

TEST REPORT

FCC ID:2BBCJ-M5

Applicant..... : Elgin Engineering LLC
Address of Applicant..... : 2020 E Randol Mill Rd #307 Arlington Texas United States 76011
Manufacturer..... : Elgin Engineering LLC
Address of Manufacturer..... : 2020 E Randol Mill Rd #307 Arlington Texas United States 76011
Trademark..... : /
Product..... : Elgin Havoc
Model No..... : M5
Additional Model(s)..... : /
Model Difference..... : /
Prepared by..... : Guangdong Zhonghan Testing Technology Co., Ltd.
Address..... : Room 104/201, Building 1, Yibaolai Industrial Park, Qiaotou, Fuhai Subdistrict, Bao'an District, Shenzhen, Guangdong, China
Date of Receipt..... : Aug. 31, 2026
Date of Test(s)..... : Aug. 31, 2026 - Sep. 16, 2026
Date of Issue..... : Sep. 16, 2026
Test Standard(s)..... : FCC Part 15 Subpart C 15.247
Test Method..... : ANSI C63.10: 2020+Cor.1:2023+C63.10a: 2024+Errata to C63.10a: 2024 KDB 558074 D01 15.247 Meas Guidance v05r02
Conclusions..... : PASS

In the configuration tested, the EUT complied with the standards specified above.

Prepared by:

Leon Li

Leon Li/ Engineer

Reviewed by:

Camille Li

Camille Li/ Director

Approved by:

Levi Lee

Levi Lee/ Manager

Note: The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report shall not be reproduced except in full, without prior written approval of ZHT. This document may be altered or revised by ZHT, personnel only, and shall be noted in the revision of the document



Table of Contents

1. General Information	4
1.1 General Description of EUT (Equipment Under Test)	4
1.2 Block Diagram Showing the Configuration of System Test	6
1.3 Support Equipment	6
1.4 Description of Test Mode	7
1.5 Description of Test Software Setting	8
1.7 Measurement Uncertainty	9
1.8 Test Facility	9
2. Test Results Summary	10
3. Test Software	10
4. Test Equipment	11
5. Conducted Emission	12
5.1 Test Standard and Limit	12
5.2 Test Setup	12
5.3 Test procedure	12
5.4 Deviation From Test Standard	12
5.5 EUT Operating Mode	12
5.6 Test Data	12
6. Radiated and Conducted Unwanted Emissions	13
6.1 Test Standard and Limit	13
6.2 Test Setup	14
6.3 Test procedure	14
6.4 Deviation From Test Standard	15
6.5 EUT Operating Mode	15
6.6 Test Data	15
7. Restricted Bands and Band Edge Requirement	16
7.1 Test Standard and Limit	16
7.2 Test Setup	16
7.3 Test Procedure	16
7.4 Deviation From Test Standard	17
7.5 EUT Operating Mode	17
7.6 Test Data	17
8. Occupied and 20dB Bandwidth	18
8.1 Test Standard and Limit	18
8.2 Test Setup	18
8.3 Test Procedure	18
8.4 Deviation From Test Standard	18
8.5 EUT Operating Mode	18
8.6 Test Data	18
9. Peak Output Power Test	19
9.1 Test Standard and Limit	19
9.2 Test Setup	19
9.3 Test Procedure	19
9.4 Deviation From Test Standard	19
9.5 EUT Operating Mode	19
9.6 Test Data	20
10. Carrier frequency separation	21
10.1 Test Standard and Limit	21
10.2 Test Setup	21
10.3 Test Procedure	21
10.4 Deviation From Test Standard	21
10.5 Antenna Connected Construction	21
10.6 Test Data	21
11. Time of occupancy (dwell time)	22
11.1 Test Standard and Limit	22
11.2 Test Setup	22



11.3	Test procedure	22
11.4	Deviation From Test Standard	23
11.5	Antenna Connected Construction	23
11.6	Test Data	23
12.	Number of hopping frequencies	24
12.1	Test Standard and Limit	24
12.2	Test Setup	24
12.3	Test Pocedure	24
12.4	Deviation From Test Standard	24
12.5	Antenna Connected Construction	24
12.6	Test Data	24
13.	Antenna Requirement	25
13.1	Test Standard and Limit	25
13.2	Deviation From Test Standard	25
13.3	Antenna Connected Construction	25
13.4	Test Data	25
14.	Test Setup Photos	26
15.	EUT Photos	26
Attachment A--	Unwanted Emissions Data	27



1. General Information

1.1 General Description of EUT (Equipment Under Test)

EUT Name	:	Elgin Havoc
Test Model No.	:	M5
Ratings	:	Input: 5V  1A or DC 3.7V Rechargeable Li-ion battery
Operation frequency	:	2402MHz-2480MHz
Modulation Type	:	GFSK, $\pi/4$ DQPSK, 8DPSK
Channel Separation	:	1MHz
Number of Channel	:	Please see Note(2)
Antenna Type	:	Bipolar antenna
Antenna Gain	:	1.83dBi
Hardware Version	:	V1.0
Software Version	:	V1.0
Sample Number:	:	260831111YP001
Remark: The antenna gain provided by the applicant, if the data provided by the applicant is not accurate, Guangdong Zhonghan Testing Technology Co., Ltd. does not assume any responsibility.		

Note:

(1) For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.



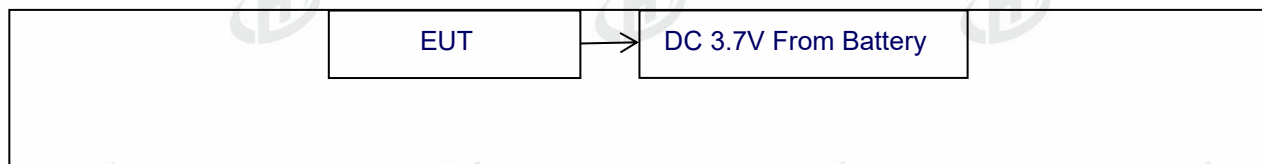
(2) Channel List:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
00	2402	01	2403	02	2404
03	2405	04	2406	05	2407
06	2408	07	2409	08	2410
09	2411	10	2412	11	2413
12	2414	13	2415	14	2416
15	2417	16	2418	17	2419
18	2420	19	2421	20	2422
21	2423	22	2424	23	2425
24	2426	25	2427	26	2428
27	2429	28	2430	29	2431
30	2432	31	2433	32	2434
33	2435	34	2436	35	2437
36	2438	37	2439	38	2440
39	2441	40	2442	41	2443
42	2444	43	2445	44	2446
45	2447	46	2448	47	2449
48	2450	49	2451	50	2452
51	2453	52	2454	53	2455
54	2456	55	2457	56	2458
57	2459	58	2460	59	2461
60	2462	61	2463	62	2464
63	2465	64	2466	65	2467
66	2468	67	2469	68	2470
69	2471	70	2472	71	2473
72	2474	73	2475	74	2476
75	2477	76	2478	77	2479
78	2480				

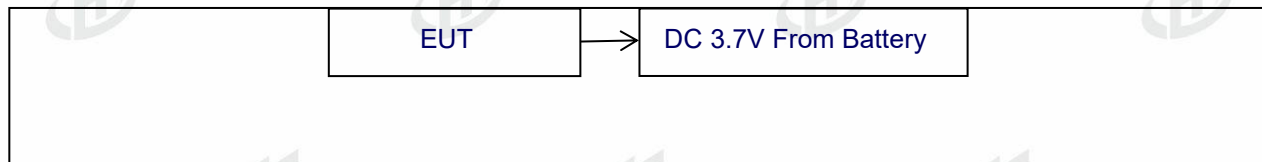


1.2 Block Diagram Showing the Configuration of System Test

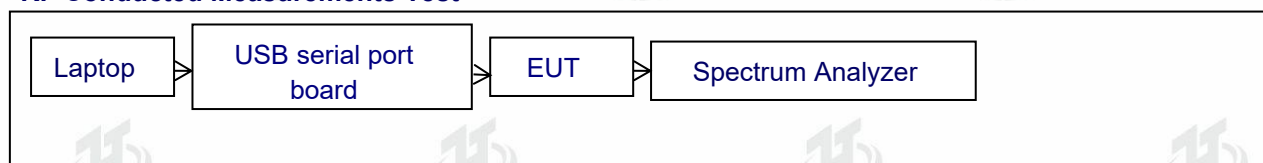
Radiated Measurements Test (Below 1G)



Radiated Measurements Test (Above 1G)



RF Conducted Measurements Test



1.3 Support Equipment

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Note
E-1	Laptop	Lenovo (Beijing) Co., Ltd	ThinkPad E480	/	AE
E-2	USB serial port board	/	/	/	AE

Notes:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.



1.4 Description of Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

For Radiated and RF Conducted Test	
Final Test Mode	Description
Mode 1	TX GFSK Mode Channel 00
Mode 2	TX Mode(GFSK) Channel 00/39/78
Mode 3	TX Mode($\pi/4$ -DQPSK) Channel 00/39/78
Mode 4	TX Mode(8DPSK) Channel 00/39/78
Mode 5	Hopping Mode(GFSK)
Mode 6	Hopping Mode($\pi/4$ -DQPSK)
Mode 7	Hopping Mode(8DPSK)

Note:M5 is a test model, and the left and right earphones are the same in the circuit, only the PCB layout is different. Therefore, So chose the right earphone for all the tests, while the left earphone was tested for radiation emissions and radiation spurious tests between 30MHz and 1GHz.



1.5 Description of Test Software Setting

During testing channel & Power controlling software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product power parameters of RF setting.

Test Software Version: Airoha Tool Kit - V3.3.5			
Mode	Data Rate	Channel	Parameters
GFSK	1Mbps	00	DEF
	1Mbps	39	DEF
	1Mbps	78	DEF
$\pi/4$ DQPSK	2Mbps	00	DEF
	2Mbps	39	DEF
	2Mbps	78	DEF
8DPSK	3Mbps	00	DEF
	3Mbps	39	DEF
	3Mbps	78	DEF



1.7 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.

No.	Item	Uncertainty
1	Conducted Emission Test	0.92dB
2	RF conducted power	0.27dB
3	Conducted spurious emissions	0.21dB
4	All radiated emissions (9k-30MHz)	1.68dB
5	All radiated emissions (30-1GHz)	5.1dB
6	All radiated emissions (1-6GHz)	3.9dB
7	All radiated emissions (6GHz-18GHz)	4.3dB
8	All radiated emissions (18-40GHz)	4.65dB
9	Temperature	0.5°C
10	Humidity	2%
11	Occupied Bandwidth	4.96%
12	Power Spectral Density	0.71dB

Decision Rule

- ☒ Uncertainty is not included
☐ Uncertainty is included

1.8 Test Facility

Guangdong Zhonghan Testing Technology Co., Ltd.
Room 104/201, Building 1, Yibaolai Industrial Park, Qiaotou, Fuhai Subdistrict, Bao'an District, Shenzhen, Guangdong, China



2. Test Results Summary

Standard Section	Test Item	Judgment	Remark
FCC 15.207(a)	Conducted Emission	N/A	N/A
FCC 15.209 & 15.247(d)	Radiated Unwanted Emissions	PASS	N/A
FCC 15.203	Antenna Requirement	PASS	N/A
FCC 15.247(a)	99% Occupied Bandwidth & 20dB Bandwidth	PASS	N/A
FCC 15.247(b)(1)	Peak Output Power	PASS	N/A
FCC 15.247(a)(1)	Carrier frequency separation	PASS	N/A
FCC 15.247(a)(1)	Time of occupancy	PASS	N/A
FCC 15.247(b)(1)	Number of Hopping Frequency	PASS	N/A
FCC 15.247(d)	Band Edge	PASS	N/A
FCC 15.207(a)	Conducted Unwanted Emissions	PASS	N/A
FCC 15.205	Emissions in Restricted Bands	PASS	N/A
/	On Time and Duty Cycle	/	N/A
Note 1: N/A is an abbreviation for Not Applicable.			

3. Test Software

Test Item	Test Software	Manufacturer	Version No.
Radiated Emission	EZ-EMC	EZ	FA-03A2 RE+
RF Conducted Measurement	MTS 8310	MWRFTest	4.0.0.0



4. Test Equipment

Radiation Test equipment						
Equipment	Manufacturer	Model	Serial No.	Equipment No.	Last Cal.	Next Cal.
Receiver	R&S	ESCI	100874	ZH-E005	Apr. 24, 2026	Apr. 23, 2027
Loop Antenna	TESEQ	HLA6121	58357	ZH-E036	July 10, 2026	July 9, 2027
Amplifier	Schwarzbeck	BBV 9743 B	00378	ZH-E019	Apr. 24, 2026	Apr. 23, 2027
Amplifier	Schwarzbeck	BBV 9718 B	00040	ZH-E021	May 8, 2026	May 7, 2027
Bilog Antenna	Schwarzbeck	VULB9162	00498	ZH-E017	Apr. 25, 2026	Apr. 24, 2027
Horn Antenna	Schwarzbeck	BBHA9120D	02623	ZH-E020	Apr. 25, 2026	Apr. 24, 2027
Horn Antenna	A.H.SYSTEMS	SAS574	588	ZH-E062	Oct. 20, 2025	Oct. 19, 2026
Amplifier	AEROFLEX	100KHz-40GHz	097	ZH-E063	Oct. 20, 2025	Oct. 19, 2026
Spectrum Analyzer	R&S	FSV40	101413	ZH-E064	Apr. 24, 2026	Apr. 23, 2027
Spectrum Analyzer	KEYSIGHT	N9020A	MY53420208	ZH-E032	Apr. 24, 2026	Apr. 23, 2027
WIDBAND RADIO COMMUNICATION TESTER	R&S	CMW500	109863	ZH-E033	Apr. 24, 2026	Apr. 23, 2027
Single Generator	Agilent	N5182A	MY48180575	ZH-E034	Apr. 24, 2026	Apr. 23, 2027
CABLE	EMToni	DA800-NM-NM-11000MM	/	ZH-E018	Apr. 24, 2026	Apr. 23, 2027
Conduction Test equipment						
Equipment	Manufacturer	Model	Last Cal.	Next Cal.		
Receiver	R&S	ESCI	100874	ZH-E005	Apr. 24, 2026	Apr. 23, 2027
LISN	R&S	ENV216	102794	ZH-E006	Jul. 8, 2026	Jul. 7, 2027
ISN CAT 6	Schwarzbeck	NTFM 8158	00318	ZH-E012	Apr. 24, 2026	Apr. 23, 2027
ISN CAT 5	Schwarzbeck	CAT5 8158	00343	ZH-E013	Apr. 24, 2026	Apr. 23, 2027
Capacitive Voltage Probe	Schwarzbeck	CVP 9222C	00101	ZH-E014	May 8, 2026	May 7, 2027
Current Transformer Clamp	Schwarzbeck	SW 9605	SW9605 #209	ZH-E015	May 8, 2026	May 7, 2027
CABLE	EMToni	RG223-NM-BNCM-2000MM	/	ZH-E007	Apr. 24, 2026	Apr. 23, 2027
USBC-C cable	Xiaomi	C-C 1M	/	/	Apr. 24, 2026	Apr. 23, 2027
RF Conducted Test equipment						
Spectrum Analyzer	KEYSIGHT	N9020A	MY53420208	ZH-E032	Apr. 24, 2026	Apr. 23, 2027
Power Sensor	MWRFTest	MW100-RFCB	/	ZH-E066	Apr. 24, 2026	Apr. 23, 2027
DC power supply	R&S	SMB100A	259098	/	Apr. 15, 2026	Apr. 14, 2027
Constant Temperature and Humidity Test Chamber	OJN	OJN-9606	/	/	Apr. 15, 2026	Apr. 14, 2027



5. Conducted Emission

5.1 Test Standard and Limit

5.1.1 Test Standard

FCC Part 15.207

5.1.2 Test Limit

Frequency	Maximum RF Line Voltage (dB μ V)	
	Quasi-peak Level	Average Level
150kHz~500kHz	66 ~ 56 *	56 ~ 46 *
500kHz~5MHz	56	46
5MHz~30MHz	60	50

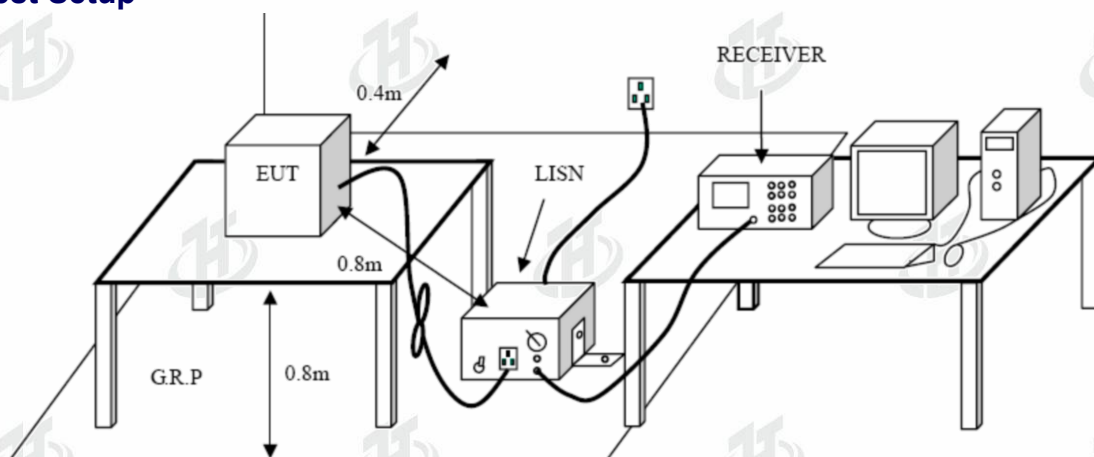
Notes:

(1) *Decreasing linearly with logarithm of the frequency.

(2) The lower limit shall apply at the transition frequencies.

(3) The limit decrease in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

5.2 Test Setup



5.3 Test procedure

- The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
- Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
- I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
- LISN at least 80 cm from nearest part of EUT chassis.
- The bandwidth of EMI test receiver is set at 9 kHz, and the test frequency band is from 0.15MHz to 30MHz.

5.4 Deviation From Test Standard

No deviation

5.5 EUT Operating Mode

Please refer to the description of test mode.

5.6 Test Data

The Product is powered by the DC only, the test item is not applicable.



6. Radiated and Conducted Unwanted Emissions

6.1 Test Standard and Limit

6.1.1 Test Standard

FCC Part 15.209 & FCC Part 15.247(d)

6.1.2 Test Limit

General field strength limits at frequencies Below 30MHz		
Frequency (MHz)	Field Strength (microvolt/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
Note: 1, The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.		

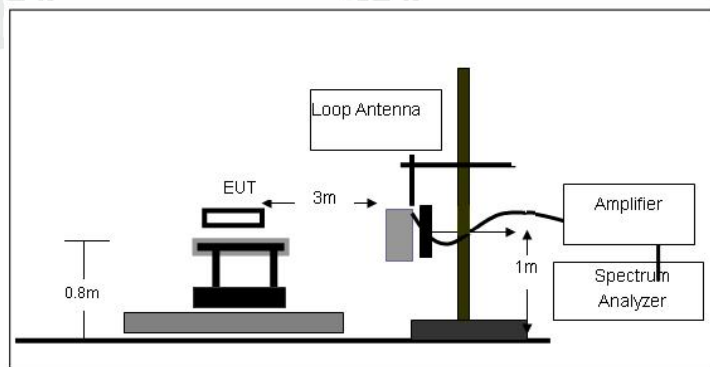
General field strength limits at frequencies above 30 MHz		
Frequency (MHz)	Field strength (μV/m at 3 m)	Measurement Distance (meters)
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

General field strength limits at frequencies Above 1000MHz		
Frequency (MHz)	Distance of 3m (dBuV/m)	
	Peak	Average
Above 1000	74	54
Note: (1) The tighter limit applies at the band edges. (2) Emission Level(dBuV/m)=20log Emission Level(uV/m)		

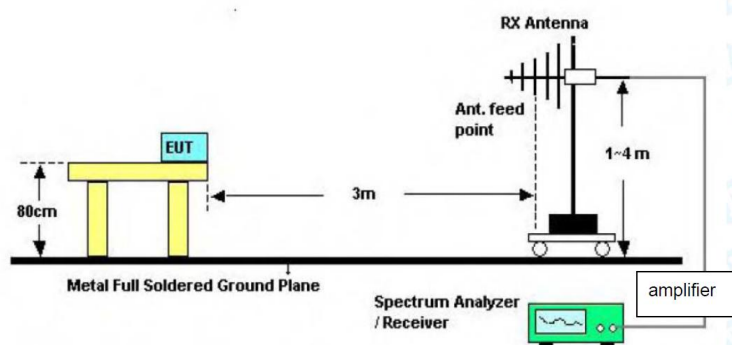
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB.

6.2 Test Setup

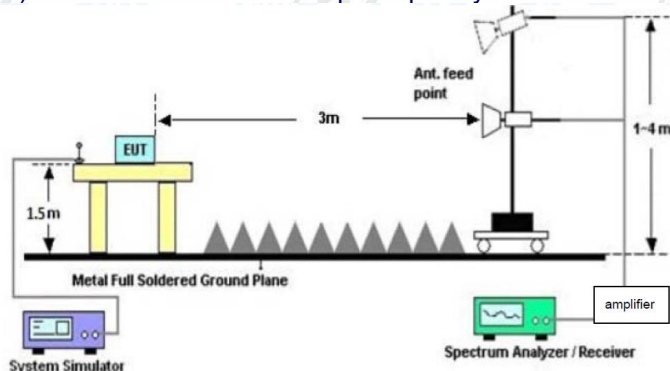
Radiated measurement



(A) Radiated Emission Test-Up Frequency Below 30MHz

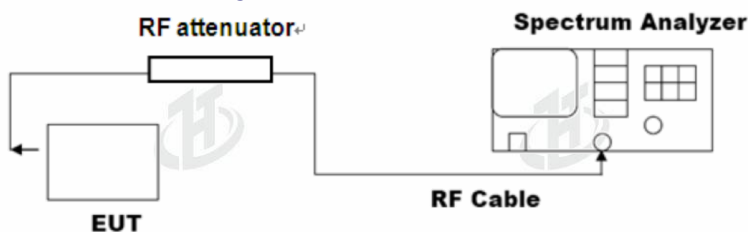


(B) Radiated Emission Test-Up Frequency 30MHz~1GHz



(C) Radiated Emission Test-Up Frequency Above 1GHz

Conducted measurement



6.3 Test procedure

---Radiated measurement

- The measuring distance of 3m shall be used for measurements at frequency up to 1GHz and above 1 GHz. The EUT was placed on a rotating 0.8m high above ground, the table was rotated 360 degrees to determine the position of the highest radiation.
- Measurements at frequency above 1GHz. The EUT was placed on a rotating 1.5m high above the ground. RF absorbers covered the ground plane with a minimum area of 3.0m by 3.0m between the EUT and measurement receiver antenna. The RF absorber shall not



exceed 30cm in high above the conducting floor. The table was rotated 360 degrees to determine the position of the highest radiation.

- The Test antenna shall vary between 1m and 4m, Both Horizontal and Vertical antenna are set to make measurement.
- The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.
- If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit Below 1 GHz, the EUT shall be deemed to meet QP Limits and then no additional QP Mode measurement performed. But the Peak Value and average value both need to comply with applicable limit above 1 GHz.
- Testing frequency range 30MHz-1GHz the measuring instrument use VBW=120 kHz with Quasi-peak detection. Testing frequency range 9KHz-150Hz the measuring instrument use VBW=200Hz with Quasi-peak detection. Testing frequency range 9KHz-30MHz the measuring instrument use VBW=9kHz with Quasi-peak detection.
- Testing frequency range above 1GHz the measuring instrument use RBW=1 MHz and VBW=3 MHz with Peak Detector for Peak Values, and use RBW=1 MHz and VBW=10 Hz with Peak Detector for Average Values.
- For the actual test configuration, please see the test setup photo.

--- Conducted measurement

- Reference level measurement

Establish a reference level by using the following procedure:

- a) Set instrument center frequency to DTS channel center frequency.
- b) Set the span to ≥ 1.5 times the DTS bandwidth.
- c) Set the RBW = 100 kHz.
- d) Set the VBW $\geq [3 \times \text{RBW}]$.
- e) Detector = peak.
- f) Sweep time = auto couple.
- g) Trace mode = max hold.
- h) Allow trace to fully stabilize.
- i) Use the peak marker function to determine the maximum PSD level.

Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

- Emission level measurement

Establish an emission level by using the following procedure:

- a) Set the center frequency and span to encompass frequency range to be measured.
- b) Set the RBW = 100 kHz.
- c) Set the VBW $\geq [3 \times \text{RBW}]$.
- d) Detector = peak.
- e) Sweep time = auto couple.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements specified in 11.11. Report the three highest emissions relative to the limit

6.4 Deviation From Test Standard

No deviation

6.5 EUT Operating Mode

Please refer to the description of test mode.

6.6 Test Data

Radiated measurement please refer to the Attachment A inside test report.
Conducted measurement please refer to the external appendix report of BT.

7. Restricted Bands and Band Edge Requirement

7.1 Test Standard and Limit

7.1.1 Test Standard

FCC Part 15.205 & FCC Part 15.247(d)

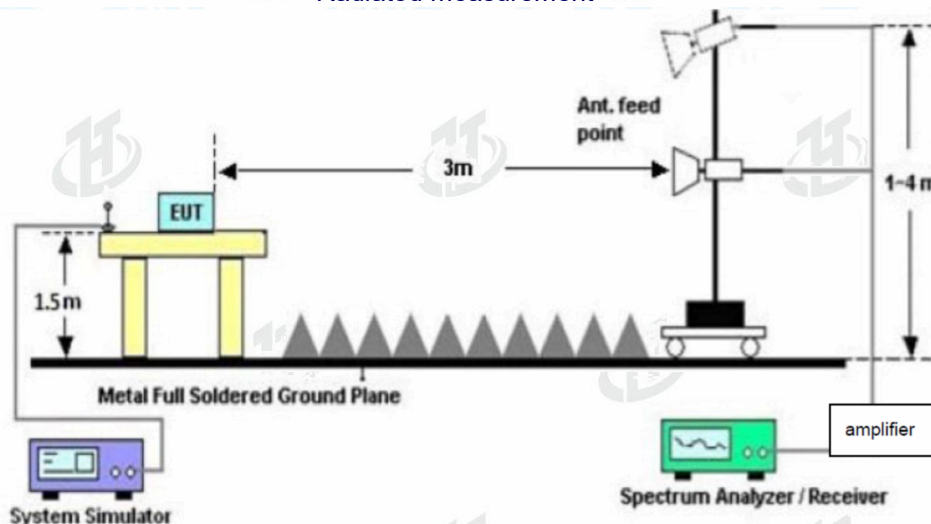
7.1.2 Test Limit

Restricted Frequency Band (MHz)	Distance Meters (at 3m)	
	Peak (dBuV/m)	Average (dBuV/m)
2310 ~2390	74	54
2483.5 ~2500	74	54
	Peak (dBm) see 7.3 e)	Average (dBm) see 7.3 e)
2310 ~2390	-21.20	-41.20
2483.5 ~2500	-21.20	-41.20

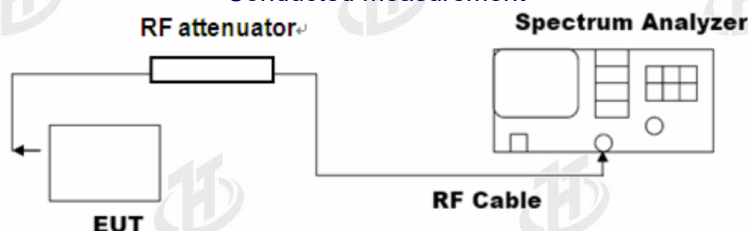
Note:
According to the ANSI C63.10 11.12.2 antenna-port conducted measurements may also be used as an alternative to radiated measurements for determining compliance in the restricted frequency bands requirements. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case emissions is required.

7.2 Test Setup

Radiated measurement



Conducted measurement



7.3 Test Procedure

---Radiated measurement

- Measurements at frequency above 1GHz. The EUT was placed on a rotating 1.5m high above the ground. RF absorbers covered the ground plane with a minimum area of 3.0m by 3.0m between the EUT and measurement receiver antenna. The RF absorber shall not exceed 30cm in high above the conducting floor. The table was rotated 360 degrees to determine the position of the highest radiation.
- The Test antenna shall vary between 1m and 4m, Both Horizontal and Vertical antenna are set to make measurement.
- The initial step in collecting conducted emission data is a spectrum analyzer peak



detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.

- The Peak Value and average value both need to comply with applicable limit above 1 GHz.
- Testing frequency range above 1GHz the measuring instrument use RBW=1 MHz and VBW=3 MHz with Peak Detector for Peak Values, and use RBW=1 MHz and VBW=10 Hz with Peak Detector for Average Values.
- For the actual test configuration, please see the test setup photo.

--- Conducted measurement

- a) Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency (see 11.12.2.3 through 11.12.2.5 for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
- b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP (see 11.12.2.6 for guidance on determining the applicable antenna gain).
- c) Add the appropriate maximum ground reflection factor to the EIRP (6 dB for frequencies ≤ 30 MHz; 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive; and 0 dB for frequencies > 1000 MHz).
- d) For MIMO devices, measure the power of each chain and sum the EIRP of all chains in linear terms (i.e., watts and mW).
- e) Convert the resultant EIRP to an equivalent electric field strength using the following relationship:

$$E = \text{EIRP} - 20 \log d + 104.8$$

where

E is the electric field strength in dBuV/m

EIRP is the equivalent isotropically radiated power in dBm

d is the specified measurement distance in m

- f) Compare the resultant electric field strength level with the applicable regulatory limit.

- g) Perform the radiated spurious emission test.

7.4 Deviation From Test Standard

No deviation

7.5 EUT Operating Mode

Please refer to the description of test mode.

7.6 Test Data

Please refer to the external appendix report of BT.



8. Occupied and 20dB Bandwidth

8.1 Test Standard and Limit

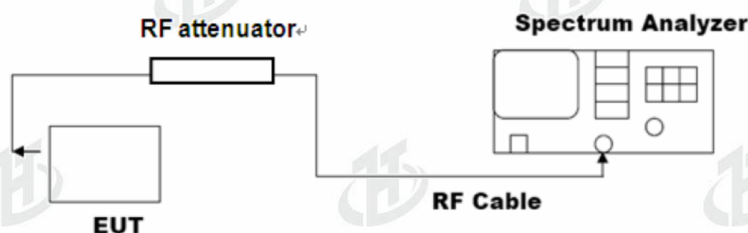
8.1.1 Test Standard

FCC Part 15.205 & FCC Part 15.247(a)

8.1.2 Test Limit

For an FHSS system operating in the 2400 to 2483.5 MHz band, there are no limits for 20dB bandwidth and 99% occupied bandwidth.

8.2 Test Setup



8.3 Test Procedure

- The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:
 - a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
 - b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
 - c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than $[10 \log (OBW/RBW)]$ below the reference level. Specific guidance is given in 4.1.5.2.
 - d) Step a) through step c) might require iteration to adjust within the specified range.
 - e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
 - f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.
 - g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.
 - h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

8.4 Deviation From Test Standard

No deviation

8.5 EUT Operating Mode

Please refer to the description of test mode.

8.6 Test Data

Please refer to the external appendix report of BT.



9. Peak Output Power Test

9.1 Test Standard and Limit

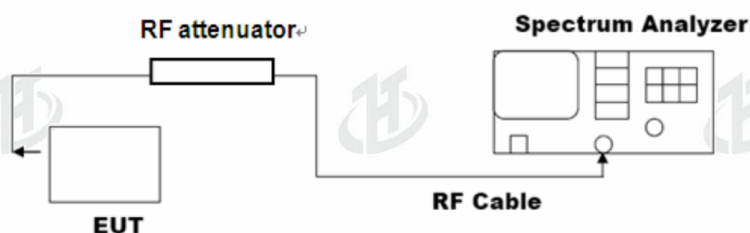
9.1.1 Test Standard

FCC Part 15.247(b)(1)

9.1.2 Test Limit

Test Item	Limit	Frequency Range(MHz)
PeakOutput Power	$P_{\text{max-pk}} \leq 1 \text{ W}$ $N_{\text{ch}} \geq 75$ $f \geq \text{MAX} \{ 25 \text{ kHz, BW20dB} \}$ max. BW20dB not specified $t_{\text{ch}} \leq 0.4 \text{ s for } T = 0.4 * N_{\text{ch}}$	2400~2483.5
	$P_{\text{max-pk}} \leq 0.125 \text{ W}$ $N_{\text{ch}} \geq 15$ $f \geq [\text{MAX}\{25 \text{ kHz, } 0.67 * \text{BW20dB}\}$ OR MAX{25 kHz, BW20dB}] max. BW20dB not specified $t_{\text{ch}} \leq 0.4 \text{ s for } T = 0.4 * N_{\text{ch}}$	
t_{ch} = average time of occupancy; T = period; N_{ch} = # hopping frequencies; BW = bandwidth; f = hopping channel carrier frequency separation		

9.2 Test Setup



9.3 Test Procedure

- This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:
 - a) Use the following spectrum analyzer settings:
 - 1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
 - 2) RBW > 20 dB bandwidth of the emission being measured.
 - 3) VBW ≥ RBW.
 - 4) Sweep: Auto.
 - 5) Detector function: Peak.
 - 6) Trace: Max hold.
 - b) Allow trace to stabilize.
 - c) Use the marker-to-peak function to set the marker to the peak of the emission.
 - d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
 - e) A plot of the test results and setup description shall be included in the test report.
- NOTE-A peak responding power meter may be used, where the power meter and sensor system video bandwidth is greater than the occupied bandwidth of the unlicensed wireless device, rather than a spectrum analyzer.

9.4 Deviation From Test Standard

No deviation

9.5 EUT Operating Mode

Please refer to the description of test mode.



ZHONGHAN

Report No.: ZHT-260831111W01-2
Page 20 of 36

9.6 Test Data

Please refer to the external appendix report of BT.



10. Carrier frequency separation

10.1 Test Standard and Limit

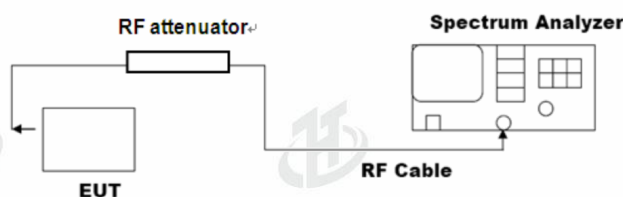
10.1.1 Test Standard

FCC Part 15.247(a)(1)

10.1.2 Test Limit

Test Item	Limit	Frequency Range(MHz)
Carrier frequency separation	$P_{\text{max-pk}} \leq 1 \text{ W}$ $N_{\text{ch}} \geq 75$ $f \geq \text{MAX} \{ 25 \text{ kHz, BW20dB} \}$ max. BW20dB not specified $t_{\text{ch}} \leq 0.4 \text{ s for } T = 0.4 * N_{\text{ch}}$	2400~2483.5
	$P_{\text{max-pk}} \leq 0.125 \text{ W}$ $N_{\text{ch}} \geq 15$ $f \geq [\text{MAX}\{25 \text{ kHz, } 0.67 * \text{BW20dB}\}$ OR MAX{25 kHz, BW20dB}] max. BW20dB not specified $t_{\text{ch}} \leq 0.4 \text{ s for } T = 0.4 * N_{\text{ch}}$	
t_{ch} = average time of occupancy; T = period; N_{ch} = # hopping frequencies; BW = bandwidth; f = hopping channel carrier frequency separation		

10.2 Test Setup



10.3 Test Procedure

- The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
 - a) Span: Wide enough to capture the peaks of two adjacent channels.
 - b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
 - c) Video (or average) bandwidth (VBW) $\geq$ RBW.
 - d) Sweep: Auto.
 - e) Detector function: Peak.
 - f) Trace: Max hold.
 - g) Allow the trace to stabilize.
- Use the marker-delta function to determine the separation between the peaks of the adjacent channels.
- Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report..

10.4 Deviation From Test Standard

No deviation

10.5 Antenna Connected Construction

Please refer to the description of test mode.

10.6 Test Data

Please refer to the external appendix report of BT.



11. Time of occupancy (dwell time)

11.1 Test Standard and Limit

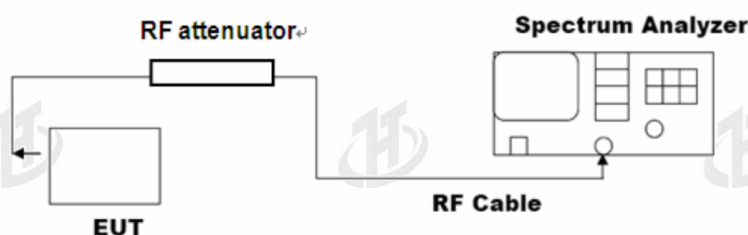
11.1.1 Test Standard

FCC Part 15.247(a)(1)

11.1.2 Test Limit

Test Item	Limit	Frequency Range(MHz)
Time of occupancy (dwell time)	$P_{\text{max-pk}} \leq 1 \text{ W}$ $N_{\text{ch}} \geq 75$ $f \geq \text{MAX} \{ 25 \text{ kHz, BW20dB} \}$ max. BW20dB not specified $t_{\text{ch}} \leq 0.4 \text{ s for } T = 0.4 * N_{\text{ch}}$	2400~2483.5
	$P_{\text{max-pk}} \leq 0.125 \text{ W}$ $N_{\text{ch}} \geq 15$ $f \geq [\text{MAX}\{25 \text{ kHz, } 0.67 * \text{BW20dB}\}$ OR MAX{25 kHz, BW20dB}] max. BW20dB not specified $t_{\text{ch}} \leq 0.4 \text{ s for } T = 0.4 * N_{\text{ch}}$	
t_{ch} = average time of occupancy; T = period; N_{ch} = # hopping frequencies; BW = bandwidth; f = hopping channel carrier frequency separation		

11.2 Test Setup



11.3 Test procedure

- The EUT shall have its hopping function enabled. 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 $\gg 1 / T$, where T is the expected dwell time per channel.
 - Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
 - Detector function: Peak.
 - Trace: Max hold.

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

$$(\text{Number of hops in the period specified in the requirements}) = (\text{number of hops on spectrum analyzer}) \times (\text{period specified in the requirements} / \text{analyzer sweep time})$$

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.



The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

11.4 Deviation From Test Standard

No deviation

11.5 Antenna Connected Construction

Please refer to the description of test mode.

11.6 Test Data

Please refer to the external appendix report of BT.



12. Number of hopping frequencies

12.1 Test Standard and Limit

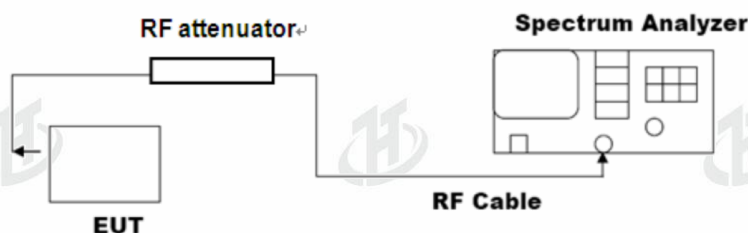
12.1.1 Test Standard

FCC Part 15.247(b)(1)

12.1.2 Test Limit

Test Item	Limit	Frequency Range(MHz)
Carrier frequency separation	$P_{\text{max-pk}} \leq 1 \text{ W}$ $N_{\text{ch}} \geq 75$ $f \geq \text{MAX} \{ 25 \text{ kHz, BW20dB} \}$ max. BW20dB not specified $t_{\text{ch}} \leq 0.4 \text{ s for } T = 0.4 * N_{\text{ch}}$	2400~2483.5
	$P_{\text{max-pk}} \leq 0.125 \text{ W}$ $N_{\text{ch}} \geq 15$ $f \geq [\text{MAX}\{25 \text{ kHz, } 0.67 * \text{BW20dB}\}$ OR $\text{MAX}\{25 \text{ kHz, BW20dB}\}]$ max. BW20dB not specified $t_{\text{ch}} \leq 0.4 \text{ s for } T = 0.4 * N_{\text{ch}}$	
t_{ch} = average time of occupancy; T = period; N_{ch} = # hopping frequencies; BW = bandwidth; f = hopping channel carrier frequency separation		

12.2 Test Setup



12.3 Test Procedure

• The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

- Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
- RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
- VBW $\geq$ RBW.
- Sweep: Auto.
- Detector function: Peak.
- Trace: Max hold.
- Allow the trace to stabilize.

It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies.

Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

12.4 Deviation From Test Standard

No deviation

12.5 Antenna Connected Construction

Please refer to the description of test mode.

12.6 Test Data

Please refer to the external appendix report of BT.



13. Antenna Requirement

13.1 Test Standard and Limit

13.1.1 Test Standard

FCC Part 15.203

13.1.2 Test Limit

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.

13.2 Deviation From Test Standard

No deviation

13.3 Antenna Connected Construction

The gains of the antenna used for transmitting is 1.83dBi, and the antenna de-signed with permanent attachment and no consideration of replacement. Please see the EUT photo for details.

13.4 Test Data

The EUT antenna is a Bipolar antenna. It complies with the standard requirement.

Antenna Type
☒ Permanent attached antenna
☐ Unique connector antenna
☐ Professional installation antenna



14. Test Setup Photos

Reference to the appendix I for details.

15. EUT Photos

Reference to the appendix II for details.

**Attachment A--Unwanted Emissions Data**

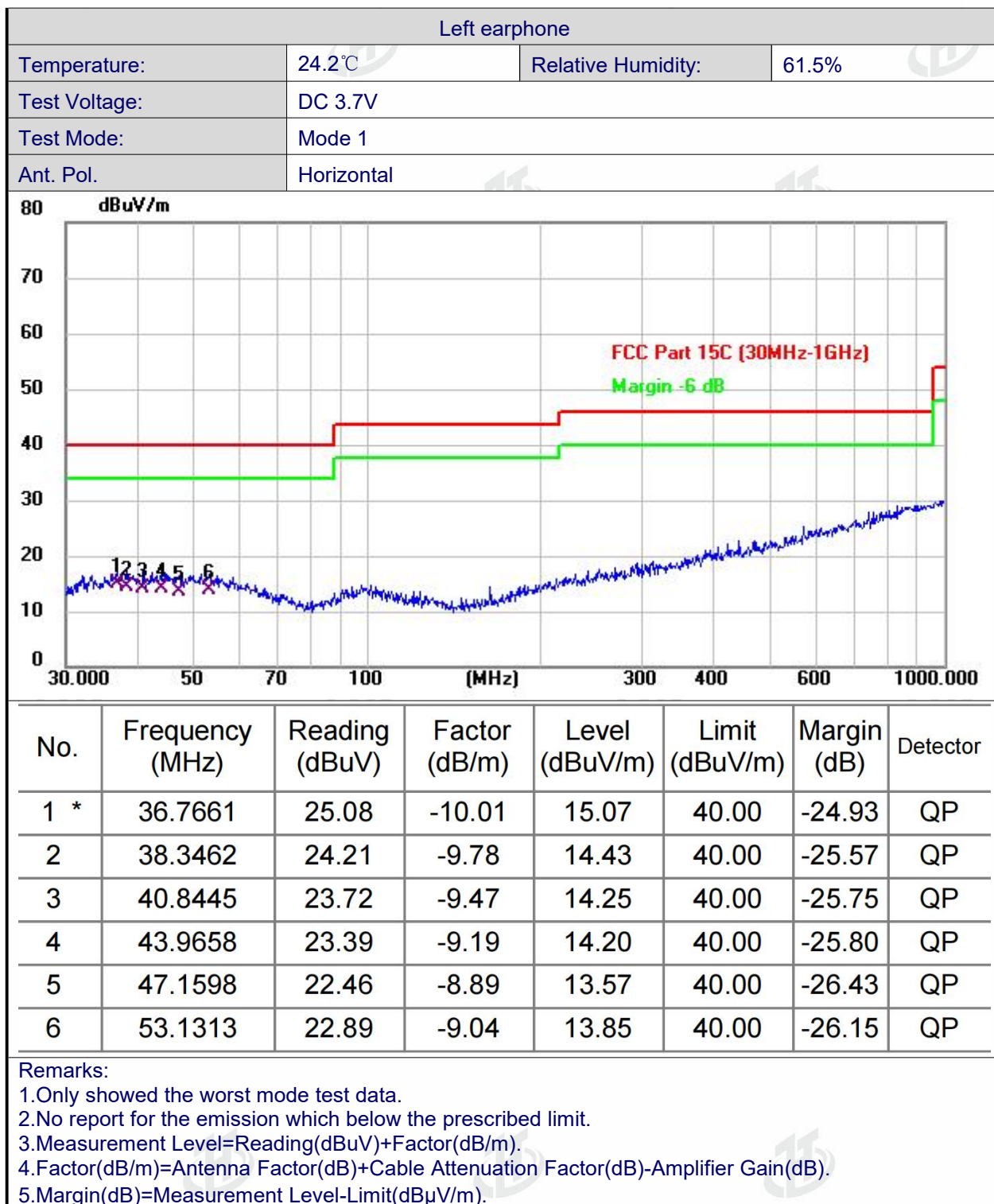
9 KHz~30 MHz

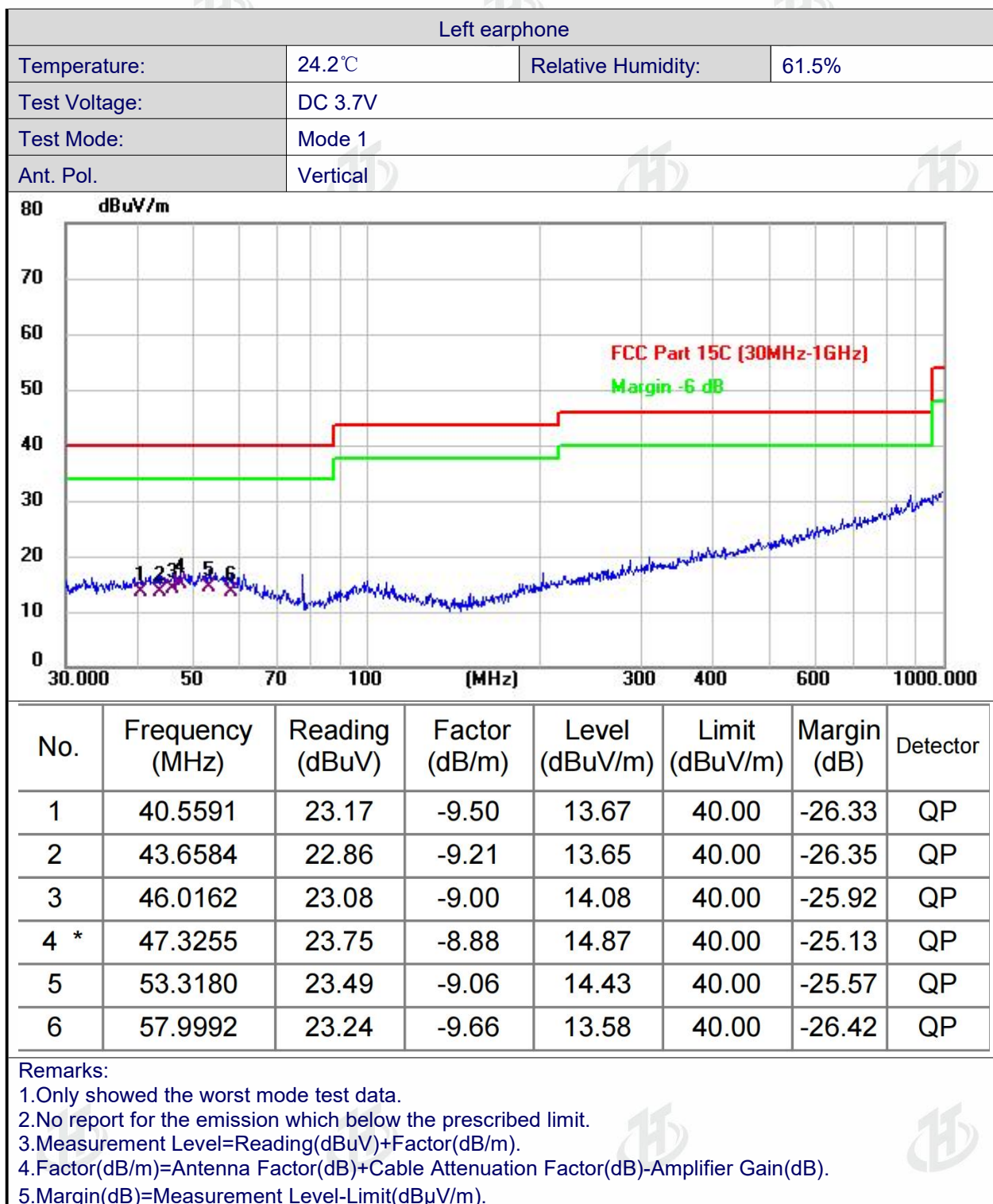
From 9 KHz to 30 MHz: Conclusion:

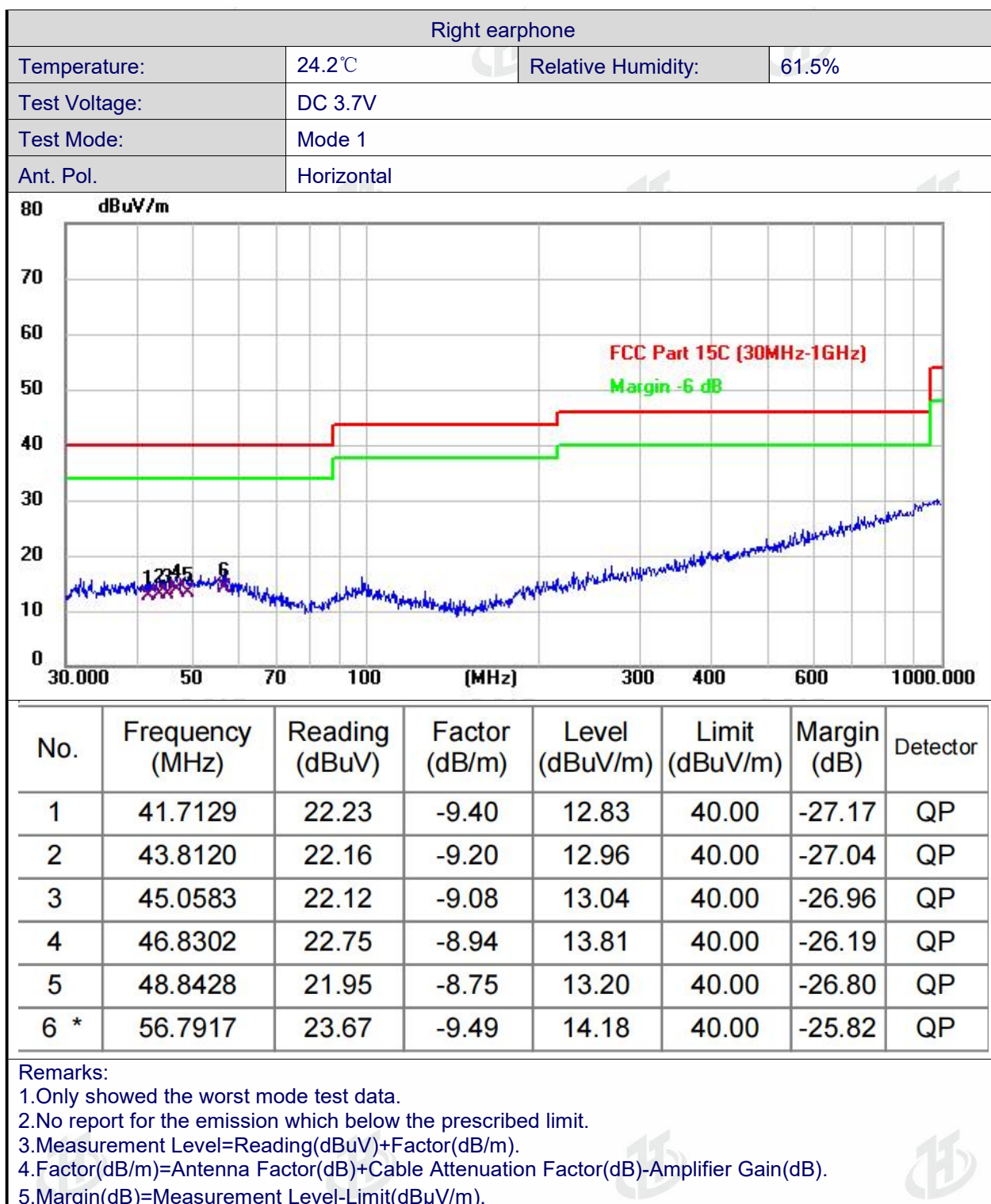
Note: The amplitude of spurious emissions which are attenuated by more than 20dB

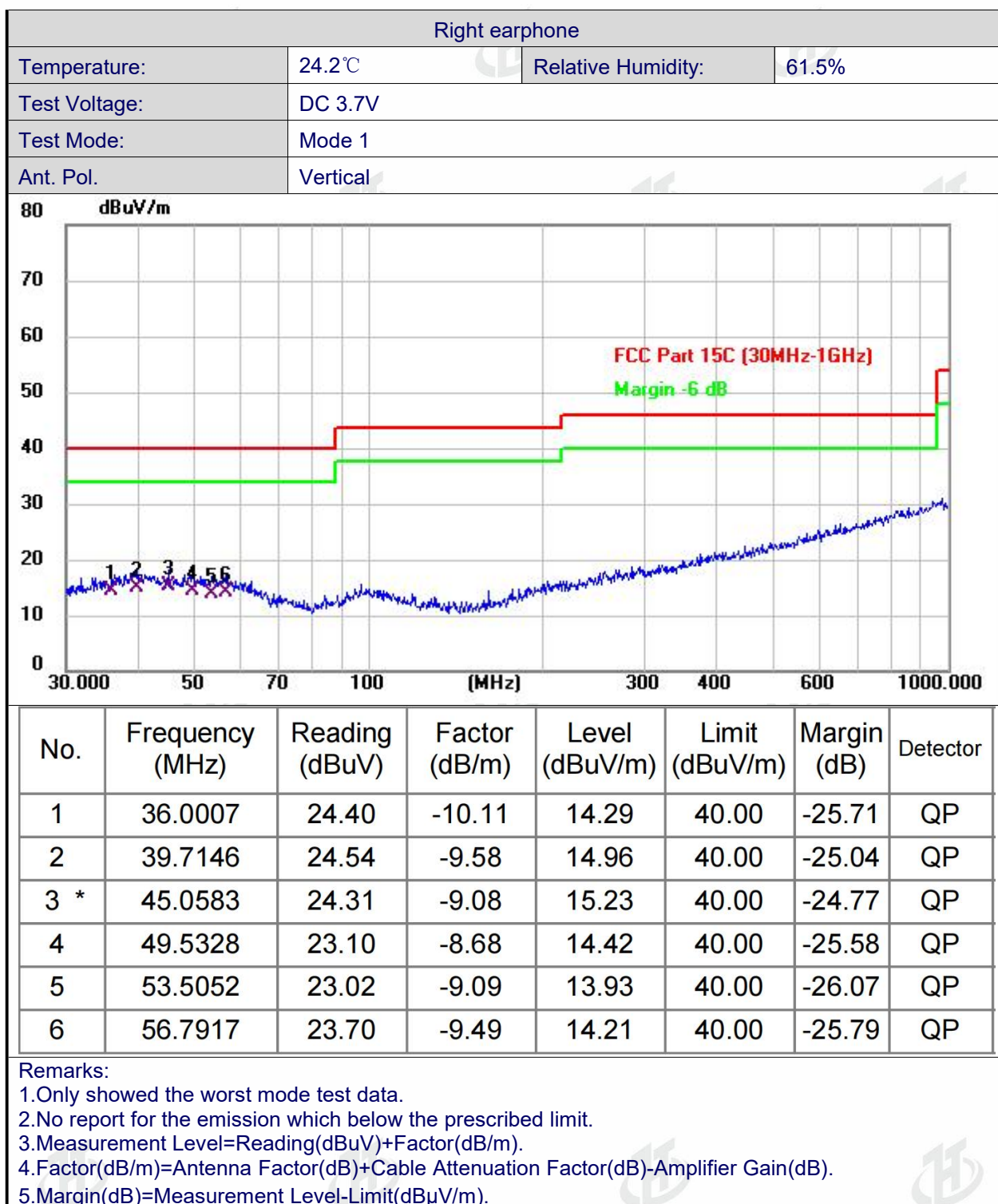
Below the permissible value has no need to be reported.

30MHz~1GHz



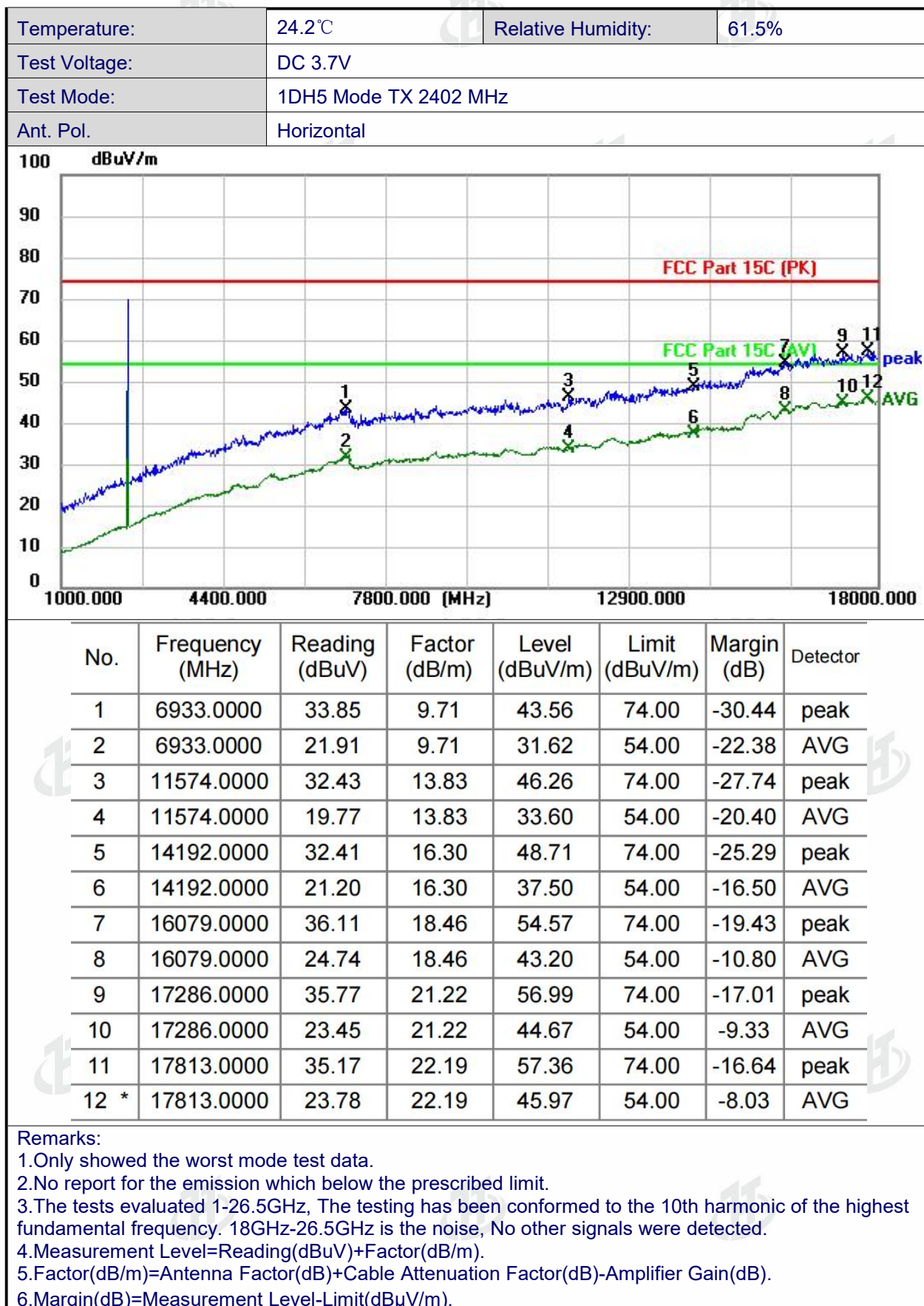


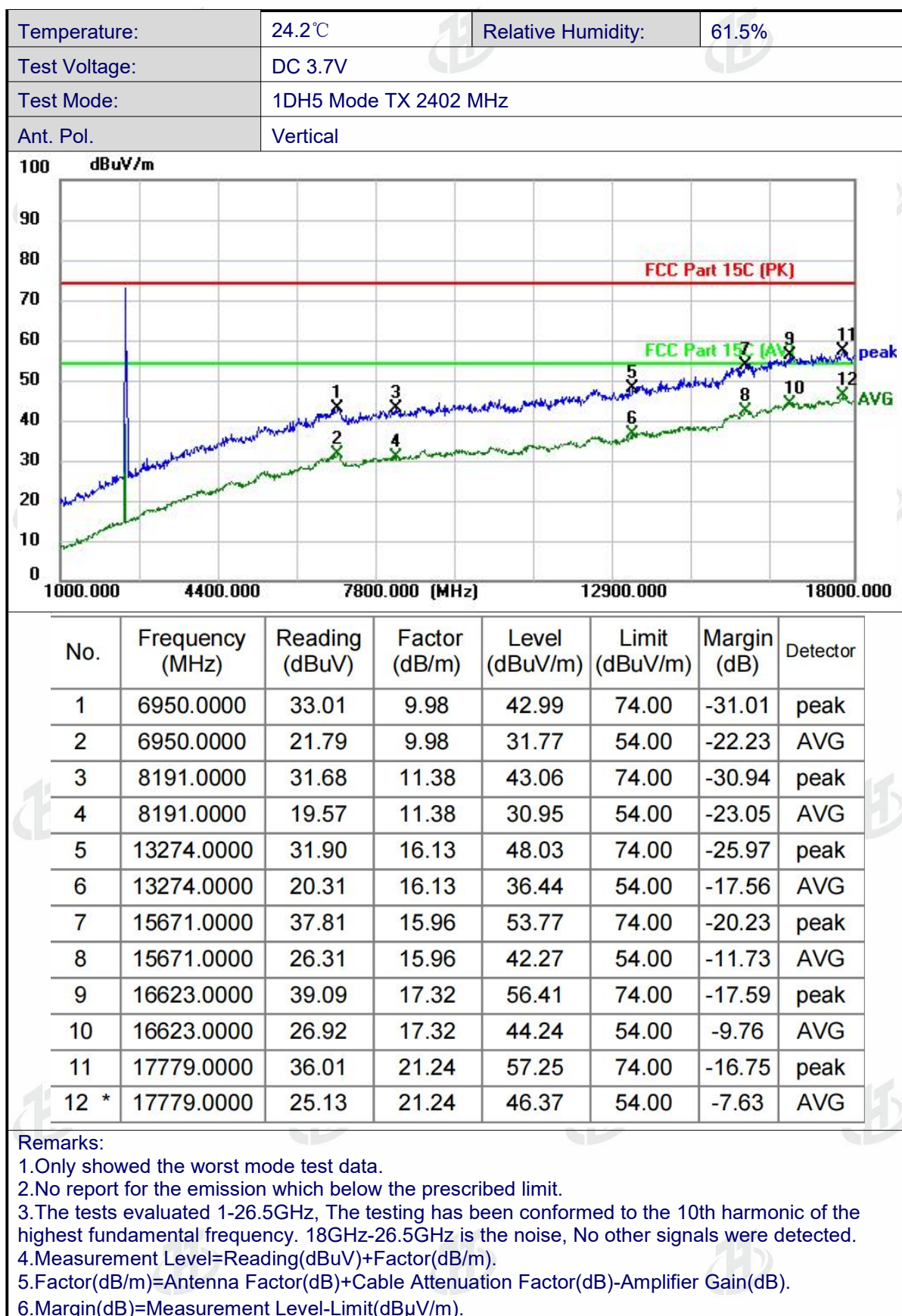


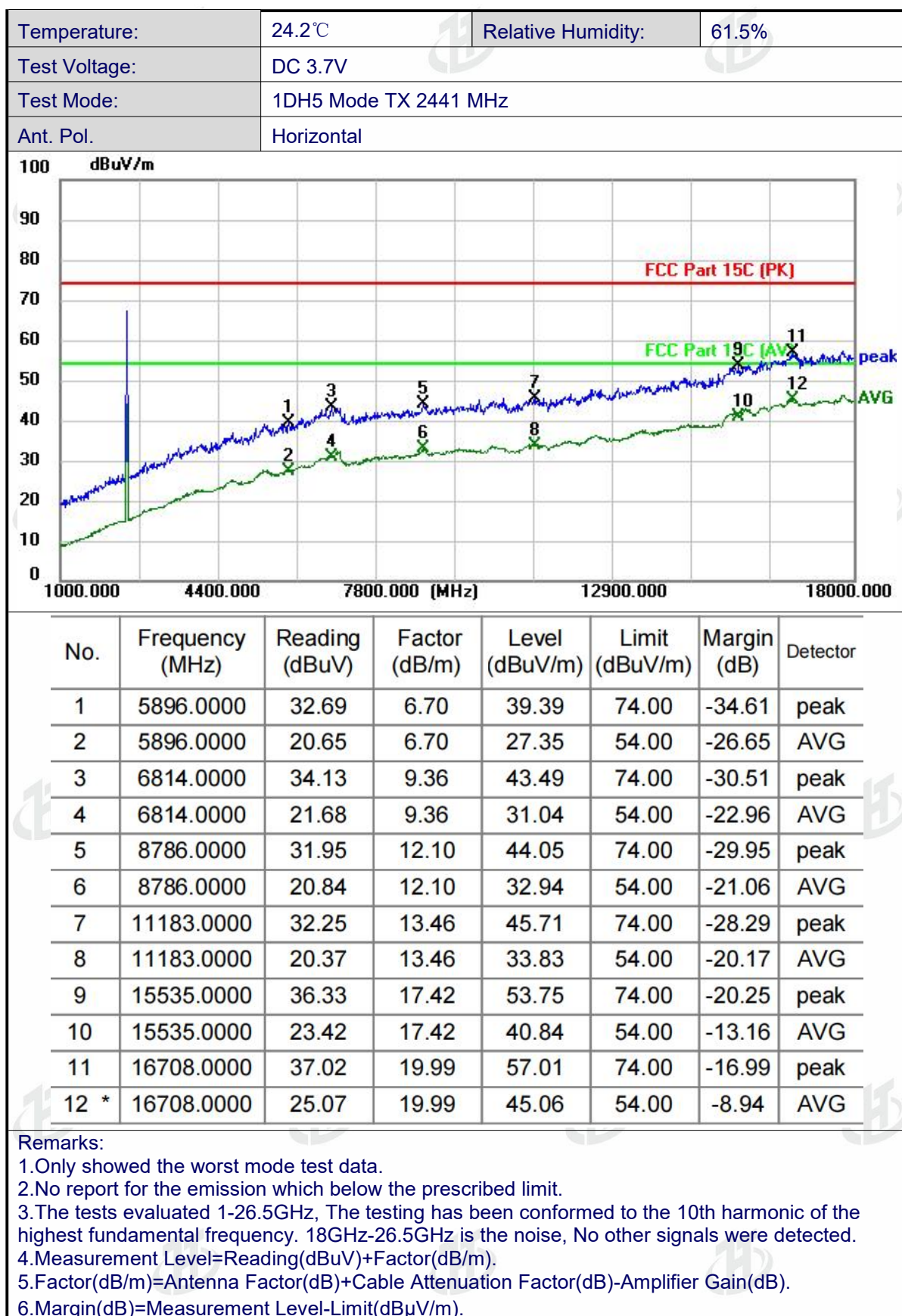


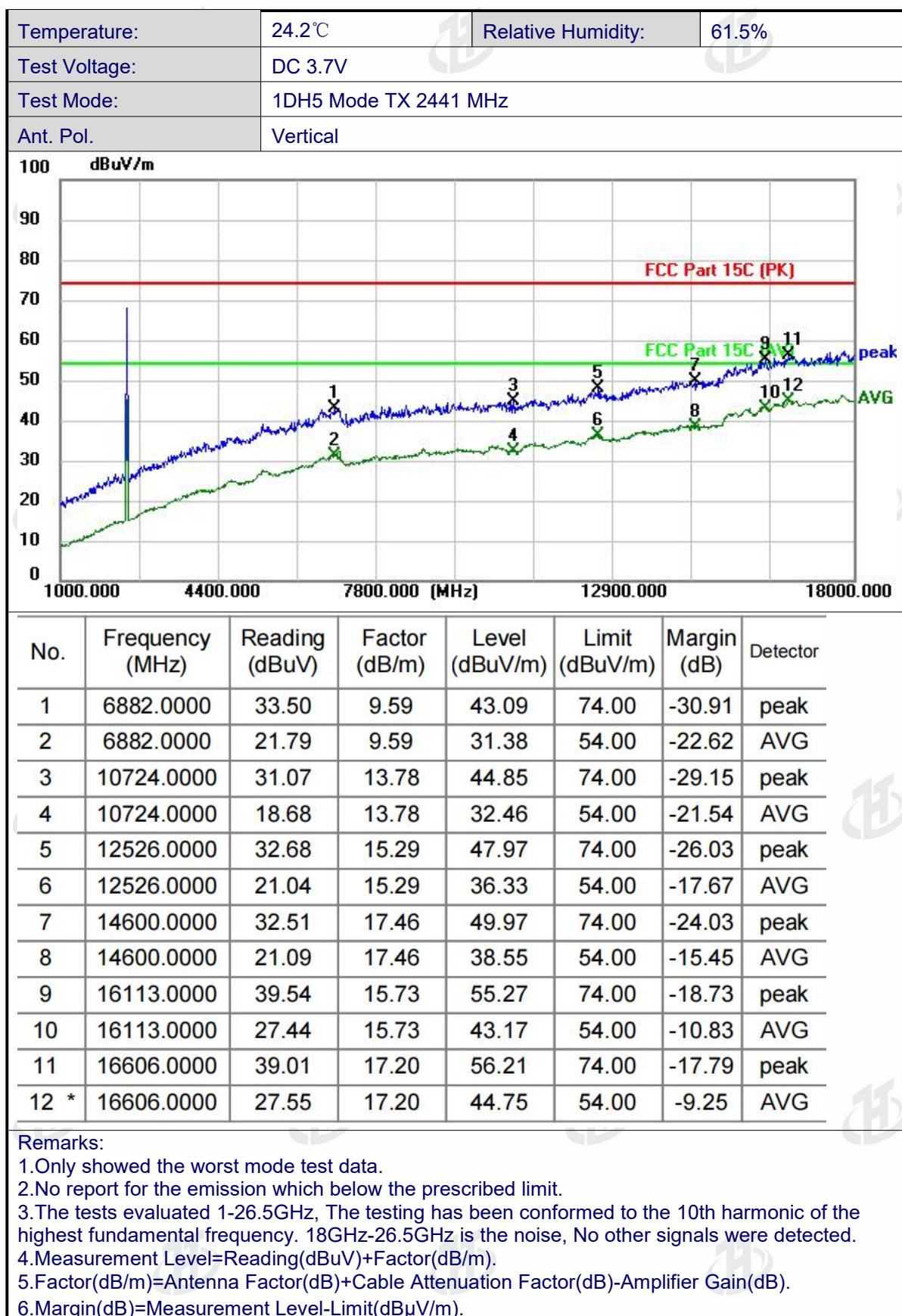


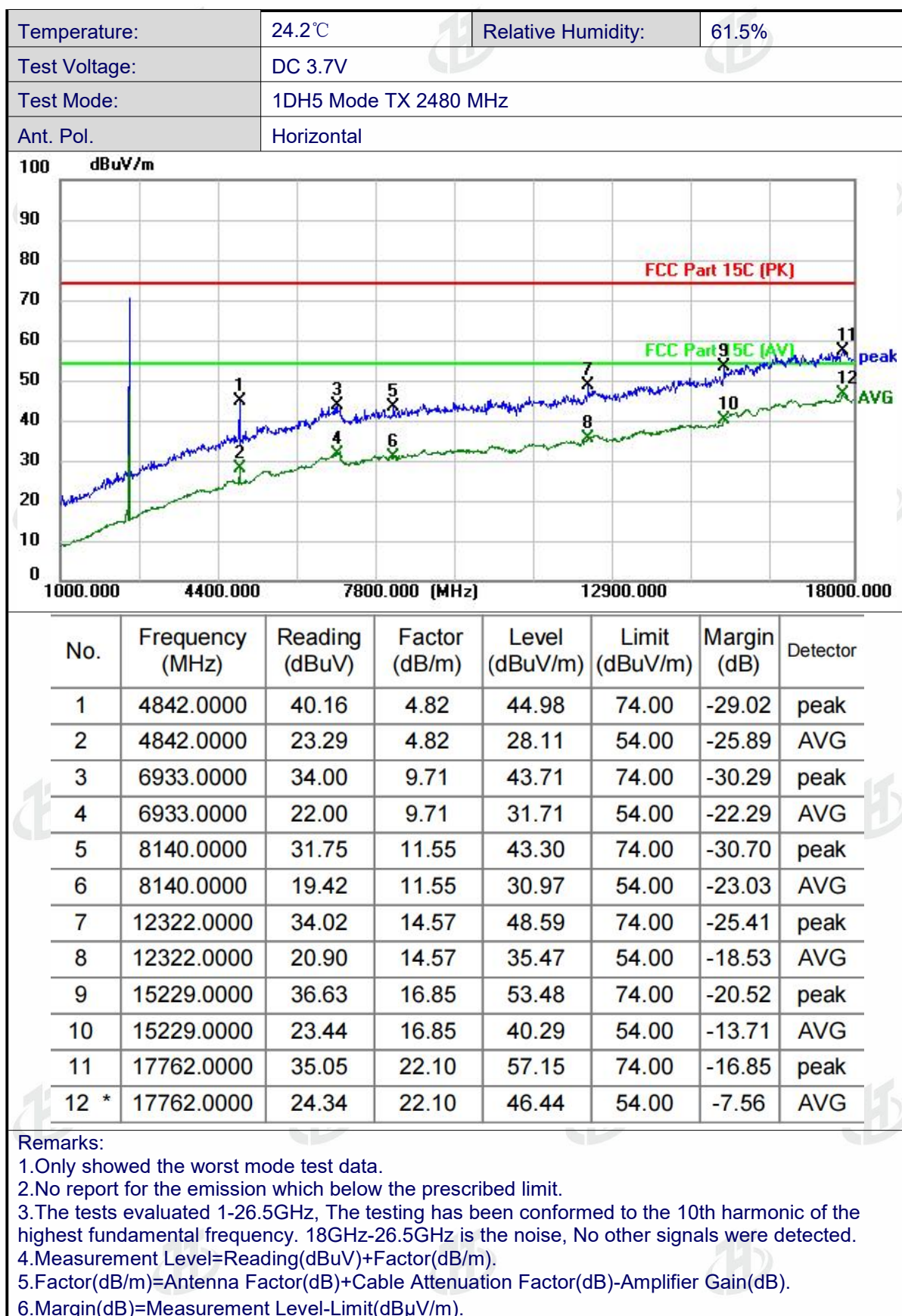
Above 1GHz

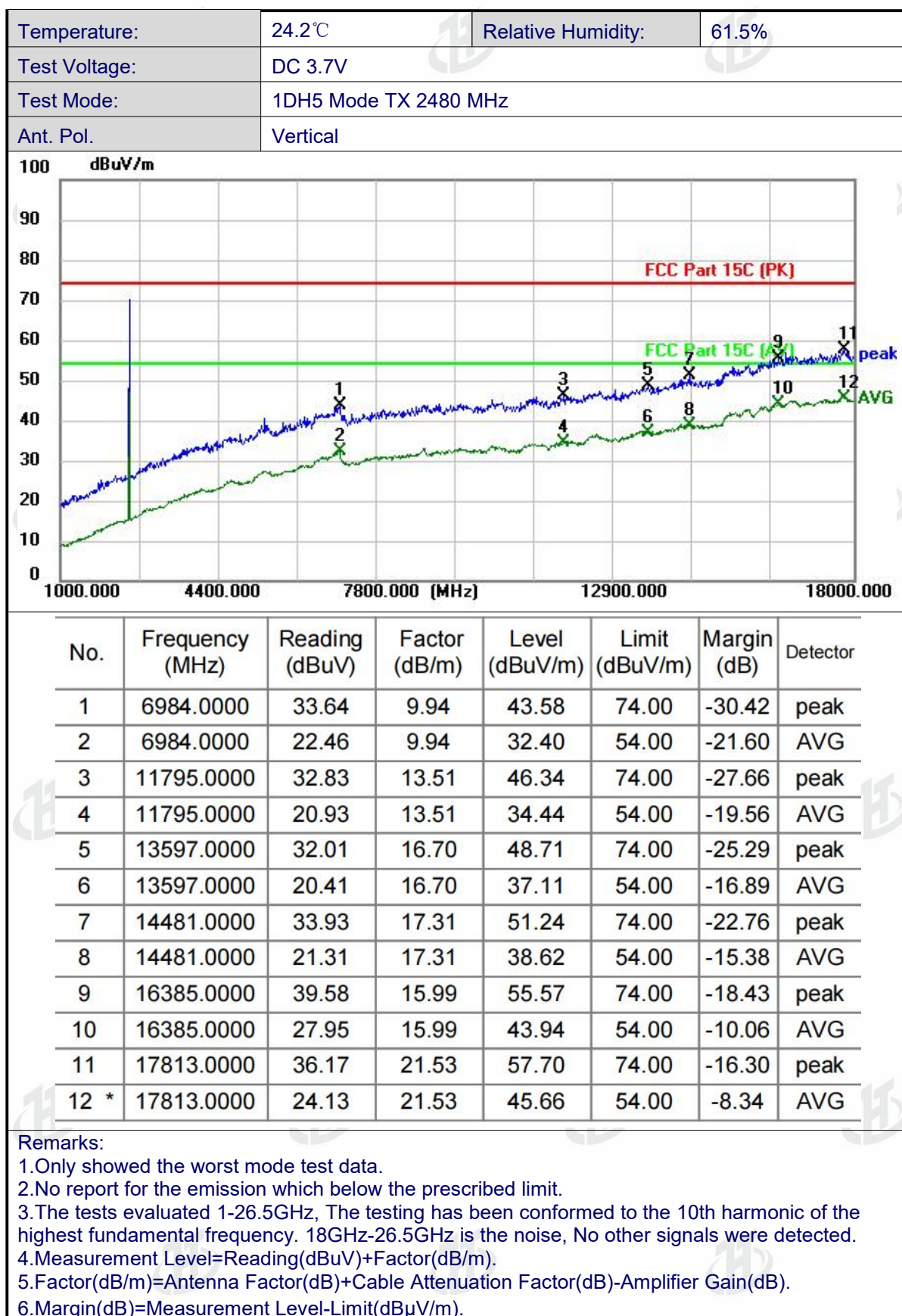












End of report