
Atmospheric Pressure	1013mbar

3. Conducted Emissions Measurement Uncertainty

   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 30MHz – 40GHz is ±1.5dB.

4. Test date : February 15, 2017

   Tested By : Leen Yang

Standard Requirement:

(b) Undesirable emission limits. Except as shown in paragraph (b)(7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(1) For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of − 27 dBm/MHz.

(2) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of − 27 dBm/MHz.

(3) For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of − 27 dBm/MHz.

(4) For transmitters operating in the 5.725-5.85 GHz band:

Procedures:

Measurement Procedure Band edge:

Bandedge are measured by setting the analyzer as follows:

(i) RBW = 1 MHz.

(ii) VBW ≥ 3 MHz.

(iii) Detector = Peak.

(iv) Sweep time = auto.

(v) Trace mode = max hold.

(vi) Allow sweeps to continue until the trace stabilizes. Note that if the transmission is not continuous, the time required for the trace to stabilize will increase by a factor of approximately 1/x, where x is the duty cycle. For example, at 50 percent duty cycle, the measurement time will increase by a factor of two relative to measurement time for continuous transmission.

Unwanted band-edge emissions may be measured using either of the special band-edge measurement techniques (the marker-delta or integration methods) described below. Note that the marker-delta method is primarily a radiated measurement technique that requires the 99% occupied bandwidth edge to be within 2 MHz of the authorized band edge, whereas the integration method can be used in either a radiated or conducted measurement without any special requirement with regards to the displacement of the unwanted emission(s) relative to the authorized bandwidth.

(i) Marker-Delta Method.

The marker-delta method, as described in ANSI C63.10, can be used to perform measurements of the radiated unwanted emissions level of emissions provided that the 99% occupied bandwidth of the fundamental is within 2 MHz of the authorized band-edge..

(ii) Integration Method •

For maximum emissions measurements, follow the procedures described in section II.G.5., " Procedures for Unwanted Maximum Emissions Measurements above 1000 MHz" , except for the following changes:

◦ Set RBW = 100 kHz

◦ Set VBW ≥ 3 • RBW

◦ Perform a band-power integration across the 1 MHz bandwidth in which the band-edge emission level is to be measured. CAUTION: You must ensure that the spectrum analyzer or EMI

receiver is set for peak-detection and max-hold for this measurement.

• For average emissions measurements, follow the procedures described in section II.G.6., " Procedures for Average Unwanted Emissions Measurements above 1000 MHz" , except for the following changes:

◦ Set RBW = 100 kHz

◦ Set VBW ≥ 3 • RBW

◦ Perform a band-power integration across the 1 MHz bandwidth in which the band-edge emission level is to be measured.

Test Result: Pass.

Please refer to the following tables and plots.

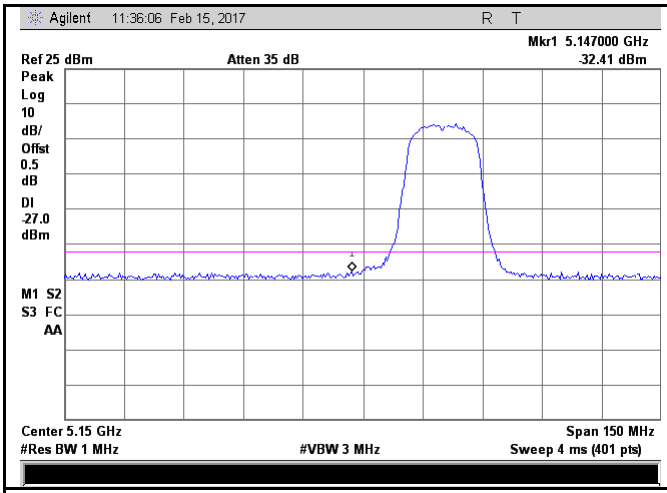
Band edge measurement result

Test mode	Freq Band (MHz)	CH	Frequency (MHz)	Measured Bandedge (dBm)	Limit (dBm)	Result
802.11ac (20M)	5150-5350	Low	5150	-32.41	-27	Pass
		High	5350	-33.20	-27	Pass
	5470-5725	Low	5470	-32.81	-27	Pass
		High	5725	-33.39	-27	Pass
	5725-5850	Low	5725	-33.32	-27	Pass
		High	5775	-33.78	-27	Pass
802.1ac (40M)	5150-5350	Low	5150	-32.78	-27	Pass
		High	5350	-32.87	-27	Pass
	5470-5725	Low	5470	-32.49	-27	Pass
		High	5725	-33.55	-27	Pass
	5725-5850	Low	5725	-32.97	-27	Pass
		High	5850	-33.57	-27	Pass
802.1ac (80M)	5150-5350	Low	5150	-30.84	-27	Pass
		High	5350	-33.40	-27	Pass
	5470-5725	Low	5470	-31.25	-27	Pass
		High	5725	-32.94	-27	Pass
	5725-5850	Low	5725	-32.24	-27	Pass
		High	5850	-32.71	-27	Pass

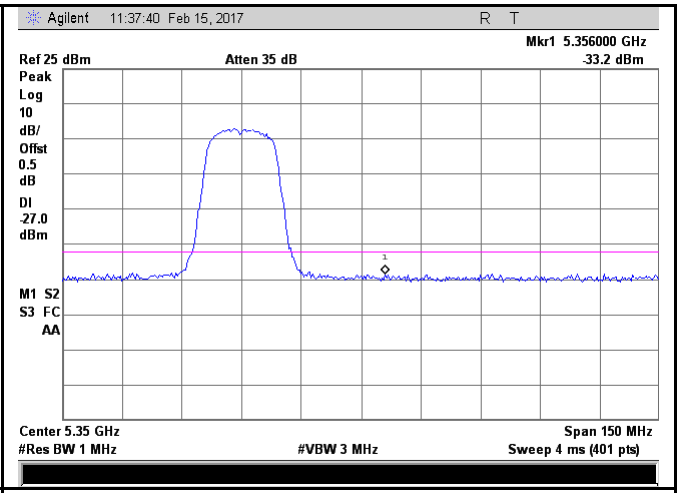
Test Plots

Band Edge measurement result

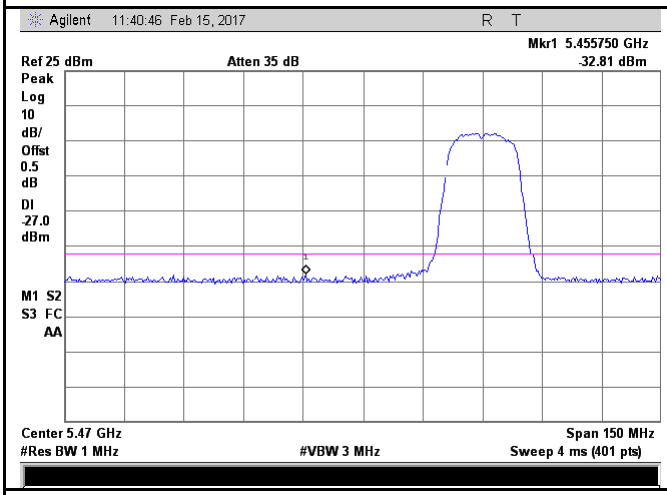
802.11ac (20M)



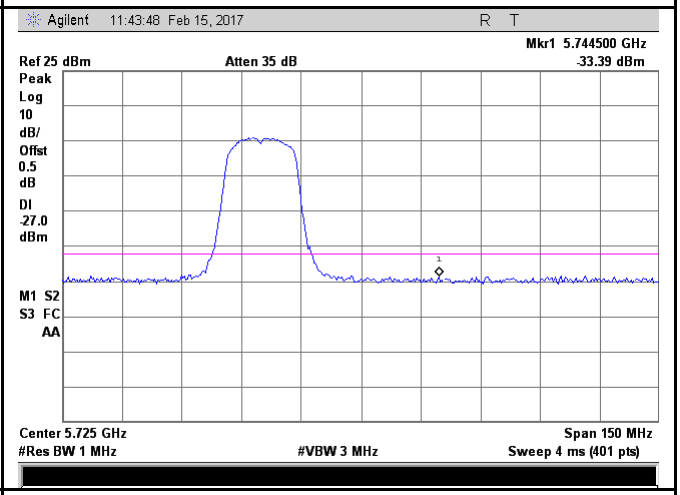
5150-5350MHz Band Edge - Low CH 5150



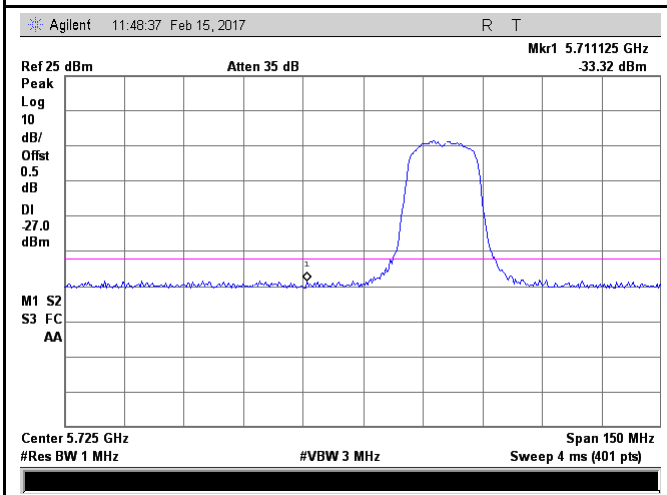
5150-5350MHz Band Edge - High CH 5350



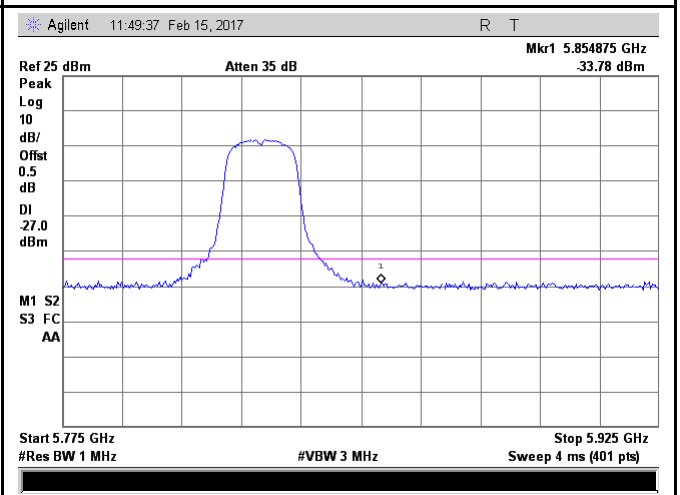
5470-5725MHz Band Edge - Low CH 5470



5470-5725MHz Band Edge - High CH 5725

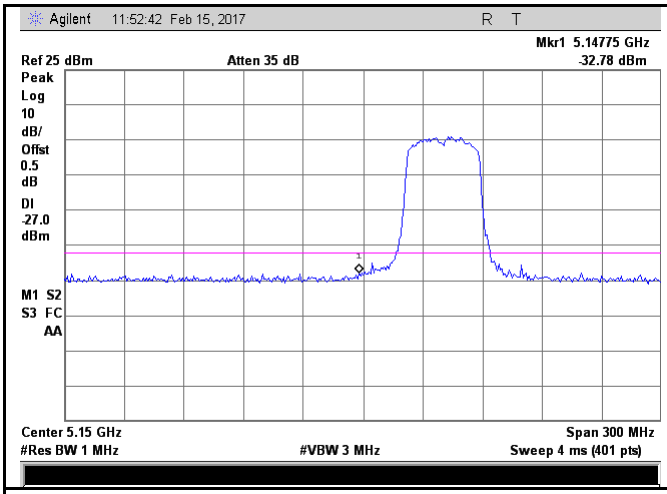


5725-5850MHz Band Edge - Low CH 5725

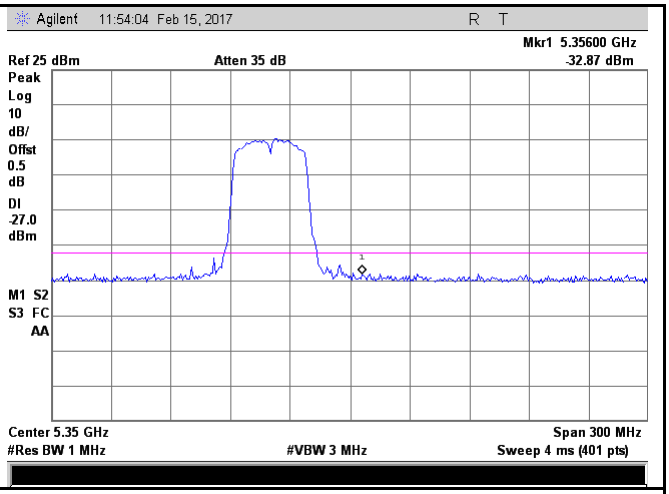


5725-5850MHz Band Edge - High CH 5775

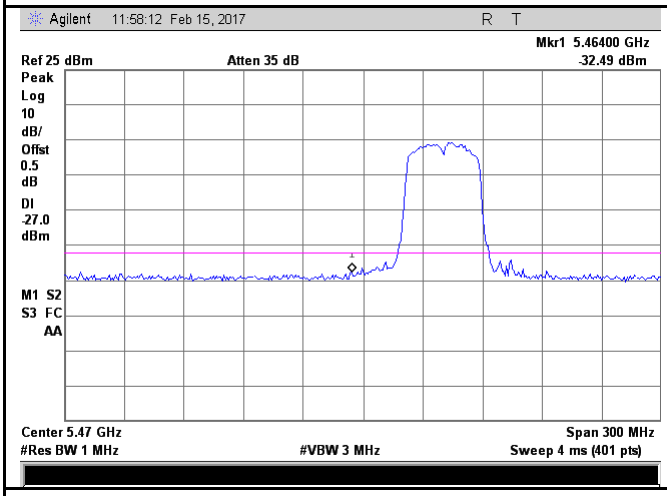
802.11ac (40M)



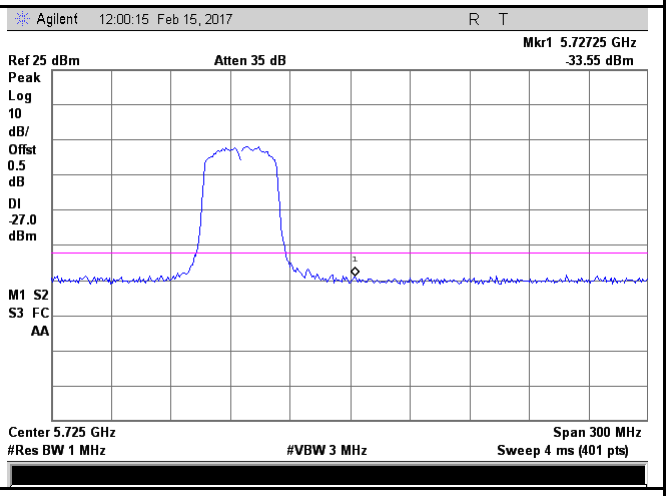
5150-5350MHz Band Edge - Low CH 5150



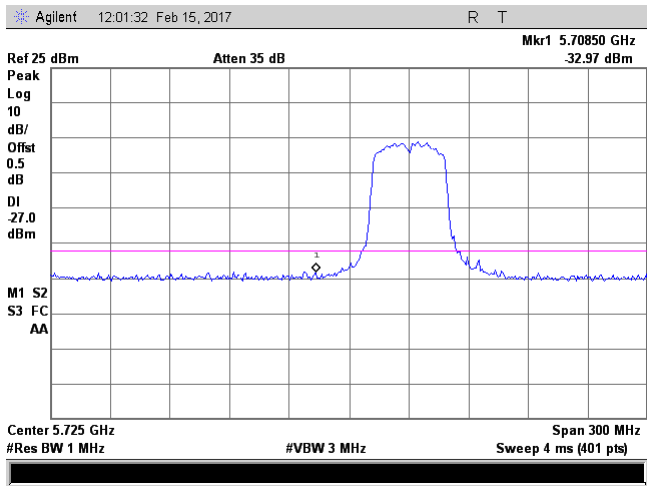
5150-5350MHz Band Edge - High CH 5350



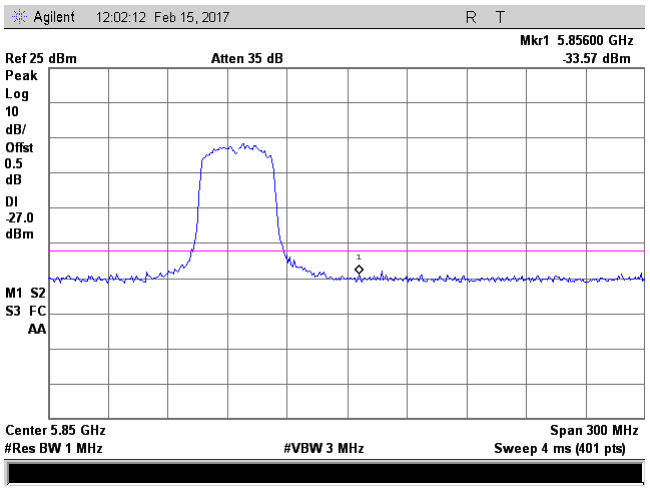
5470-5725MHz Band Edge - Low CH 5470



5470-5725MHz Band Edge - High CH 5725

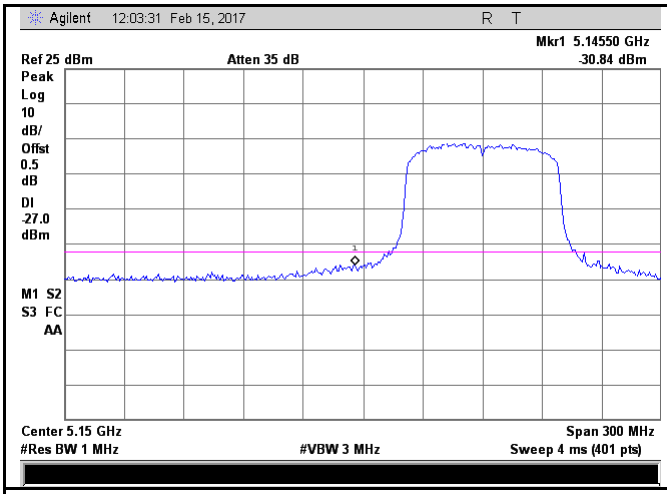


5725-5850MHz Band Edge - Low CH 5725

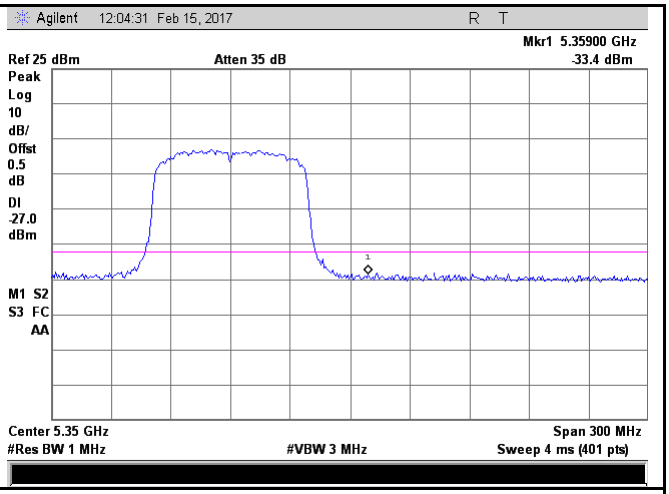


5725-5850MHz Band Edge - High CH 5850

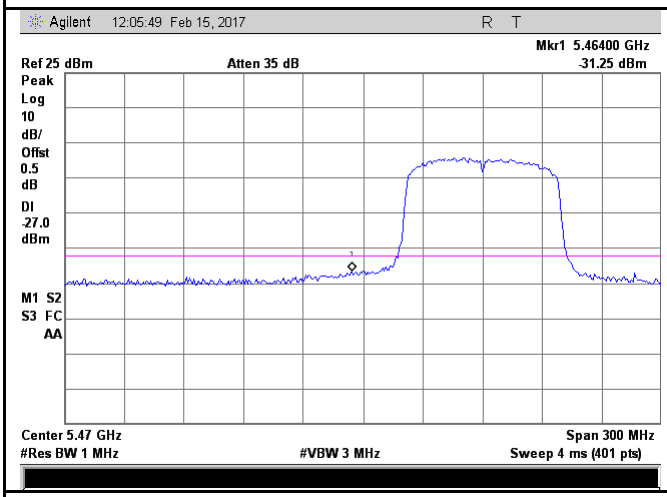
802.11ac (80M)



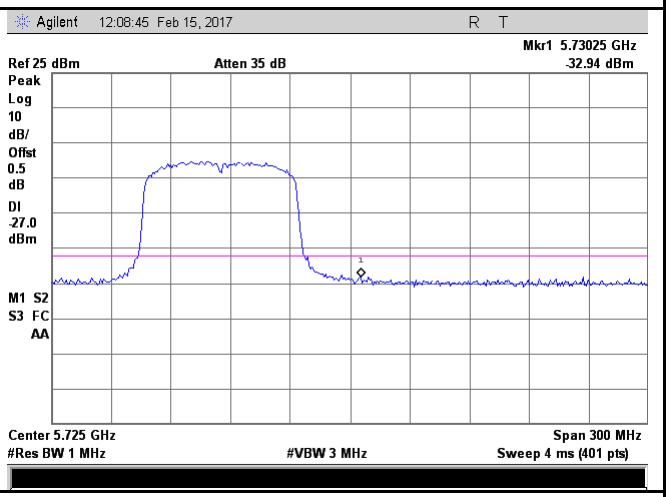
5150-5350MHz Band Edge - Low CH 5150



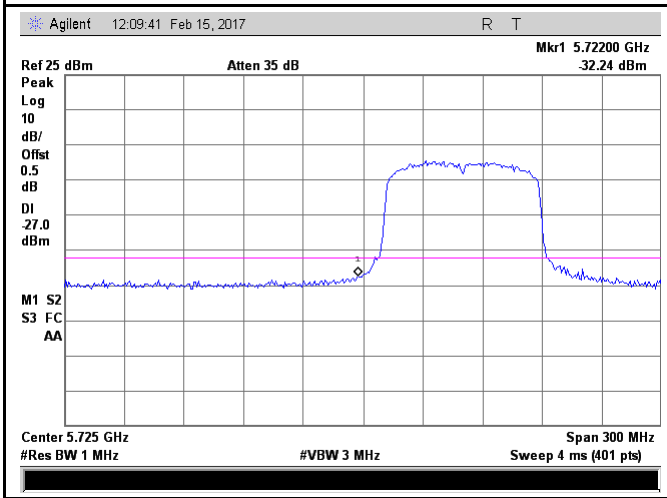
5150-5350MHz Band Edge - High CH 5350



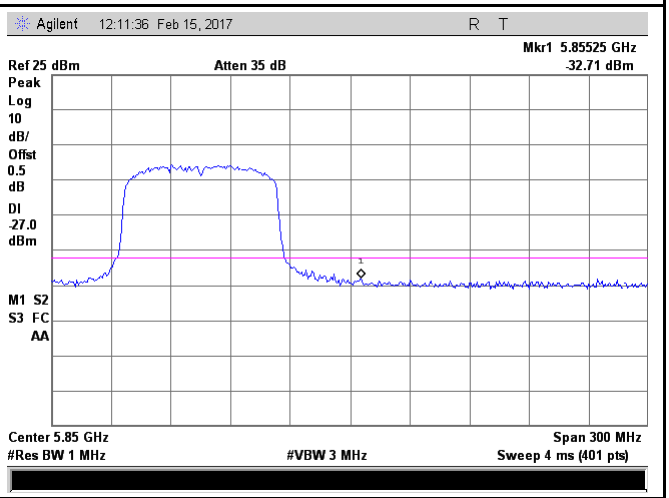
5470-5725MHz Band Edge - Low CH 5470



5470-5725MHz Band Edge - High CH 5725



5725-5850MHz Band Edge - Low CH 5725



5725-5850MHz Band Edge - High CH 5850

Note: Add a correction factor (antenna gain+ attenuator loss + cable loss) to the offset of the spectrum analyzer.

6.7 §15.207 (a) - AC Power Line Conducted Emissions

Requirement:

Frequency of emission (MHz)	Conducted limit (dBμ V)	
	Quasi-peak	Average
0.15– 0.5	66 to 56*	56 to 46*
0.5– 5	56	46
5– 30	60	50

*Decreases with the logarithm of the frequency.

Procedures:

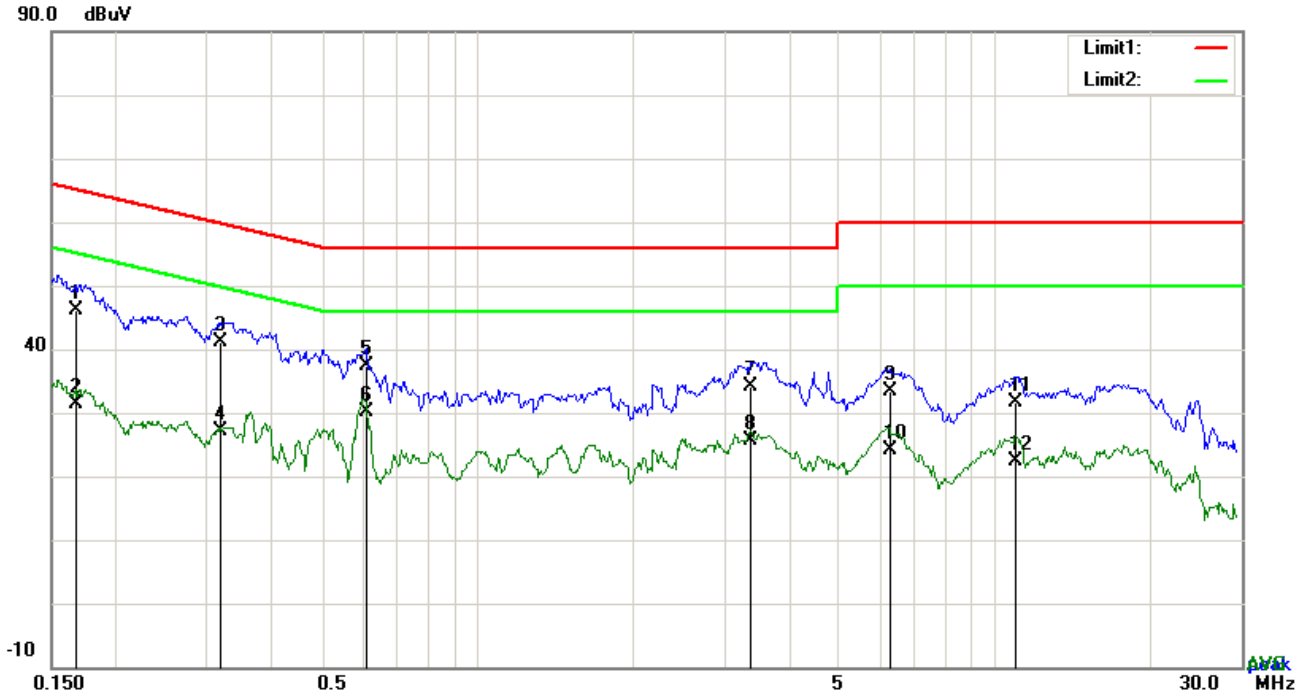
1. All possible modes of operation were investigated. Only the 6 worst case emissions measured, using the correct CISPR and Average detectors, are reported. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 9kHz – 30MHz (Average & Quasi-peak) is ±3.5dB.
4. Environmental Conditions

Temperature	22°C
Relative Humidity	55%
Atmospheric Pressure	1013mbar

5. Test date : February 15, 2017
   Tested By : Leen Yang

Result: Pass

Test Mode:	Transmitting Mode

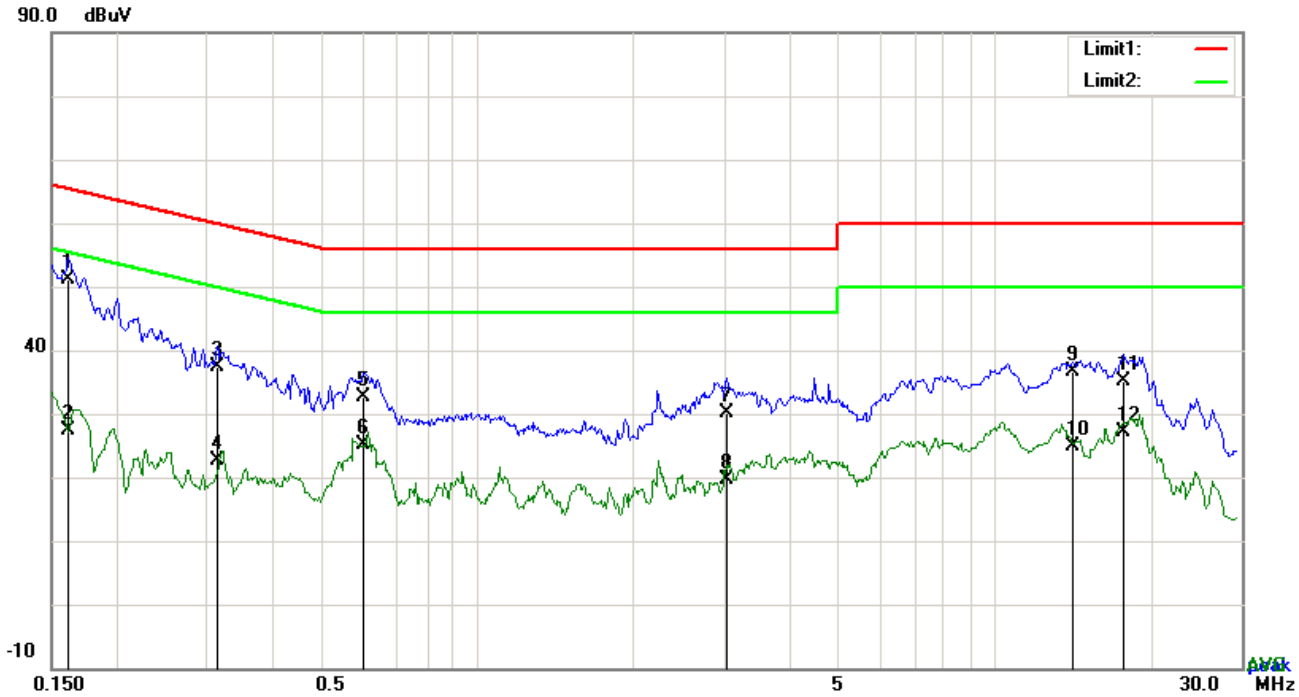


Test Data

Phase Line Plot at 120Vac, 60Hz

No.	P/L	Frequency (MHz)	Reading (dBµV)	Detector	Corrected (dB)	Result (dBµV)	Limit (dBµV)	Margin (dB)
1	L1	0.1668	36.09	QP	10.03	46.12	65.12	-19.00
2	L1	0.1668	21.23	AVG	10.03	31.26	55.12	-23.86
3	L1	0.3183	31.17	QP	10.03	41.20	59.75	-18.55
4	L1	0.3183	17.22	AVG	10.03	27.25	49.75	-22.50
5	L1	0.6075	27.43	QP	10.03	37.46	56.00	-18.54
6	L1	0.6075	20.02	AVG	10.03	30.05	46.00	-15.95
7	L1	3.3635	24.10	QP	10.06	34.16	56.00	-21.84
8	L1	3.3635	15.65	AVG	10.06	25.71	46.00	-20.29
9	L1	6.2520	23.39	QP	10.10	33.49	60.00	-26.51
10	L1	6.2520	14.08	AVG	10.10	24.18	50.00	-25.82
11	L1	10.9629	21.43	QP	10.16	31.59	60.00	-28.41
12	L1	10.9629	12.25	AVG	10.16	22.41	50.00	-27.59

Test Mode:	Transmitting Mode

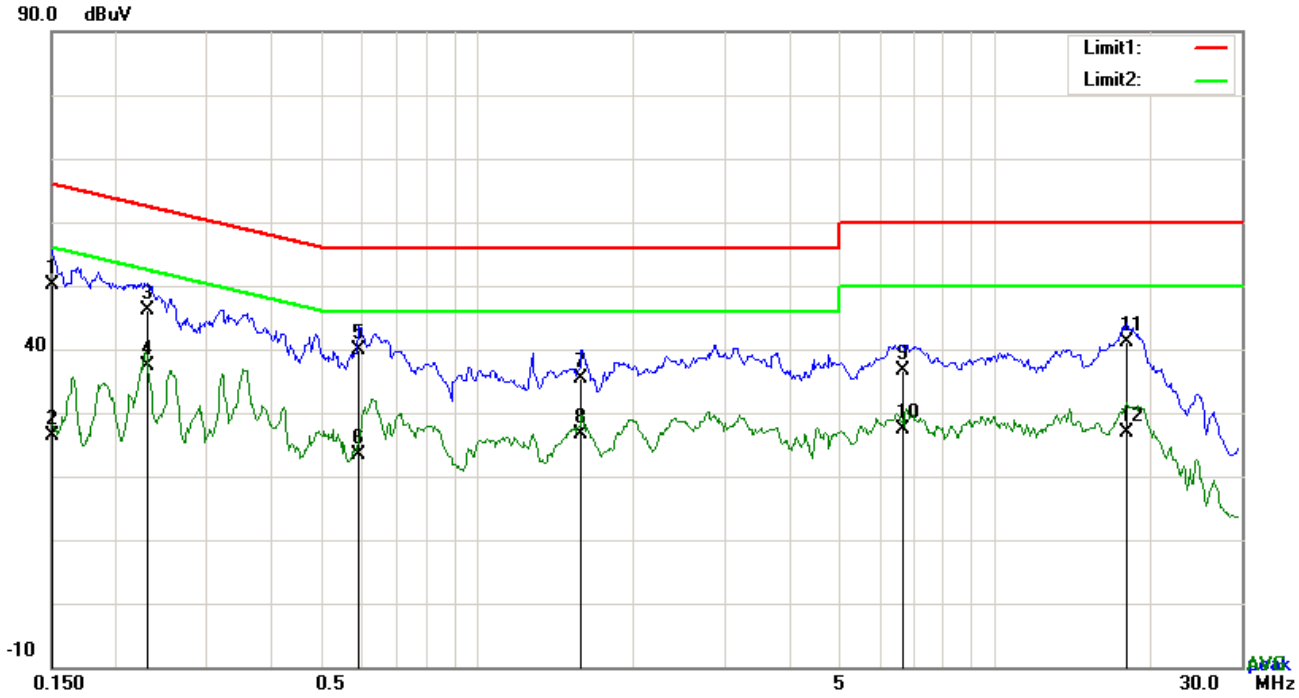


Test Data

Phase Neutral Plot at 120Vac, 60Hz

No.	P/L	Frequency (MHz)	Reading (dBµV)	Detector	Corrected (dB)	Result (dBµV)	Limit (dBµV)	Margin (dB)
1	N	0.1617	41.21	QP	10.02	51.23	65.38	-14.15
2	N	0.1617	17.46	AVG	10.02	27.48	55.38	-27.90
3	N	0.3138	27.39	QP	10.02	37.41	59.87	-22.46
4	N	0.3138	12.57	AVG	10.02	22.59	49.87	-27.28
5	N	0.6024	22.67	QP	10.02	32.69	56.00	-23.31
6	N	0.6024	15.16	AVG	10.02	25.18	46.00	-20.82
7	N	3.0253	20.20	QP	10.05	30.25	56.00	-25.75
8	N	3.0253	9.50	AVG	10.05	19.55	46.00	-26.45
9	N	14.1696	26.32	QP	10.19	36.51	60.00	-23.49
10	N	14.1696	14.59	AVG	10.19	24.78	50.00	-25.22
11	N	17.7576	24.89	QP	10.23	35.12	60.00	-24.88
12	N	17.7576	16.89	AVG	10.23	27.12	50.00	-22.88

Test Mode:	Transmitting Mode

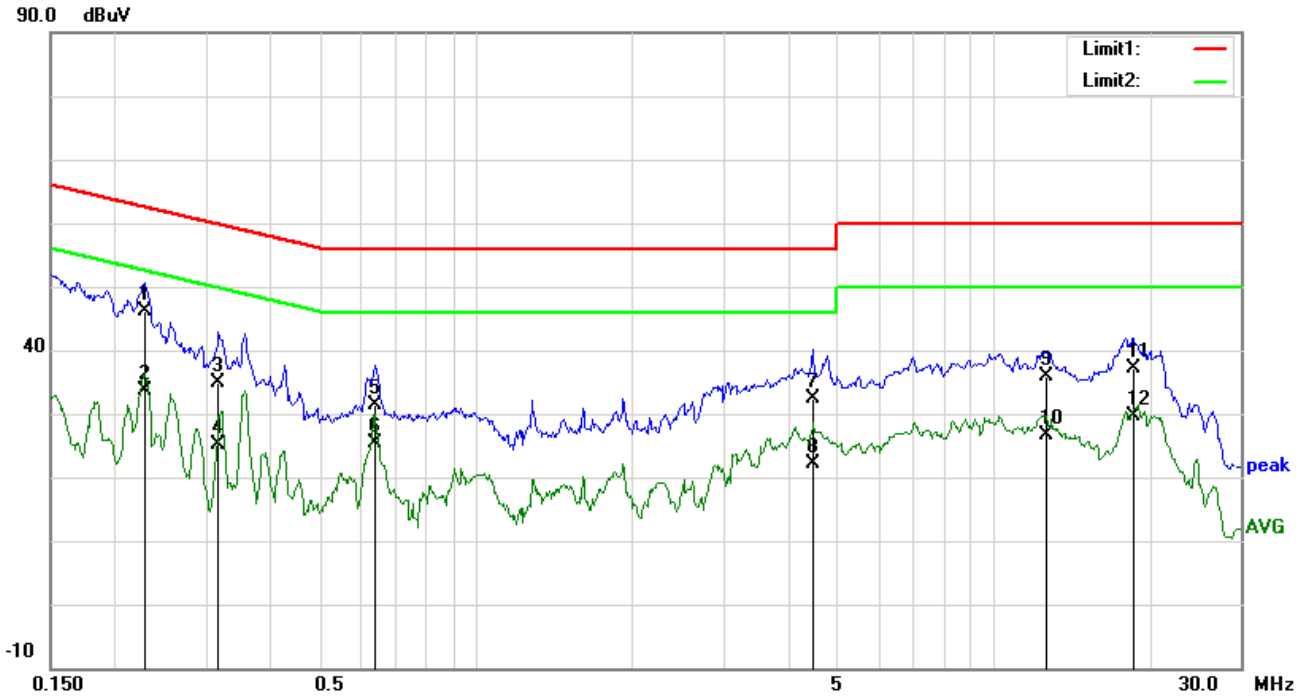


Test Data

Phase Line Plot at 240Vac, 60Hz

No.	P/L	Frequency (MHz)	Reading (dBµV)	Detector	Corrected (dB)	Result (dBµV)	Limit (dBµV)	Margin (dB)
1	L1	0.1500	40.08	QP	10.03	50.11	66.00	-15.89
2	L1	0.1500	16.46	AVG	10.03	26.49	56.00	-29.51
3	L1	0.2292	36.14	QP	10.03	46.17	62.48	-16.31
4	L1	0.2292	27.38	AVG	10.03	37.41	52.48	-15.07
5	L1	0.5907	29.81	QP	10.03	39.84	56.00	-16.16
6	L1	0.5907	13.43	AVG	10.03	23.46	46.00	-22.54
7	L1	1.5930	25.24	QP	10.04	35.28	56.00	-20.72
8	L1	1.5930	16.71	AVG	10.04	26.75	46.00	-19.25
9	L1	6.6272	26.49	QP	10.10	36.59	60.00	-23.41
10	L1	6.6272	17.33	AVG	10.10	27.43	50.00	-22.57
11	L1	17.9441	30.86	QP	10.27	41.13	60.00	-18.87
12	L1	17.9441	16.51	AVG	10.27	26.78	50.00	-23.22

Test Mode:	Transmitting Mode



Test Data

Phase Neutral Plot at 240Vac, 60Hz

No.	P/L	Frequency (MHz)	Reading (dBµV)	Detector	Corrected (dB)	Result (dBµV)	Limit (dBµV)	Margin (dB)
1	N	0.2280	36.23	QP	10.02	46.25	62.52	-16.27
2	N	0.2280	23.57	AVG	10.02	33.59	52.52	-18.93
3	N	0.3177	24.91	QP	10.02	34.93	59.77	-24.84
4	N	0.3177	15.13	AVG	10.02	25.15	49.77	-24.62
5	N	0.6375	21.27	QP	10.02	31.29	56.00	-24.71
6	N	0.6375	15.45	AVG	10.02	25.47	46.00	-20.53
7	N	4.4625	22.35	QP	10.06	32.41	56.00	-23.59
8	N	4.4625	12.09	AVG	10.06	22.15	46.00	-23.85
9	N	12.6489	25.71	QP	10.17	35.88	60.00	-24.12
10	N	12.6489	16.34	AVG	10.17	26.51	50.00	-23.49
11	N	18.6221	27.00	QP	10.24	37.24	60.00	-22.76
12	N	18.6221	19.34	AVG	10.24	29.58	50.00	-20.42

6.8 §15.209, §15.205 & §15.407(b) - Radiated Spurious Emissions & Unwanted Emissions into Restricted Frequency Bands

1. All possible modes of operation were investigated. Only the 6 worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. Radiated Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 30MHz – 1GHz & 1GHz above (3m & 10m) is +/-6dB.
4. Environmental Conditions

Temperature	22°C
Relative Humidity	55%
Atmospheric Pressure	1013mbar

5. Test date : February 15, 2017
   Tested By : Leen Yang

Requirement: §15.407(b) specifies that emissions which fall in the restricted bands, as defined in **§15.205(a)**, must comply with the radiated emission limits specified in **§15.209(a)**.

Procedures:

Radiated Spurious Emissions Measurement

An additional consideration when performing conducted measurements of restricted band emissions is that unwanted emissions radiating from the EUT cabinet, control circuits, power leads, or intermediate circuit elements will likely go undetected in a conducted measurement configuration. To address this concern, a radiated test shall be performed to ensure that emissions emanating from the EUT cabinet (rather than the antenna port) also comply with the applicable limits.

For these radiated spurious emission measurements the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. Established procedures for performing radiated measurements shall be used (see C63.10). All detected emissions must comply with the applicable limits.

Measurement Detectors

§15.35(a) specifies that on frequencies less than and below 1000 MHz, the radiated emissions limits assume the use of a CISPR quasi-peak detector function and related measurement bandwidths. §15.35(b) specifies that on frequencies above 1000 MHz, the radiated emissions limits assume the use of an average detector and a minimum resolution bandwidth of 1 MHz. In addition, §15.35(b) that when average radiated emissions measurements are specified there is also a limit on the peak emissions level which is 20 dB above the applicable maximum permitted average emission limit. These specifications also apply to conducted emissions measurements.

1. CISPR Quasi-Peak Measurement

The specifications for the measuring instrument using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Frequency Interference (CISPR) of the International Electrotechnical Commission.

As an alternative to CISPR quasi-peak measurement, compliance can be demonstrated to the applicable emission limits using a peak detector.

2. Peak Power Measurement Procedure

Utilize the peak power measurement procedure specified in Section 8.1.1 with the following modifications:

Set analyzer center frequency to the frequency associated with the restricted band emission under examination.

Set RBW = 1 MHz.

Note that if the peak measured value complies with the average limit, it is not necessary to perform a separate average measurement. If this option is exercised, it should be so noted in the test report.

3. Average Power Measurement Procedures

The average restricted band emission levels must be measured with the EUT transmitting continuously (≥ 98% duty cycle) at its maximum power control level. Optionally, video triggering/signal gating can be used to ensure that measurements are performed only when the EUT is transmitting at its maximum power control level.

The average power measurement procedures described in Section 8.2 shall be used with the following modifications:

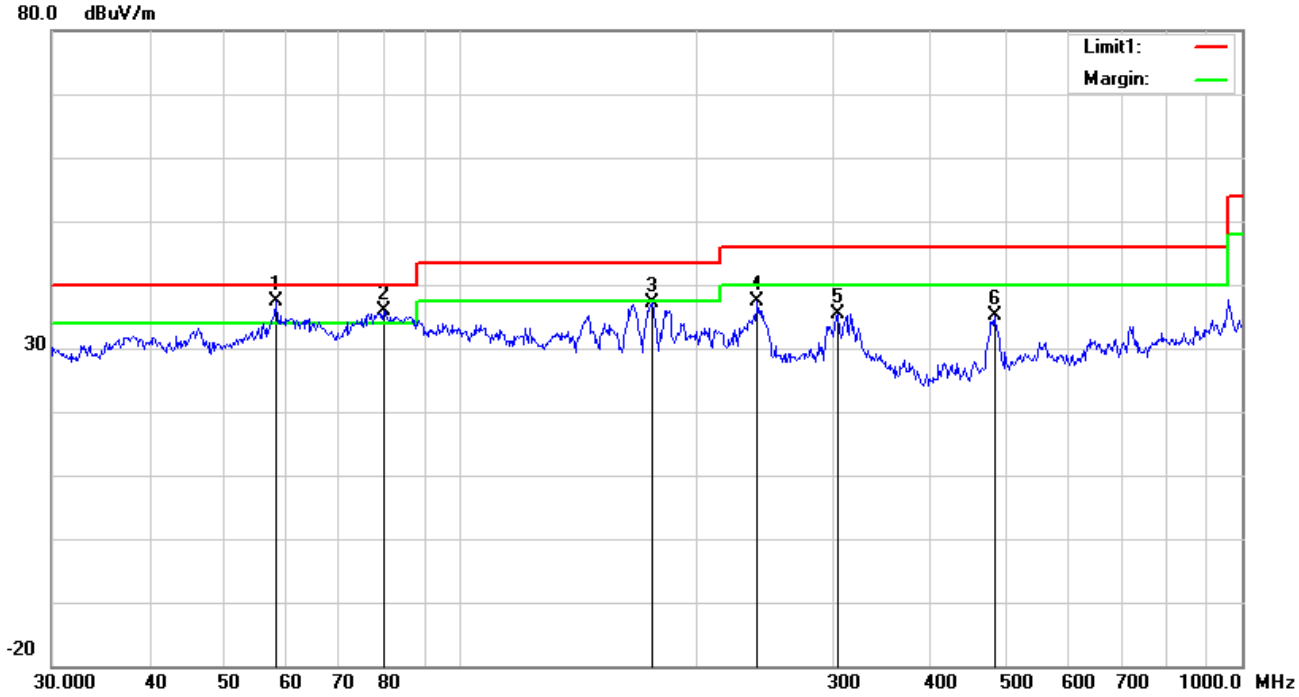
Set analyzer center frequency to the frequency associated with the restricted band emission.

Set span to at least 1 MHz.

Use peak marker function to determine the highest amplitude within the RBW (1 MHz).

Test Mode:	Transmitting Mode

(Below 1GHz)

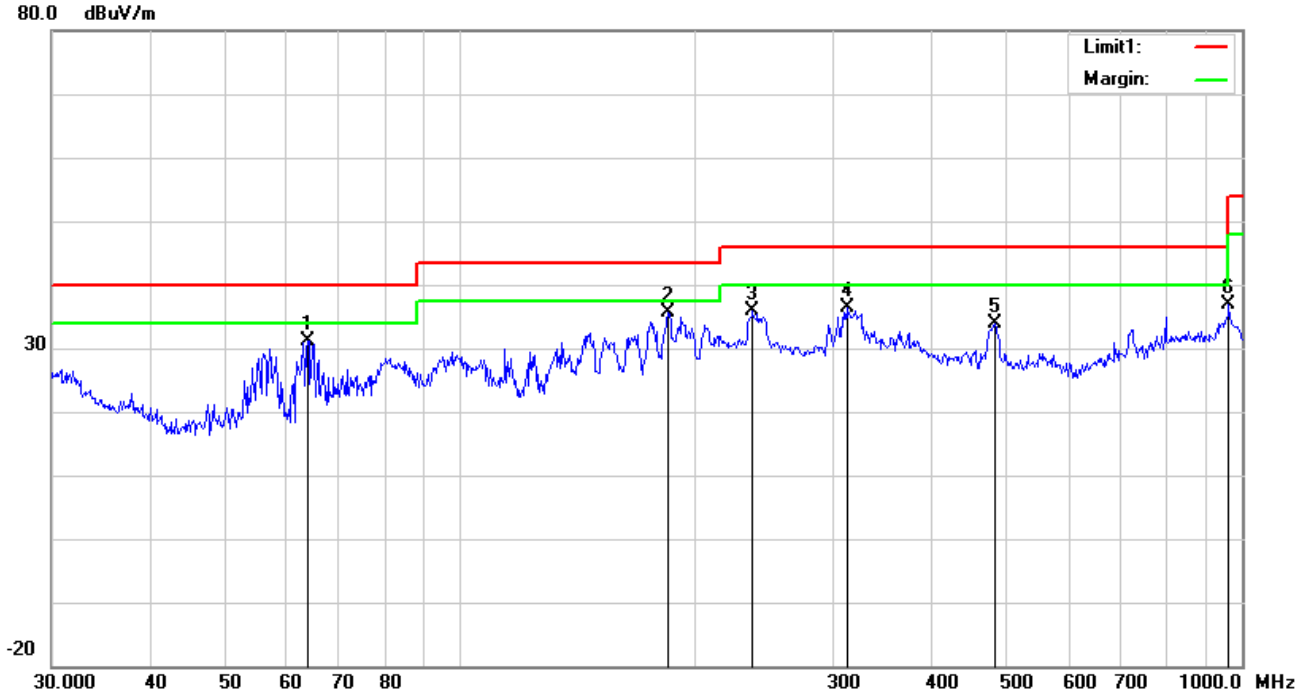


Test Data

Vertical Polarity Plot @3m

No.	P/L	Frequency	Reading	Detector	Ant_F	PA_G	Cab_L	Result	Limit	Margin	Height	Degree
		(MHz)	(dBuV/m)		(dB/m)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)	(cm)	(°)
1	V	58.2030	51.46	QP	7.50	22.40	0.76	37.32	40.00	-2.68	100	346
2	V	79.8003	49.53	QP	7.60	22.42	1.05	35.76	40.00	-4.24	100	90
3	V	176.2686	46.69	QP	11.30	22.25	1.36	37.10	43.50	-6.40	200	153
4	V	239.9873	46.43	peak	11.54	22.31	1.67	37.33	46.00	-8.67	200	355
5	V	303.5437	42.30	peak	13.67	22.28	1.81	35.50	46.00	-10.50	200	211
6	V	482.2156	37.36	peak	17.34	21.85	2.32	35.17	46.00	-10.83	100	85

(Below 1GHz)



Test Data

Horizontal Polarity Plot @3m

No.	P/L	Frequency	Reading	Detector	Ant_F	PA_G	Cab_L	Result	Limit	Margin	Height	Degree
		(MHz)	(dBuV/m)		(dB/m)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)	(cm)	( )
1	H	63.7588	45.24	peak	7.49	22.40	0.85	31.18	40.00	-8.82	300	72
2	H	184.4898	45.23	peak	11.25	22.28	1.44	35.64	43.50	-7.86	200	76
3	H	236.6447	44.85	peak	11.59	22.31	1.66	35.79	46.00	-10.21	300	121
4	H	312.1794	42.85	peak	13.86	22.26	1.85	36.30	46.00	-9.70	200	80
5	H	483.9094	36.10	peak	17.38	21.84	2.33	33.97	46.00	-12.03	300	258
6	H	962.1623	31.66	peak	22.81	20.76	3.24	36.95	54.00	-17.05	300	171

Above 1GHz

Test Mode:	Transmitting Mode

Low Channel (5180 MHz) (802.11ac20 mode worst case)

Frequency (MHz)	S.A. Reading (dBµV)	Detector (PK/AV)	Polarity (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	Pre-Amp. Gain (dB)	Cord Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
11490	30.29	AV	V	40.15	12.46	39.93	42.97	54	-11.03
11490	29.76	AV	H	40.15	12.46	39.93	42.44	54	-11.56
11490	48.17	PK	V	40.15	12.46	39.93	60.85	74	-13.15
11490	46.29	PK	H	40.15	12.46	39.93	58.97	74	-15.03
17843	30.12	AV	V	44.92	18.11	42.67	50.48	54	-3.52
17843	27.48	AV	H	44.92	18.11	42.67	47.84	54	-6.16
17843	48.72	PK	V	44.92	18.11	42.67	69.08	74	-4.92
17843	47.16	PK	H	44.92	18.11	42.67	67.52	74	-6.48

Middle Channel (5300 MHz) (802.11ac20 mode worst case)

Frequency (MHz)	S.A. Reading (dBµV)	Detector (PK/AV)	Polarity (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	Pre-Amp. Gain (dB)	Cord Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
11570	30.47	AV	V	40.15	12.46	39.93	43.15	54	-10.85
11570	28.13	AV	H	40.15	12.46	39.93	40.81	54	-13.19
11570	43.78	PK	V	40.15	12.46	39.93	56.46	74	-17.54
11570	42.94	PK	H	40.15	12.46	39.93	55.62	74	-18.38
17829	28.44	AV	V	44.92	18.03	42.67	48.72	54	-5.28
17829	25.41	AV	H	44.92	18.03	42.67	45.69	54	-8.31
17829	45.37	PK	V	44.92	18.03	42.67	65.65	74	-8.35
17829	42.81	PK	H	44.92	18.03	42.67	63.09	74	-10.91

High Channel (5320 MHz) (802.11ac20 mode worst case)

Frequency (MHz)	S.A. Reading (dBμV)	Detector (PK/AV)	Polarity (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	Pre-Amp. Gain (dB)	Cord Amp. (dBμV/m)	Limit (dBμV/m)	Margin (dB)
11650	33.16	AV	V	40.15	12.46	39.93	45.84	54	-8.16
11650	29.85	AV	H	40.15	12.46	39.93	42.53	54	-11.47
11650	43.71	PK	V	40.15	12.46	39.93	56.39	74	-17.61
11650	42.1	PK	H	40.15	12.46	39.93	54.78	74	-19.22
17855	28.31	AV	V	44.92	18.24	42.67	48.8	54	-5.2
17855	26.94	AV	H	44.92	18.24	42.67	47.43	54	-6.57
17855	46.88	PK	V	44.92	18.24	42.67	67.37	74	-6.63
17855	45.23	PK	H	44.92	18.24	42.67	65.72	74	-8.28

Note:

1, The testing has been conformed to 40GHz;
2, All other emissions more than 30 dB below the limit
3, X-Axis, Y-Axis and Z-Axis were investigated. The results above show only the worst case.

6.9 In-Service Monitoring for Channel Move Time and Channel Closing Transmission Time

These tests define how the following DFS parameters are verified during In-Service Monitoring; Channel Closing Transmission Time, Channel Move Time, and Non-Occupancy Period.

The steps below define the procedure to determine the above mentioned parameters when a radar Burst with a level equal to the DFS Detection Threshold + 1dB is generated on the Operating Channel of the U-NII device.

A U-NII device operating as a Client Device will associate with the UUT (Master) at Mid Channel. Stream the MPEG test file from the Master Device to the Client Device on the selected Channel for the entire period of the test.

At time T0 the Radar Waveform generator sends a Burst of pulses for each of the radar types at -62dBm.

Observe the transmissions of the UUT at the end of the radar Burst on the Operating Channel for duration greater than 10 seconds. Measure and record the transmissions from the UUT during the observation time (Channel Move Time). Compare the Channel Move Time and Channel Closing Transmission Time results to the limits defined in the DFS Response requirement values table.

Channel Closing Transmission Time- Measurement

A type 1 waveform was introduced to the EUT and the Spectrum Analyzer sweep time was set to 1s for monitoring and capturing the plot. A LabView program was created to collect trace data and capturing the plot. The program will calculate the channel closing time base on the spectrum analyzer result. The result will be calculated based on FCC procedure.

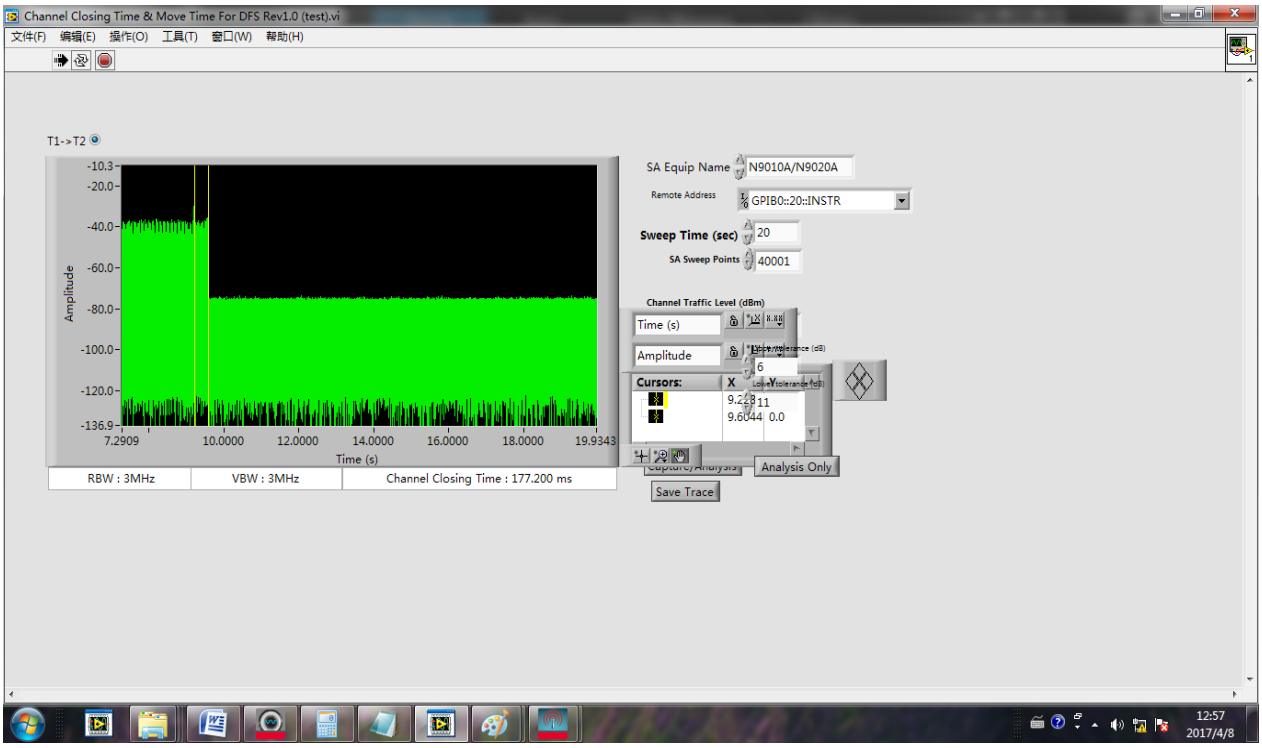
C= N*Dwell

C is the closing time, N is the number of spectrum analyzer sampling bins showing a U-NII transmission and dwell is the dwell time per bin.

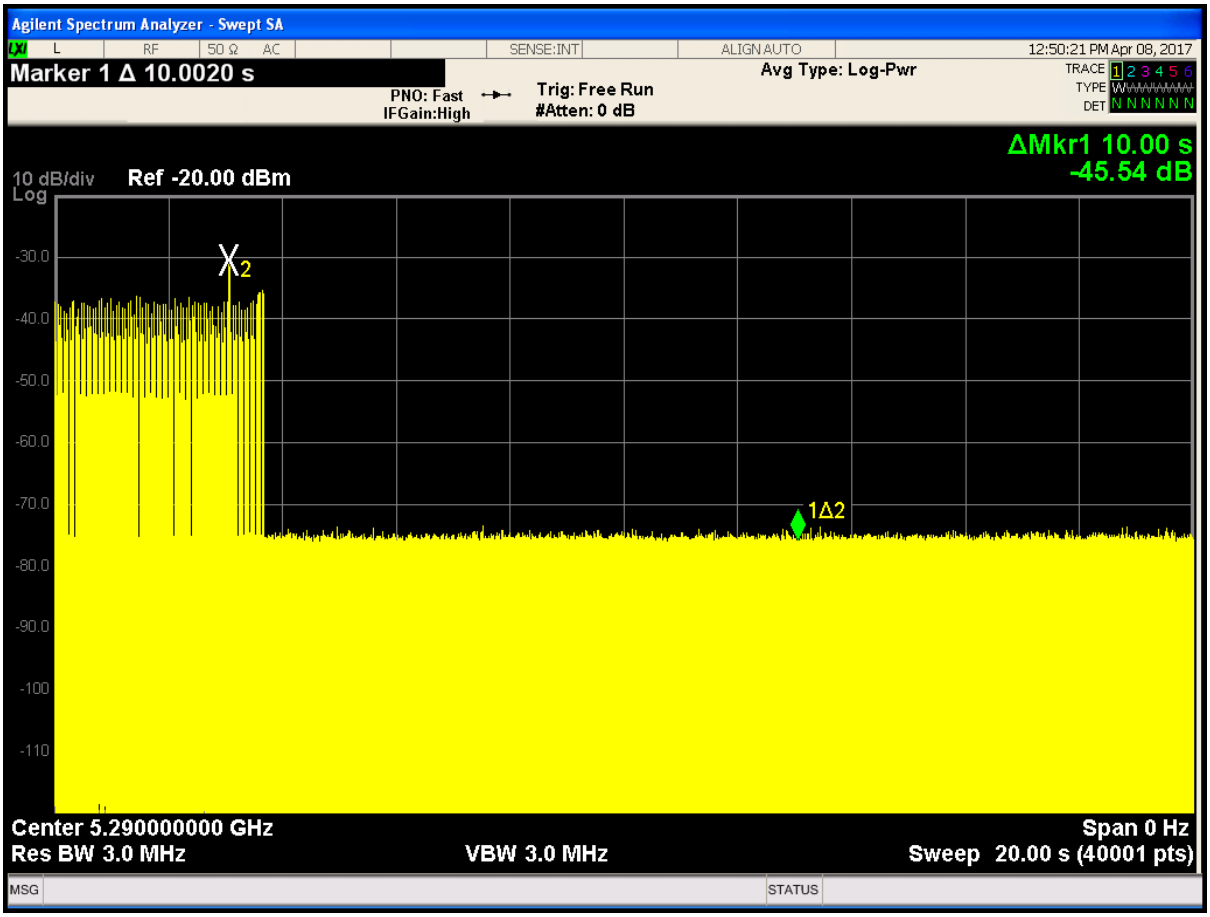
Dwell= S/B

Where Dwell is the dwell time per spectrum analyzer sampling bin, S is the sweep time and B is the number 0f spectrum analyzer sampling bins.

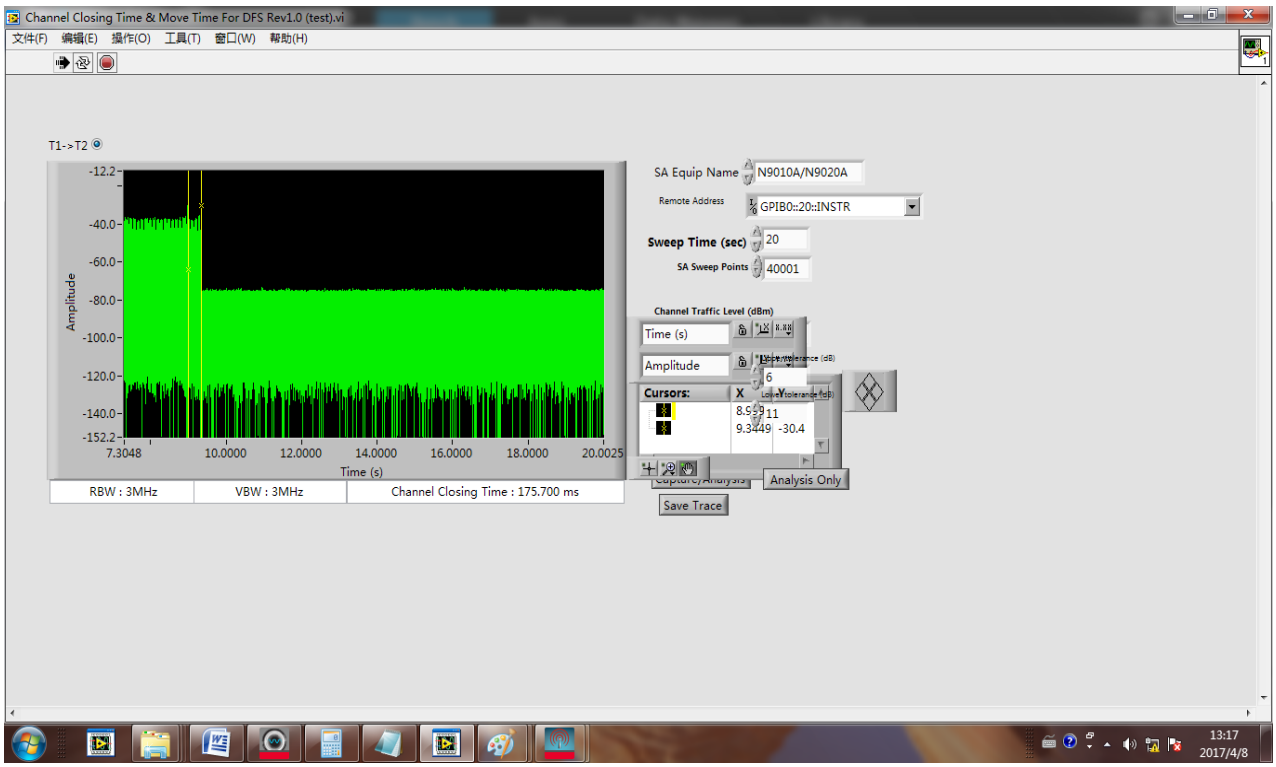
Test Plots



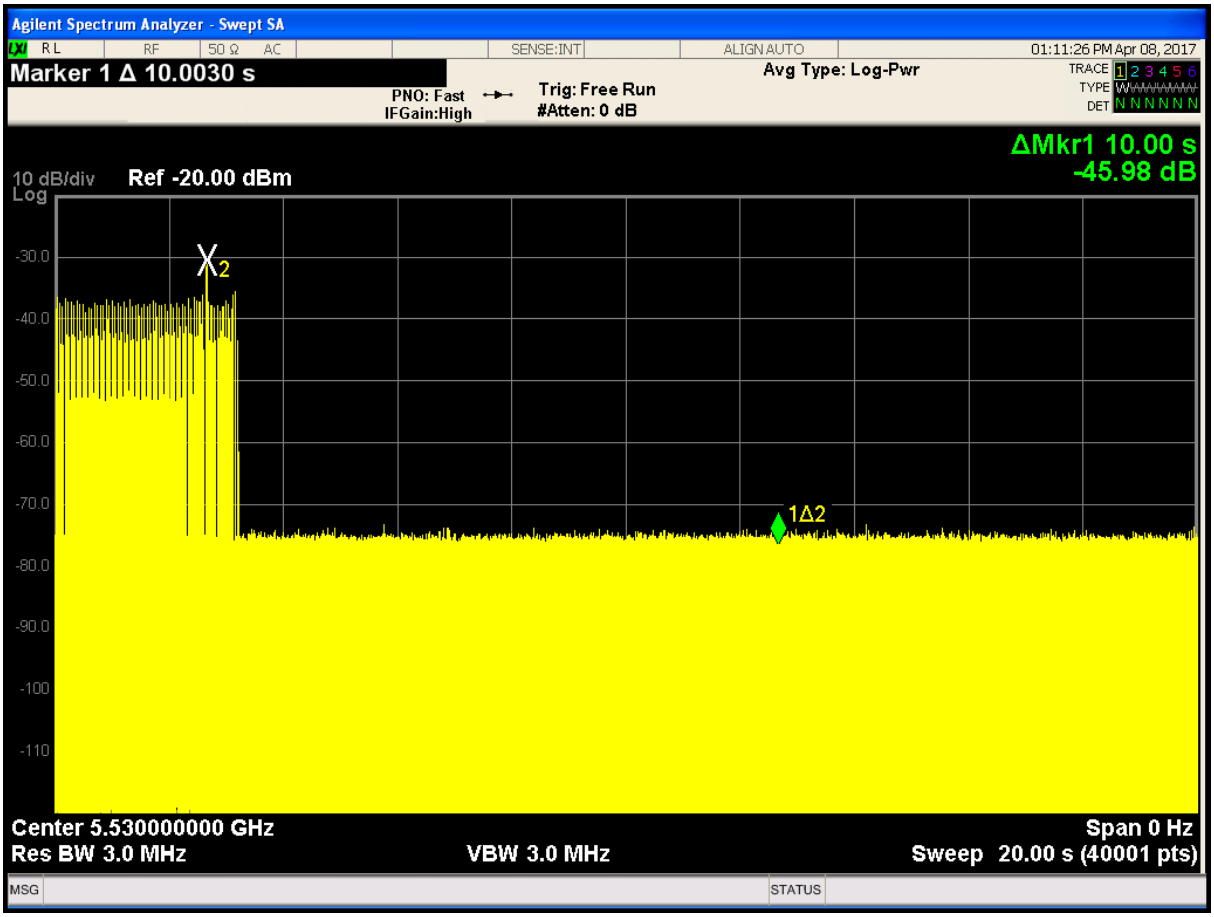
Channel Closing Time – ac80 – 5290MHz



Channel Move Time – ac80 – 5290MHz



Channel Closing Time –ac80 – 5530MHz



Channel Move Time –ac80 – 5530MHz

Annex A. TEST INSTRUMENT

Annex A.i. TEST INSTRUMENTATION & GENERAL PROCEDURES

Instrument	Model	Serial #	Cal Date	Cal Due	In use
RF conducted test					
Agilent ESA-E SERIES	E4407B	MY45108319	09/16/2016	09/15/2017	☑
Power Splitter	1#	1#	08/31/2016	08/30/2017	☑
DC Power Supply	E3640A	MY40004013	09/16/2016	09/15/2017	☑
Radiated Emissions					
EMI test receiver	ESL6	100262	09/16/2016	09/15/2017	☑
Positioning Controller	UC3000	MF780208282	11/18/2016	11/17/2017	☑
OPT 010 AMPLIFIER (0.1-1300MHz)	8447E	2727A02430	08/31/2016	08/30/2017	☑
Microwave Preamplifier (1 ~ 26.5GHz)	8449B	3008A02402	03/24/2016	03/23/2017	☑
Bilog Antenna (30MHz~6GHz)	JB6	A110712	09/20/2016	09/19/2017	☑
Double Ridge Horn Antenna (1 ~18GHz)	AH-118	71283	09/23/2016	09/22/2017	☑
Universal Radio Communication Tester	CMU200	121393	09/24/2016	09/23/2017	☑

Annex A.ii. CONDUCTED EMISSIONS TEST DESCRIPTION

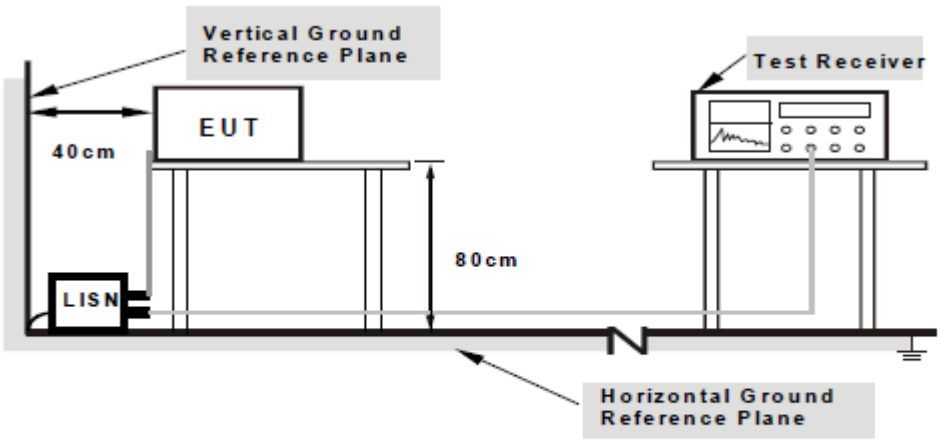
Test Set-up

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table, as shown in Annex B.

2. The power supply for the EUT was fed through a 50Ω/50μH EUT LISN, connected to filtered mains.

3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.

4. All other supporting equipments were powered separately from another main supply.



Note: 1.Support units were connected to second LISN.
2.Both of LISNs (AMN) are 80cm from EUT and at least 80cm from other units and other metal planes support units.

For the actual test configuration, please refer to the related item – Photographs of the Test Configuration1.

Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.

2. A scan was made on the NEUTRAL line (for AC mains) or Earth line (for DC power) over the required frequency range using an EMI test receiver.

3. High peaks, relative to the limit line, were then selected.

4. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 10 kHz. For FCC tests, only Quasi-peak measurements were made; while for CISPR/EN tests, both Quasi-peak and Average measurements were made.

5. Steps 2 to 4 were then repeated for the LIVE line (for AC mains) or DC line (for DC power).

Description of Conducted Emission Program

This EMC Measurement software run LabView automation software and offers a common user interface for electromagnetic interference (EMI) measurements. This software is a modern and powerful tool for controlling and monitoring EMI test receivers and EMC test systems. It guarantees reliable collection, evaluation, and documentation of measurement results. Basically, this program will run a pre-scan measurement before it proceeds with the final measurement. The pre-scan routine will run the common scan range from 150 kHz to 30 MHz; the program will first start a peak and average scan on selectable measurement time and step size. After the program complete the pre-scan, this program will perform the Quasi Peak and Average measurement, based on the pre-scan peak data reduction result.

Sample Calculation Example

At 20 MHz limit = 250 μV = 47.96 dBμV

Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.20 dB

Q-P reading obtained directly from EMI Receiver = 40.00 dBμV
(Calibrated for system losses)

Therefore, Q-P margin = 47.96 – 40.00 = 7.96 i.e. **7.96 dB below limit**

Annex A. iii RADIATED EMISSIONS TEST DESCRIPTION

EUT Characterisation

EUT characterisation, over the frequency range from 30MHz to 10th Harmonic , was done in order to minimise radiated emissions testing time while still maintaining high confidence in the test results.

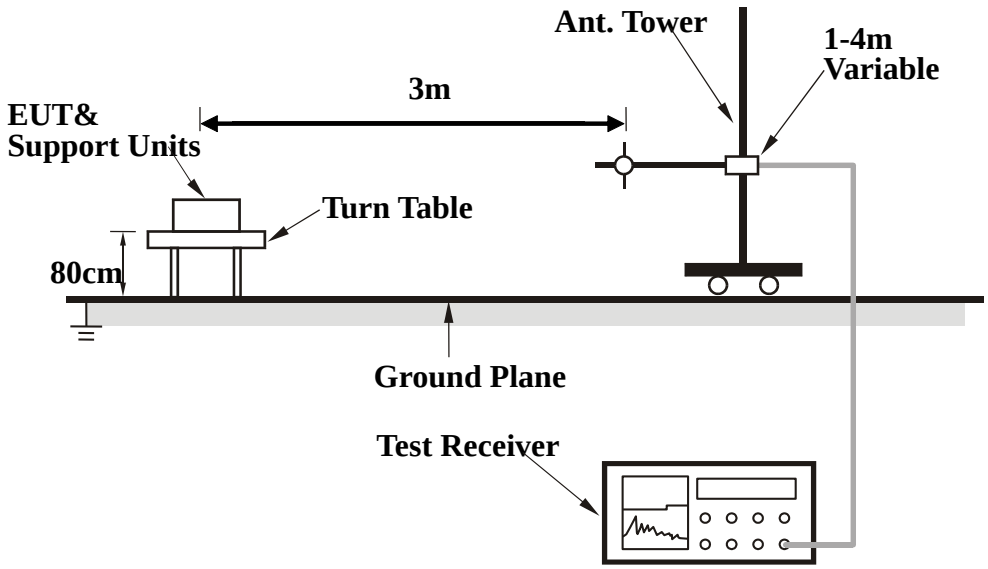
The EUT was placed in the chamber, at a height of about 0.8m on a turntable. Its radiated emissions frequency profile was observed, using a spectrum analyzer /receiver with the appropriate broadband antenna placed 3m away from the EUT. Radiated emissions from the EUT were maximised by rotating the turntable manually, changing the antenna polarisation and manipulating the EUT cables while observing the frequency profile on the spectrum analyzer / receiver. Frequency points at which maximum emissions occurred, clock frequencies and operating frequencies were then noted for the formal radiated emissions test at the Open Area Test Site (OATS).

Test Set-up

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table.

2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.

3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.



Test Method

The following procedure was performed to determine the maximum emission axis of EUT:
1. With the receiving antenna is H polarization, rotate the EUT in turns with three orthogonal axes to determine the axis of maximum emission.
2. With the receiving antenna is V polarization, rotate the EUT in turns with three orthogonal axes to determine the axis of maximum emission.
3. Compare the results derived from above two steps. So, the axis of maximum emission from EUT was determined and the configuration was used to perform the final measurement.

Final Radiated Emission Measurement
1. Setup the configuration according to figure 1. Turn on EUT and make sure that it is in normal function.

2. For emission frequencies measured below 1 GHz, a pre-scan is performed in a shielded chamber to determine the accurate frequencies of higher emissions will be checked on a open test site. As the same purpose, for emission frequencies measured above 1 GHz, a pre-scan also be performed with a 1 meter measuring distance before final test.

3. For emission frequencies measured below and above 1 GHz, set the spectrum analyzer on a 100 kHz and 1 MHz resolution bandwidth respectively for each frequency measured in step 2.

4. The search antenna is to be raised and lowered over a range from 1 to 4 meters in horizontally polarized orientation. Position the highness when the highest value is indicated on spectrum analyzer, then change the orientation of EUT on test table over a range from 0。 to 360。with a speed as slow as possible, and keep the azimuth that highest emission is indicated on the spectrum analyzer. Vary the antenna position again and record the highest value as a final reading.

5. Repeat step 4 until all frequencies need to be measured was complete.

6. Repeat step 5 with search antenna in vertical polarized orientations.

During the radiated emission test, the Spectrum Analyzer was set with the following configurations:

Frequency Band (MHz)	Function	Resolution bandwidth	Video Bandwidth
30 to 1000	Peak	100 kHz	100 kHz
Above 1000	Peak	1 MHz	1 MHz
	Average	1 MHz	10 Hz

Sample Calculation Example

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. For the limit is employed average value, therefore the peak value can be transferred to average value by subtracting the duty factor. The basic equation with a sample calculation is as follows:

Peak = Reading + Corrected Factor

where

Corr. Factor = Antenna Factor + Cable Factor - Amplifier Gain (if any)

And the average value is

Average = Peak Value + Duty Factor or

Set RBW = 1MHz, VBW = 10Hz.

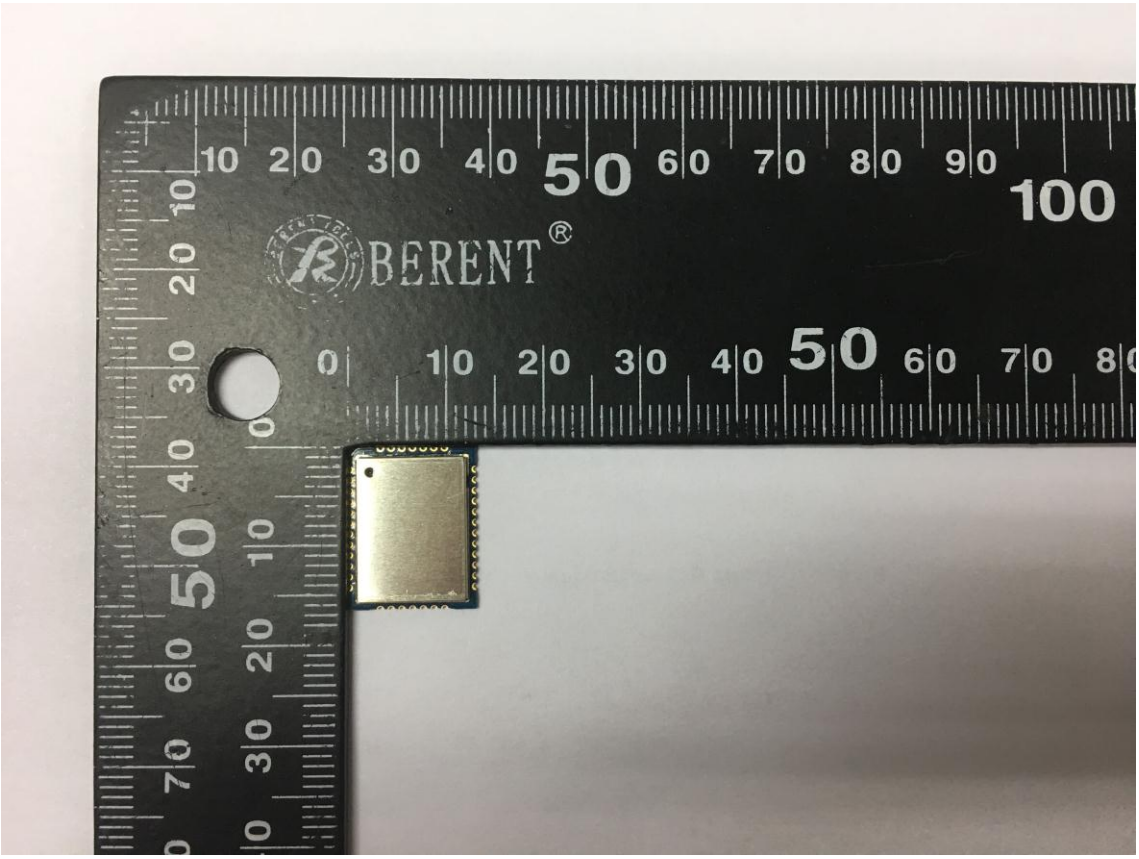
Note :

If the measured frequencies are fall in the restricted frequency band, the limit employed must be quasi peak value when frequencies are below or equal to 1 GHz. And the measuring instrument is set to quasi peak detector function.

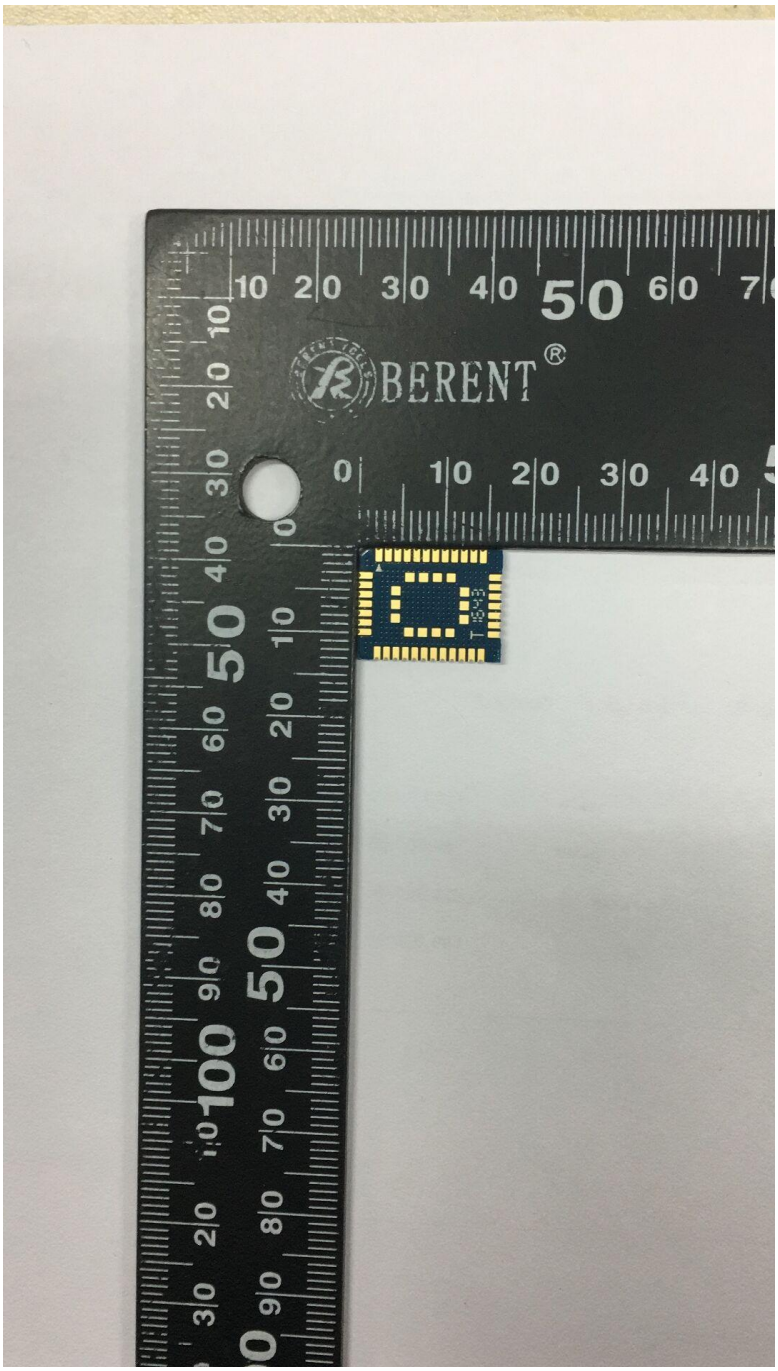
Annex B. EUT And Test Setup Photographs

Annex B.i. Photograph: EUT External Photo

EUT - Front View

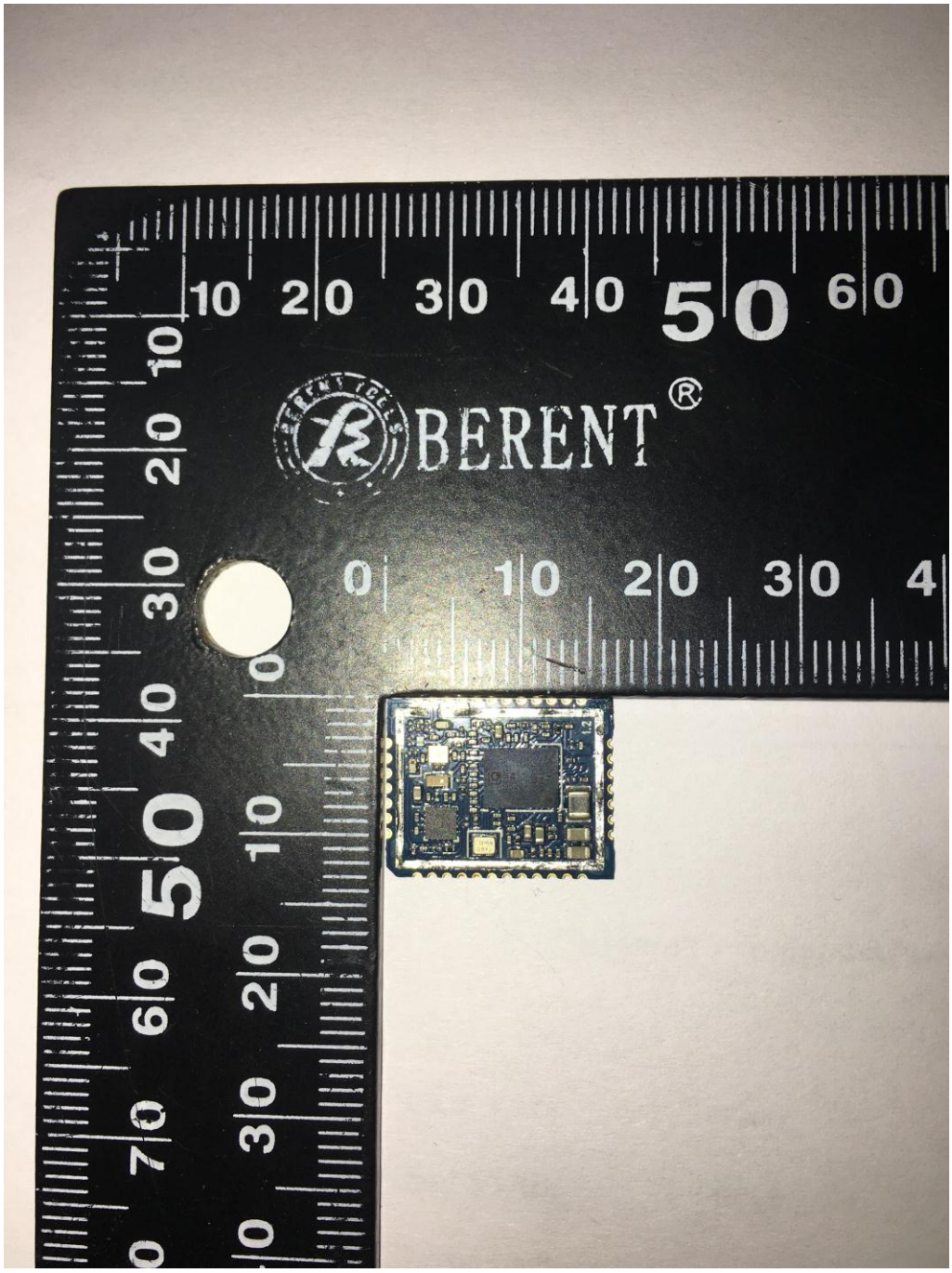


EUT - Rear View

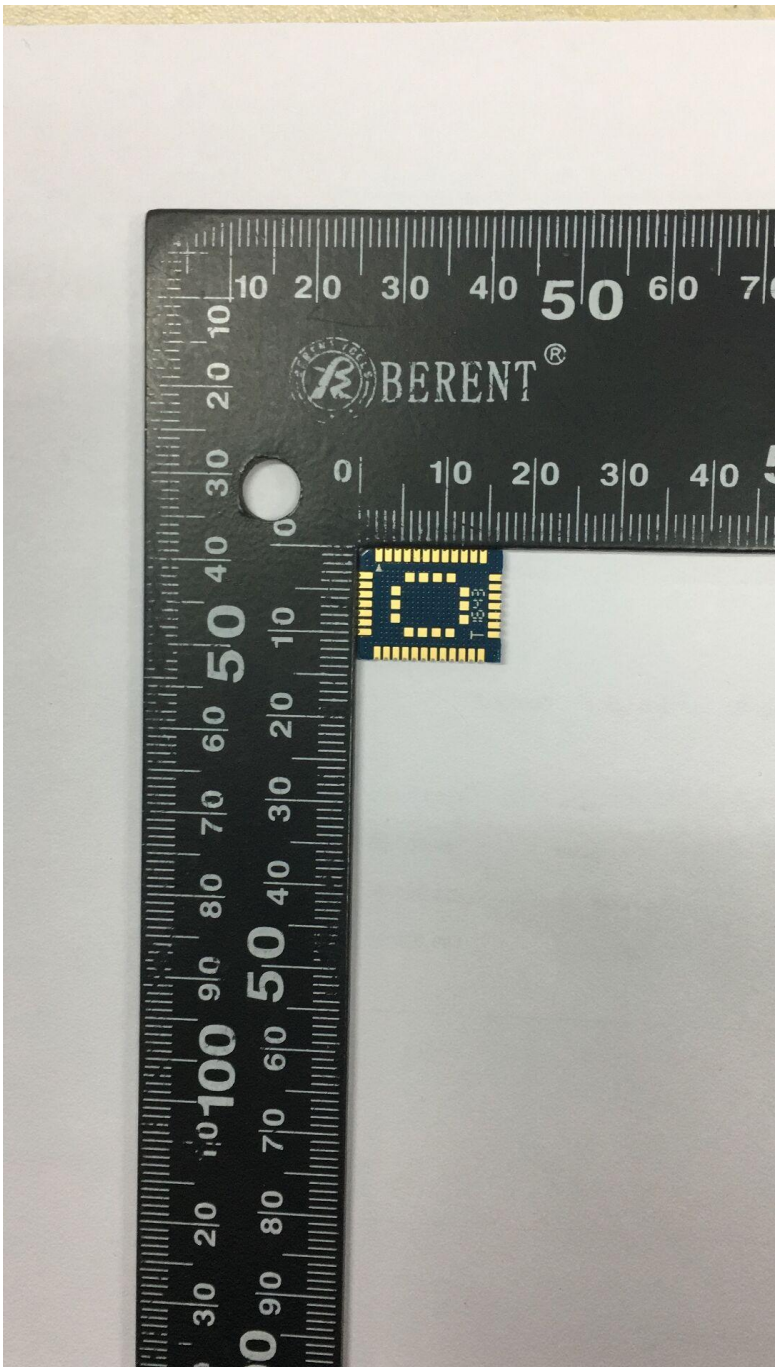


Annex B.ii. Photograph: EUT Internal Photo

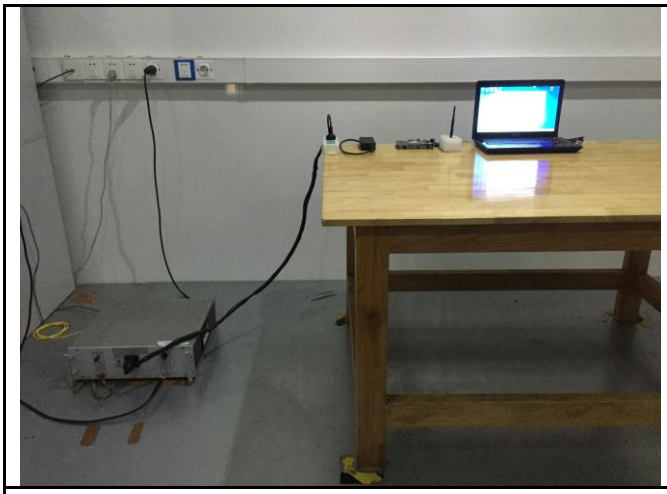
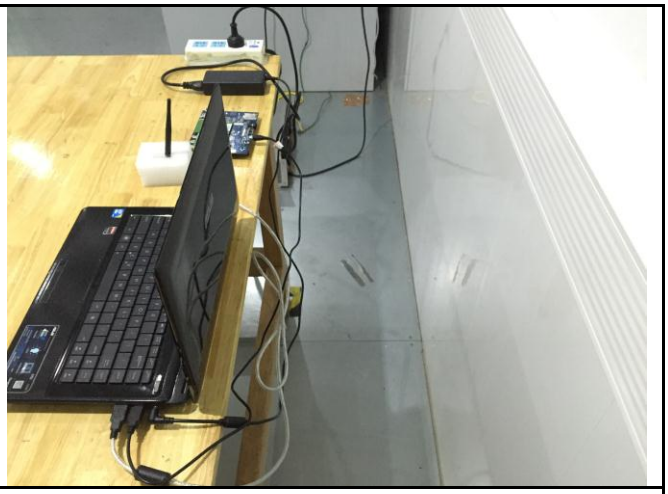
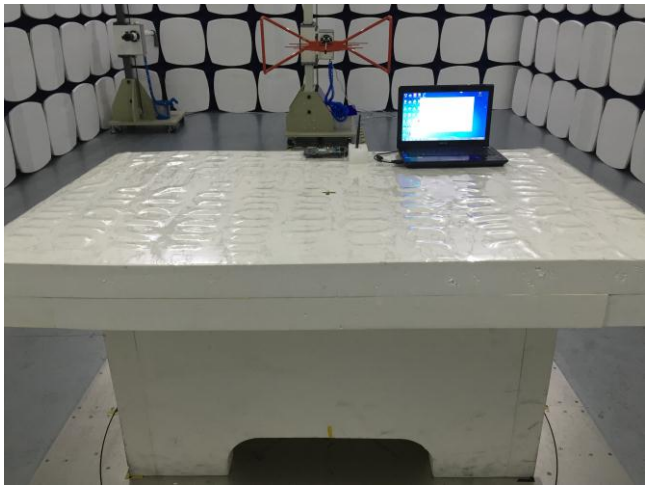
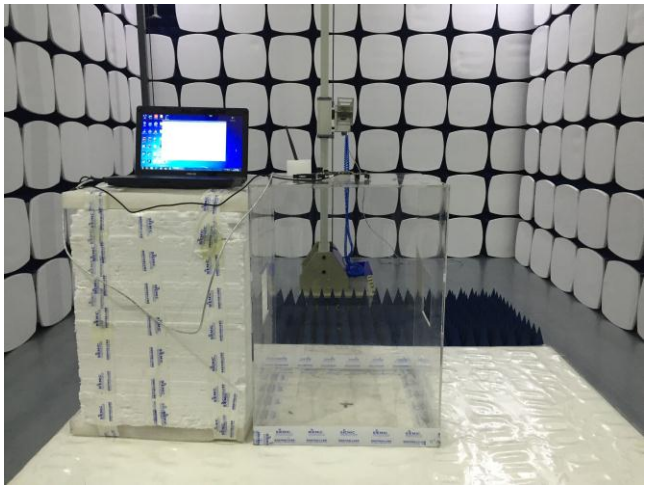
EUT- without Shielding – Front View



EUT - Rear View



Annex B.iii. Photograph: Test Setup Photo

	
Conducted Emissions Test Setup Front View	Conducted Emissions Test Setup Side View
	
Radiated Spurious Emissions Test Setup Below 1GHz	Radiated Spurious Emissions Test Setup Above 1GHz

Annex C. TEST SETUP AND SUPPORTING EQUIPMENT

EUT TEST CONDITIONS

Annex C. i. SUPPORTING EQUIPMENT DESCRIPTION

The following is a description of supporting equipment and details of cables used with the EUT.

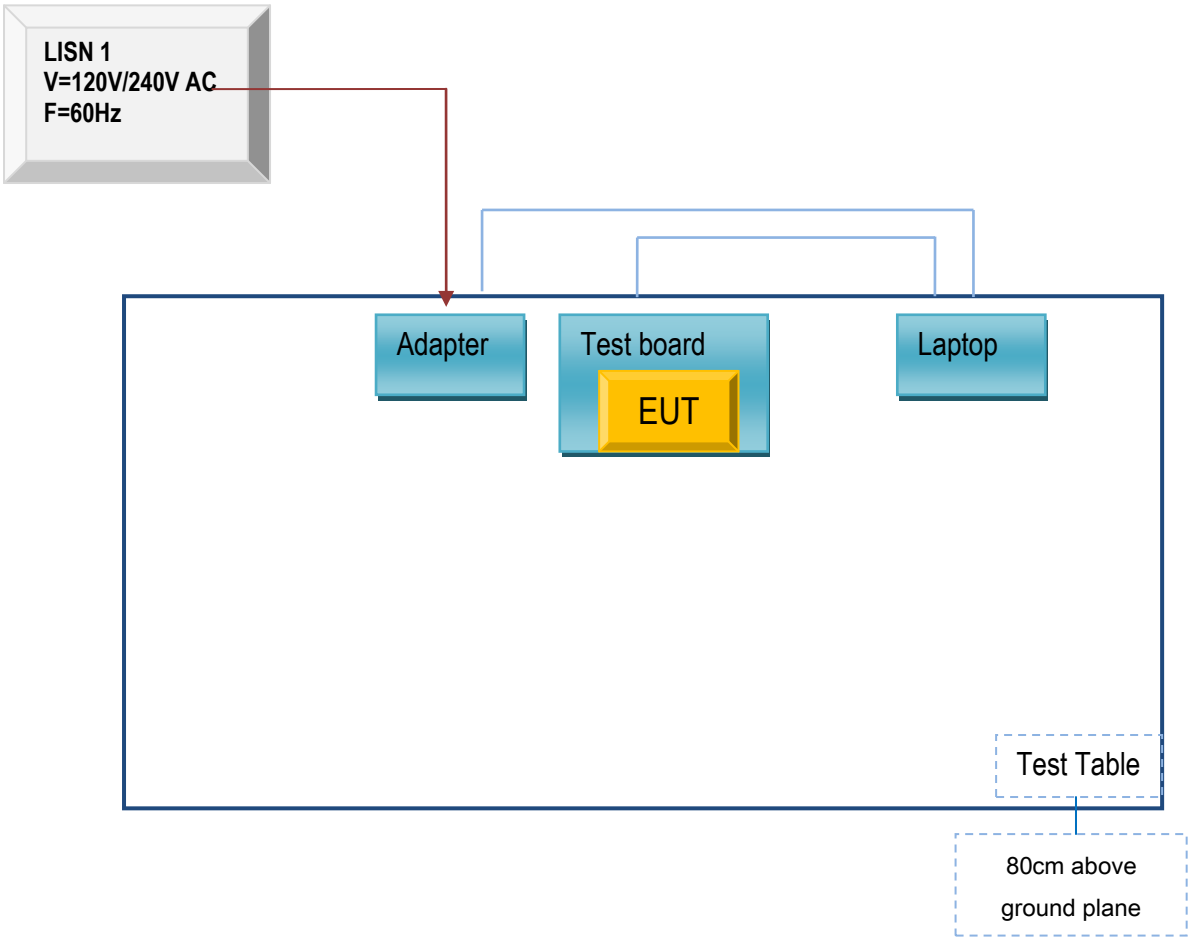
Supporting Equipment:

Manufacturer	Equipment Description	Model	Serial No
Lenovo	Laptop	E40	LR-1EHRX
Quectel Wireless Solutions Co., Ltd.	Test Board	Q1-A0770	MP87108N1000974

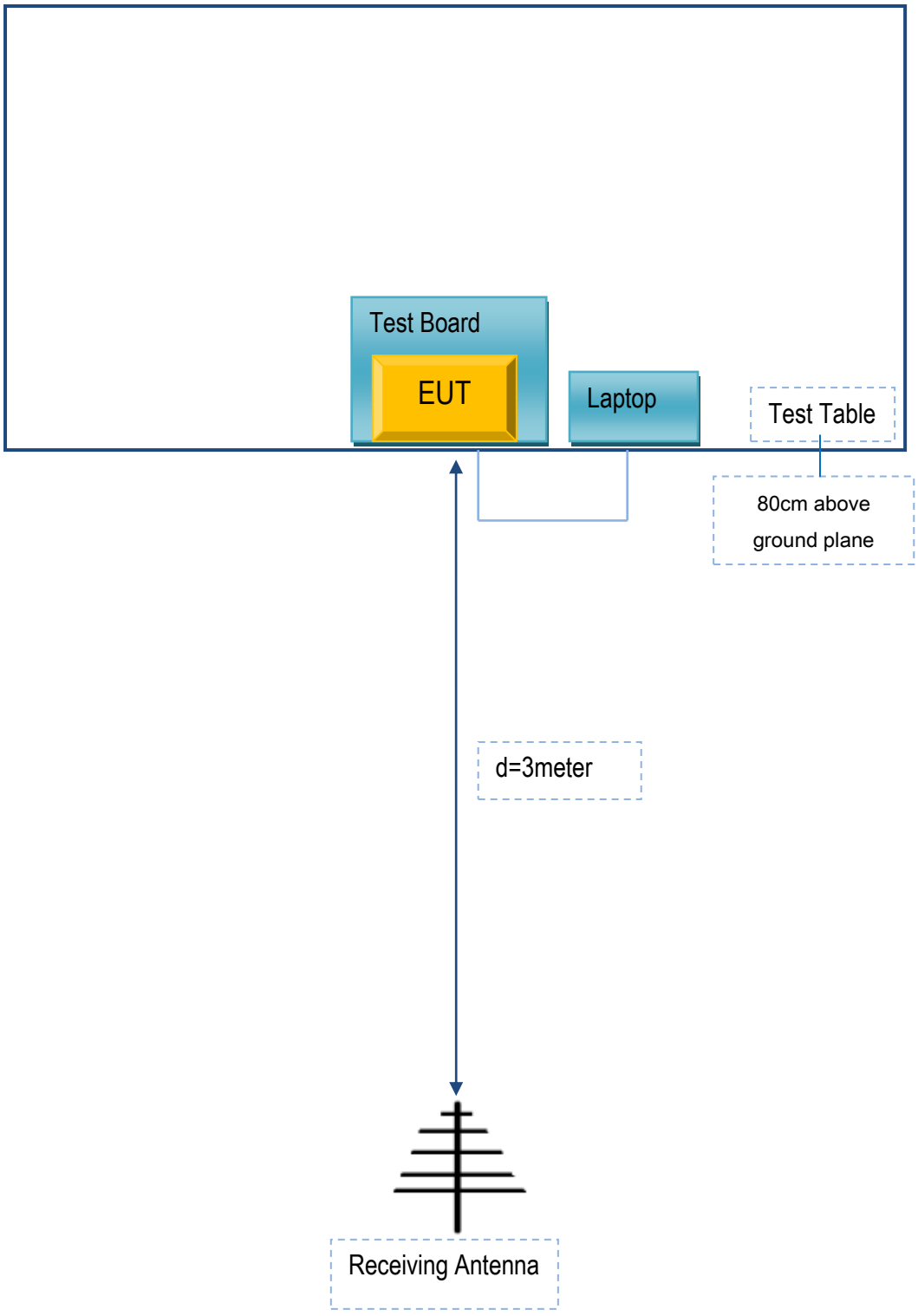
Supporting Cable:

Cable type	Shield Type	Ferrite Core	Length	Serial No
Power Cable	Un-shielding	No	0.8m	GT211032
USB Cable	Un-shielding	No	1m	MP87108N1000974

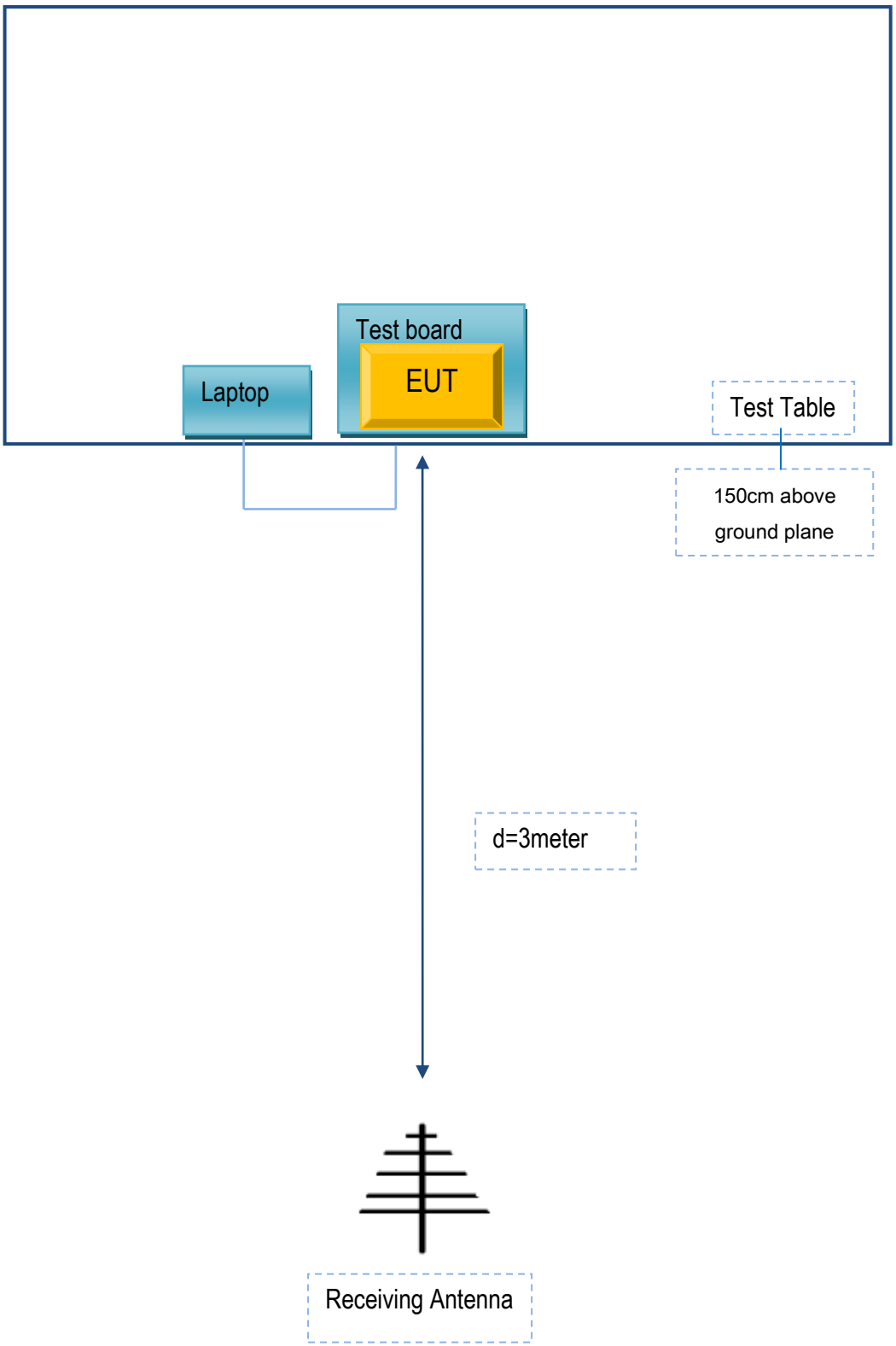
Block Configuration Diagram for AC Line Conducted Emissions



Block Configuration Diagram for Radiated Emissions （Below 1GHz）.



Block Configuration Diagram for Radiated Emissions （Above 1GHz）.



Annex C.ii. EUT OPERATING CONDITIONS

The following is the description of how the EUT is exercised during testing.

Test	Description Of Operation
Emissions Testing	The EUT was continuously transmitting to stimulate the worst case.

Annex D. User Manual / Block Diagram / Schematics / Partlist

See attachment

Annex E. DECLARATION OF SIMILARITY

N/A