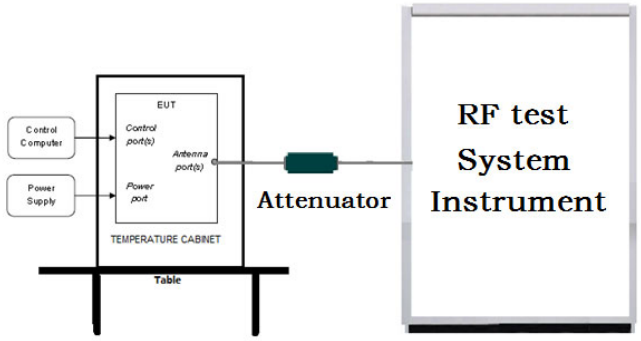
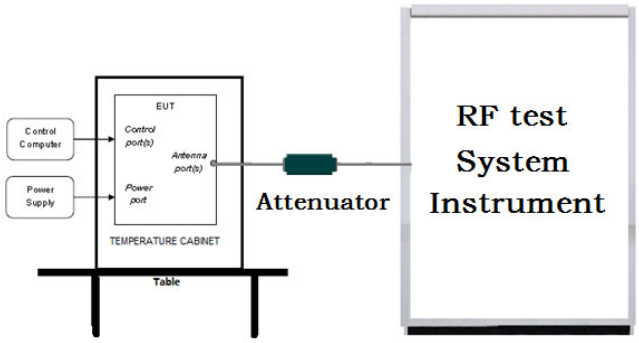
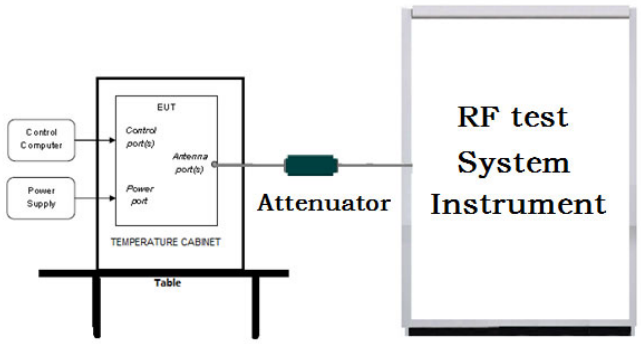
5.5 Carrier Frequency Separation

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset=Cable loss+ attenuation factor.
Test Procedure:	1. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 2. Set to the maximum power setting and enable the EUT transmit continuously. 3. Enable the EUT hopping function. 4. Use the following spectrum analyzer settings: Span = wide enough to capture the peaks of two adjacent channels; RBW is set to approximately 30% of the channel spacing, adjust as necessary to best identify the center of each individual channel; VBW≥RBW; Sweep = auto; Detector function = peak; Trace = max hold. 5. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Record the value in report.
Limit:	Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.
Exploratory Test Mode:	Hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type
Test Results:	Refer to Appendix A

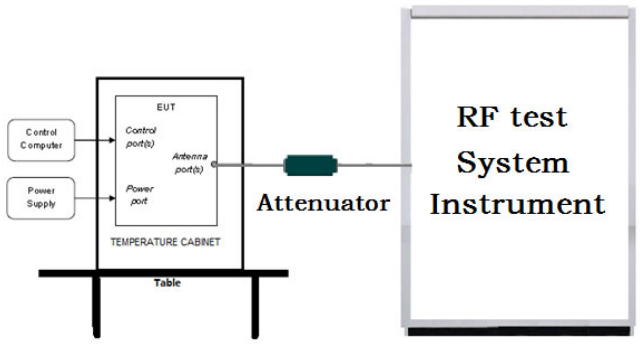
5.6 Number of Hopping Channel

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset=Cable loss+ attenuation factor.
Test Procedure:	1. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 2. Set to the maximum power setting and enable the EUT transmit continuously. 3. Enable the EUT hopping function. 4. Use the following spectrum analyzer settings: Span = the frequency band of operation; set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller; VBW≥RBW; Sweep= auto; Detector function = peak; Trace = max hold. 5. The number of hopping frequency used is defined as the number of total channel. 6. Record the measurement data in report.
Limit:	Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.
Test Mode:	Hopping transmitting with all kind of modulation
Test Results:	Refer to Appendix A

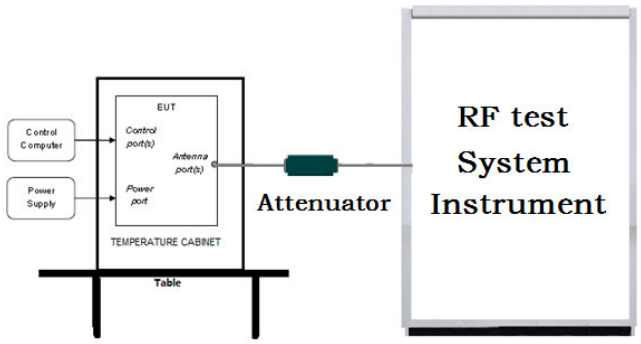
5.7 Time of Occupancy

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset=Cable loss+ attenuation factor.
Test Procedure:	1. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 2. Set to the maximum power setting and enable the EUT transmit continuously. 3. Enable the EUT hopping function. 4. Use the following spectrum analyzer settings: Span = zero span, centered on a hopping channel; RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel; VBW≥RBW; Sweep = as necessary to capture the entire dwell time per hopping channel; Detector function = peak; Trace = max hold. 5. Measure and record the results in the test report.
Limit:	The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.
Test Mode:	Hopping transmitting with all kind of modulation and all kind of data type.
Test Results:	Refer to Appendix A

5.8 Band edge Measurements

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset=Cable loss+ attenuation factor.
Test Procedure:	1. Set to the maximum power setting and enable the EUT transmit continuously. 2. Set RBW = 100 kHz, VBW = 300 kHz (≥RBW). Band edge emissions must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100kHz RBW. The attenuation shall be 30 dB instead of 20 dB when RMS conducted output power procedure is used. 3. Enable hopping function of the EUT and then repeat step 2 and 3. 4. Measure and record the results in the test report.
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Exploratory Test Mode:	Hopping and Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type
Test Results:	Refer to Appendix A

5.9 Conducted Spurious Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset=Cable loss+ attenuation factor.
Test Procedure:	1. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 2. Set to the maximum power setting and enable the EUT transmit continuously. 3. Set RBW = 100 kHz, VBW = 300kHz, scan up through 10th harmonic. All harmonics / spurs must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100kHz RBW. 4. Measure and record the results in the test report. 5. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type
Test Results:	Refer to Appendix A

5.10 Pseudorandom Frequency Hopping Sequence

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1) requirement:
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively. Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.	
EUT Pseudorandom Frequency Hopping Sequence	
Hopping Mechanism VA-IH006 family use adaptive frequency hopping. There are at 20 radio non-overlap channels (above 20dBc) in the 2.4GHz ISM band. The channel transmission bandwidth is about 3.5MHz. We can allocate 20 non-overlap channels between 2410MHz to 2477MHz. Like AFH of Bluetooth, VA-IH006 provide smart channel selection algorithm to avoid radio interference from other 2.4GHz devices. The system will generate a pseudorandom ordered list base on: 1) A 8 bit factory ID(8 bit) 2) A 6 bit set number ID(6 bit)	

5.11 Radiated Spurious Emission & Restricted bands

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205
Test Method:	ANSI C63.10: 2013
Test Site:	Measurement Distance: 3m (Semi-Anechoic Chamber)

Receiver Setup:

Frequency	Detector	RBW	VBW	Remark
0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
30MHz-1GHz	Peak	100 kHz	300kHz	Peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10kHz	Average

Limit:

Frequency	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
1.705MHz-30MHz	30	-	-	30
30MHz-88MHz	100	40.0	Quasi-peak	3
88MHz-216MHz	150	43.5	Quasi-peak	3
216MHz-960MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1GHz	500	54.0	Average	3

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

Test Setup:	

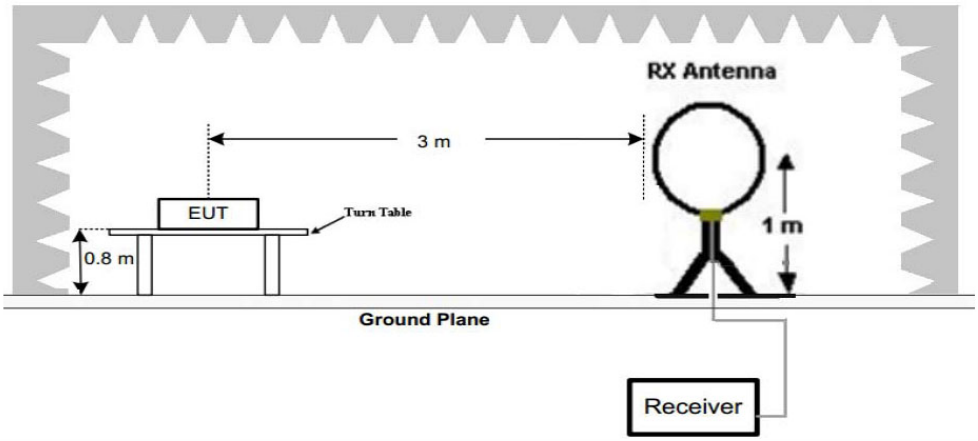


Figure 1. Below 30MHz

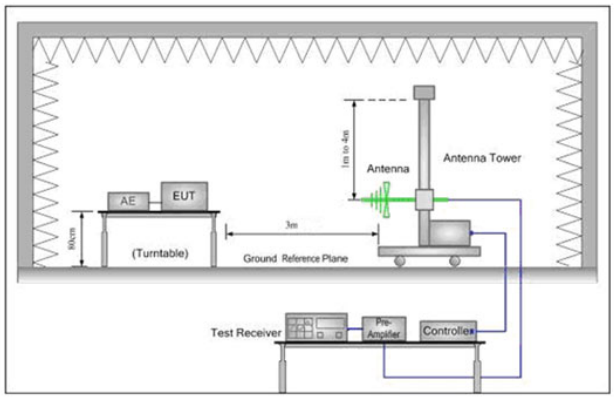


Figure 2. 30MHz to 1GHz

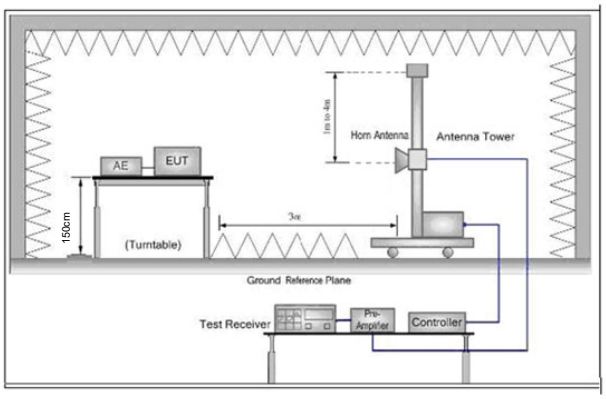


Figure 3. Above 1 GHz

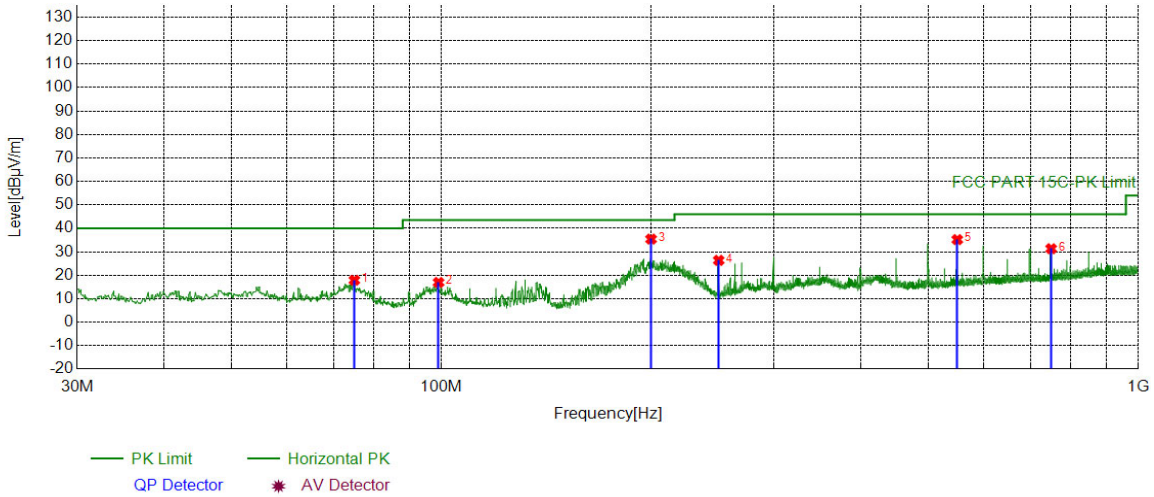
Test Procedure:	a. 1) Below 1G: The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. 2) Above 1G: The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. Note: For the radiated emission test above 1GHz: Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane. b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. c. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both

	horizontal and vertical polarizations of the antenna are set to make the measurement. d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet. g. Test the EUT in the lowest channel (2402MHz),the middle channel (2441MHz),the Highest channel (2480MHz) h. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case. i. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type and GFSK modulation with adapter VSD0500120VU was the worst case. Pretest the EUT at Transmitting mode, For below 1GHz part, through pre-scan, the worst case was the lowest channel. Only the worst case was recorded in the report.
Test Results:	Pass

Radiated Spurious Emission below 1GHz:

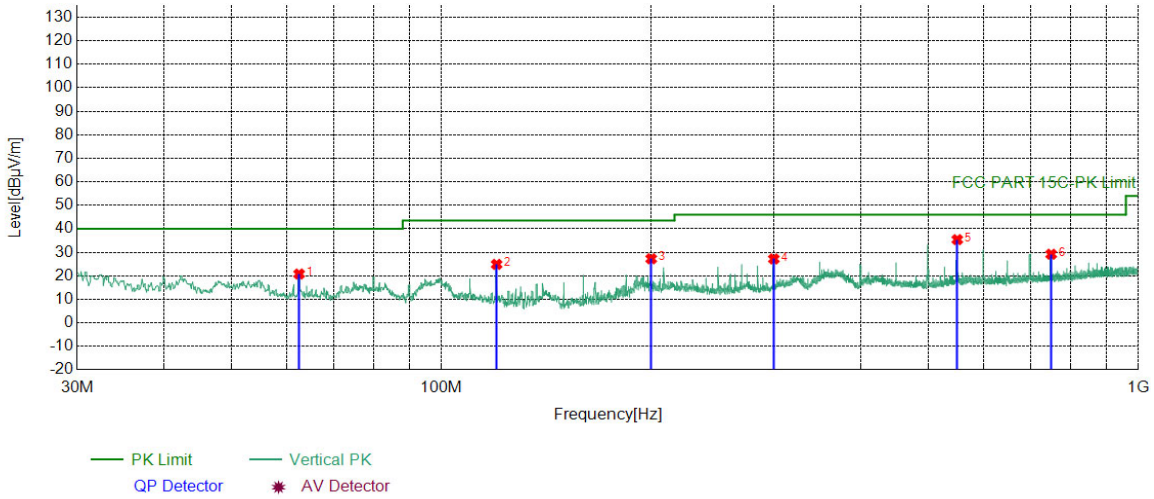
During the test, the Radiates Emission from 30MHz to 1GHz was performed in all modes, only the worst case lowest channel of DH5 for GFSK with adapter VSD0500120VU was recorded in the report.

Test Graph



Suspected List									
NO	Freq. [MHz]	Factor [dB]	Reading [dBµV]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Result	Polarity	Remark
1	75.0125	-21.68	39.56	17.88	40.00	22.12	PASS	Horizontal	PK
2	99.0709	-18.57	35.50	16.93	43.50	26.57	PASS	Horizontal	PK
3	199.961	-17.84	53.25	35.41	43.50	8.09	PASS	Horizontal	PK
4	250.018	-16.56	42.92	26.36	46.00	19.64	PASS	Horizontal	PK
5	549.972	-9.82	45.01	35.19	46.00	10.81	PASS	Horizontal	PK
6	750.006	-7.00	38.31	31.31	46.00	14.69	PASS	Horizontal	PK

Test Graph



Suspected List

NO	Freq. [MHz]	Factor [dB]	Reading [dBµV]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Result	Polarity	Remark
1	62.4983	-19.07	39.85	20.78	40.00	19.22	PASS	Vertical	PK
2	120.025	-20.08	44.97	24.89	43.50	18.61	PASS	Vertical	PK
3	200.058	-17.84	45.08	27.24	43.50	16.26	PASS	Vertical	PK
4	299.978	-15.44	42.62	27.18	46.00	18.82	PASS	Vertical	PK
5	549.972	-9.82	45.22	35.40	46.00	10.60	PASS	Vertical	PK
6	750.006	-7.00	36.19	29.19	46.00	16.81	PASS	Vertical	PK

Radiated Spurious Emission above 1GHz:

Mode:	GFSK Transmitting	Channel:	2410
Remark:			

NO	Freq. [MHz]	Factor [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity	Remark
1	1436.04	1.42	42.69	44.11	74.00	29.89	PASS	Horizontal	PK
2	1995.89	4.53	41.15	45.68	74.00	28.32	PASS	Horizontal	PK
3	4820.12	-16.22	62.81	46.59	74.00	27.41	PASS	Horizontal	PK
4	7051.27	-11.70	54.77	43.07	74.00	30.93	PASS	Horizontal	PK
5	9211.41	-7.89	53.04	45.15	74.00	28.85	PASS	Horizontal	PK
6	14307.7	-0.31	50.16	49.85	74.00	24.15	PASS	Horizontal	PK
7	1136.61	0.83	43.03	43.86	74.00	30.14	PASS	Vertical	PK
8	1644.86	2.58	41.86	44.44	74.00	29.56	PASS	Vertical	PK
9	4819.12	-16.22	65.54	49.32	54.00	4.68	PASS	Vertical	AV
10	4820.12	-16.22	72.97	56.75	74.00	17.25	PASS	Vertical	PK
11	7471.29	-11.21	55.36	44.15	74.00	29.85	PASS	Vertical	PK
12	10786.5	-6.26	52.68	46.42	74.00	27.58	PASS	Vertical	PK
13	14386.7	1.00	49.21	50.21	74.00	23.79	PASS	Vertical	PK

Mode:	GFSK Transmitting	Channel:	2441.5
Remark:			

NO	Freq. [MHz]	Factor [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity	Remark
1	1256.62	0.95	42.95	43.90	74.00	30.10	PASS	Horizontal	PK
2	1835.88	3.55	42.09	45.64	74.00	28.36	PASS	Horizontal	PK
3	4883.12	-16.21	63.48	47.27	74.00	26.73	PASS	Horizontal	PK
4	7061.27	-11.67	54.25	42.58	74.00	31.42	PASS	Horizontal	PK
5	9655.44	-7.55	53.41	45.86	74.00	28.14	PASS	Horizontal	PK
6	12568.6	-4.34	52.65	48.31	74.00	25.69	PASS	Horizontal	PK
7	1237.42	0.90	43.25	44.15	74.00	29.85	PASS	Vertical	PK
8	1684.46	2.84	42.77	45.61	74.00	28.39	PASS	Vertical	PK
9	4883.12	-16.21	70.73	54.52	74.00	19.48	PASS	Vertical	PK
10	4884.12	-16.20	67.15	50.95	54.00	3.05	PASS	Vertical	AV
11	7604.30	-11.21	54.01	42.80	74.00	31.20	PASS	Vertical	PK
12	9146.40	-8.31	53.79	45.48	74.00	28.52	PASS	Vertical	PK
13	14394.7	1.13	49.04	50.17	74.00	23.83	PASS	Vertical	PK

Mode:	GFSK Transmitting	Channel:	2477
Remark:			

NO	Freq. [MHz]	Factor [dB]	Reading [dB μ V]	Level [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Result	Polarity	Remark
1	1306.430	1.08	43.02	44.10	74.00	29.90	PASS	Horizontal	PK
2	1784.878	3.23	42.92	46.15	74.00	27.85	PASS	Horizontal	PK
3	4954.130	-15.99	61.41	45.42	74.00	28.58	PASS	Horizontal	PK
4	7346.289	-11.61	54.80	43.19	74.00	30.81	PASS	Horizontal	PK
5	9162.410	-8.18	53.18	45.00	74.00	29.00	PASS	Horizontal	PK
6	13740.71	-1.71	50.93	49.22	74.00	24.78	PASS	Horizontal	PK
7	1349.635	1.22	42.45	43.67	74.00	30.33	PASS	Vertical	PK
8	1734.073	3.06	41.42	44.48	74.00	29.52	PASS	Vertical	PK
9	4954.130	-15.99	68.42	52.43	74.00	21.57	PASS	Vertical	PK
10	6488.232	-12.71	55.20	42.49	74.00	31.51	PASS	Vertical	PK
11	9228.415	-7.90	53.15	45.25	74.00	28.75	PASS	Vertical	PK
12	11724.58	-6.22	53.26	47.04	74.00	26.96	PASS	Vertical	PK

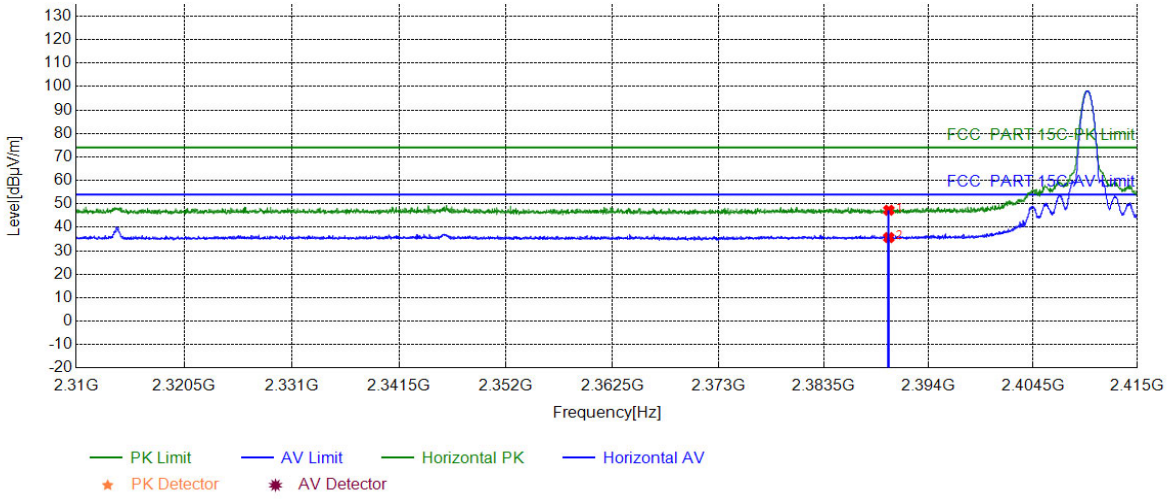
Remark:

1) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:
   Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor
2) Scan from 9kHz to 25GHz, the disturbance above 10GHz and below 30MHz was very low. As shown in this section, for frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. So, only the peak measurements were shown in the report.

Restricted bands:

Mode:		Channel:	2410
Remark:			

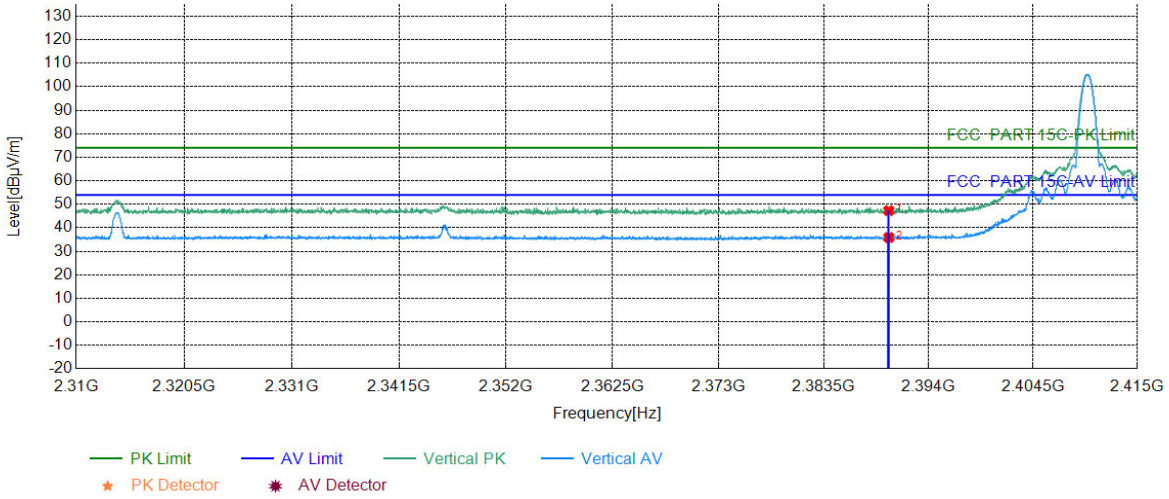
Test Graph



Suspected List									
NO	Freq. [MHz]	Factor [dB]	Reading [dBµV]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Result	Polarity	Remark
1	2390.0000	5.77	41.53	47.30	74.00	26.70	PASS	Horizontal	PK
2	2390.0000	5.77	29.87	35.64	54.00	18.36	PASS	Horizontal	AV

Mode:		Channel:	2410
Remark:			

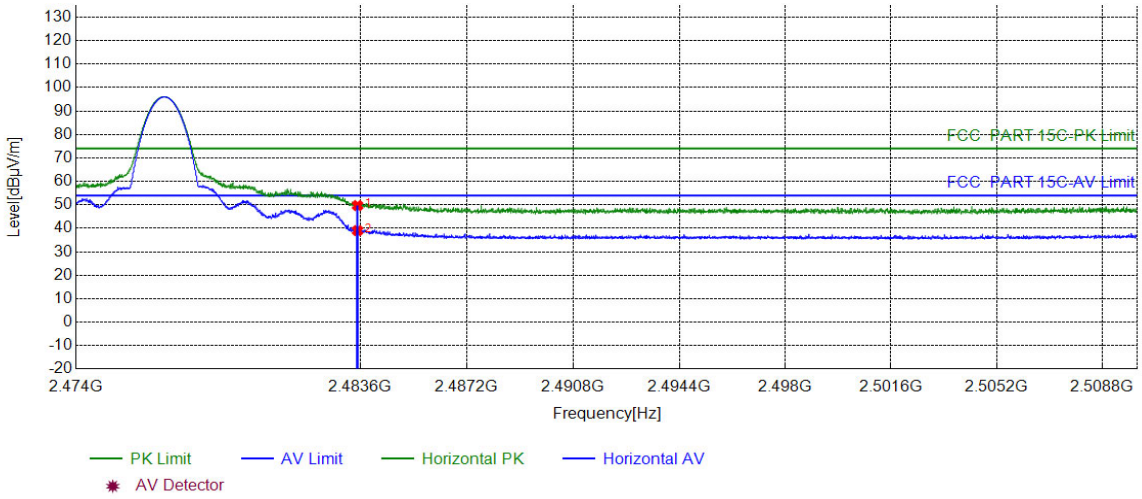
Test Graph



Suspected List									
NO	Freq. [MHz]	Factor [dB]	Reading [dBµV]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Result	Polarity	Remark
1	2390.0000	5.77	41.54	47.31	74.00	26.69	PASS	Vertical	PK
2	2390.0000	5.77	30.10	35.87	54.00	18.13	PASS	Vertical	AV

Mode:		Channel:	2477
Remark:			

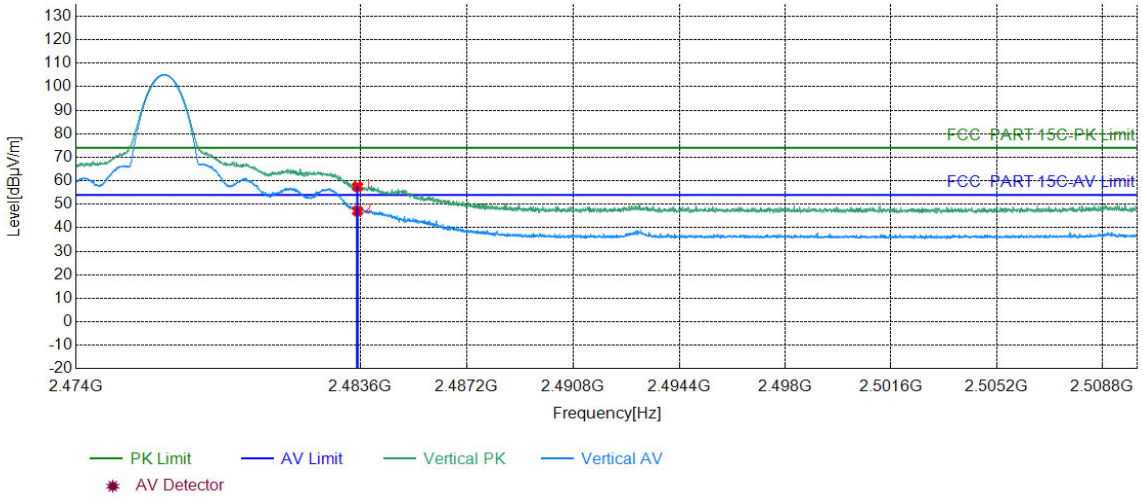
Test Graph



Suspected List									
NO	Freq. [MHz]	Factor [dB]	Reading [dBµV]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Result	Polarity	Remark
1	2483.5000	6.57	43.14	49.71	74.00	24.29	PASS	Horizontal	PK
2	2483.5000	6.57	32.46	39.03	54.00	14.97	PASS	Horizontal	AV

Mode:		Channel:	2477
Remark:			

Test Graph



Suspected List									
NO	Freq. [MHz]	Factor [dB]	Reading [dBµV]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Result	Polarity	Remark
1	2483.5000	6.57	50.95	57.52	74.00	16.48	PASS	Vertical	PK
2	2483.5000	6.57	40.57	47.14	54.00	6.86	PASS	Vertical	AV

Note:
The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:
Final Test Level =Receiver Reading - Correct Factor
Correct Factor = Preamplifier Factor– Antenna Factor–Cable Factor

6 Appendix A

Refer to Appendix: RF Conducted Test Data of EED32N80972801.