



Test Report

Report No.: MTi240726004-15E2

Date of issue: 2024-10-26

Applicant: Shenzhen ZhiHaiHe Tech Co.,Ltd

Product: Varmilo Mechanical Keyboard

Model(s): APT87, APT88, APT92

FCC ID: 2AF8O-APT87

Shenzhen Microtest Co., Ltd.

<http://www.mtitest.cn>

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Test Result Certification

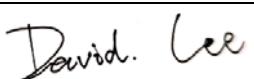
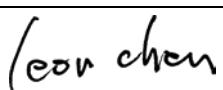
Applicant:	ShenZhen ZhiHaiHe Tech Co.,Ltd
Address:	5th Floor, Block 2, 10th Industrial Zone, Tian Liao Community, Yu Tang Area, Guang Ming District, Shenzhen, China
Manufacturer:	ShenZhen ZhiHaiHe Tech Co.,Ltd
Address:	5th Floor, Block 2, 10th Industrial Zone, Tian Liao Community, Yu Tang Area, Guang Ming District, Shenzhen, China

Product description

Product name:	Varmilo Mechanical Keyboard
Trademark:	Varmilo
Model name:	APT87
Series Model:	APT88, APT92
Standards:	FCC 47 CFR Part 15.249
Test method:	ANSI C63.10-2013

Date of Test

Date of test:	2024-09-11 to 2024-10-24
Test result:	Pass

Test Engineer	:	 (Maleah Deng)
Reviewed By	:	 (David Lee)
Approved By	:	 (Leon Chen)

1 General Description

1.1 Description of EUT

Product name:	Varmilo Mechanical Keyboard
Model name:	APT87
Series Model:	APT88, APT92
Model difference:	All the models are the same circuit and module, except the model name and color.
Electrical rating:	Input: DC 5V 500mA Battery: DC 3.7V 3400mAh
Hardware version:	Cable: USB-A to USB-C cable 180cm Dongle*1
Software version:	APT88-V1.0(H)
Accessories:	KB01_APT87_V20240725
Test sample(s) number:	MTi240726004-15S1001

RF specification:

Operation frequency:	2404-2478MHz
Channel number:	38
Modulation type:	GFSK
Antenna designation:	Antenna type: PCB Antenna Antenna gain: 1dBi
Max. Field Strength:	81.08dBuV/m

1.2 Description of test modes

No.	Emission test modes
Mode1	TX-GFSK

1.2.1 Operation channel list

Channel	Frequency (MHz)						
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476

8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	/	/
10	2422	20	2442	30	2462	/	/

1.2.2 Test channels

Chanel	Frequency
Lowest	2404MHz
Middle	2440MHz
Highest	2478MHz

Note: The test software has been used to control EUT for working in engineering mode, that enables selectable channel, and capable of continuous transmitting mode.

Test Software:

For power setting, refer to below table.

Test Software:	RF Test		
Mode	2404MHz	2440MHz	2478MHz
GFSK	0*07	0*07	0*07

1.2.3 Description of support units

Support equipment list			
Description	Model	Serial No.	Manufacturer
/	/	/	/

1.3 Measurement uncertainty

Measurement	Uncertainty
Conducted emissions (AMN 150kHz~30MHz)	±3.1dB
Occupied channel bandwidth	±3 %
Radiated spurious emissions (above 1GHz)	±5.3dB
Radiated spurious emissions (9kHz~30MHz)	±4.3dB
Radiated spurious emissions (30MHz~1GHz)	±4.7dB
Temperature	±1 °C
Humidity	± 5 %

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

2 Summary of Test Result

No.	FCC reference	Description of test	Result
1	§ 15.203	Antenna requirement	Pass
2	§ 15.207	AC power line conducted emissions	Pass
3	15.249(d)	Radiated spurious emissions	Pass
4	15.249(a)	Field Strength of the Fundamental signal	Pass
5	15.215	20dB and 99% Bandwidth	Pass

3 Test Facilities and Accreditations

3.1 Test laboratory

Test laboratory:	Shenzhen Microtest Co., Ltd.
Test site location:	101, No. 7, Zone 2, Xinxing Industrial Park, Fuhai Avenue, Xinhe Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China
Telephone:	(86-755)88850135
Fax:	(86-755)88850136
CNAS Registration No.:	CNAS L5868
FCC Registration No.:	448573



4 Equipment List

No.	Equipment	Manufacturer	Model	Serial No.	Cal. date	Cal. Due
Conducted Emission at AC power line						
1	EMI Test Receiver	Rohde&schwarz	ESCI3	101368	2024-03-20	2025-03-19
2	Artificial mains network	Schwarzbeck	NSLK 8127	183	2024-03-21	2025-03-20
3	Artificial Mains Network	Rohde & Schwarz	ESH2-Z5	100263	2024-03-20	2025-03-19
20dB and 99% Bandwidth						
1	Wideband Radio Communication Tester	Rohde&schwarz	CMW500	149155	2024-03-20	2025-03-19
2	ESG Series Analog Signal Generator	Agilent	E4421B	GB40051240	2024-03-21	2025-03-20
3	PXA Signal Analyzer	Agilent	N9030A	MY51350296	2024-03-21	2025-03-20
4	Synthesized Sweeper	Agilent	83752A	3610A01957	2024-03-21	2025-03-20
5	MXA Signal Analyzer	Agilent	N9020A	MY50143483	2024-03-21	2025-03-20
6	RF Control Unit	Tonscend	JS0806-1	19D8060152	2024-03-21	2025-03-20
7	Band Reject Filter Group	Tonscend	JS0806-F	19D8060160	2024-03-21	2025-03-20
8	ESG Vector Signal Generator	Agilent	N5182A	MY50143762	2024-03-20	2025-03-19
9	DC Power Supply	Agilent	E3632A	MY40027695	2024-03-21	2025-03-20
Field Strength of the Fundamental signal						
Radiated spurious emissions (above 1GHz)						
1	EMI Test Receiver	Rohde&schwarz	ESCI7	101166	2024-03-20	2025-03-19
2	Double Ridged Broadband Horn Antenna	Schwarzbeck	BBHA 9120 D	2278	2023-06-17	2025-06-16
3	Amplifier	Agilent	8449B	3008A01120	2024-03-20	2025-03-19
4	MXA signal analyzer	Agilent	N9020A	MY54440859	2024-03-21	2025-03-20
5	PXA Signal Analyzer	Agilent	N9030A	MY51350296	2024-03-21	2025-03-20
6	Horn antenna	Schwarzbeck	BBHA 9170	00987	2023-06-17	2025-06-16
7	Pre-amplifier	Space-Dtronics	EWLAN1840 G	210405001	2024-03-21	2025-03-20
Radiated spurious emissions (below 1GHz)						
1	EMI Test Receiver	Rohde&schwarz	ESCI7	101166	2024-03-20	2025-03-19

No.	Equipment	Manufacturer	Model	Serial No.	Cal. date	Cal. Due
Conducted Emission at AC power line						
1	EMI Test Receiver	Rohde&schwarz	ESCI3	101368	2024-03-20	2025-03-19
2	Artificial mains network	Schwarzbeck	NSLK 8127	183	2024-03-21	2025-03-20
3	Artificial Mains Network	Rohde & Schwarz	ESH2-Z5	100263	2024-03-20	2025-03-19
2	TRILOG Broadband Antenna	schwarabeck	VULB 9163	9163-1338	2023-06-11	2025-06-10
3	Active Loop Antenna	Schwarzbeck	FMZB 1519 B	00066	2024-03-23	2025-03-22
4	Amplifier	Hewlett-Packard	8447F	3113A06184	2024-03-20	2025-03-19

5 Test Result

5.1 Antenna requirement

15.203 requirement

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, 15.221, or §15.236. 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.

Description of the antenna of EUT

The antenna of EUT is PCB antenna (Antenna Gain: 1 dBi). which is no consideration of replacement.



5.2 Conducted Emission at AC power line

5.2.1 Limits

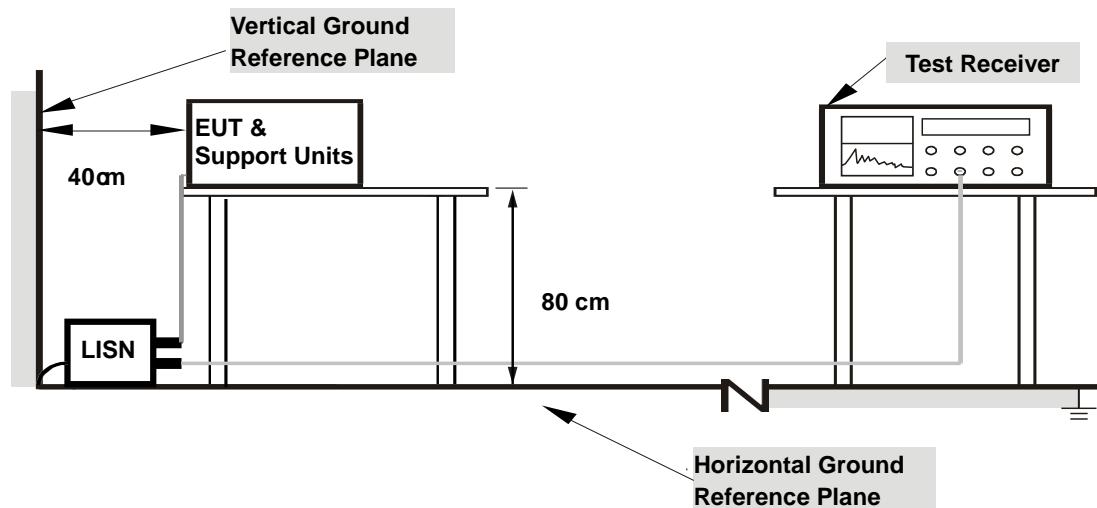
Frequency (MHz)	Detector type / Bandwidth	Limit-Quasi-peak dB μ V	Limit-Average dB μ V
0.15 -0.5	Average / 9 kHz	66 to 56	56 to 46
0.5 -5		56	46
5 -30		60	50

Note 1: the limit decreases with the logarithm of the frequency in the range of 0.15 MHz to 0.5 MHz.

5.2.2 Test Procedures

- The test setup is refer to the standard ANSI C63.10-2013.
- The EUT is connected to the main power through a line impedance stabilization network (LISN). All support equipment is powered from additional LISN(s).
- Emissions were measured on each current carrying line of the EUT using an EMI test receiver connected to the LISN powering the EUT.
- The test receiver scanned from 150 kHz to 30 MHz for emissions in each of the test modes described in Item 1.2.
- The test data of the worst-case condition(s) was recorded.

5.2.3 Test setup



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

5.2.4 Test Result

Notes:

All modes of operation of the EUT were investigated, and only the worst-case results are reported.

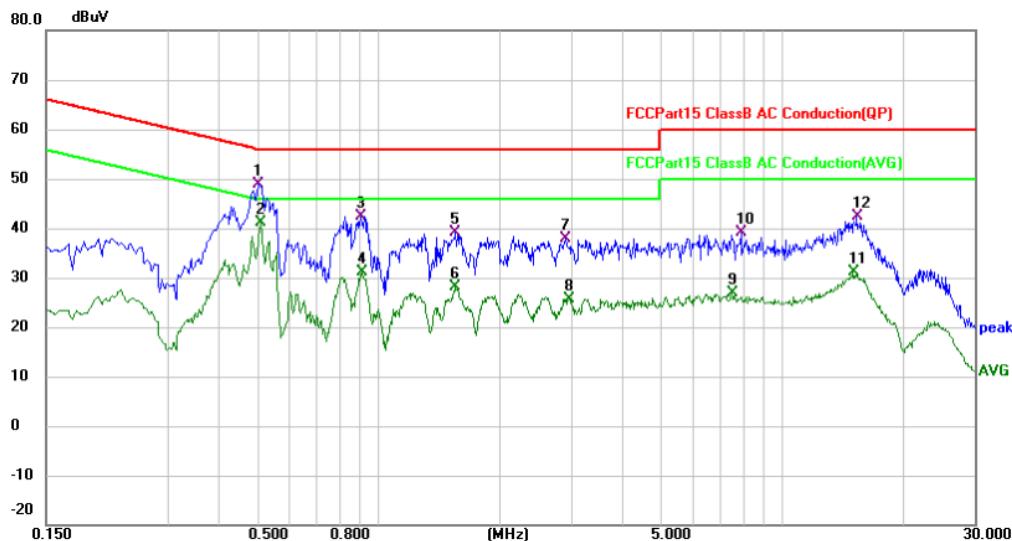
Calculation formula:

Measurement (dB μ V) = Reading Level (dB μ V) + Correct Factor (dB)
 Over (dB) = Measurement (dB μ V) – Limit (dB μ V)



5.2.5 Test Data:

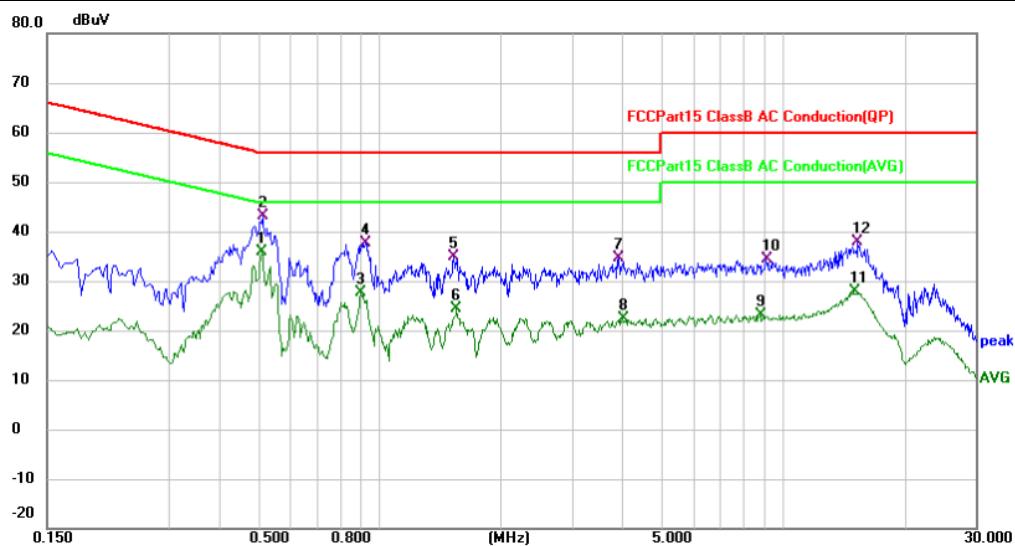
Mode1 / Line: Line / CH: H



No.	Mk.	Freq. MHz	Reading Level	Correct Factor	Measure- ment	Limit	Over	Comment
			dBuV	dB	dBuV	dB	Detector	
1	0.5060	38.20	10.72	48.92	56.00	-7.08	QP	
2 *	0.5100	30.46	10.72	41.18	46.00	-4.82	AVG	
3	0.9060	31.72	10.74	42.46	56.00	-13.54	QP	
4	0.9140	20.44	10.74	31.18	46.00	-14.82	AVG	
5	1.5540	28.40	10.76	39.16	56.00	-16.84	QP	
6	1.5540	17.28	10.76	28.04	46.00	-17.96	AVG	
7	2.9020	27.04	10.80	37.84	56.00	-18.16	QP	
8	2.9620	14.93	10.80	25.73	46.00	-20.27	AVG	
9	7.5220	15.01	11.82	26.83	50.00	-23.17	AVG	
10	7.9220	27.41	11.71	39.12	60.00	-20.88	QP	
11	15.0340	19.65	11.41	31.06	50.00	-18.94	AVG	
12	15.3180	30.89	11.44	42.33	60.00	-17.67	QP	



Mode1 / Line: Neutral / CH: H



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dB	Over	
							Detector	Comment
1	*	0.5100	25.09	10.74	35.83	46.00	-10.17	AVG
2		0.5140	32.42	10.74	43.16	56.00	-12.84	QP
3		0.9020	16.76	10.76	27.52	46.00	-18.48	AVG
4		0.9260	26.89	10.76	37.65	56.00	-18.35	QP
5		1.5339	24.04	10.78	34.82	56.00	-21.18	QP
6		1.5580	13.58	10.78	24.36	46.00	-21.64	AVG
7		3.9100	23.87	10.85	34.72	56.00	-21.28	QP
8		4.0020	11.45	10.85	22.30	46.00	-23.70	AVG
9		8.7780	12.11	11.09	23.20	50.00	-26.80	AVG
10		9.0780	23.27	11.10	34.37	60.00	-25.63	QP
11		15.0620	16.56	11.40	27.96	50.00	-22.04	AVG
12		15.3300	26.36	11.43	37.79	60.00	-22.21	QP

5.3 Radiated spurious emission

5.3.1 Limits

FCC PART 15.249(a);

Except as provided in paragraph (a) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Frequency (MHz)	Field Strength of Fundamental (mV/m)	Field Strength of Harmonics (μV/m)
902-928	50	500
2400-2483.5	50	500
5725-5875	50	500

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

§ 15.209 Radiated emission limits at restricted bands:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note 1: the tighter limit applies at the band edges.

Note 2: the emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector

§ 15.35 (b) requirements:

When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, e.g., see §§ 15.250, 15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

According to ANSI C63.10-2013, the tests shall be performed in the frequency range shown in the following table:

Frequency range of measurements for unlicensed wireless device

Lowest frequency generated in the device	Upper frequency range of measurement
9 kHz to below 10 GHz	10th harmonic of highest fundamental frequency or to 40 GHz, whichever is lower
At or above 10 GHz to below 30 GHz	5th harmonic of highest fundamental frequency or to 100 GHz, whichever is lower
At or above 30 GHz	5th harmonic of highest fundamental frequency or to 200 GHz, whichever is lower, unless otherwise specified

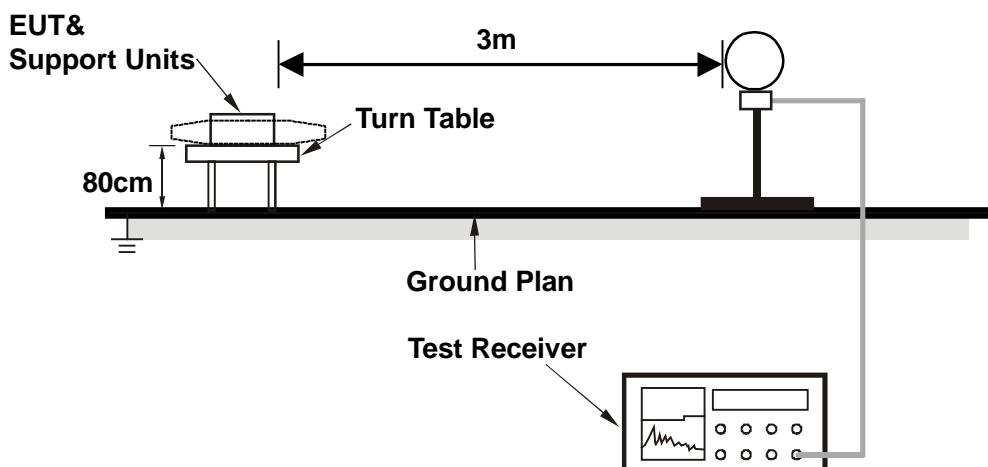
Frequency range of measurements for unlicensed wireless device with digital device

Highest frequency generated or used in the device or on which the device operates or tunes	Upper frequency range of measurement
Below 1.705 MHz	30 MHz
1.705 MHz to 108 MHz	1000 MHz
108 MHz to 500 MHz	2000 MHz
500 MHz to 1000 MHz	5000 MHz
Above 1000 MHz	5th harmonic of the highest frequency or 40 GHz, whichever is lower

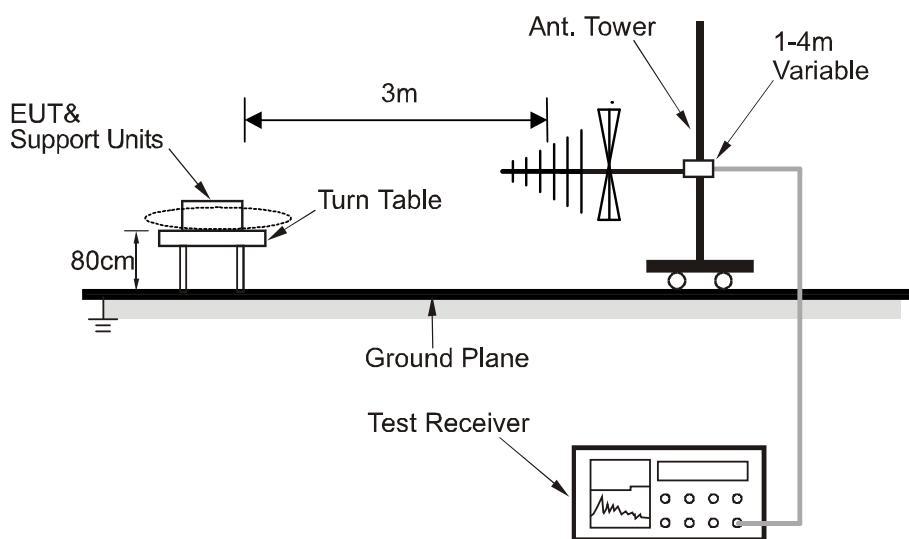


5.3.2 Test setup

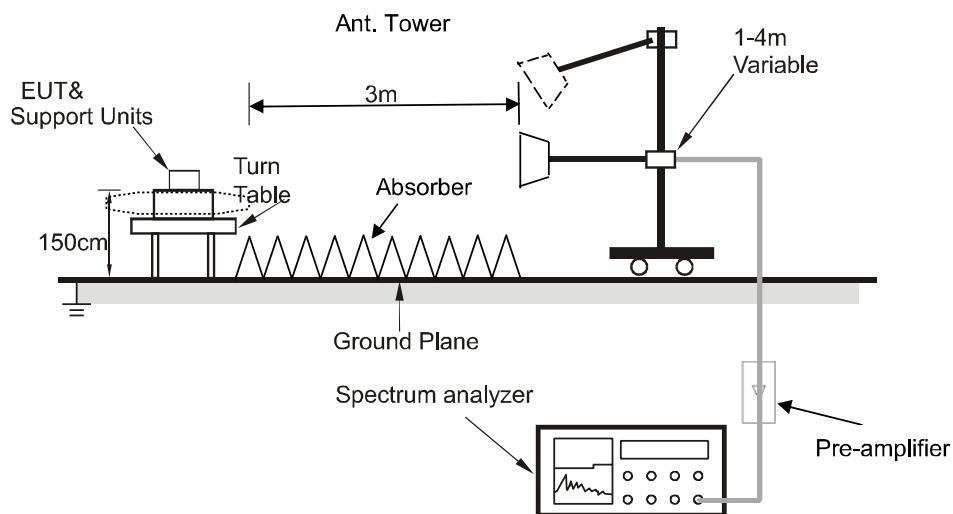
Below 30MHz:



30MHz~1GHz:



Above 1GHz:



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

5.3.3 Test procedure

- a) Test method: ANSI C63.10-2013 Section 6.3, 6.4, 6.5, 6.6, 11.11, 11.12, 11.13.
- b) The EUT is placed on an on-conducting table 0.8 meters above the ground plane for measurement below 1GHz, 1.5 meters above the ground plane for measurement above 1GHz.
- c) Emission below 18 GHz were measured at a 3 meters test distance, above 18 GHz were measured at 1-meter test distance with the application of a distance correction factor
- d) The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

Test instrument setup

Frequency	Test receiver / Spectrum analyzer setting
9 kHz ~ 150 kHz	Quasi Peak / RBW: 200 Hz
150 kHz ~ 30 MHz	Quasi Peak / RBW: 9 kHz
30 MHz ~ 1 GHz	Quasi Peak / RBW: 120 kHz
Above 1 GHz	Peak / RBW: 1 MHz, VBW: 3MHz, Peak detector AVG / RBW: 1 MHz, VBW: 3MHz, Average detector

5.3.4 Test results

Notes:

The amplitude of spurious emissions which are attenuated more than 20 dB below the limits are not reported.

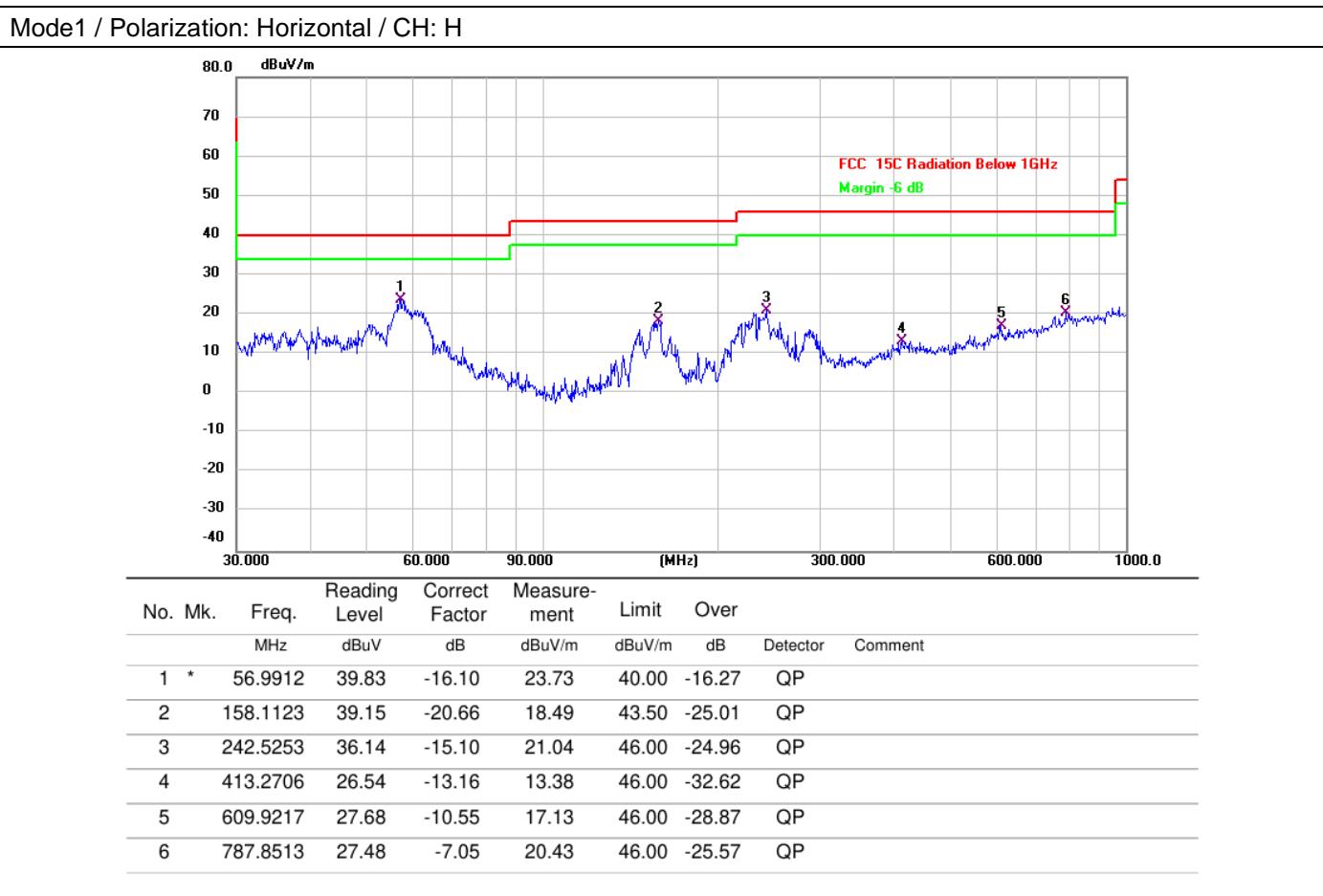
All modes of operation of the EUT were investigated, and only the worst-case results are reported.
There were no emissions found below 30MHz within 20dB of the limit.

Calculation formula:

Measurement (dB μ V/m) = Reading Level (dB μ V) + Correct Factor (dB/m)
Over (dB) = Measurement (dB μ V/m) – Limit (dB μ V/m)



Radiated emissions between 30MHz – 1GHz



Mode1 / Polarization: Vertical / CH: H



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		39.0245	43.69	-24.89	18.80	40.00	-21.20	QP	
2	*	57.3923	46.74	-21.36	25.38	40.00	-14.62	QP	
3		158.1123	36.15	-17.38	18.77	43.50	-24.73	QP	
4		230.9068	42.97	-20.35	22.62	46.00	-23.38	QP	
5		411.8240	28.13	-14.02	14.11	46.00	-31.89	QP	
6		682.3484	26.43	-9.08	17.35	46.00	-28.65	QP	



Radiated emissions 1 GHz ~ 25 GHz

Mode1 / Polarization: Horizontal / CH: L

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		4808.000	45.12	0.53	45.65	74.00	-28.35	peak
2		4808.000	39.63	0.53	40.16	54.00	-13.84	AVG
3		7212.000	49.44	7.84	57.28	74.00	-16.72	peak
4	*	7212.000	42.37	7.84	50.21	54.00	-3.79	AVG
5		9616.000	44.81	8.88	53.69	74.00	-20.31	peak
6		9616.000	39.38	8.88	48.26	54.00	-5.74	AVG

Mode1 / Polarization: Vertical / CH: L

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		4808.000	43.64	0.53	44.17	74.00	-29.83	peak
2		4808.000	37.71	0.53	38.24	54.00	-15.76	AVG
3		7212.000	46.40	7.84	54.24	74.00	-19.76	peak
4	*	7212.000	39.42	7.84	47.26	54.00	-6.74	AVG
5		9616.000	45.05	8.88	53.93	74.00	-20.07	peak
6		9616.000	38.38	8.88	47.26	54.00	-6.74	AVG



Mode1 / Polarization: Horizontal / CH: M

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		4880.000	43.69	0.56	44.25	74.00	-29.75	peak
2		4880.000	37.70	0.56	38.26	54.00	-15.74	AVG
3		7320.000	48.17	7.54	55.71	74.00	-18.29	peak
4	*	7320.000	41.67	7.54	49.21	54.00	-4.79	AVG
5		9760.000	43.99	9.33	53.32	74.00	-20.68	peak
6		9760.000	37.81	9.33	47.14	54.00	-6.86	AVG

Mode1 / Polarization: Vertical / CH: M

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		4880.000	44.08	0.56	44.64	74.00	-29.36	peak
2		4880.000	36.60	0.56	37.16	54.00	-16.84	AVG
3		7320.000	49.19	7.54	56.73	74.00	-17.27	peak
4	*	7320.000	42.64	7.54	50.18	54.00	-3.82	AVG
5		9760.000	43.98	9.33	53.31	74.00	-20.69	peak
6		9760.000	39.19	9.33	48.52	54.00	-5.48	AVG



Mode1 / Polarization: Horizontal / CH: H

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		4956.000	44.14	0.63	44.77	74.00	-29.23	peak
2		4956.000	38.63	0.63	39.26	54.00	-14.74	AVG
3		7434.000	49.49	7.95	57.44	74.00	-16.56	peak
4	*	7434.000	42.18	7.95	50.13	54.00	-3.87	AVG
5		9912.000	44.83	9.67	54.50	74.00	-19.50	peak
6		9912.000	37.58	9.67	47.25	54.00	-6.75	AVG

Mode1 / Polarization: Vertical / CH: H

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		4956.000	44.68	0.63	45.31	74.00	-28.69	peak
2		4956.000	37.30	0.63	37.93	54.00	-16.07	AVG
3		7434.000	48.94	7.95	56.89	74.00	-17.11	peak
4	*	7434.000	42.03	7.95	49.98	54.00	-4.02	AVG
5		9912.000	44.82	9.67	54.49	74.00	-19.51	peak
6		9912.000	37.49	9.67	47.16	54.00	-6.84	AVG



Radiated emissions at band edge

Mode1 / Polarization: Horizontal / CH: L

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		2310.000	48.28	-4.83	43.45	74.00	-30.55	peak
2		2310.000	38.22	-4.83	33.39	54.00	-20.61	AVG
3		2390.000	54.83	-4.31	50.52	74.00	-23.48	peak
4		2390.000	38.48	-4.31	34.17	54.00	-19.83	AVG
5		2400.000	53.98	-4.25	49.73	74.00	-24.27	peak
6		2400.000	38.89	-4.25	34.64	54.00	-19.36	AVG

Mode1 / Polarization: Vertical / CH: L

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		2310.000	48.61	-4.83	43.78	74.00	-30.22	peak
2		2310.000	38.16	-4.83	33.33	54.00	-20.67	AVG
3		2390.000	52.93	-4.31	48.62	74.00	-25.38	peak
4		2390.000	38.32	-4.31	34.01	54.00	-19.99	AVG
5		2400.000	51.28	-4.25	47.03	74.00	-26.97	peak
6		2400.000	38.55	-4.25	34.30	54.00	-19.70	AVG

Mode1 / Polarization: Horizontal / CH: H

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB
1		2483.500	49.29	-4.21	45.08	74.00	-28.92
2	*	2483.500	38.33	-4.21	34.12	54.00	-19.88
3		2500.000	48.98	-4.10	44.88	74.00	-29.12
4		2500.000	38.39	-4.10	34.29	54.00	-19.71

Mode1 / Polarization: Vertical / CH: H

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB
1		2483.500	49.41	-4.21	45.20	74.00	-28.80
2	*	2483.500	38.39	-4.21	34.18	54.00	-19.82
3		2500.000	48.76	-4.10	44.66	74.00	-29.34
4		2500.000	38.26	-4.10	34.16	54.00	-19.84

5.3.5 Band edge—Field strength of fundamental

Frequency (MHz)	Ant. Polarization	Emission level dB μ V/m	Limits dB μ V/m	Detector	Result
2404	H	81.08	114		Peak
2404	H	80.62	94	AVG	Pass
2404	V	78.65	114	Peak	Pass
2404	V	78.11	94	AVG	Pass

Frequency (MHz)	Ant. Polarization	Emission level dB μ V/m	Limits dB μ V/m	Detector	Result
2440	H	75.44	114		Peak
2440	H	74.87	94	AVG	Pass
2440	V	77.12	114	Peak	Pass
2440	V	76.53	94	AVG	Pass

Frequency (MHz)	Ant. Polarization	Emission level dB μ V/m	Limits dB μ V/m	Detector	Result
2478	H	75.97	114		Peak
2478	H	75.42	94	AVG	Pass
2478	V	73.41	114	Peak	Pass
2478	V	72.82	94	AVG	Pass

5.4 20dB and 99% bandwidth

5.4.1 Limits

FCC §15.215(c)

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in § 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

5.4.2 Test setup



5.4.3 Test procedures

Use the following spectrum analyzer settings:

For 20 dB bandwidth

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel

RBW $\geq 1\%$ of the 20 dB bandwidth

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth and 99% occupied bandwidth of the emission

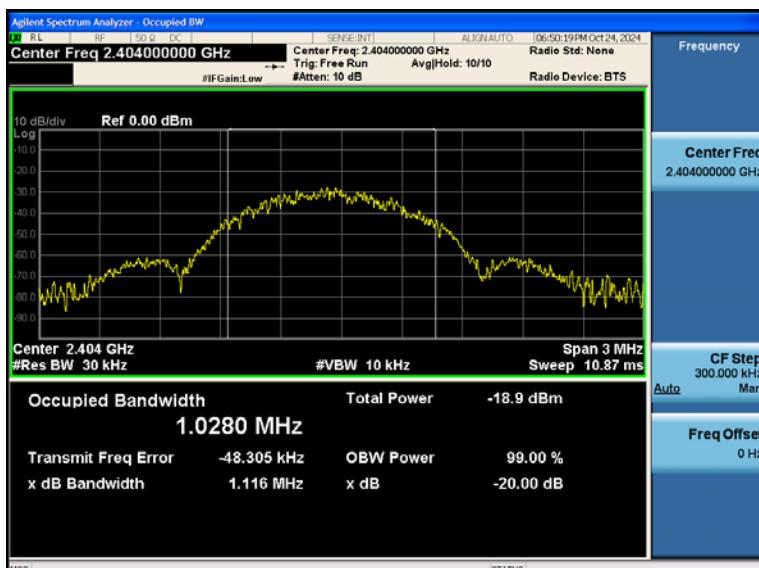
5.4.4 Test results

Test channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
CH1	2404	1.116	1.0280
CH19	2440	1.089	1.0245
CH38	2478	1.130	1.0316



20dB occupied bandwidth

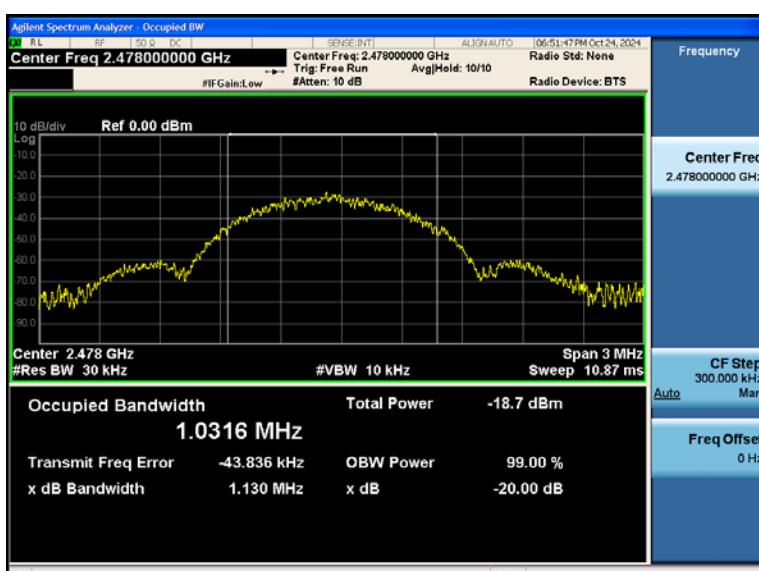
CH1



CH19



CH38



Photographs of the Test Setup

See the appendix – Test Setup Photos.

Photographs of the EUT

See the appendix - EUT Photos.

----End of Report----