FCC TEST REPORT
for
TunerWorks Korea Corp.

HUD (Head Up Display)
Model No.: Kivic HUD

Prepared for	:	TunerWorks Korea Corp.
Address	:	697-18, Manyeon Ro, Jeongnam Myeon, Hwaseong City, Gyeonggi Do, South Korea

Prepared By	:	Shenzhen Anbotek Compliance Laboratory Limited
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Report Number	:	R0117011599W2
Date of Test	:	Feb. 22~Mar. 23, 2017
Date of Report	:	Mar. 24, 2017

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TEST REPORT

Applicant	:	TunerWorks Korea Corp.
Manufacturer	:	TunerWorks Korea Corp.
EUT	:	HUD (Head Up Display)
Model No.	:	Kivic HUD
Serial No.	:	N.A.
Trade Mark	:	N.A.
Rating	:	Input DC 5V~12V, 1.5A

Measurement Procedure Used:
FCC Part15 Subpart E 2016, Paragraph 15.407

The device described above is tested by Shenzhen Anbotek Compliance Laboratory Limited to determine the maximum emission levels emanating from the device and the severe levels of the device can endure and its performance criterion. The measurement results are contained in this test report and Shenzhen Anbotek Compliance Laboratory Limited is assumed full of responsibility for the accuracy and completeness of these measurements. Also, this report shows that the EUT (Equipment Under Test) is technically compliant with the FCC Part 15 Subpart E requirements.

This report applies to above tested sample only and shall not be reproduced in part without written approval of Shenzhen Anbotek Compliance Laboratory Limited.

Date of Test : Feb. 22~Mar. 23, 2017

Prepared by : Kyle Xu
(Tested Engineer / Kyle Xu)

Reviewer : Brown Lu
(Project Manager / Brown Lu)

Approved & Authorized Signer : Tom Chen
(Manager / Tom Chen)

1. GENERAL INFORMATION

1.1. Description of Device (EUT)

EUT : HUD (Head Up Display)

Model Number : Kivic HUD

Test Power Supply : DC 12V

Frequency :

Types of module	Operating Frequency
WiFi 2.4G (802.11b/ g/ n(HT20))	2412-2462MHz
WiFi 5G (802.11a/ n(HT20))	5180-5240MHz
BT 4.0+EDR	2402-2480MHz

Modulation : WiFi:
802.11a OFDM, 802.11b CCK; 802.11g OFDM, 802.11n MCS
BT 4.0: GFSK
BT EDR: GFSK, π/4DQPSK, 8DPSK

Antenna Type : Ceramic Antenna

Antenna Gain: : WIFI & BT EDR: 3.6 dBi
BT 4.0: 1.99 dBi

Applicant : TunerWorks Korea Corp.
Address : 697-18, Manyeon Ro, Jeongnam Myeon, Hwaseong City, Gyeonggi Do, South Korea

Manufacturer : TunerWorks Korea Corp.
Address : 697-18, Manyeon Ro, Jeongnam Myeon, Hwaseong City, Gyeonggi Do, South Korea

Date of receipt : Feb. 22, 2017
Date of Test : Feb. 22~Mar. 23, 2017

Remark : This report is for WiFi 5G.

1.2. Auxiliary Equipment Used during Test

Car Adapter : Input: DC 12V, 1.5A
Output: DC 12V, 1.5A

1.3. Description of Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

FCC-Registration No.: 752021
Shenzhen Anbotek Compliance Laboratory Limited, EMC Laboratory has been registed and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 752021, July 06, 2016.

IC-Registration No.: 8058A-1
Shenzhen Anbotek Compliance Laboratory Limited., EMC Laboratory has been registered and fully described in a report filed with the (IC) Industry Canada. The acceptance letter from the IC is maintained in our files. Registration 8058A, Jun. 13, 2016.

Test Location
All Emissions tests were performed at
Shenzhen Anbotek Compliance Laboratory Limited. at 1/F., Building 1, SEC Industrial Park, No.0409 Qianhai Road, Nanshan District, Shenzhen, Guangdong, China

1.4. Measurement Uncertainty

Radiation Uncertainty : Ur = 4.1 dB (Horizontal)
Ur = 4.3 dB (Vertical)

Conduction Uncertainty : Uc = 3.4dB

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10: 2013 and FCC Part 15, Paragraph 15.247.

2.1. Summary of Test Results

The EUT has been tested according to the following specifications:

Standard	Test Type	Result
FCC Part 15, Paragraph 15.207 & 15.407	Conducted Emission	PASS
FCC Part 15, Paragraph 15.407(b)(1)(4)(5)(7)	Undesireable Emission Restricted Band	PASS
FCC Part 15, Paragraph 15.407(a)(1)	26dB Bandwidth	PASS
FCC Part 15, Paragraph 15.407(a)(1)(2)(3)	Maximum Conducted Output Power	PASS
FCC Part 15, Paragraph 15.407(a)(1)(2)(3)	Peak Power Spectrual Density	PASS
FCC Part 15, Paragraph 15.203	Antenna Requirement	PASS

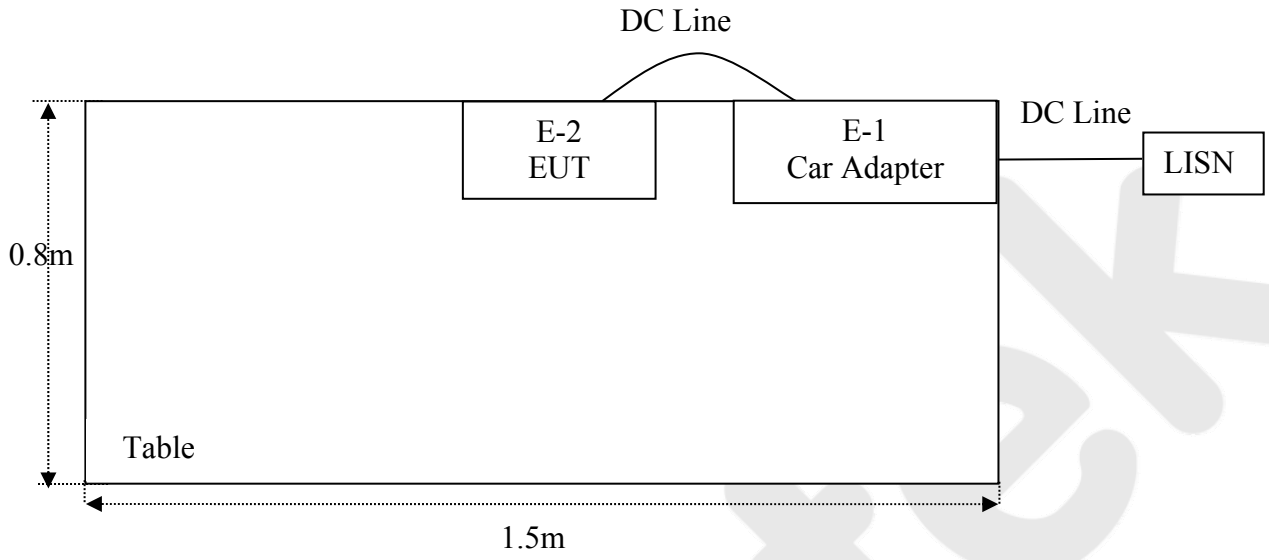
2.2. Description of Test Modes

The EUT has been tested under operating condition.
Software used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

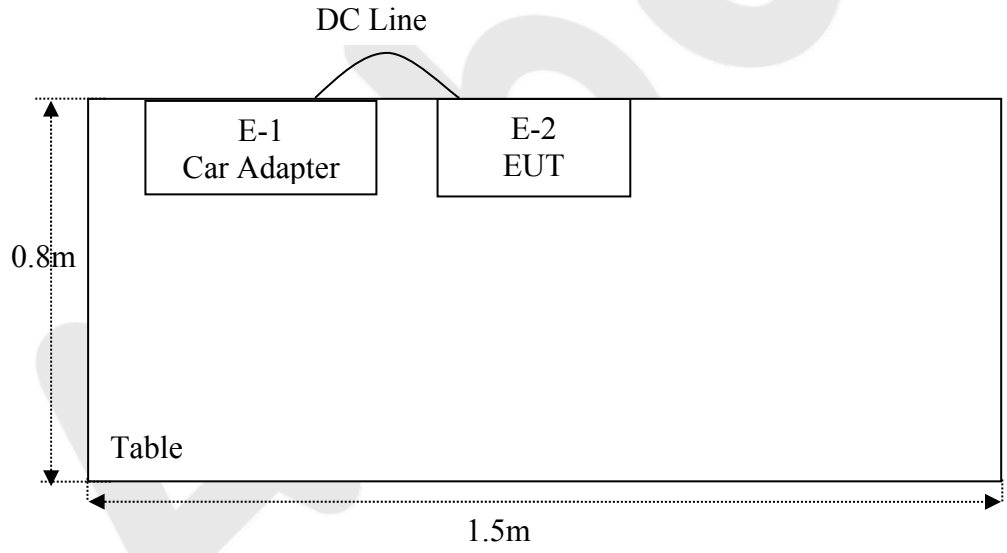
Mode	Test channel
IEEE802.11a	5180MHz
	5200MHz
	5240MHz
IEEE802.11n(HT20)	5180MHz
	5200MHz
	5240MHz

2.3. Description Of Test Setup

CE



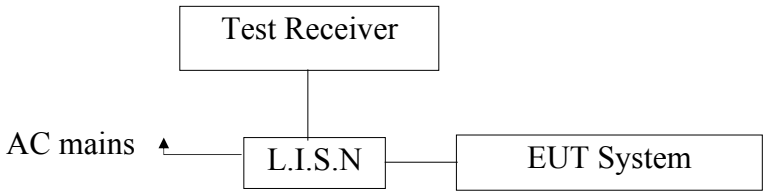
RE



3. Conducted Emission Test

3.1. Block Diagram of Test Setup

3.1.1. Block diagram of connection between the EUT and simulators



3.2. Power Line Conducted Emission Measurement Limits (15.207)

Frequency MHz	Limits dB(μV)	
	Quasi-peak Level	Average Level
0.15 ~ 0.50	66 ~ 56*	56 ~ 46*
0.50 ~ 5.00	56	46
5.00 ~ 30.00	60	50

Notes: 1. *Decreasing linearly with logarithm of frequency.
2. The lower limit shall apply at the transition frequencies.

3.3. Configuration of EUT on Measurement

The following equipments are installed on Power Line Conducted Emission Measurement to meet the commission requirement and operating regulations in a manner which tends to maximize its emission characteristics in a normal application.

3.4. Operating Condition of EUT

3.4.1. Setup the EUT and simulator as shown as Section 3.1.

3.4.2. Turn on the power of all equipment.

3.4.3. Let the EUT work in test mode (5G WiFi Mode) and measure it.

3.5. Test Procedure

The EUT system is connected to the power mains through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm coupling impedance for the EUT system. Please refer the block diagram of the test setup and photographs. Both sides of AC line are checked to find out the maximum conducted emission. In order to find the maximum emission levels, the relative positions of equipment and all of the interface cables shall be changed according to FCC ANSI C63.10-2013 on Conducted Emission Measurement.

The bandwidth of test receiver (ESCI) set at 9KHz.

The frequency range from 150KHz to 30MHz is checked.

The test results are reported on Section 3.6.

3.6. Test equipment

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1.	Two-Line V-network	Rohde & Schwarz	ENV216	100055	Jul. 19, 2016	1 Year
2.	EMI Test Receiver	Rohde & Schwarz	ESCI	100627	Jun. 17, 2016	1 Year
3.	RF Switching Unit	Compliance Direction	RSU-M2	38303	Jun. 17, 2016	1 Year

3.7. Power Line Conducted Emission Measurement Results

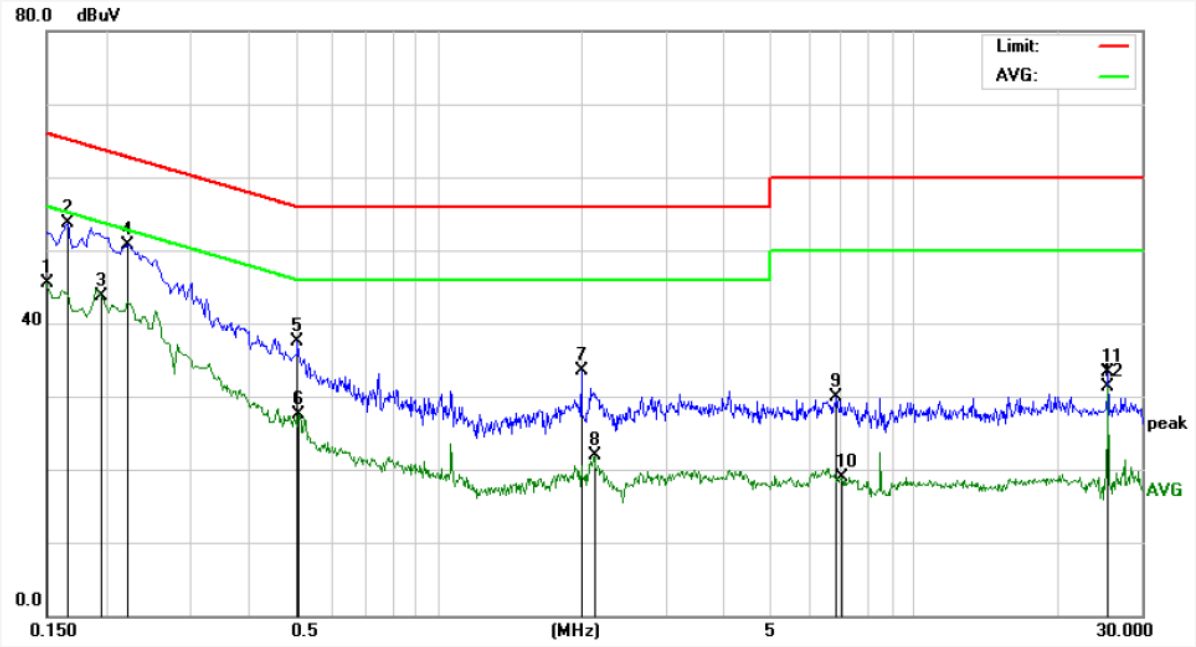
PASS.

The frequency range from 150KHz to 30 MHz is investigated.

The EUT was tested on (5G WiFi Mode) Mode is attached in the following pages.

CONDUCTED EMISSION TEST DATA

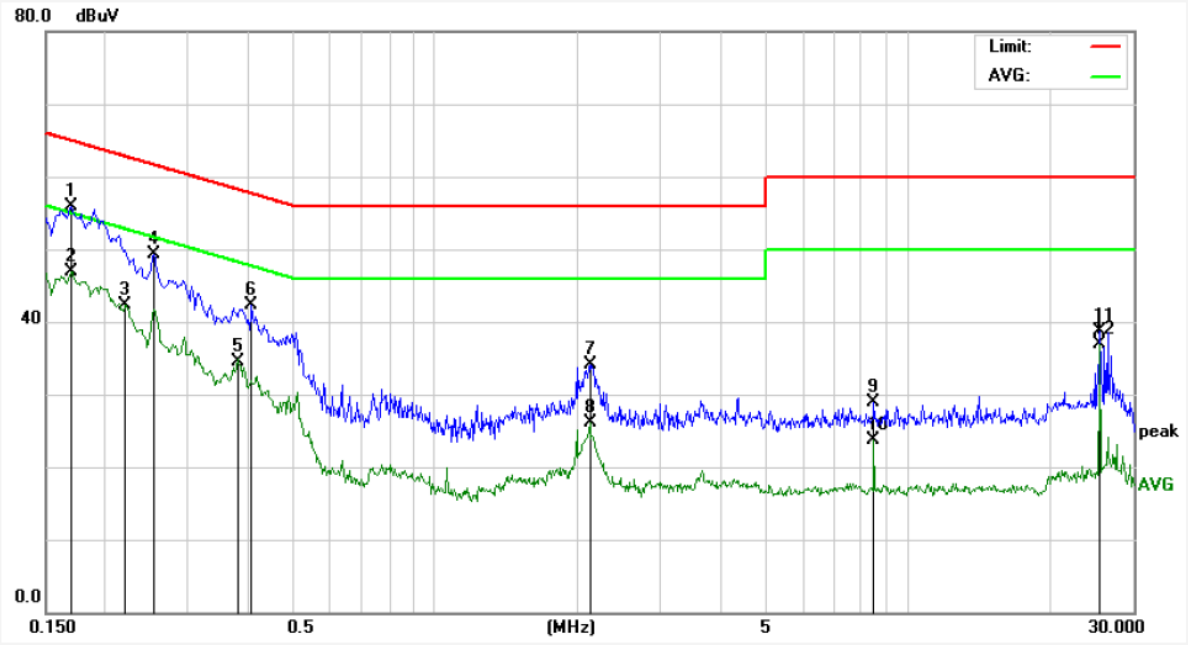
Test Site:	1# Shielded Room
Operating Condition:	5G WiFi Mode
Test Specification:	DC 12V
Comment:	Live Line
	Tem.:25℃ Hum.:50%



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Over Limit (dB)	Detector	Remark
1	0.1500	25.69	19.90	45.59	55.99	-10.40	AVG	
2	0.1660	33.87	19.90	53.77	65.15	-11.38	QP	
3	0.1955	23.82	19.90	43.72	53.80	-10.08	AVG	
4	0.2220	30.88	19.89	50.77	62.74	-11.97	QP	
5	0.5060	17.53	19.98	37.51	56.00	-18.49	QP	
6	0.5100	7.56	19.98	27.54	46.00	-18.46	AVG	
7	1.9980	13.36	20.14	33.50	56.00	-22.50	QP	
8	2.1260	1.73	20.14	21.87	46.00	-24.13	AVG	
9	6.8540	9.55	20.26	29.81	60.00	-30.19	QP	
10	7.0380	-1.29	20.26	18.97	50.00	-31.03	AVG	
11	25.4580	13.03	20.28	33.31	60.00	-26.69	QP	
12	25.4580	11.02	20.28	31.30	50.00	-18.70	AVG	

CONDUCTED EMISSION TEST DATA

Test Site: 1# Shielded Room
Operating Condition: 5G WiFi Mode
Test Specification: DC 12V
Comment: Neutral Line
Tem.:25℃ Hum.:50%



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Over Limit (dB)	Detector	Remark
1	0.1700	35.97	19.90	55.87	64.96	-9.09	QP	
2	0.1700	27.03	19.90	46.93	54.96	-8.03	AVG	
3	0.2207	22.47	19.89	42.36	52.79	-10.43	AVG	
4	0.2540	29.46	19.89	49.35	61.62	-12.27	QP	
5	0.3830	14.61	19.93	34.54	48.21	-13.67	AVG	
6	0.4100	22.40	19.94	42.34	57.65	-15.31	QP	
7	2.1220	13.97	20.14	34.11	56.00	-21.89	QP	
8	2.1220	5.87	20.14	26.01	46.00	-19.99	AVG	
9	8.4860	8.66	20.30	28.96	60.00	-31.04	QP	
10	8.4860	3.37	20.30	23.67	50.00	-26.33	AVG	
11	25.4580	18.34	20.28	38.62	60.00	-21.38	QP	
12	25.4580	16.62	20.28	36.90	50.00	-13.10	AVG	

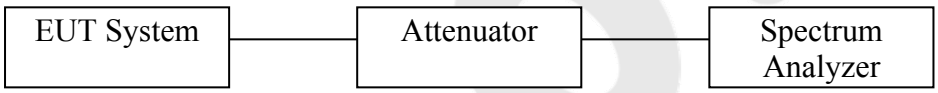
4.Bandwidth

4.1. Test Limit

The maximum power spectral density is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements in the 5.725-5.85 GHz band are made over a reference bandwidth of 500 kHz or the 26 dB emission bandwidth of the device, whichever is less. Measurements in the 5.15-5.25 GHz, 5.25-5.35 GHz, and the 5.47-5.725 GHz bands are made over a bandwidth of 1 MHz or the 26 dB emission bandwidth of the device, whichever is less. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full reference bandwidth.

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

4.2. Test Setup



4.3. Test Procedure

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

3. Set the spectrum analyzer as:
26 dB &99%bandwidth
RBW = approximately 1% of the emission bandwidth;
Set the VBW＞RBW;
Detector= Peak
Trace mode= Max hold.
Sweep- auto couple.
6 dB bandwidth
RBW = 100kHz;
Set the video bandwidth (VBW) ≥ 3 RBW ;
Detector= Peak
Trace mode= Max hold.
Sweep- auto couple.

4. Measure the maximum width of the emission that is 26dB /6dB down from the maximum of the emission. Compare this with the RBW setting of the analyzer.
5. Repeat until all the rest channels are investigated.

4.4. Test Equipment

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1.	Spectrum Analysis	Agilent	E4407B	US39390582	Jul. 12, 2016	1 Year
2.	Preamplifier	Instruments corporation	EMC011830	980100	Jun. 17, 2016	1 Year
3.	EMI Test Receiver	Rohde & Schwarz	ESPI	101604	Jun. 17, 2016	1 Year
4.	Double Ridged Horn Antenna	Instruments corporation	GTH-0118	351600	May 06, 2016	1 Year
5.	Bilog Broadband Antenna	Schwarzbeck	VULB9163	VULB 9163-289	May 06, 2016	1 Year
6.	Pre-amplifier	SONOMA	310N	186860	Jun. 17, 2016	1 Year
7.	EMI Test Software EZ-EMC	SHURPLE	N/A	N/A	N/A	N/A
8	Power Sensor	Agilent	KFSW150502	15I00041SN045	Jun. 17, 2016	1 Year
9	MXA Spectrum Analysis	Agilent	N9020A	MY51170037	Jun. 17, 2016	1 Year
10	MXG RF Vector Signal Generator	Agilent	N5182A	MY48180656	Jun. 17, 2016	1 Year
11	Signal Generator	Agilent	E4421B	MY41000743	Jun. 17, 2016	1 Year
12	DC Power supply	IV	IV-8080	YQSB0096	Jun. 17, 2016	1 Year
13	TEMP&HUMI PROGRAMMABLE CHAMBER	Bell Group	BE-THK-150M8	SE-0137	Jun. 17, 2016	1 Year
14	Spectrum Analysis	Rohde & Schwarz	FSV40	132.1.3008K39 -100965	Jun. 17, 2016	1 Year
15	Pre-amplifier	Agilent	8449B	3008A00252	Jun. 17, 2016	1 Year
16	Horn Antenna	SCHWARZBECK	BBHA9170	9170-068	Jun. 17, 2016	1 Year

4.5. Test Results

Pass.
Please refer to the following data.

Bandwidth:

Test Mode: IEEE 802.11a

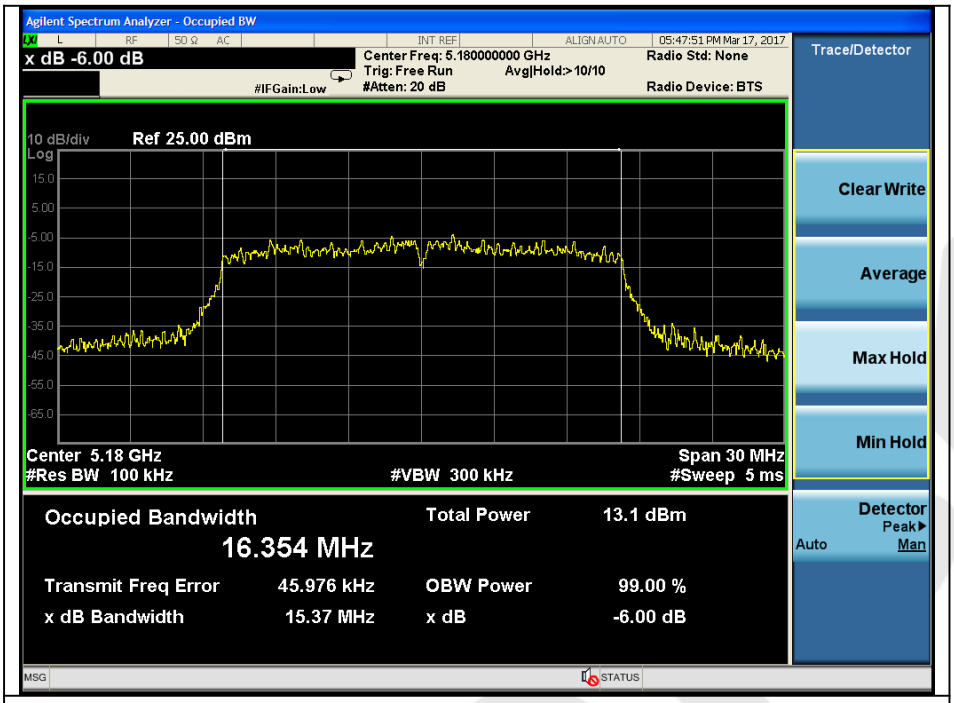
Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Limit (kHz)
Low	5180	15.37	>500
Mid	5200	15.12	
High	5240	15.95	

Channel	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	5180	18.72	16.395
Mid	5200	18.68	16.406
High	5240	18.52	16.380

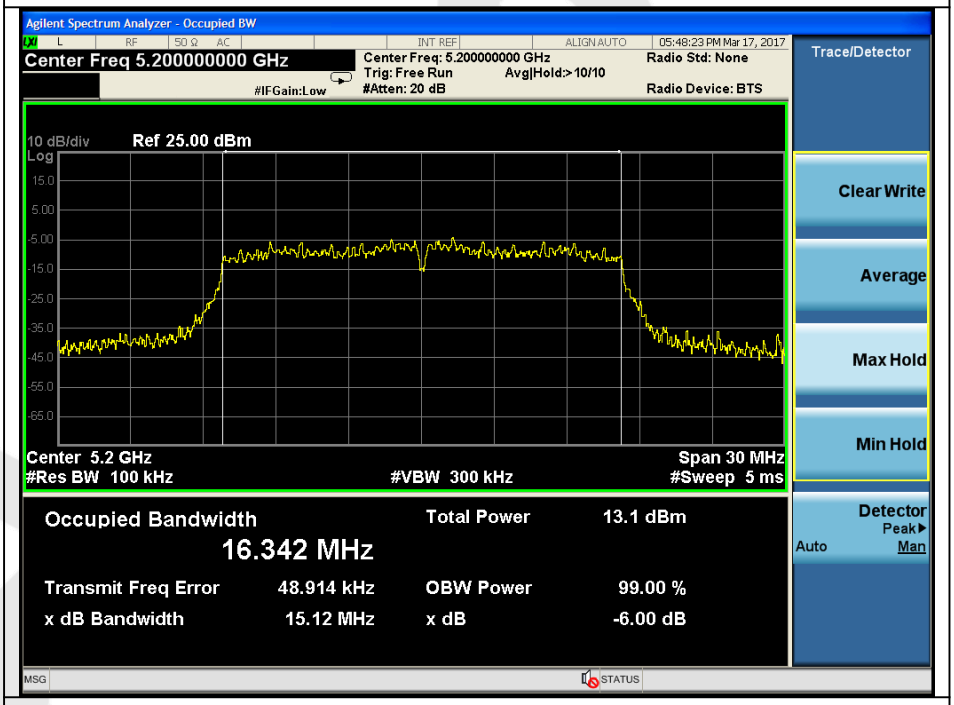
Test Mode: IEEE 802.11n(HT20)

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Limit (kHz)
Low	5180	16.92	>500
Mid	5200	17.47	
High	5240	16.00	

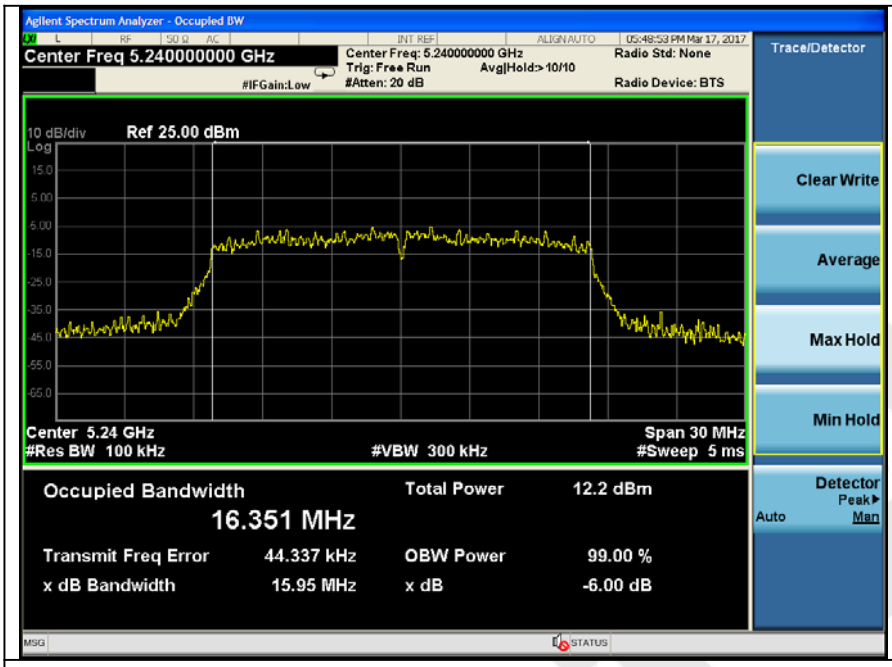
Channel	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	5180	18.89	17.521
Mid	5200	18.86	17.524
High	5240	18.83	17.517



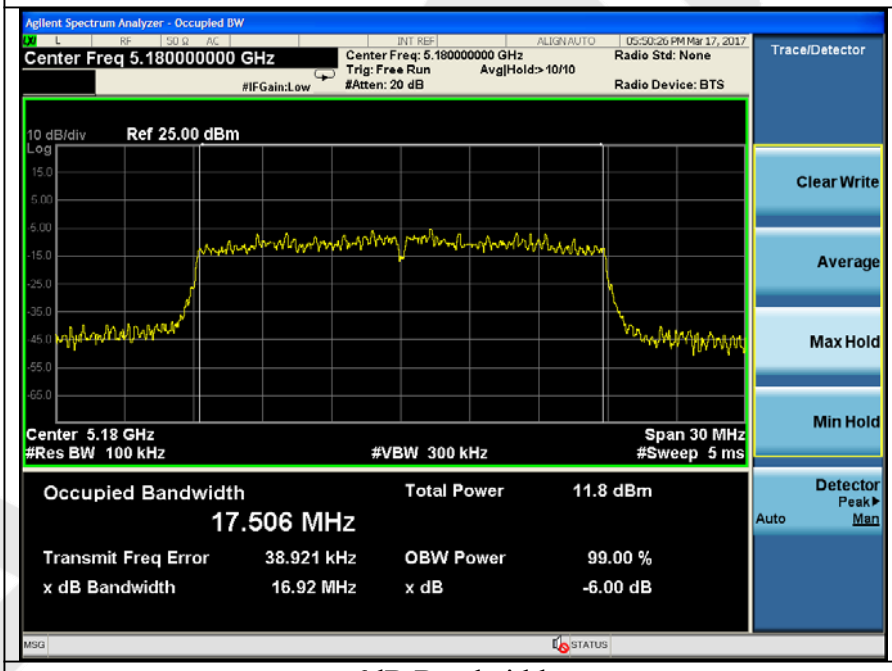
6dB Bandwidth
Test Mode: 802.11a--5180



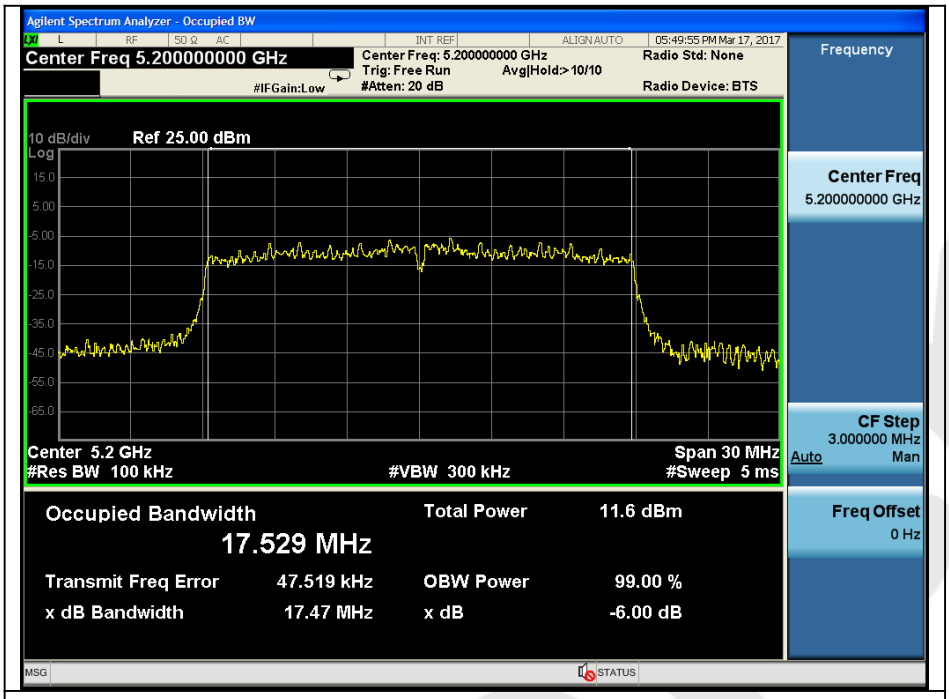
6dB Bandwidth
Test Mode: 802.11a---5200



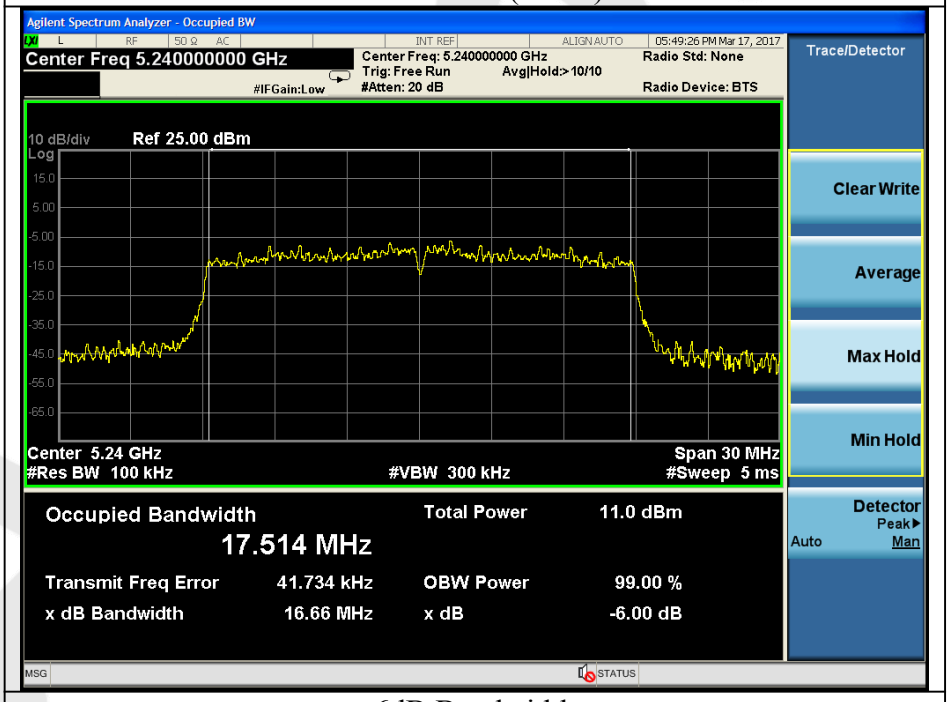
6dB Bandwidth
Test Mode: 802.11a--5240



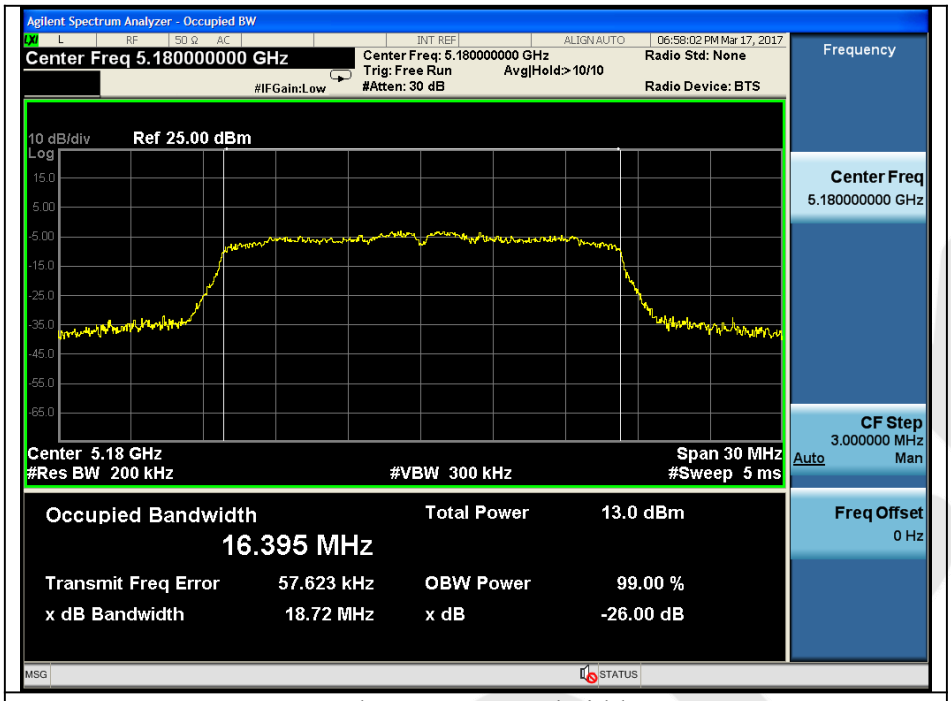
6dB Bandwidth
Test Mode: 802.11n(HT20)--5180



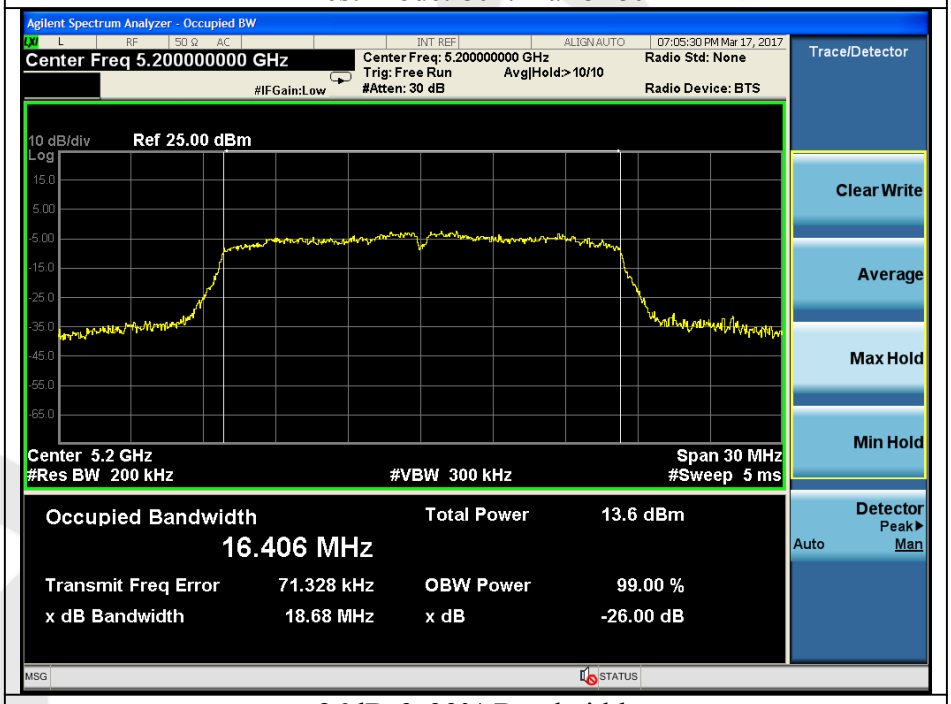
6dB Bandwidth
Test Mode: 802.11n(HT20)---5200



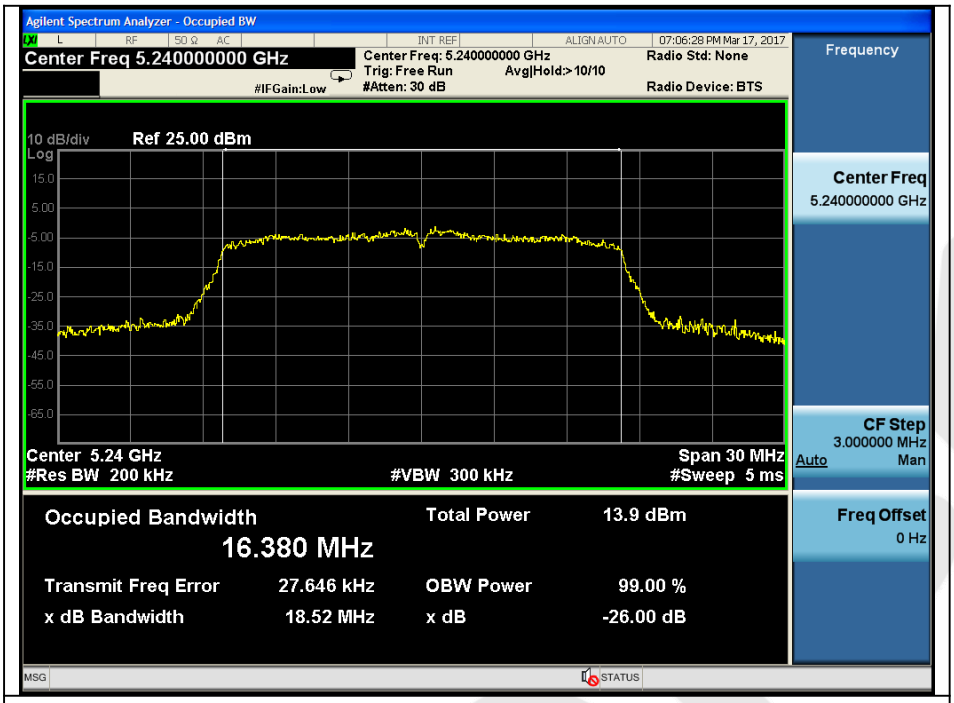
6dB Bandwidth
Test Mode: 802.11n(HT20)--5240



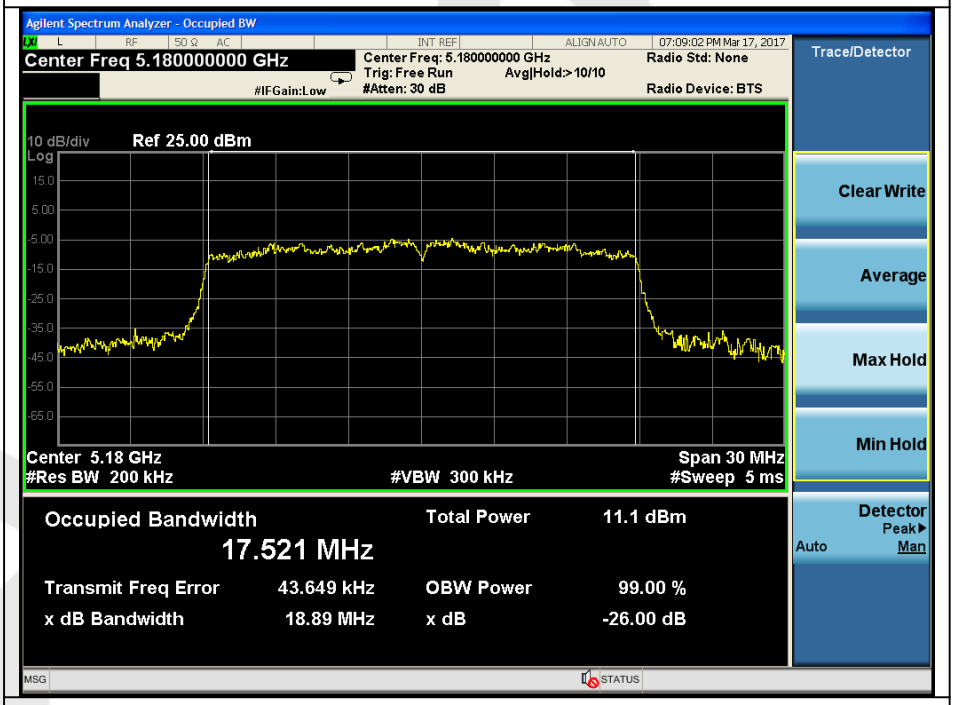
26dB & 99% Bandwidth
Test Mode: 802.11a--5180



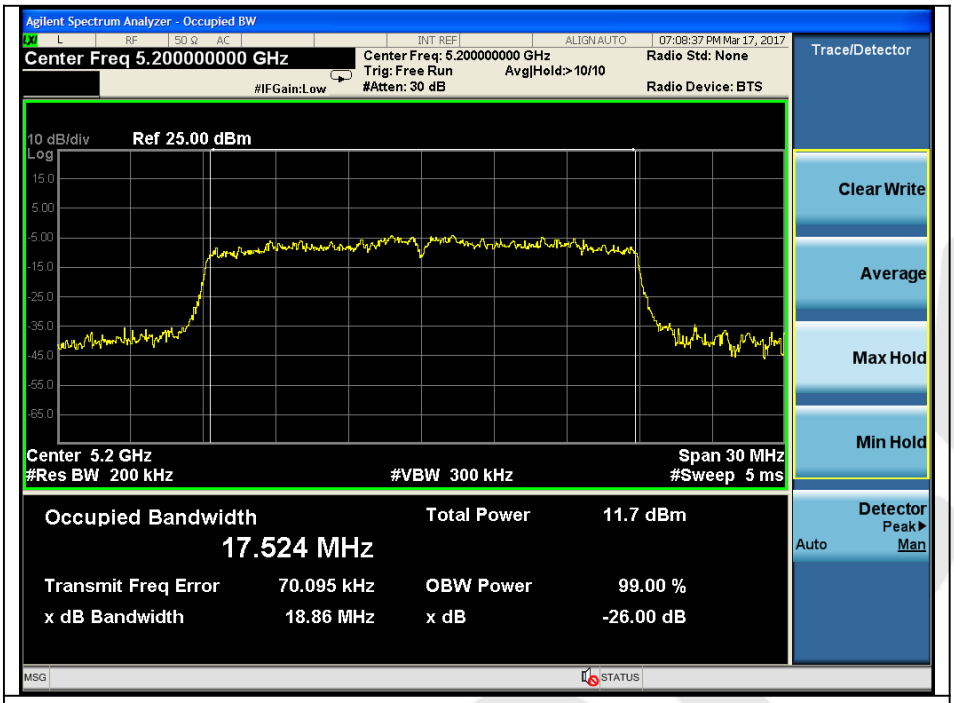
26dB & 99% Bandwidth
Test Mode: 802.11a---5200



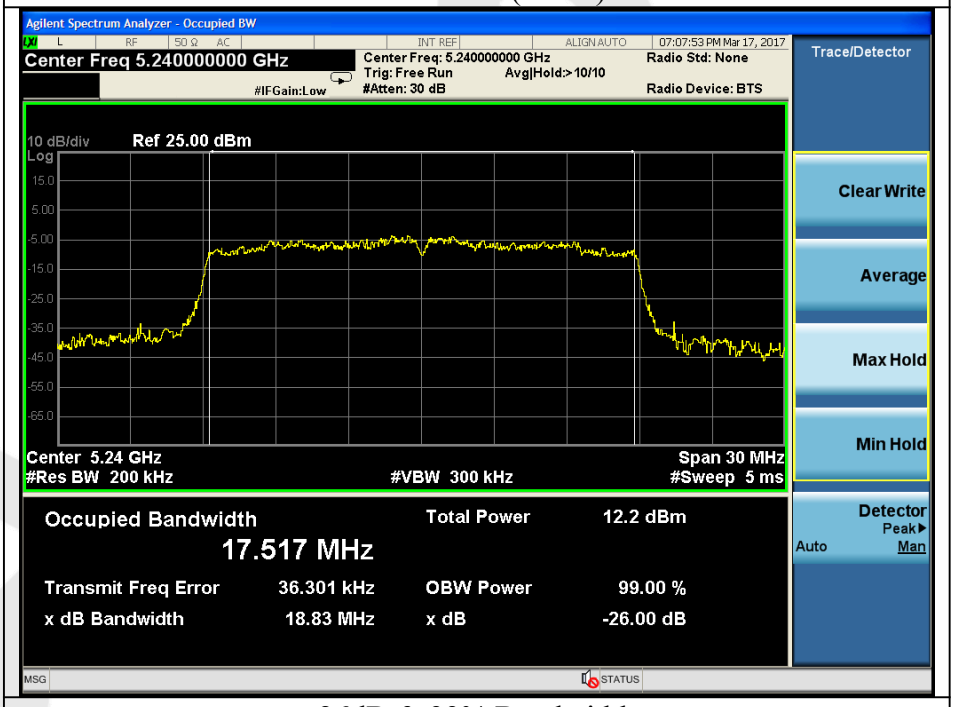
26dB & 99% Bandwidth
Test Mode: 802.11a--5240



26dB & 99% Bandwidth
Test Mode: 802.11n(HT20)--5180



26dB & 99% Bandwidth
Test Mode: 802.11n(HT20)---5200



26dB & 99% Bandwidth
Test Mode: 802.11n(HT20)--5240

5. Maximum Conducted Output Power Test

5.1. Test Limit

1) For the band 5.15-5.25 GHz.
(i) 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. In addition, 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).

(ii) For an indoor 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. In addition, 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.

(iii) For fixed point-to-point access points 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. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. 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.

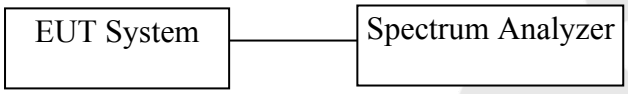
(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 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.

(2) 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. In addition, 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.

(3) For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, 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.

5.2. Test Setup



5.3. Test Procedure

1. Set span to encompass the entire emission bandwidth (EBW) (or, alternatively, the entire 99% occupied bandwidth) of the signal.
2. Set RBW = 1 MHz.
3. Set VBW ≥ 3 MHz.
4. Number of points in sweep ≥ 2 × span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
5.Sweep time = auto.
6.Detector = power averaging (rms), if available. Otherwise, use sample detector mode.
7. If transmit duty cycle < 98%, use a video trigger with the trigger level set to enable triggering only on full power pulses. Transmitter must operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98%, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to “free run.”
8. Trace average at least 100 traces in power averaging (rms) mode.
9. Compute power by integrating the spectrum across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal using the instrument’s band power measurement function with band limits set equal to the EBW (or occupied bandwidth) band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the spectrum.

5.4. Test Equipment

Same as clause 4.4.

5.5. Test Results

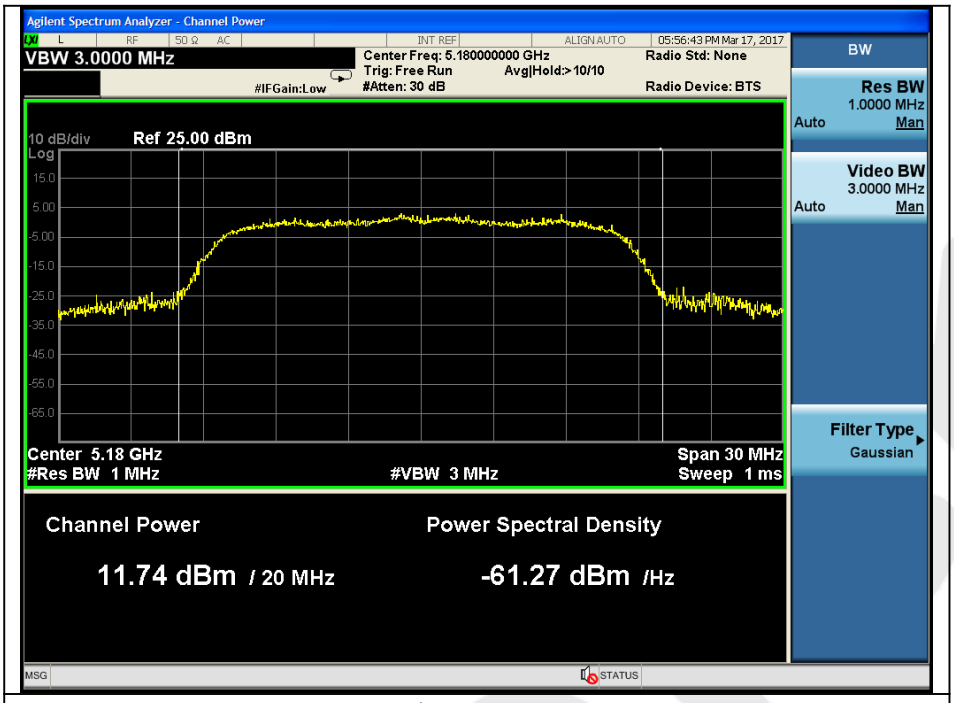
Pass.
Please refer to the following data.

Test Mode: IEEE 802.11a

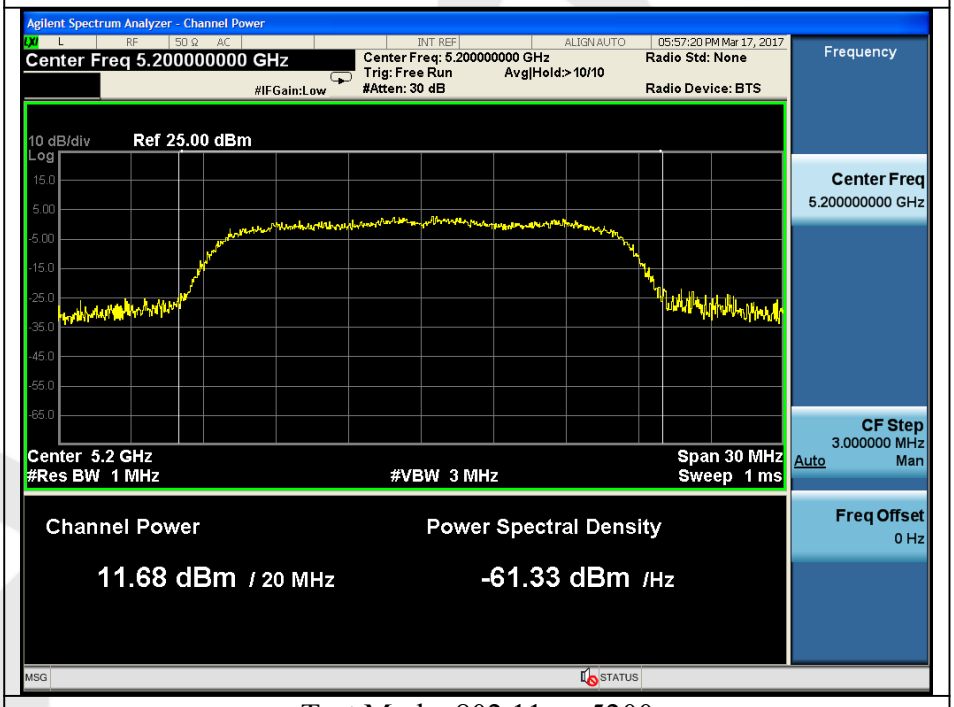
Channel	Frequency (MHz)	Maximum transmit power (dBm)	Limit (dBm)	Result
Low	5180	11.74	24.00	Pass
Mid	5200	11.68	24.00	Pass
High	5240	11.91	24.00	Pass

Test Mode: IEEE 802.11n(HT20)

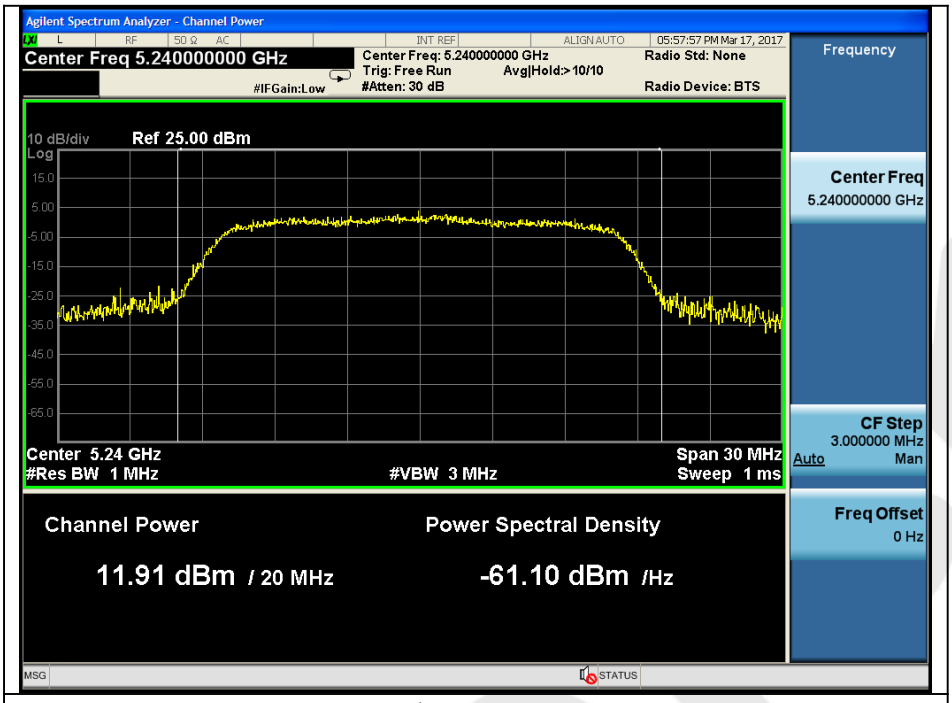
Channel	Frequency (MHz)	Maximum transmit power (dBm)	Limit (dBm)	Result
Low	5180	9.83	24.00	Pass
Mid	5200	9.98	24.00	Pass
High	5240	10.80	24.00	Pass



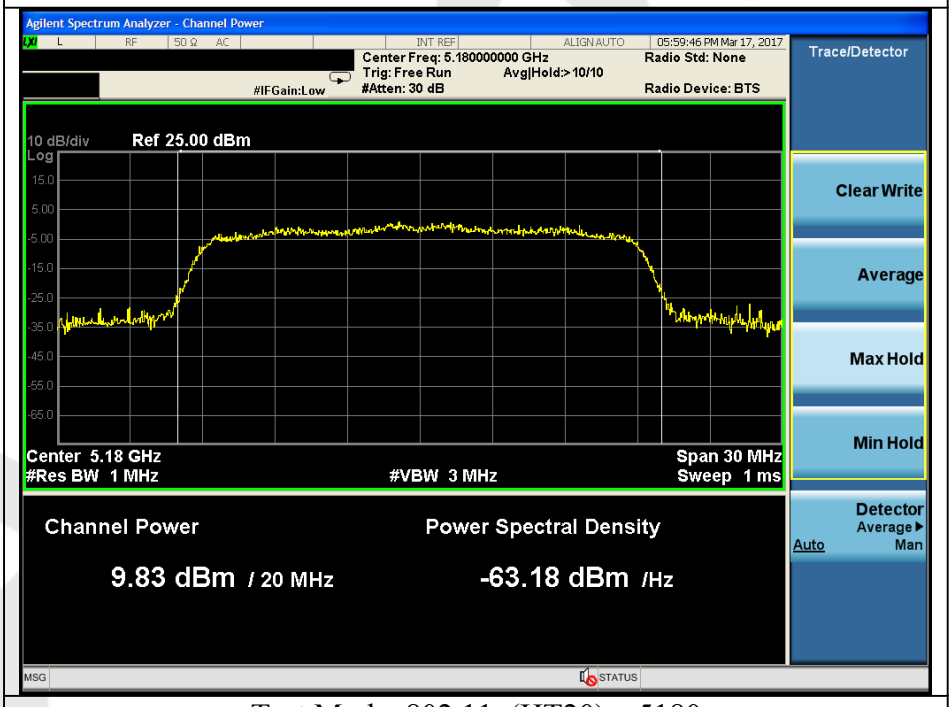
Test Mode: 802.11a---5180



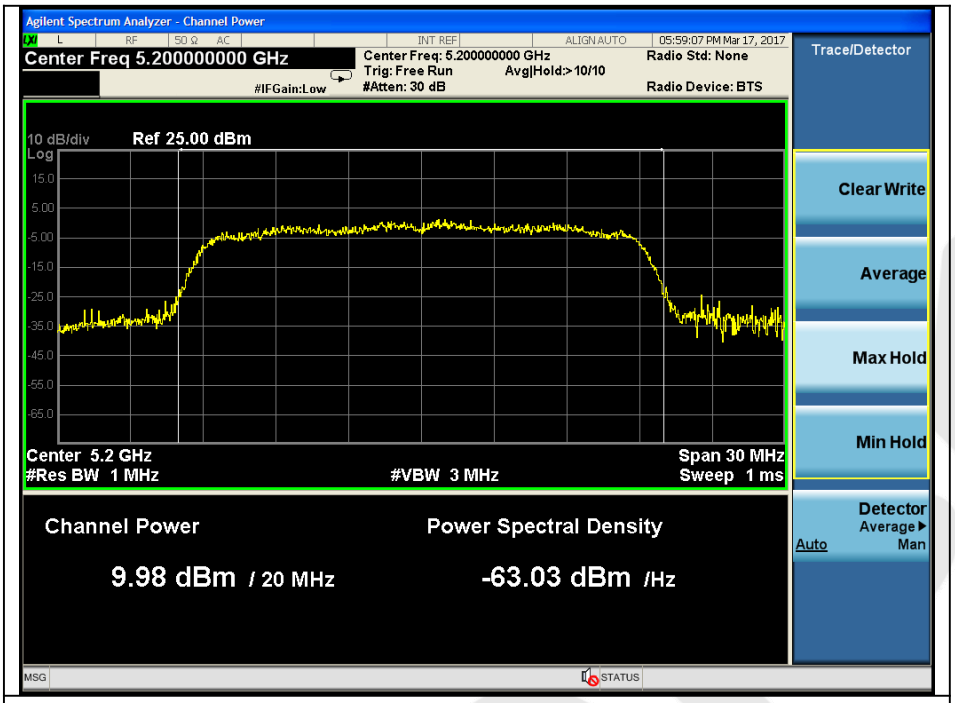
Test Mode: 802.11a---5200



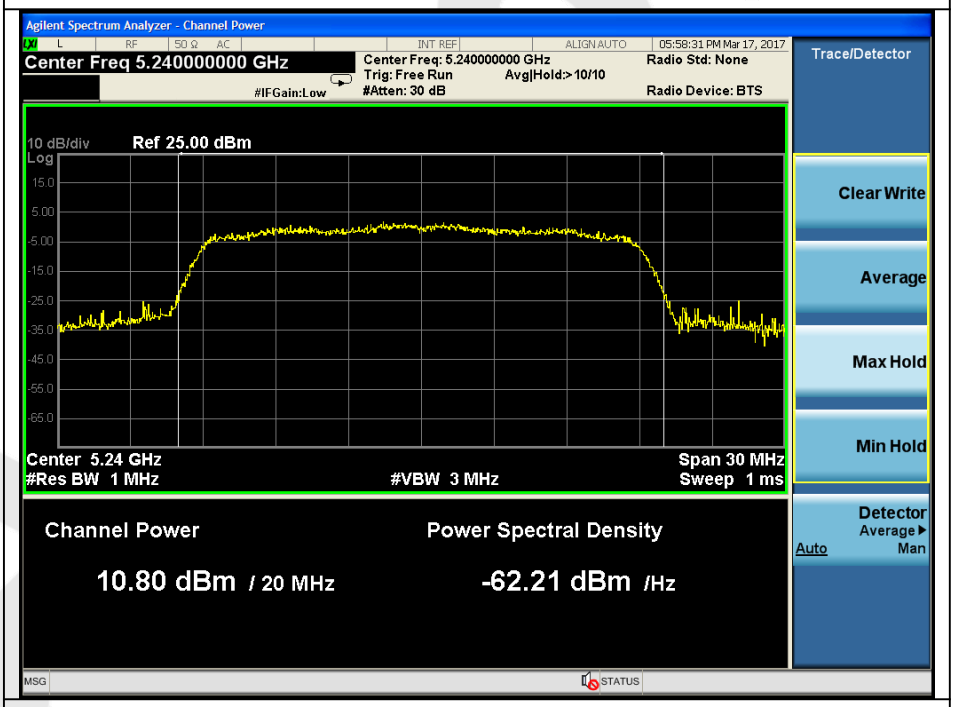
Test Mode: 802.11a---5240



Test Mode: 802.11n(HT20)---5180



Test Mode: 802.11n(HT20)---5200



Test Mode: 802.11n(HT20)---5240

6. Peak Power Spectrual Density Test

6.1. Test Limit

1) For the band 5.15-5.25 GHz.
(i) 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. In addition, 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).

(ii) For an indoor 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. In addition, 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.

(iii) For fixed point-to-point access points 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. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. 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.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, 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.

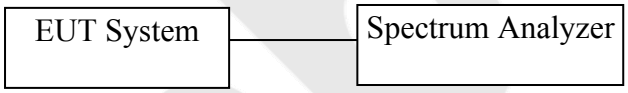
(3) For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 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.

(3) For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, 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.

The maximum power spectral density is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements in the 5.725-5.85 GHz band are made over a reference bandwidth of 500 kHz or the 26 dB emission bandwidth of the device, whichever is less. Measurements in the 5.15-5.25 GHz, 5.25-5.35 GHz, and the 5.47-5.725 GHz bands are made over a bandwidth of 1 MHz or the 26 dB emission bandwidth of the device, whichever is less. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full reference bandwidth.

6.2. Test Setup



6.3. Test Procedure

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).

1. The EUT is directly connected to the spectrum analyzer;
2. Set RBW ≥ 1/T;
3. Set VBW ≥ 3 RBW. ;
3. Set the span to encompass the entire emissions bandwidth (EBW) of the signal;
5. Detector=RMS;
6. Sweep time= auto couple;
7. Trace mode=max. hold;

6.4. Test Equipment

Same as clause 4.4.

6.5. Test Results

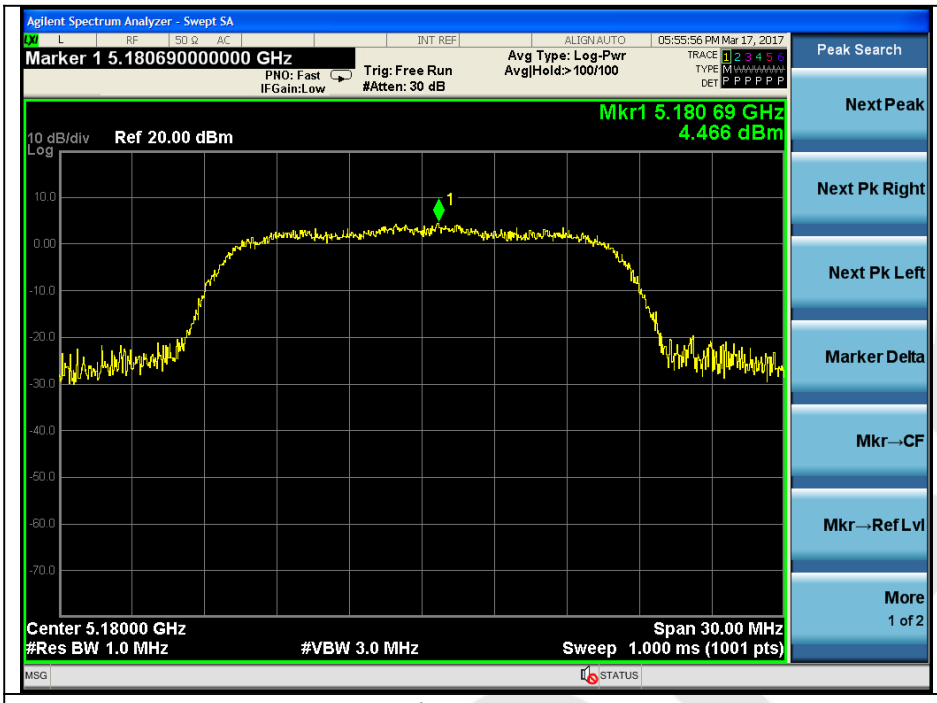
Pass.
Please refer to the following data.

Test Mode: IEEE 802.11a

Channel	Frequency (MHz)	Final Power Spectral Density (dBm)	Power Spectral Density Limit (dBm)	Result
Low	5180	4.466	11	Pass
Mid	5200	5.649	11	Pass
High	5240	6.015	11	Pass

Test Mode: IEEE 802.11n(HT20)

Channel	Frequency (MHz)	Final Power Spectral Density (dBm)	Power Spectral Density Limit (dBm)	Result
Low	5180	4.365	11	Pass
Mid	5200	2.962	11	Pass
High	5240	5.088	11	Pass



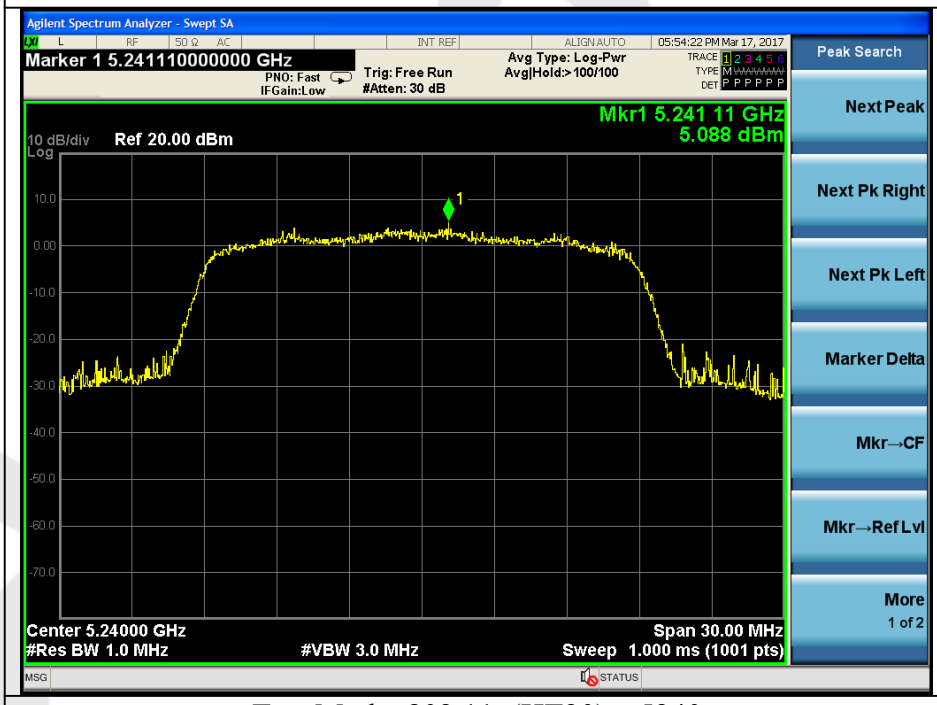
Test Mode: 802.11a---5180

Test Mode: 802.11a---5200

Test Mode: 802.11a---5240

Test Mode: 802.11n(HT20)---5180

Test Mode: 802.11n(HT20)---5200



Test Mode: 802.11n(HT20)---5240

7. Radiated Emission Test

7.1. Test Limit

8.1.1. Test Limits (< 30 MHZ)

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meter)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30

7.1.2. Test Limits (≥ 30 MHZ)

FIELD STRENGTH of Fundamental: @3M	FIELD STRENGTH of Harmonics	S15.209 30 - 88 MHz	40 dBuV/m
902-928 MHZ		88 - 216 MHz	43.5
2.4-2.4835 GHz		216 - 960 MHz	46
94 dBμV/m @3m	54 dBμV/m @3m	ABOVE 960 MHz	54dBuV/m

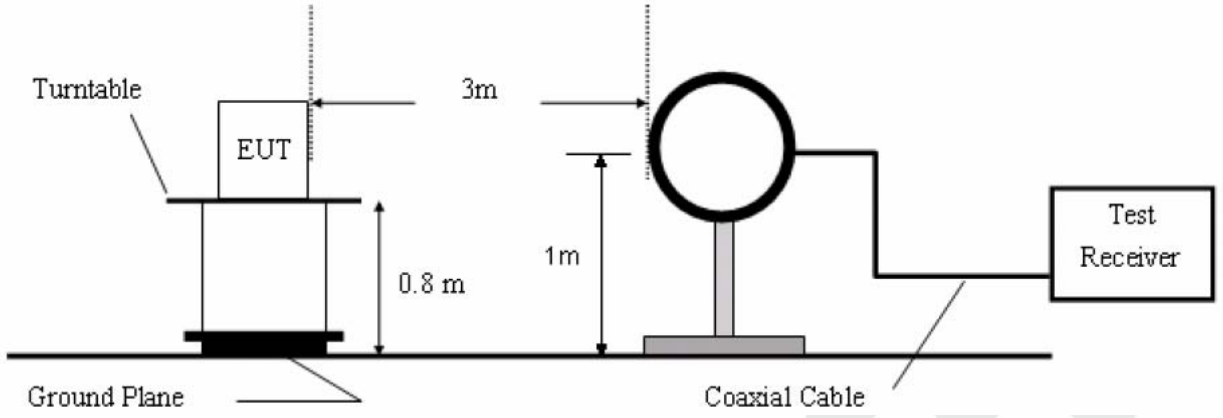
7.1.3. Restriction Band of Operation

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1]0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8

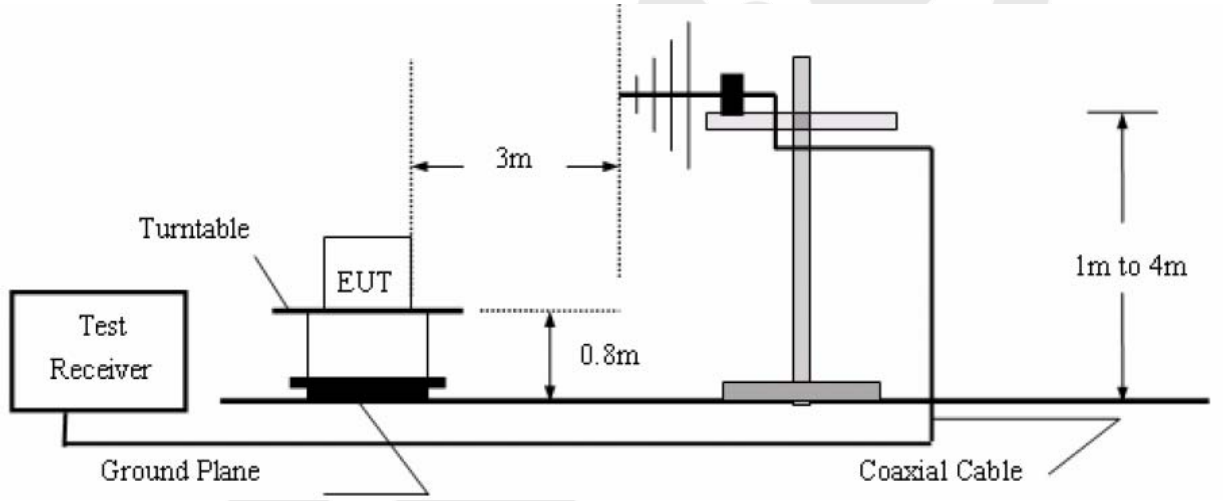
All the emissions appearing within 15.205 restricted frequency bands shall not exceed the limits shown in 15.209, all the other emissions shall be at least 20dB below the fundamental emissions, or comply with 15.209 limits.

7.2. Test Setup

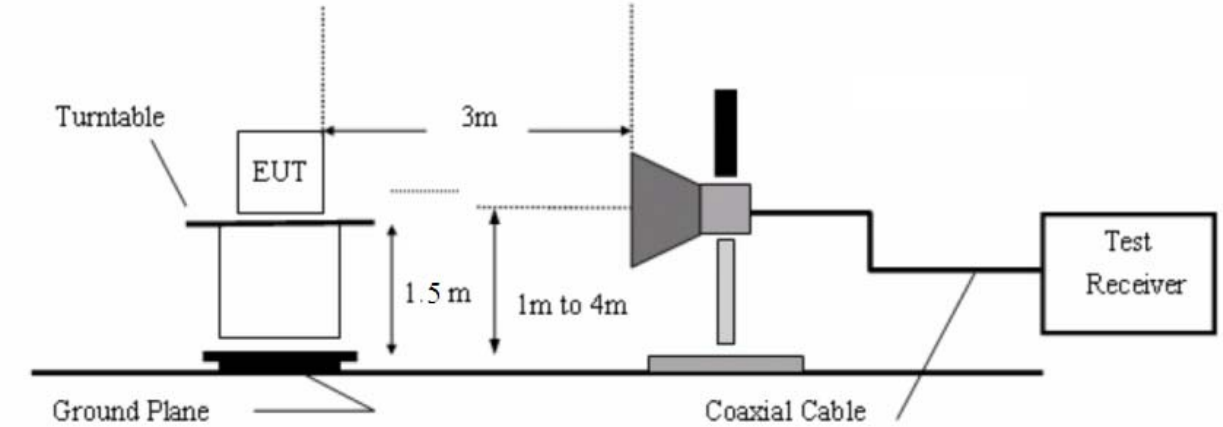
7.2.1. 9k to 30MHz emissions:



7.2.2. 30M to 1G emissions:



7.2.3. 1G to 40G emissions:



7.3. Test Procedure

For below 1GHz: The EUT is placed on a turntable, which is 0.8m above the ground plane.
For above 1GHz: The EUT is placed on a turntable, which is 1.5m above the ground plane.

The turntable shall be rotated 360 degrees to determine the position of max. emission level. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emission.

Measurements are made on 9KHz to 30MHz and 30MHz to 26GHz range with the transmitter set to the lowest, middle, and highest channels.

All readings from 30MHz to 1GHz are quasi-peak values with a resolution bandwidth of 120kHz. All reading are above 1GHz, peak & average values with a resolution bandwidth of 1MHz.
The EUT is tested in 9*6*6 Chamber. The device is evaluated in xyz orientation.

The test results are listed in Section 8.5.

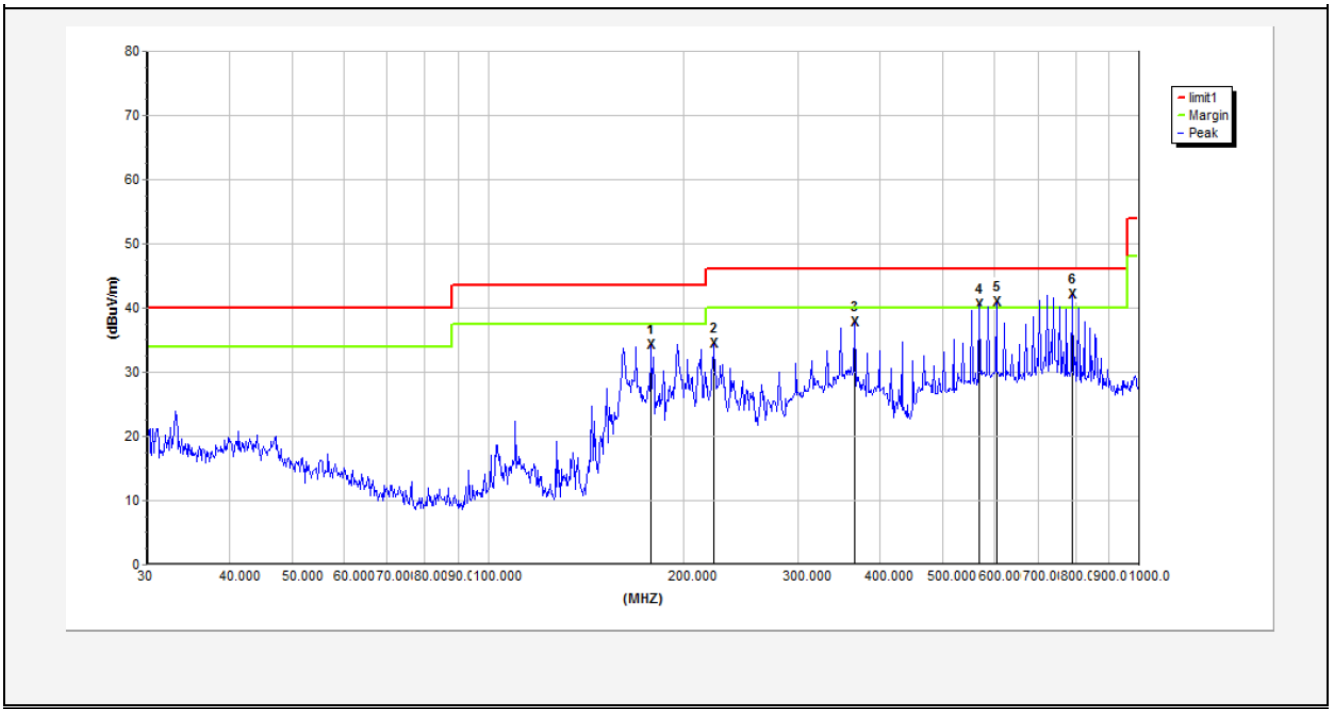
7.4. Test Equipment

Same as clause 4.4.

7.5. Test Results

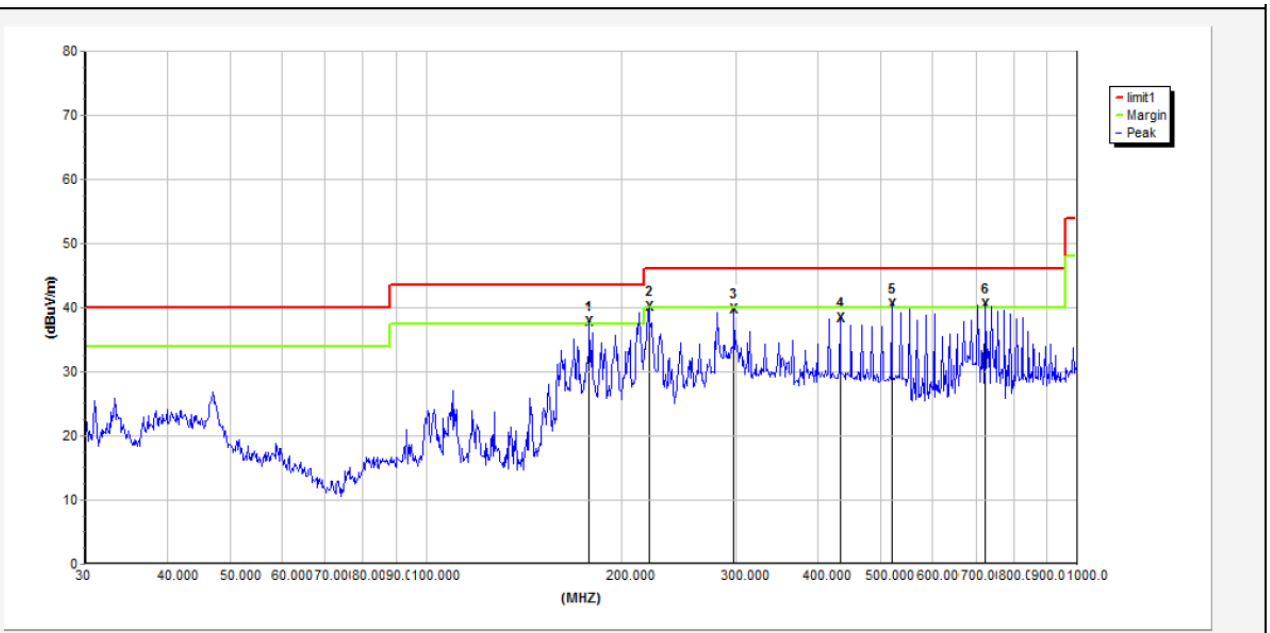
The EUT was tested on (5G WiFi Mode) is attached in the following pages.
Only the worst case (x orientation).

Job No.:	**0117011599W**	**Plarization:**	**Horizontal**
Standard:	**(RE)FCC PART15 C _3m**	**Power Source:**	**DC 12V**
Test item:	**Radiation Test**	**Temp.(C)/Hum.(%RH):**	**24.3(C)/55%RH**
Test Mode:	**5G WiFi Mode**	**Distance:**	**3m**



No.	Freq. (MHz)	Reading (dBuV/m)	Antenna (dB/m)	Amp. (dB/m)	Cable (dB/m)	Result (dBuV/m)	Limit (dBuV/m	Over Limit (dB)	Detector	Height (cm)	degree (deg)
1	178.1322	56.03	4.55	31.67	5.14	34.05	43.50	-9.45	QP	---	---
2	222.1698	54.18	6.41	31.66	5.36	34.29	46.00	-11.71	QP	---	---
3	365.5391	51.10	11.66	31.3	6.09	37.55	46.00	-8.45	QP	---	---
4	568.6127	51.45	13.49	31.44	6.8	40.30	46.00	-5.70	QP	---	---
5	603.5392	51.93	13.53	31.6	6.93	40.79	46.00	-5.21	QP	---	---
6	790.6186	48.74	16.94	31.3	7.61	41.99	46.00	-4.01	QP	---	---

Job No.:	**0117011599W**	**Plarization:**	**Vertical**
Standard:	**(RE)FCC PART15 C _3m**	**Power Source:**	**DC 12V**
Test item:	**Radiation Test**	**Temp.(C)/Hum.(%RH):**	**24.3(C)/55%RH**
Test Mode:	**5G WiFi Mode**	**Distance:**	**3m**



No.	Freq. (MHz)	Reading (dBuV/m)	Antenna (dB/m)	Amp. (dB/m)	Cable (dB/m)	Result (dBuV/m)	Limit (dBuV/m	Over Limit (dB)	Detector	Height (cm)	degree (deg)
1	178.1322	54.68	9.55	31.67	5.14	37.70	43.50	-5.80	QP	---	---
2	219.8446	55.09	11.19	31.66	5.35	39.97	46.00	-6.03	QP	---	---
3	297.2241	54.38	11.01	31.54	5.77	39.62	46.00	-6.38	QP	---	---
4	432.5457	49.56	13.56	31.15	6.35	38.32	46.00	-7.68	QP	---	---
5	519.0647	51.03	13.94	31.18	6.62	40.41	46.00	-5.59	QP	---	---
6	721.7260	48.17	16.3	31.54	7.41	40.34	46.00	-5.66	QP	---	---

Test Results (Above 1000MHz)

Test mode:	IEEE 802.11a	Test channel:	Low CH

Peak value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
10360.00	40.29	31.98	17.08	33.91	55.44	74.00	-18.56	Vertical
15540.00	35.77	32.65	20.03	34.85	53.60	74.00	-20.40	Vertical
10360.00	38.56	31.98	17.08	33.91	53.71	74.00	-20.29	Horizontal
15540.00	36.99	32.65	20.03	34.85	54.82	74.00	-19.18	Horizontal

Average value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
10360.00	30.23	31.98	17.08	33.91	45.38	54.00	-8.62	Vertical
15540.00	27.69	32.65	20.03	34.85	45.52	54.00	-8.48	Vertical
10360.00	29.68	31.98	17.08	33.91	44.83	54.00	-9.17	Horizontal
15540.00	28.39	32.65	20.03	34.85	46.22	54.00	-7.78	Horizontal

Test mode:	IEEE 802.11a	Test channel:	Mid CH

Peak value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
10400.00	40.06	32.44	17.18	33.91	55.77	74.00	-18.23	Vertical
15600.00	37.63	32.78	20.12	34.86	55.67	74.00	-18.33	Vertical
10400.00	39.58	32.44	17.18	33.91	55.29	74.00	-18.71	Horizontal
15600.00	36.77	32.78	20.12	34.86	54.81	74.00	-19.19	Horizontal

Average value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
10400.00	29.68	32.44	17.18	33.91	45.39	54.00	-8.61	Vertical
15600.00	27.33	32.78	20.12	34.86	45.37	54.00	-8.63	Vertical
10400.00	29.74	32.44	17.18	33.91	45.45	54.00	-8.55	Horizontal
15600.00	28.36	32.78	20.12	34.86	46.40	54.00	-7.60	Horizontal

Test mode:	IEEE 802.11a	Test channel:	High CH

Peak value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
10480.00	41.06	32.59	18.02	33.92	57.75	74.00	-16.25	Vertical
15720.00	38.06	32.87	20.15	34.88	56.20	74.00	-17.80	Vertical
10480.00	40.58	32.59	18.02	33.92	57.27	74.00	-16.73	Horizontal
15720.00	39.65	32.87	20.15	34.88	57.79	74.00	-16.21	Horizontal

Average value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
10480.00	31.25	32.59	18.02	33.92	47.94	54.00	-6.06	Vertical
15720.00	30.02	32.87	20.15	34.88	48.16	54.00	-5.84	Vertical
10480.00	29.58	32.59	18.02	33.92	46.27	54.00	-7.73	Horizontal
15720.00	28.39	32.87	20.15	34.88	46.53	54.00	-7.47	Horizontal

Test mode:	IEEE 802.11n(HT20)	Test channel:	Low CH

Peak value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
10360.00	39.88	31.98	17.08	33.91	55.03	74.00	-18.97	Vertical
15540.00	34.57	32.65	20.03	34.85	52.40	74.00	-21.60	Vertical
10360.00	37.69	31.98	17.08	33.91	52.84	74.00	-21.16	Horizontal
15540.00	35.88	32.65	20.03	34.85	53.71	74.00	-20.29	Horizontal

Average value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
10360.00	30.12	31.98	17.08	33.91	45.27	54.00	-8.73	Vertical
15540.00	27.81	32.65	20.03	34.85	45.64	54.00	-8.36	Vertical
10360.00	29.61	31.98	17.08	33.91	44.76	54.00	-9.24	Horizontal
15540.00	27.55	32.65	20.03	34.85	45.38	54.00	-8.62	Horizontal

Test mode:	IEEE 802.11n(HT20)	Test channel:	Mid CH

Peak value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
10400.00	39.68	32.44	17.18	33.91	55.39	74.00	-18.61	Vertical
15600.00	38.65	32.78	20.12	34.86	56.69	74.00	-17.31	Vertical
10400.00	37.54	32.44	17.18	33.91	53.25	74.00	-20.75	Horizontal
15600.00	35.69	32.78	20.12	34.86	53.73	74.00	-20.27	Horizontal

Average value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
10400.00	28.99	32.44	17.18	33.91	44.70	54.00	-9.30	Vertical
15600.00	26.35	32.78	20.12	34.86	44.39	54.00	-9.61	Vertical
10400.00	29.03	32.44	17.18	33.91	44.74	54.00	-9.26	Horizontal
15600.00	28.15	32.78	20.12	34.86	46.19	54.00	-7.81	Horizontal

Test mode:	IEEE 802.11n(HT20)	Test channel:	High CH

Peak value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
10480.00	40.35	32.59	18.02	33.92	57.04	74.00	-16.96	Vertical
15720.00	37.65	32.87	20.15	34.88	55.79	74.00	-18.21	Vertical
10480.00	37.32	32.59	18.02	33.92	54.01	74.00	-19.99	Horizontal
15720.00	38.06	32.87	20.15	34.88	56.20	74.00	-17.80	Horizontal

Average value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
10480.00	30.58	32.59	18.02	33.92	47.27	54.00	-6.73	Vertical
15720.00	31.25	32.87	20.15	34.88	49.39	54.00	-4.61	Vertical
10480.00	28.14	32.59	18.02	33.92	44.83	54.00	-9.17	Horizontal
15720.00	27.96	32.87	20.15	34.88	46.10	54.00	-7.90	Horizontal

Note:
1. Final Level =Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor

8. BAND EDGE TEST

8.1. Test Limit

For transmitter operating in the 5.15-5.25GHz band: all emissions outside of the 5.15-5.35GHz outside of the 5.15-5.35GHz band shall not exceed an EIRP of -27dBm/MHz.

For transmitters operating in the 5.25-5.35GHz band: all emissions outside of the 5.15-5.35GHz band shall not exceed an EIRP of -27dBm/MHz. Devices operating in the 5.25-5.35GHz band that generate emissions in the 5.15-5.25GHz band must meet all applicable technical requirements for operation in the 5.15-5.25GHz band (includeing indoor use) or alternatively meet an out-of-band emission EIRP limit of -27dBm/MHz in the 5.15-5.25GHz band.

For transmitters operating in the 5.45-5.725GHz band: all emissions outside of the 5.47-5.725GHz band shall not exceed an EIRP of -27dBm/MHz.

For transmitters operating in the 5.725-5.825GHz band: all emissions within the frequency range from the band edge to 10MHz above or below the band edge shall not exceed an EIRP of -17dBm/MHz; for frequencies 10MHz or greater above or below the band edge, emssions shall not exceed an EIRP of -27dBm/MHz.

8.2. Test Setup

Same as clause 7.2.

8.3. Test Procedure

For below 1GHz: The EUT is placed on a turntable, which is 0.8m above the ground plane.
For above 1GHz: The EUT is placed on a turntable, which is 1.5m above the ground plane.

The turntable shall be rotated 360 degrees to determine the position of max. emission level. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emission.

Measurements are made on 9KHz to 30MHz and 30MHz to 26GHz range with the transmitter set to the lowest, middle, and highest channels.

All readings from 30MHz to 1GHz are quasi-peak values with a resolution bandwidth of 120kHz. All reading are above 1GHz, peak & average values with a resolution bandwidth of 1MHz.
The EUT is tested in 9*6*6 Chamber.

The test results are listed in Section 9.5.

8.4. Test Equipment

Same as clause 4.4.

8.5. Test Results

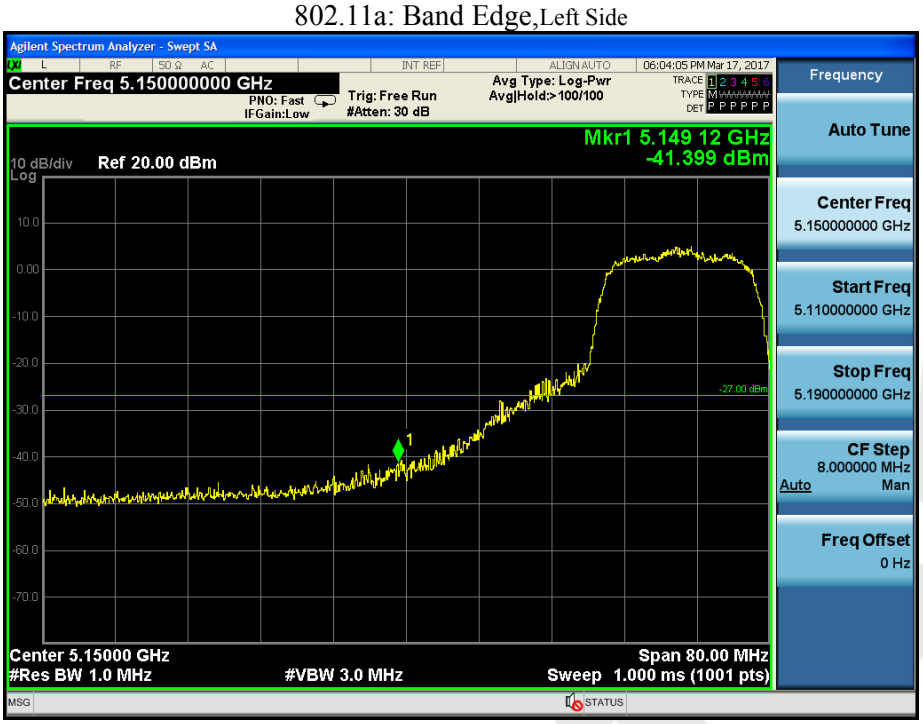
Please refer to the following pages.

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	EIRP (dBm)	Limit (dBm)	Polarization
802.11a								
5150.00	43.25	28.65	13.58	31.04	54.44	-40.76	-27.00	Horizontal
5350.00	44.96	29.16	14.68	31.96	56.84	-38.36	-27.00	Horizontal
5150.00	45.25	28.65	13.58	31.04	56.44	-38.76	-27.00	Vertical
5350.00	46.21	29.16	14.68	31.96	58.09	-37.11	-27.00	Vertical
802.11n(HT20)								
5150.00	44.56	28.65	13.58	31.04	55.75	-39.45	-27.00	Horizontal
5350.00	45.63	29.16	14.68	31.96	57.51	-37.69	-27.00	Horizontal
5150.00	45.12	28.65	13.58	31.04	56.31	-38.89	-27.00	Vertical
5350.00	44.23	29.16	14.68	31.96	56.11	-39.09	-27.00	Vertical

Remark: 1. According to KDB 789033 D02 section H) d) (iii), for measurement above 1000MHz@3m istance, the limit of EIRP is calculated as follows: EIRP[dBm] = E[dBμV/m] - 95.2

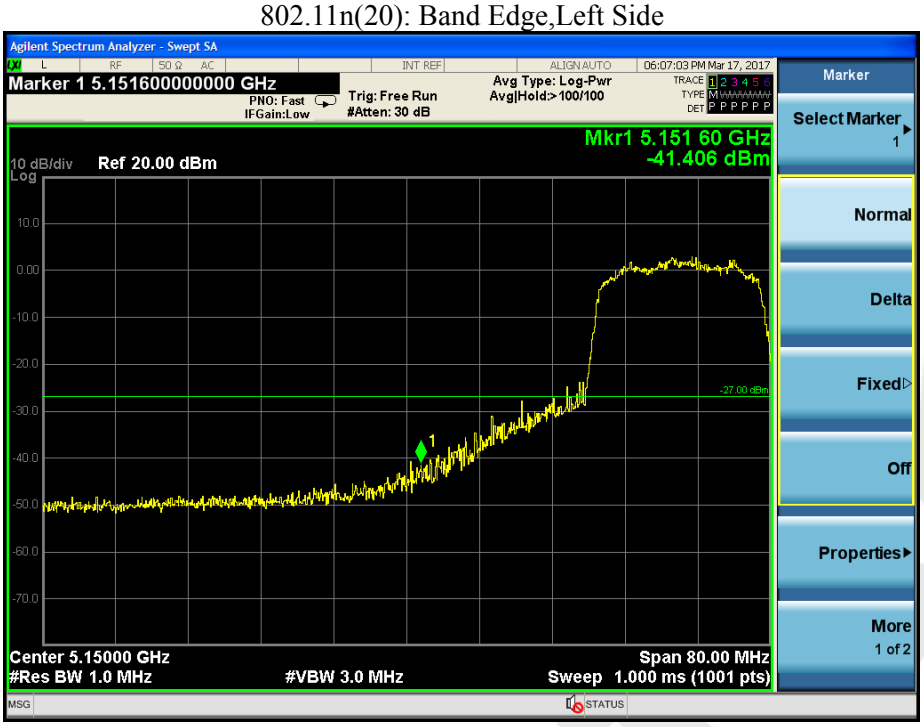
For conducted test:

802.11a: Band Edge,Left Side



802.11a: Band Edge,Right Side

802.11n(20): Band Edge,Left Side



802.11n(20): Band Edge,Right Side

Note： EIRP BAND EDGE=Reading Level+antenna gain

9. ANTENNA APPLICATION

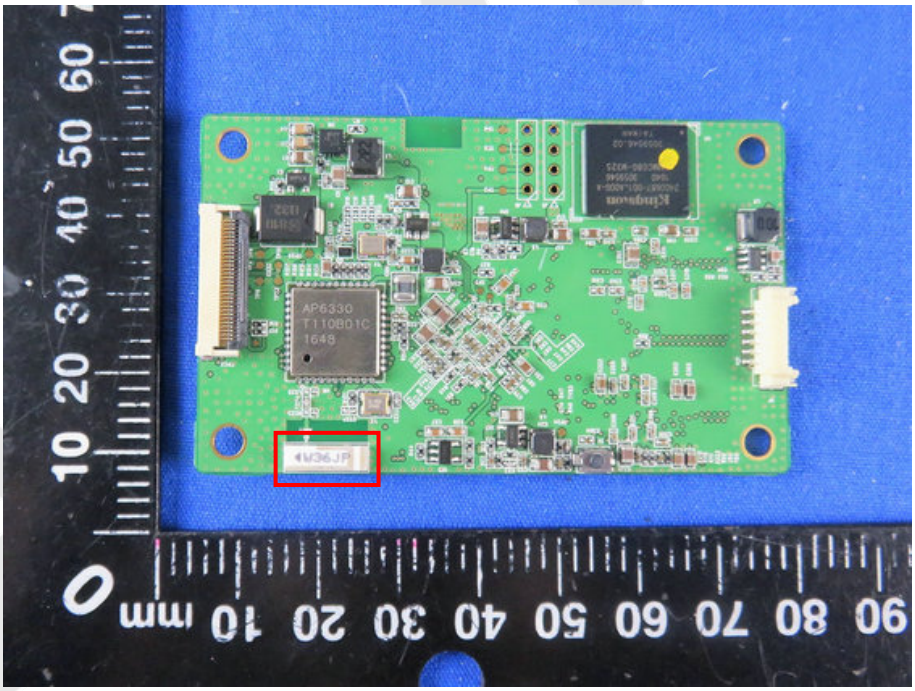
9.1. Antenna requirement

The EUT'S antenna is met the requirement of FCC part 15C section 15.407.

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 use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

9.2. Result

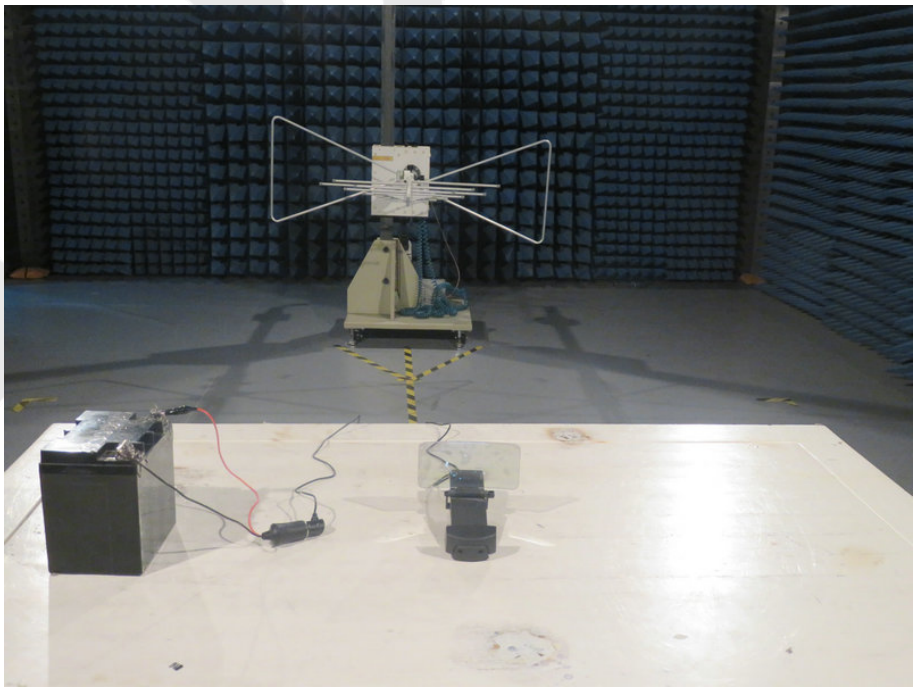
The EUT's antenna used a ceramic antenna which is permanently attached, The antenna's gain is 3.6dBi and meets the requirement.

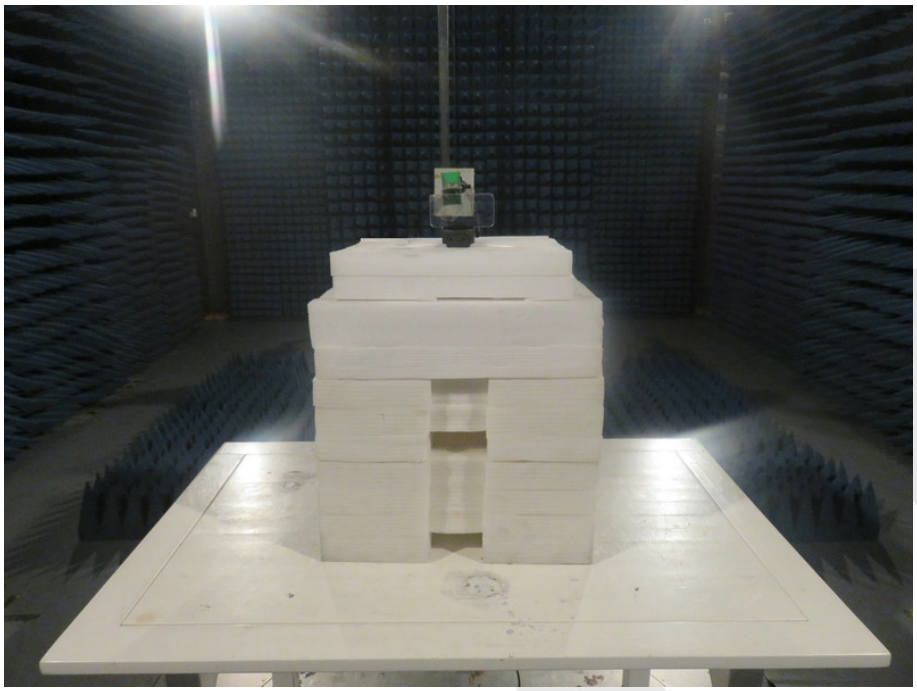


10. PHOTOGRAPH

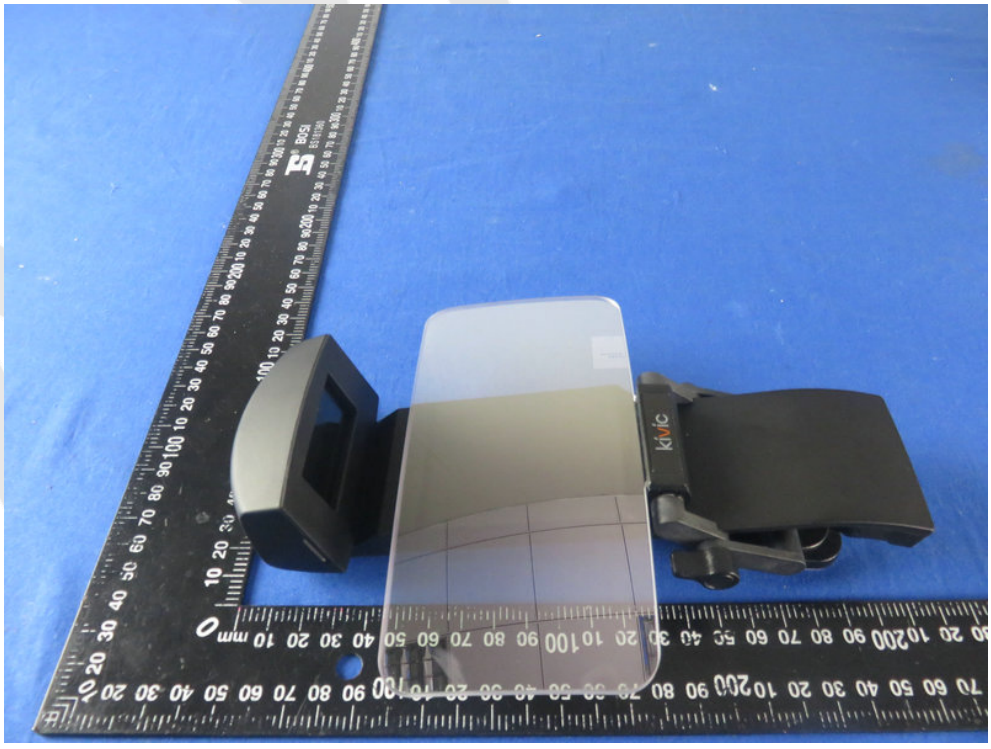
10.1. Photo of Conducted Emission Measurement

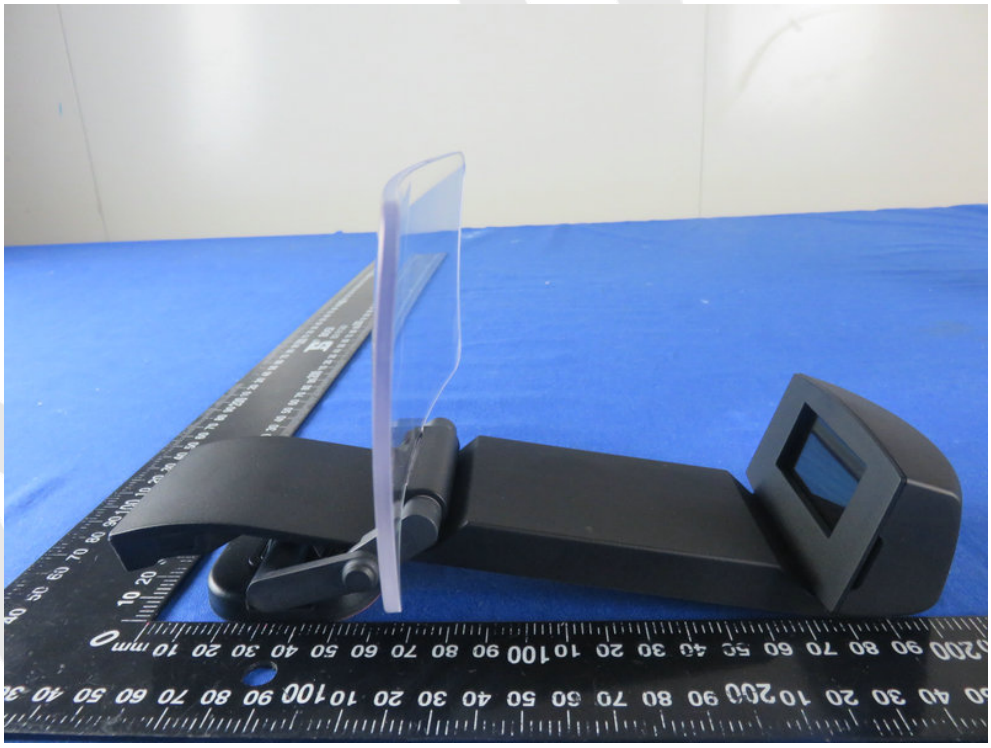
10.2. Photo of Radiation Emission Test

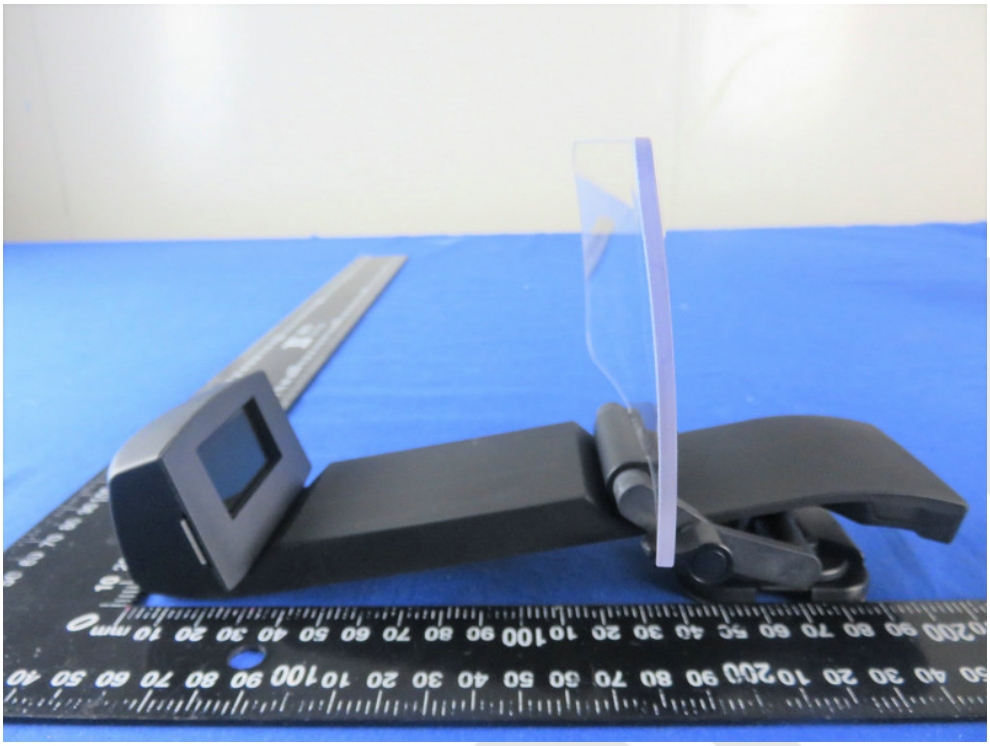




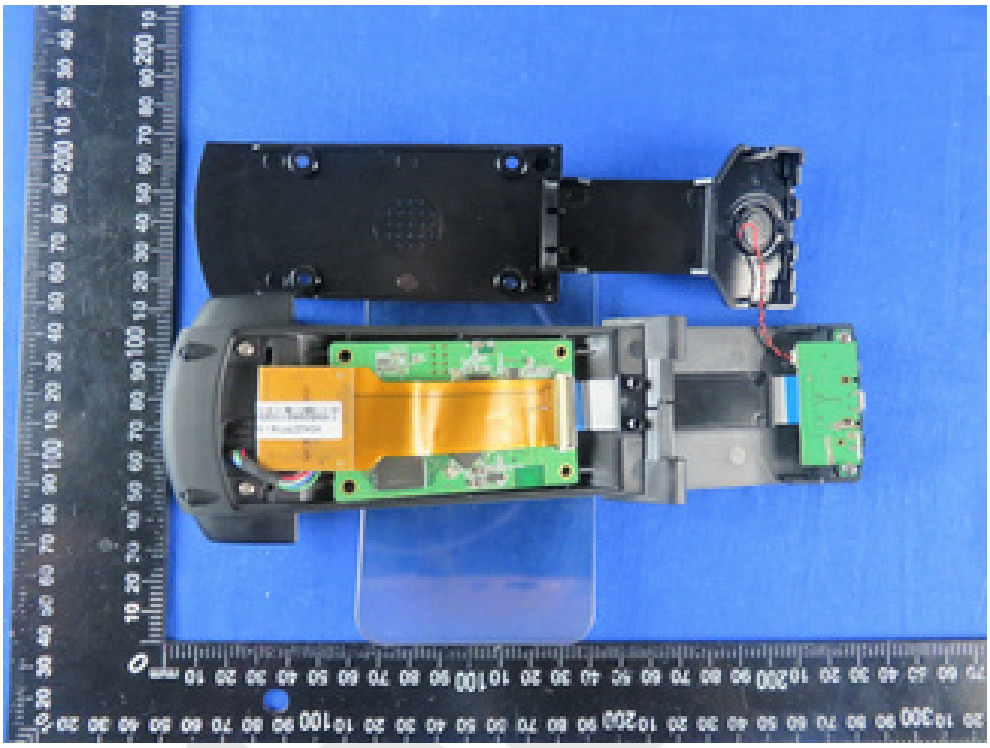
APPENDIX I (EXTERNAL PHOTOS)

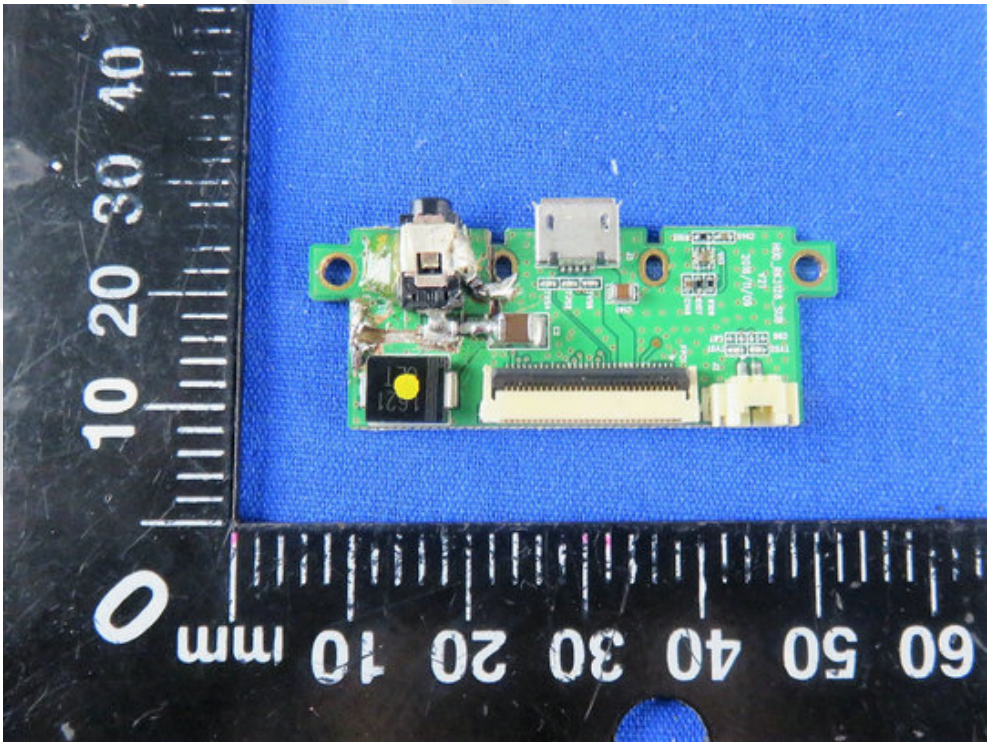


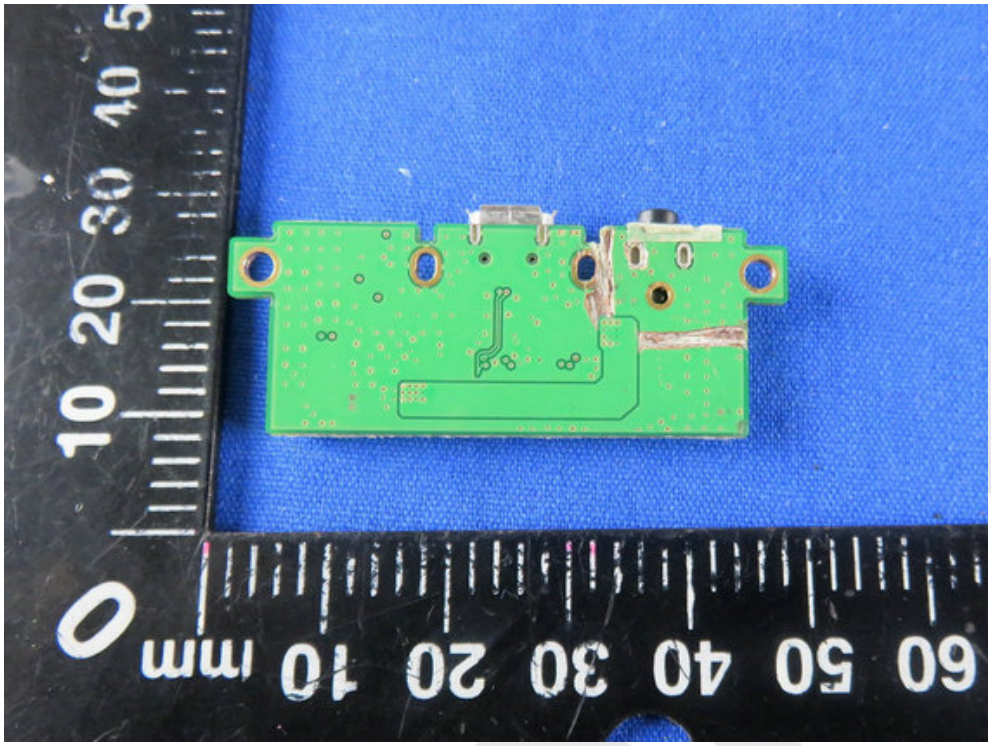


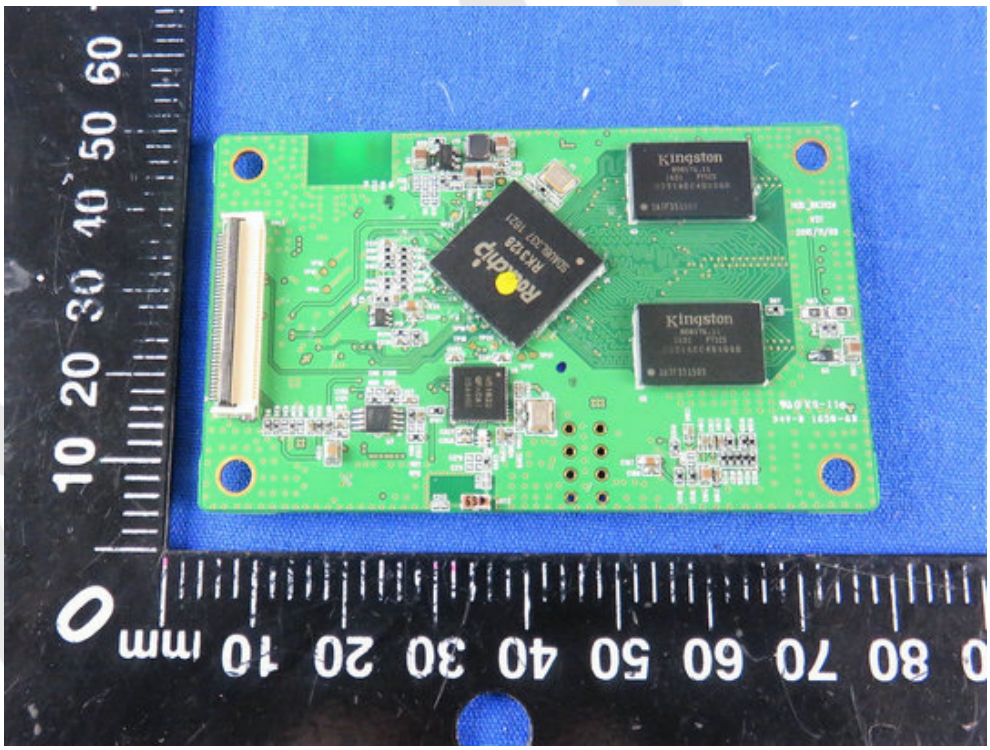


APPENDIX II(INTERNAL PHOTOS)





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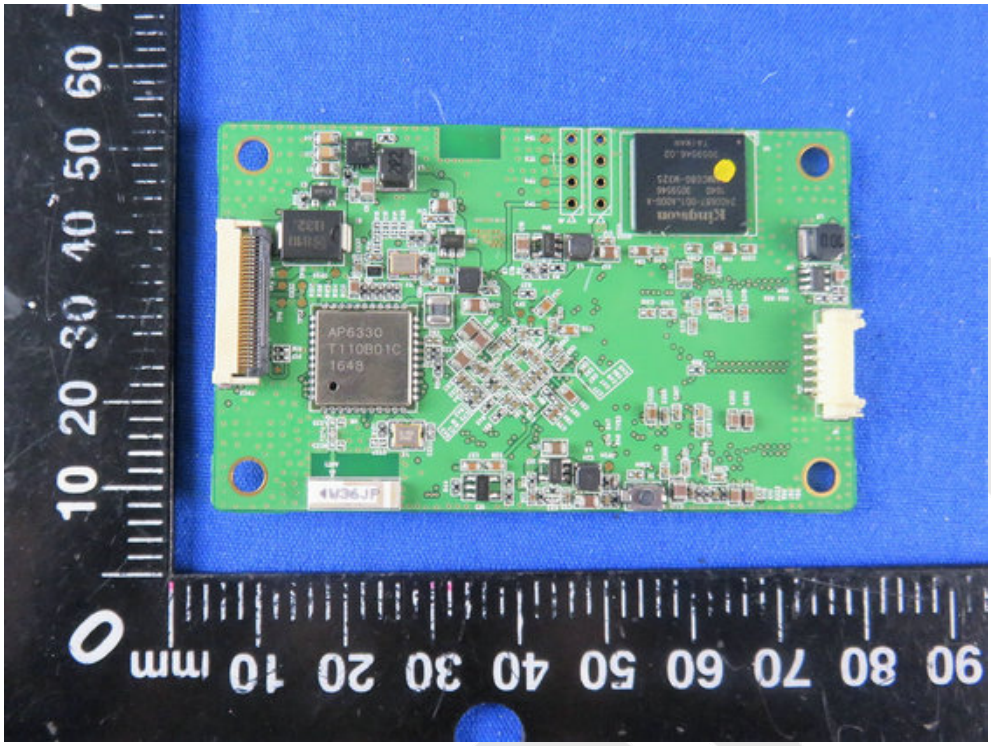
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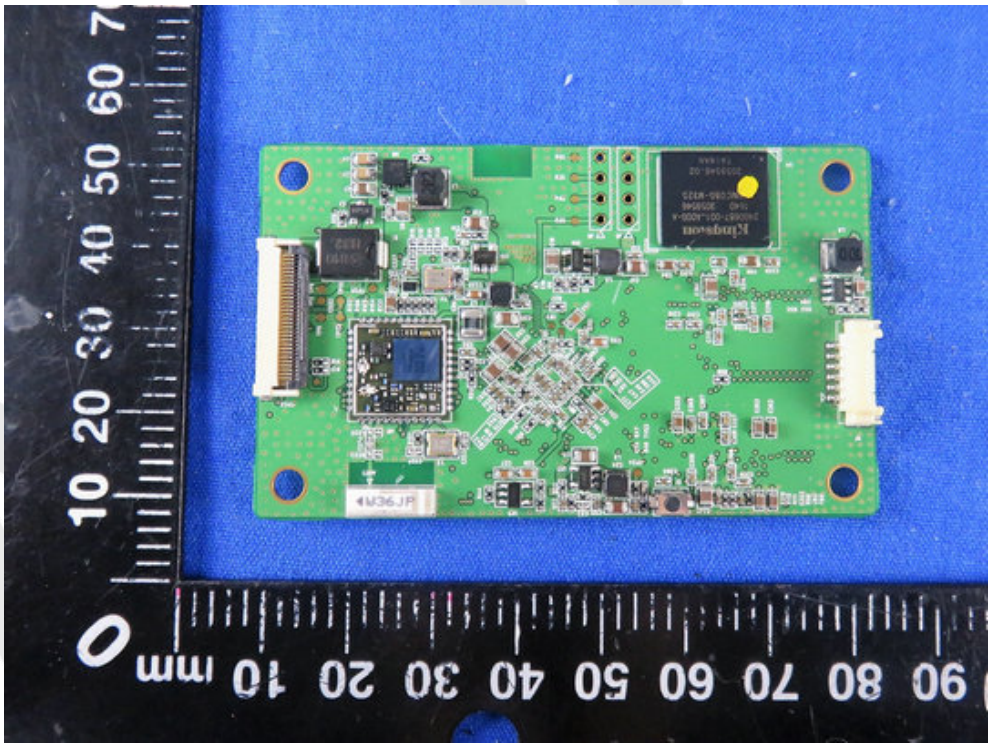

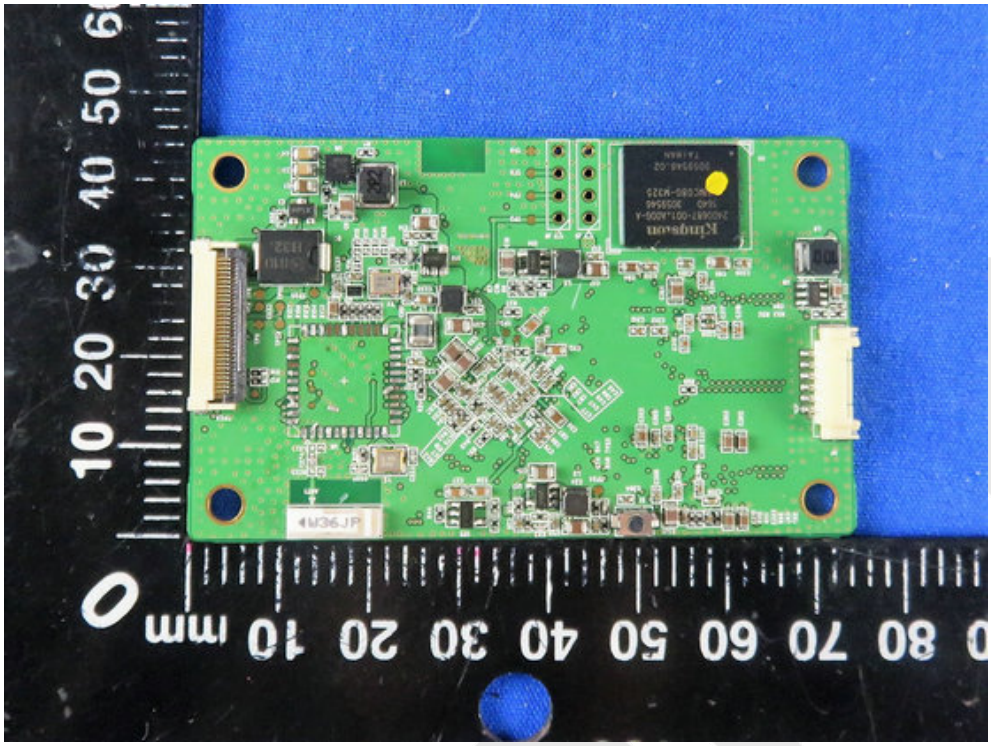

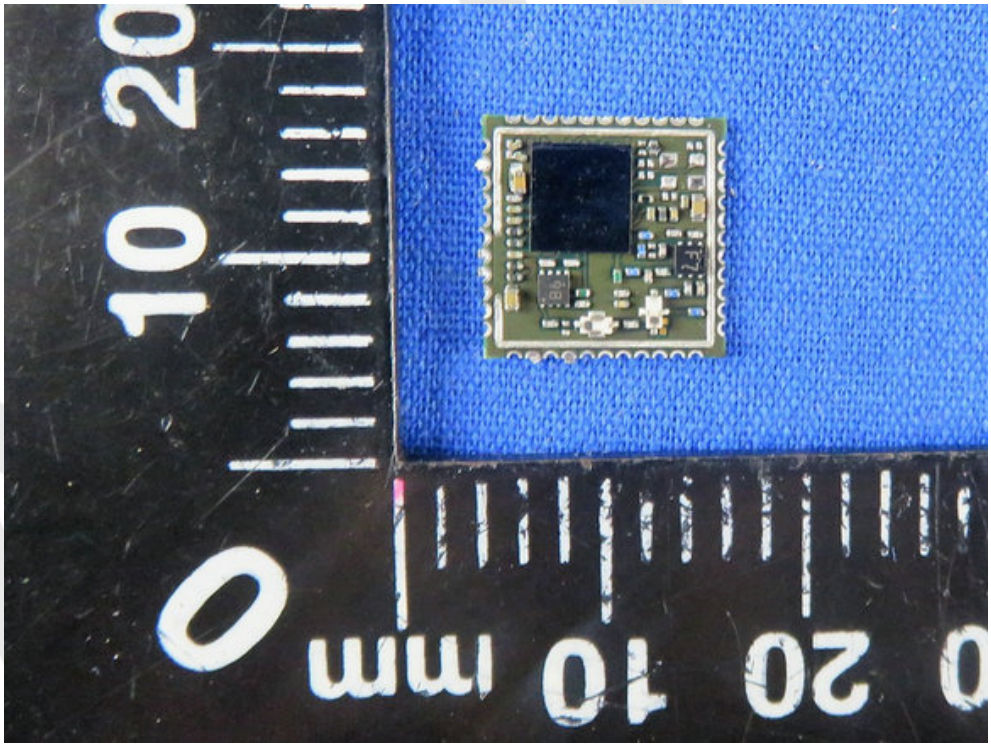

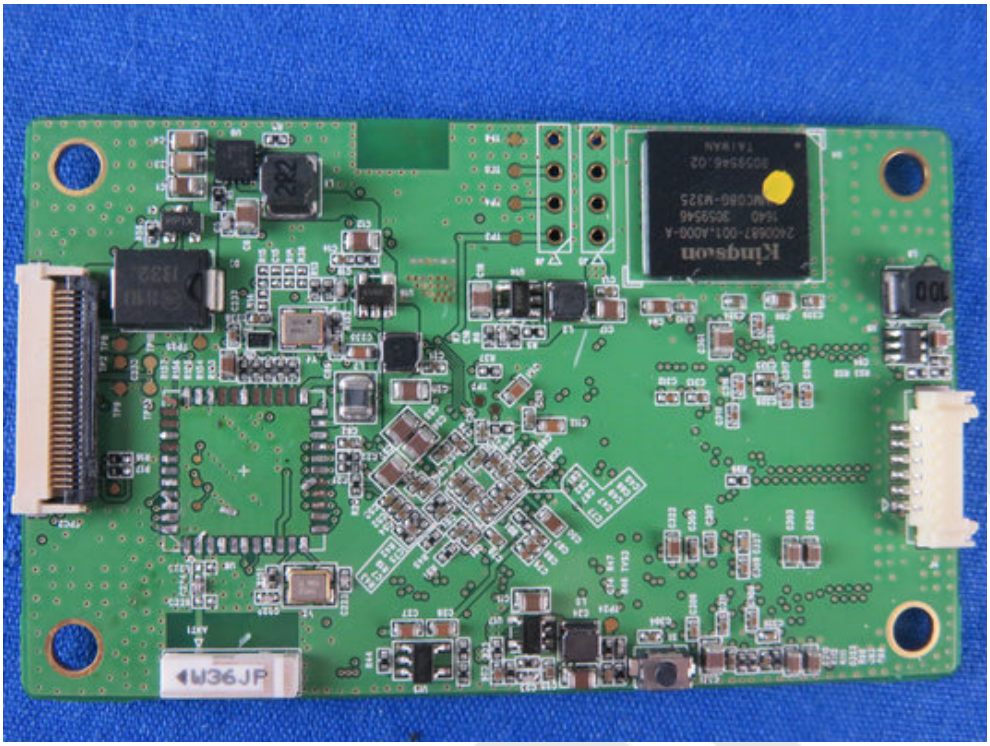
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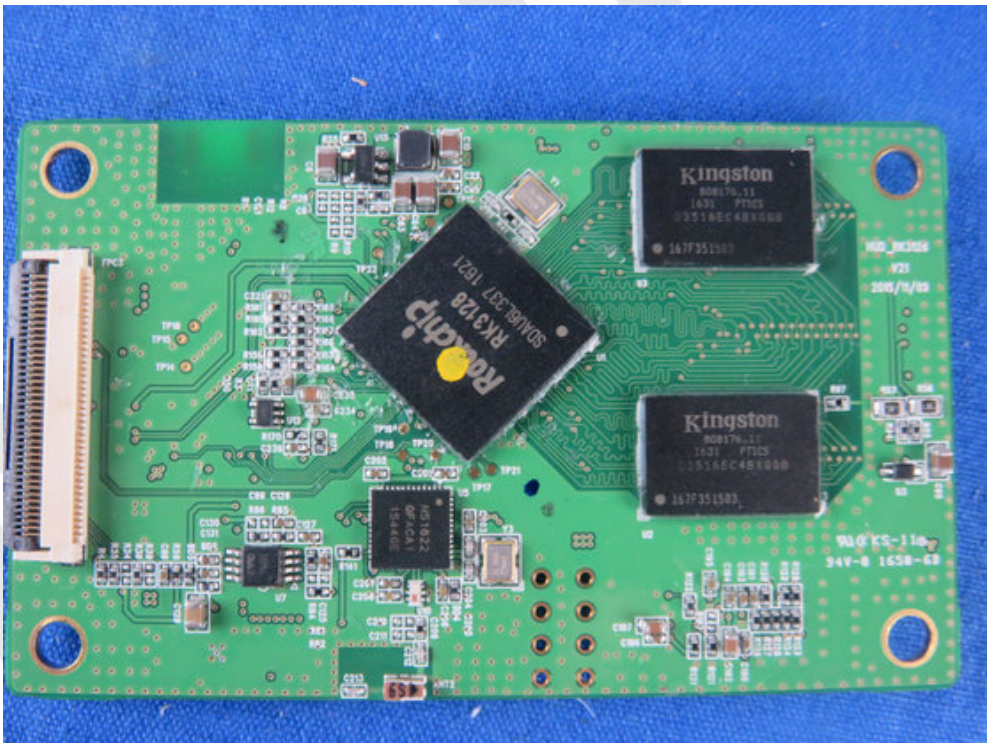
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