

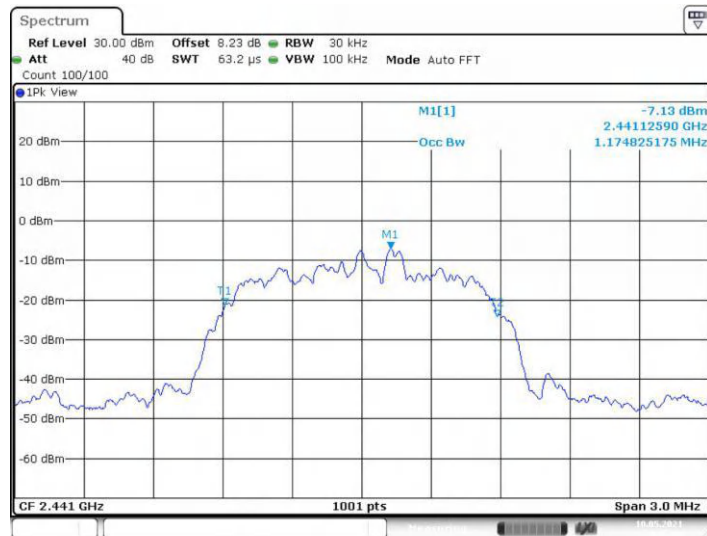
Test Mode:	2DH5			
Channel frequency (MHz)	99% OCB [MHz]	FL[MHz]	FH[MHz]	Verdict
2402	1.178	2401.410	2402.587	PASS
2441	1.175	2440.410	2441.584	PASS
2480	1.175	2479.410	2480.584	PASS

2402 MHz



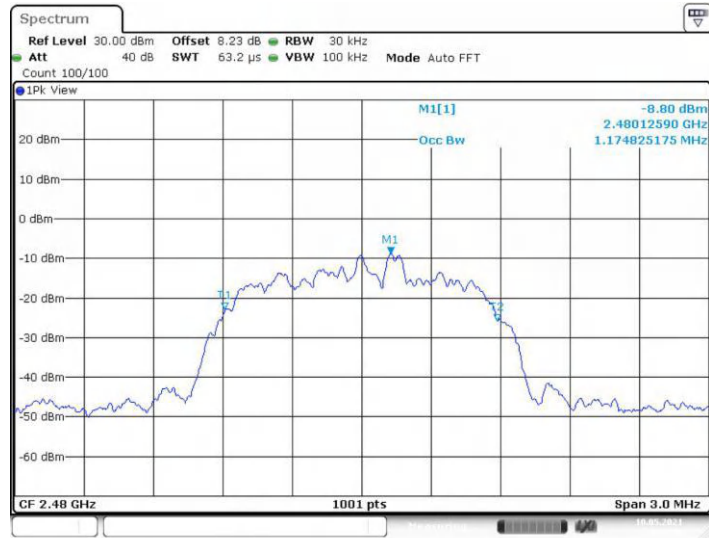
Date: 10.MAY.2021 20:24:44

2441 MHz



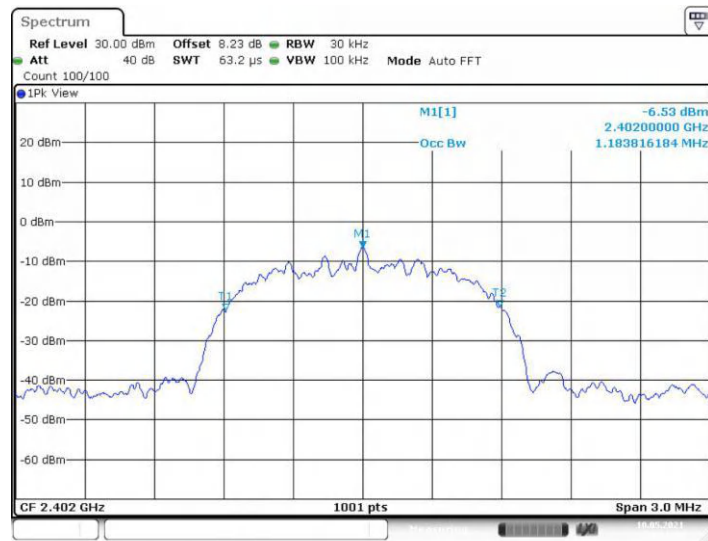
Date: 10.MAY.2021 20:27:54

2480 MHz



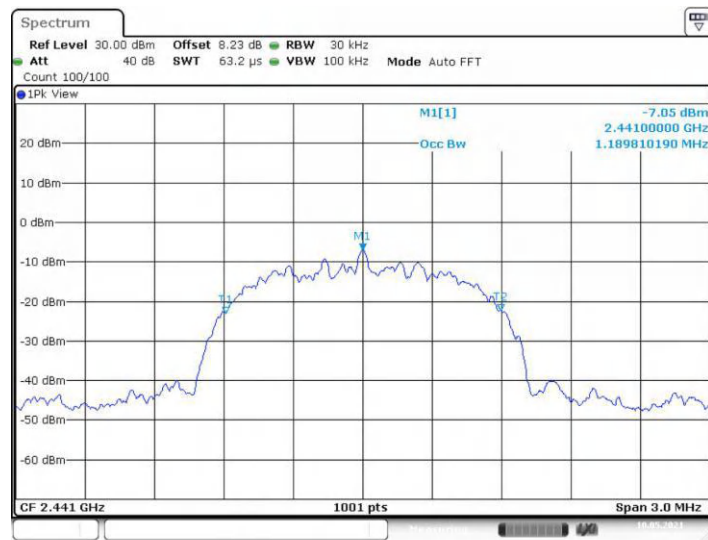
Test Mode:	3DH5			
Channel frequency (MHz)	99% OCB [MHz]	FL[MHz]	FH[MHz]	Verdict
2402	1.184	2401.410	2402.593	PASS
2441	1.19	2440.407	2441.596	PASS
2480	1.187	2479.407	2480.593	PASS

2402 MHz



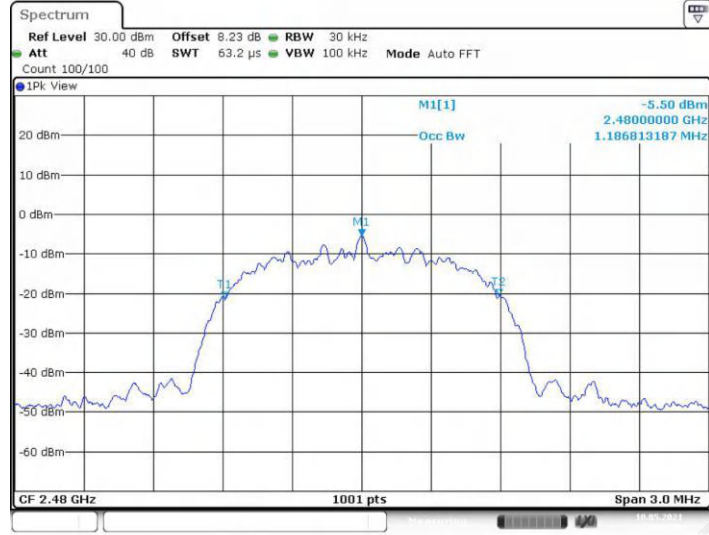
Date: 10.MAY.2021 20:33:34

2441 MHz



Date: 10.MAY.2021 20:36:18

2480 MHz



Date: 10.MAY.2021 20:38:03

3.5. Carrier Frequencies Separation

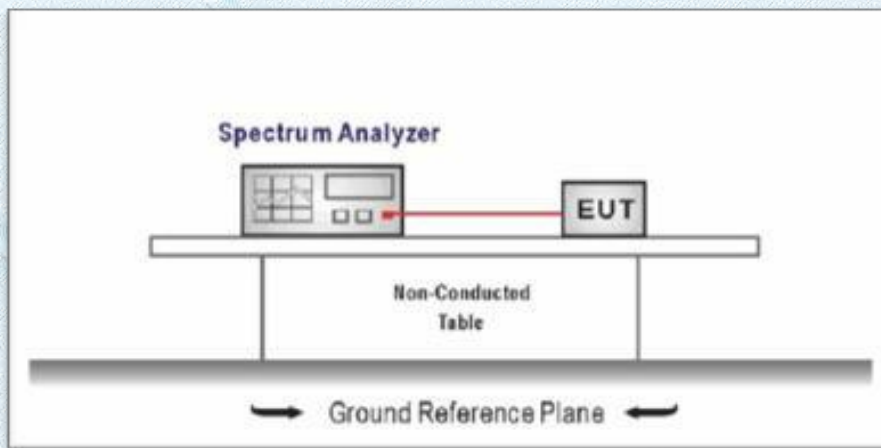
LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):

frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25kHz or the $\frac{2}{3} \times 20\text{dB}$ bandwidth of the hopping channel, whichever is greater.

Test Item	Limit	Frequency Range(MHz)
Channel Separation	$\geq 25\text{KHz}$ or \geq two-thirds of the 20 dB bandwidth Which is greater	2400~2483.5

Test Configuration



Test Procedure

1. Connect EUT RF output port to the Spectrum Analyzer through an RF attenuator.

2. Spectrum Setting:

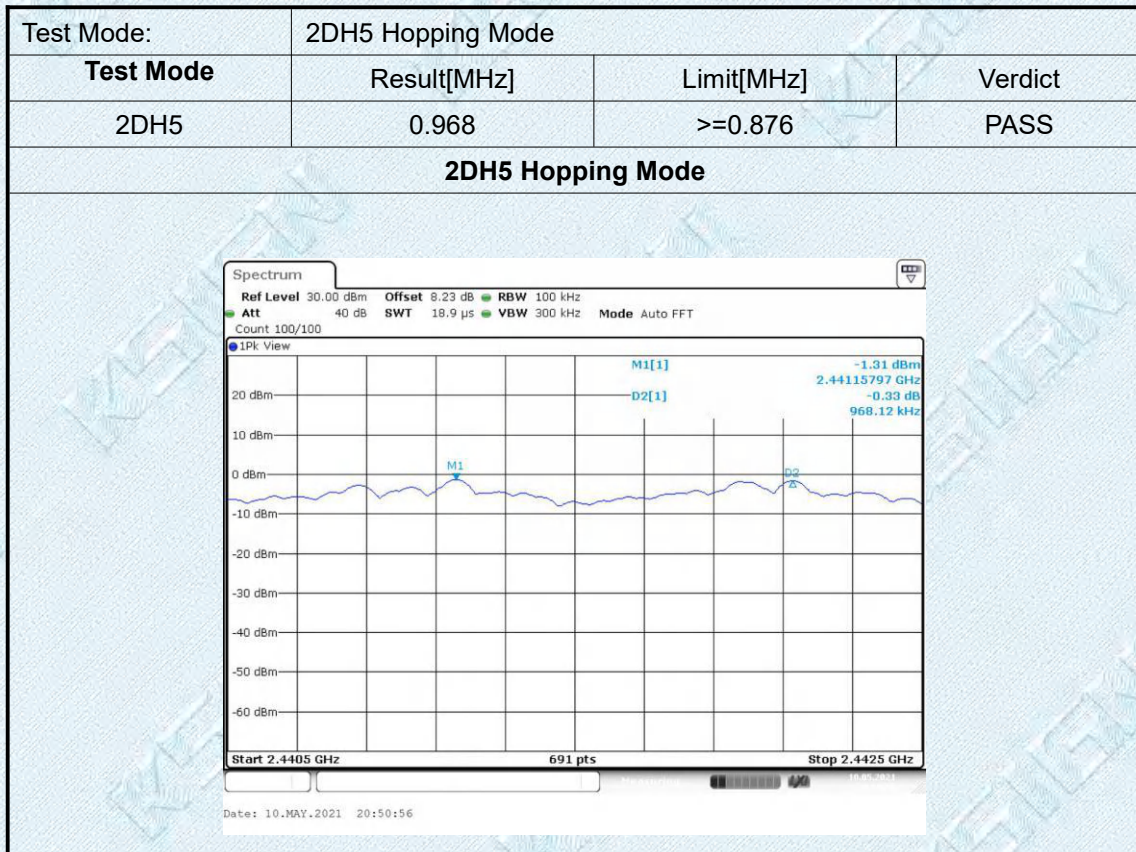
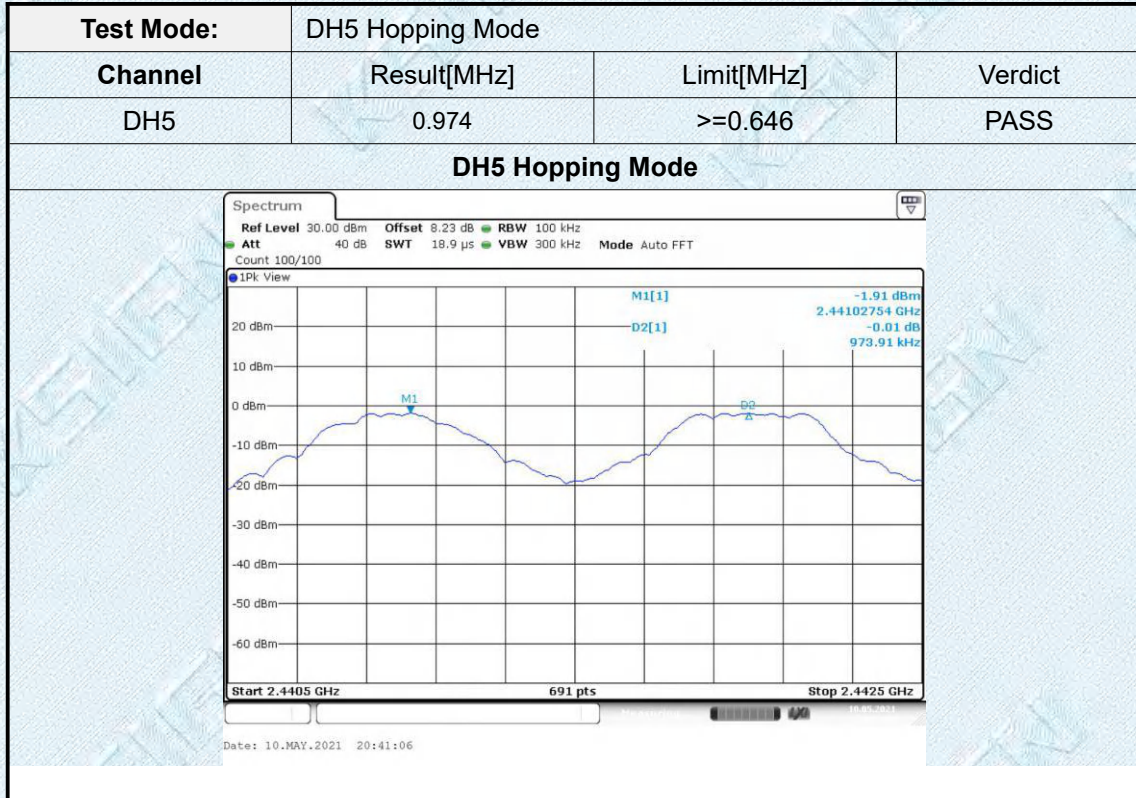
- (1) Set RBW = 100 kHz.
- (2) Set the video bandwidth (VBW) ≥ 3 RBW.
- (3) Detector = Peak.
- (4) Trace mode = Max hold.
- (5) Sweep = Auto couple.

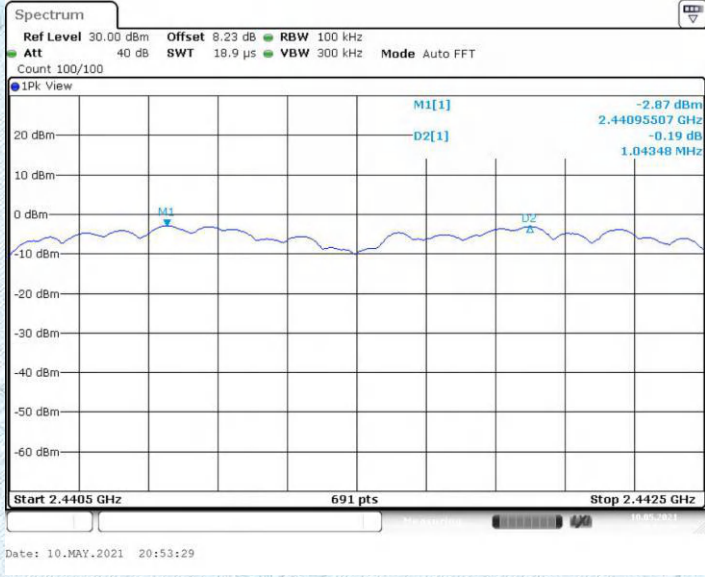
NOTE: The EUT was set to continuously transmitting in each mode and low, Middle and high channel for the test.

Test Mode

Please refer to the clause 2.3.

Test Results



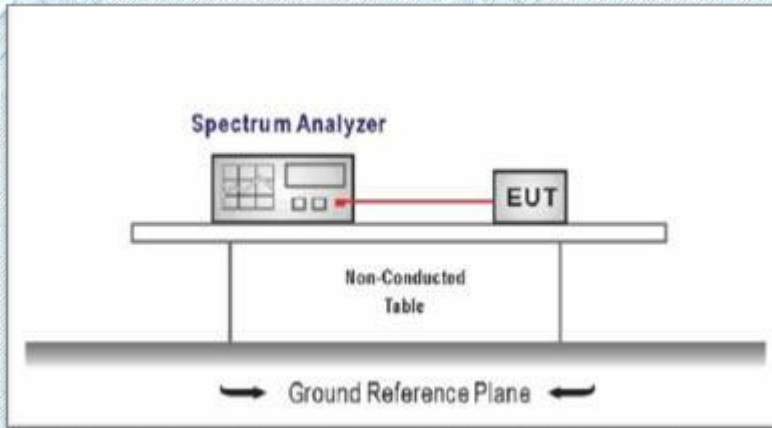
Test Mode:	3DH5 Hopping Mode		
Test Mode	Result[MHz]	Limit[MHz]	Verdict
3DH5	1.043	>=0.866	PASS
3DH5 Hopping Mode			
 <p>The spectrum plot displays a signal with two main components: M1 at 2.44095507 GHz (-2.87 dBm) and D2 at 1.04348 MHz (-0.19 dBm). The plot includes parameters such as Ref Level (30.00 dBm), Att (40 dB), Offset (8.23 dB), RBW (100 kHz), and Mode (Auto FFT).</p>			
Date: 10.MAY.2021 20:53:29			

3.6. Number of Hopping Channel

Limit

Section	Test Item	Limit
15.247	Number of Hopping Channel	>15

Test Configuration



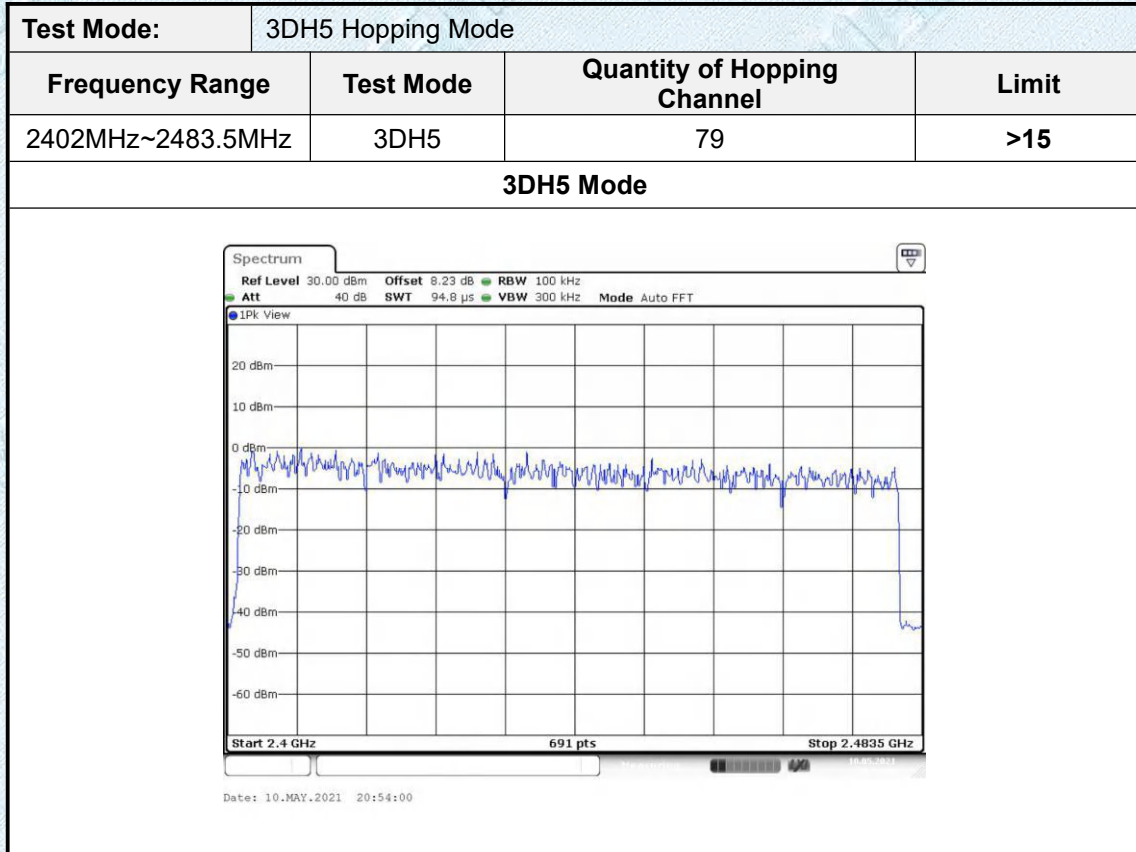
Test Procedure

1. Connect EUT RF output port to the Spectrum Analyzer through an RF attenuator.
2. Spectrum Setting:
Peak Detector: RBW=100 kHz, VBW ≥ RBW, Sweep time= Auto.

Test Mode

Please refer to the clause 2.3.

Test Result



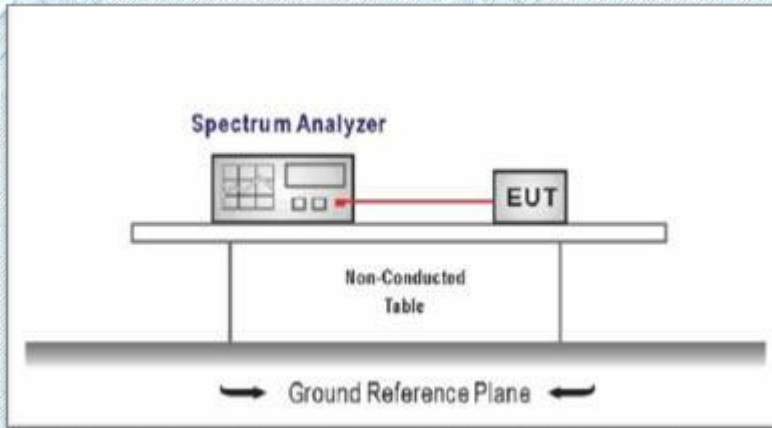
Note: The 8-DPSK modulation is the worst case and recorded in the report.

3.7. Dwell Time

Limit

Section	Test Item	Limit
15.247(a)(1)	Average Time of Occupancy	0.4 sec

Test Configuration



Test Procedure

1. Connect EUT RF output port to the Spectrum Analyzer through an RF attenuator.
2. Spectrum Setting:
 - (1) Spectrum Setting: RBW=1MHz, VBW ≥ RBW.
 - (2) Use video trigger with the trigger level set to enable triggering only on full pulses.
 - (3) Sweep Time is more than once pulse time.
 - (4) Set the center frequency on any frequency would be measure and set the frequency span to zero.
 - (5) Measure the maximum time duration of one single pulse.
 - (6) Set the EUT for packet transmitting.

Test Mode

Please refer to the clause 2.3

Test Result

Note:

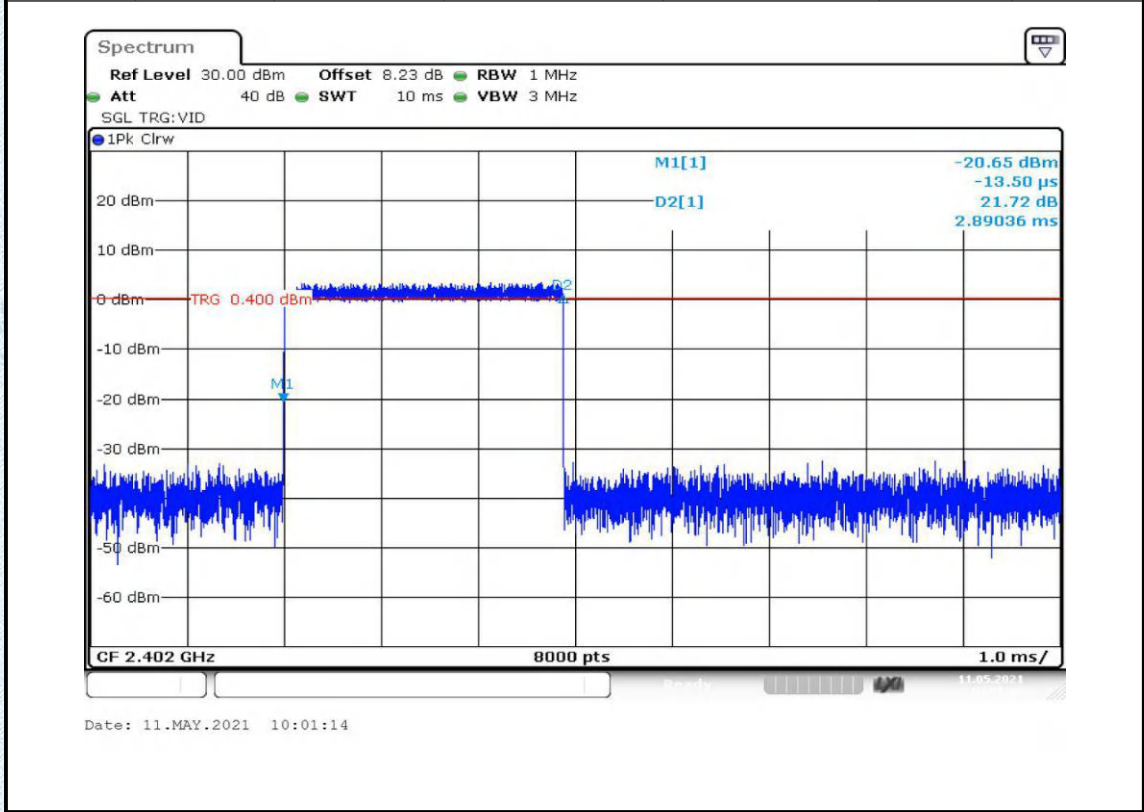
1. Dwell time = Pulse time (ms) × (1600 ÷ 2 ÷ 79) × 31.6 Second for DH1, 2DH1, 3DH1

Dwell time = Pulse time (ms) × (1600 ÷ 4 ÷ 79) × 31.6 Second for DH3, 2DH3, 3DH3

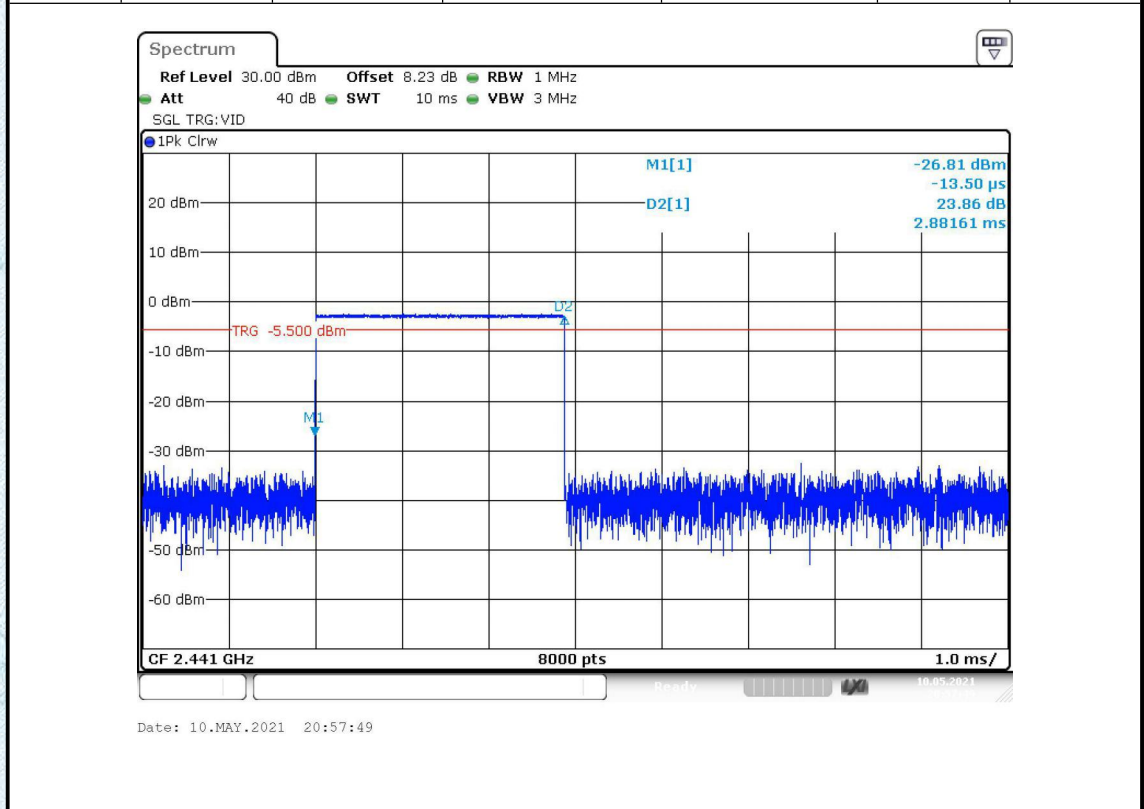
Dwell time = Pulse time (ms) × (1600 ÷ 6 ÷ 79) × 31.6 Second for DH5, 2DH5, 3DH5

2. The 3DH5 modulation is the worst case and recorded in the report .

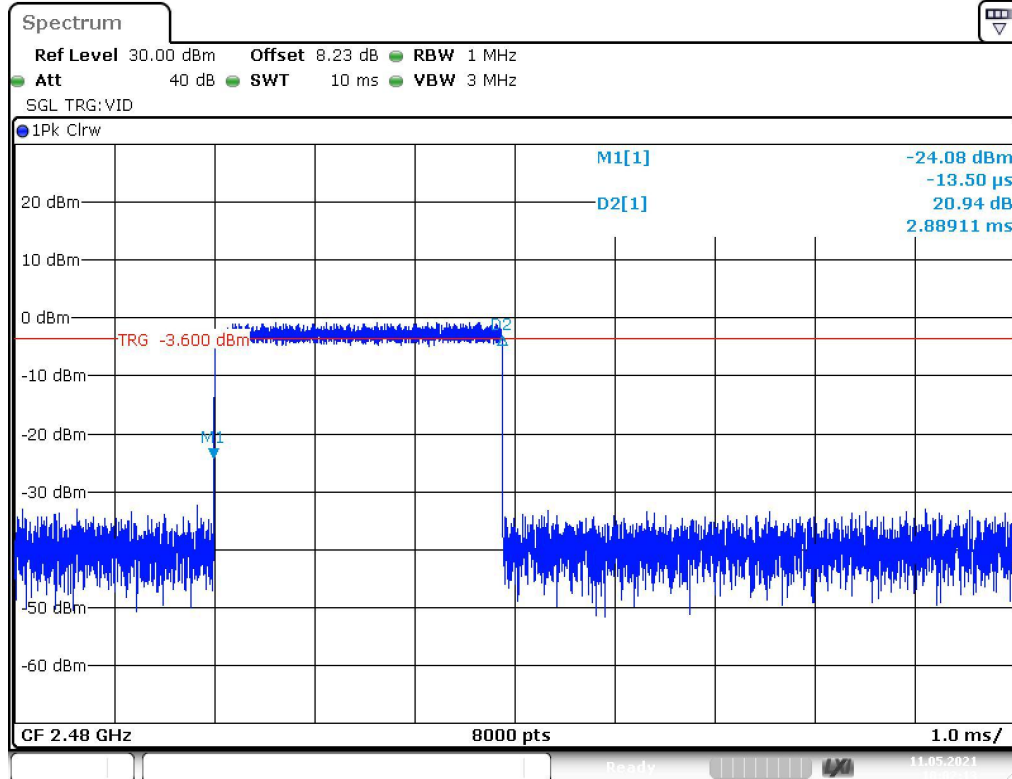
Test Mode	Channel (MHz)	Pulse Time (ms)	Total of Dwell (ms)	Period Time (s)	Limit (ms)	Result
3DH5	2402	2.89	308.27	31.6	400	PASS



Test Mode	Channel (MHz)	Pulse Time (ms)	Total of Dwell (ms)	Period Time (s)	Limit (ms)	Result
3DH5	2441	2.88	307.20	31.6	400	PASS



Test Mode	Channel (MHz)	Pulse Time (ms)	Total of Dwell (ms)	Period Time (s)	Limit (ms)	Result
3DH5	2480	2.889	308.16	31.6	400	PASS



Date: 11.MAY.2021 10:02:13

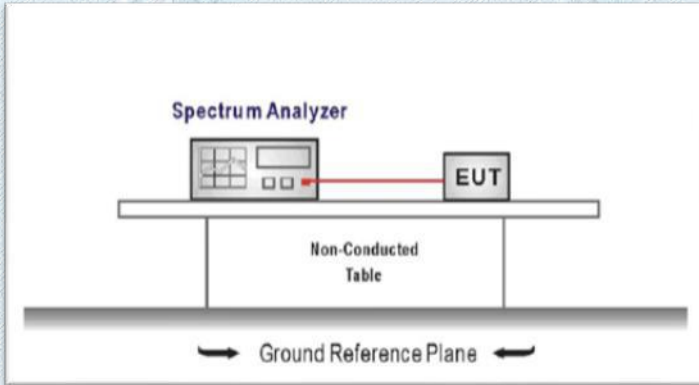
3.8. Band Edge and Spurious Emission (Conducted)

LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (d):

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.

TEST CONFIGURATION



TEST PROCEDURE

1. Connect EUT RF Output port to the Spectrum Analyzer through an RF attenuator.

2. Spectrum Setting:

RBW=100KHz

VBW=3*RBW.

Detector function: Peak.

Trace: Max hold.

Sweep = Auto couple.

Allow the trace to stabilize.

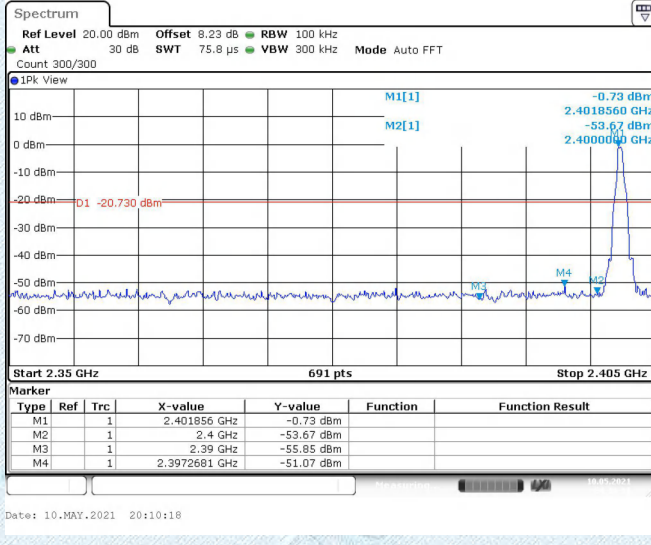
TEST MODE:

Please refer to the clause 2.3.

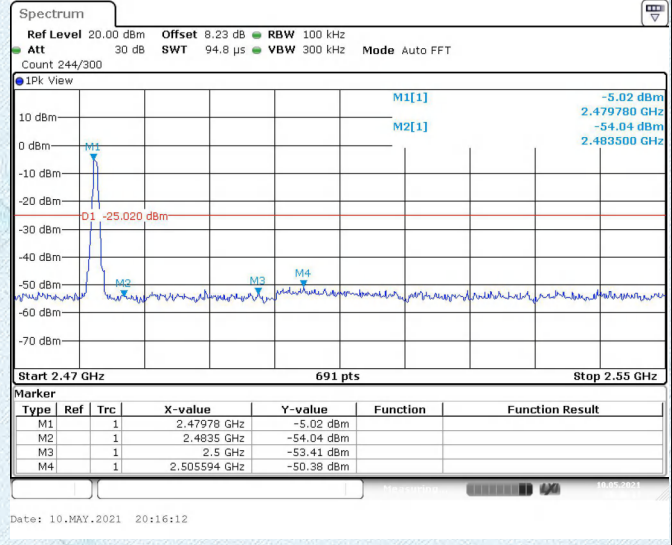
TEST RESULTS

DH5

CH00-Bandedge

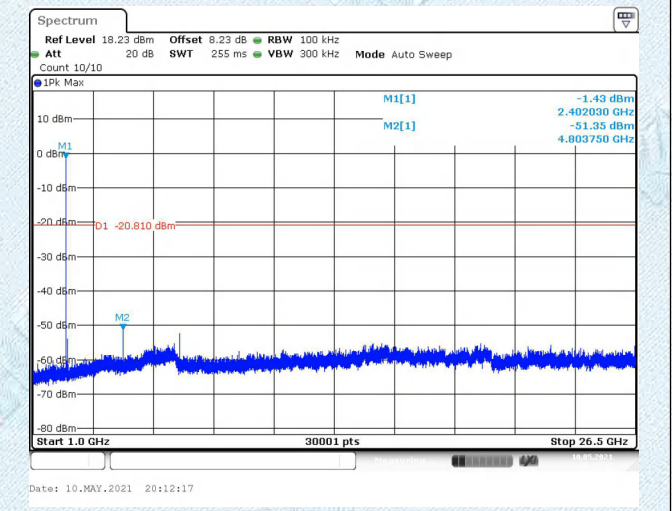
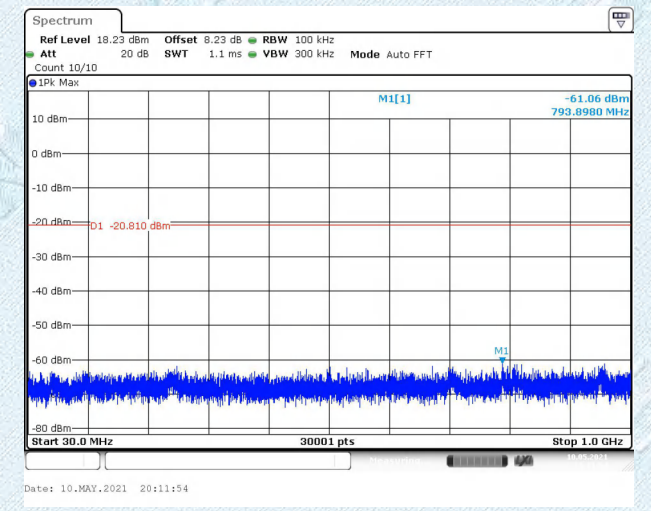


CH78-Bandedge

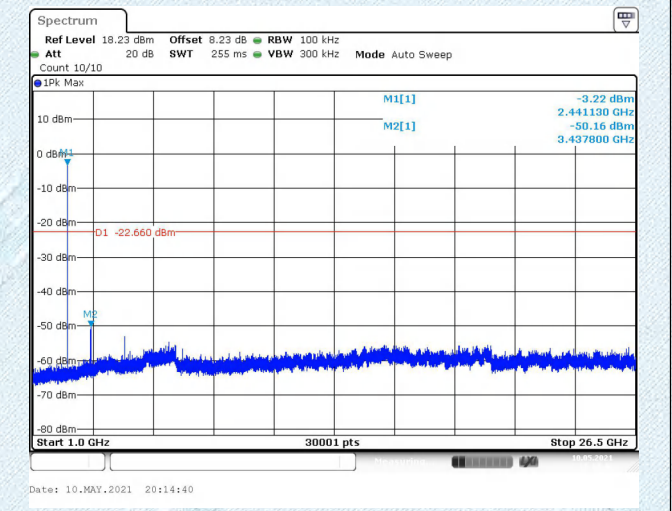
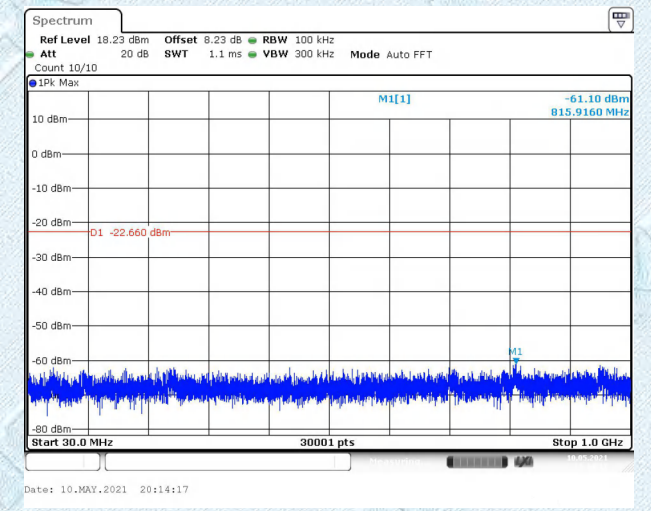


DH5

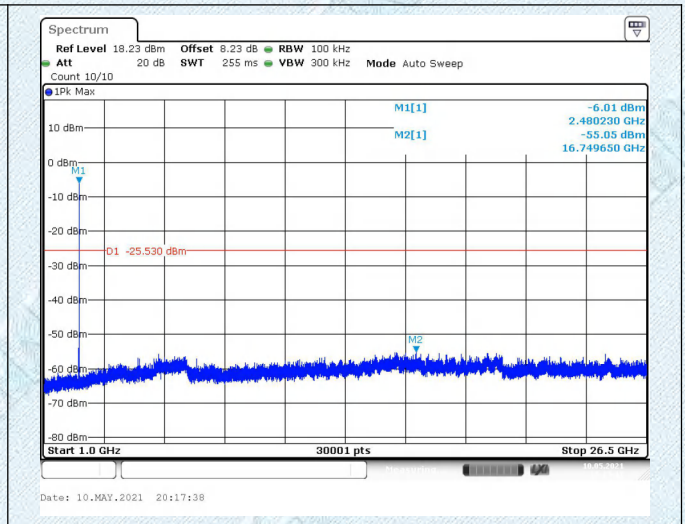
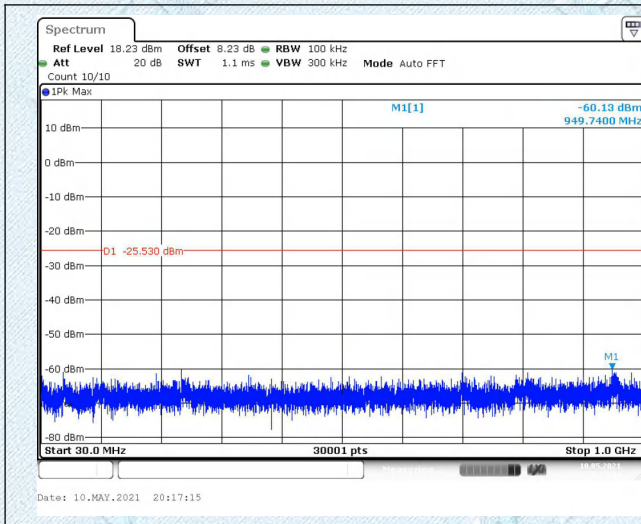
CH00-SE



CH39-SE

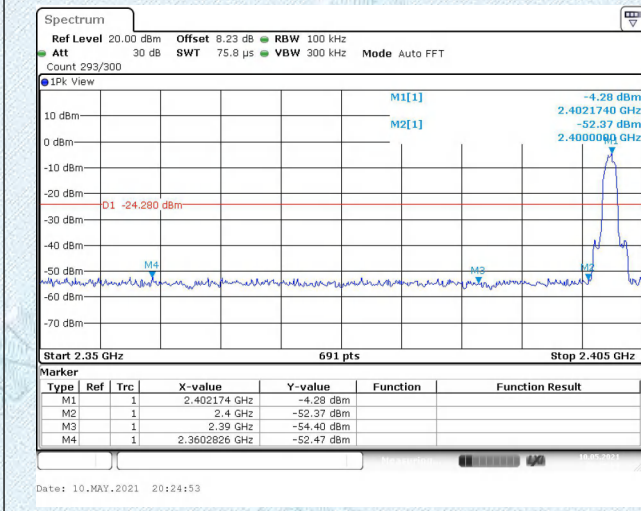


CH78-SE

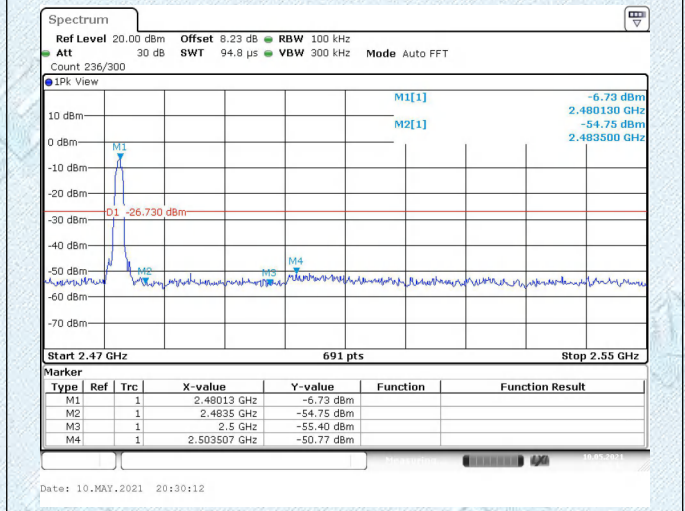


2DH5

CH00-Bandedge

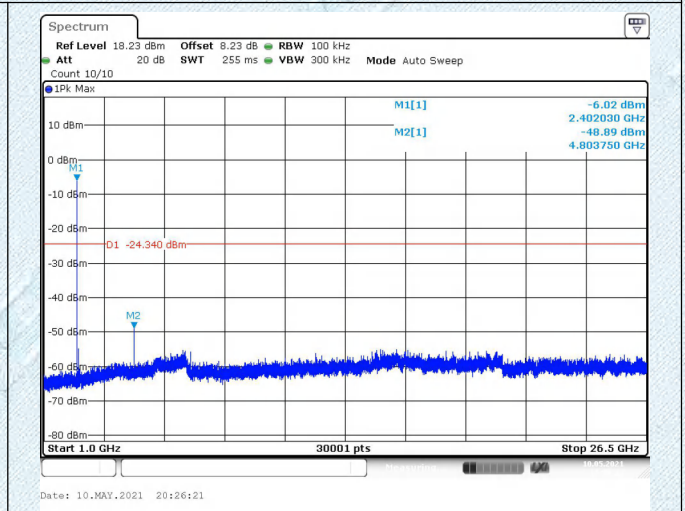
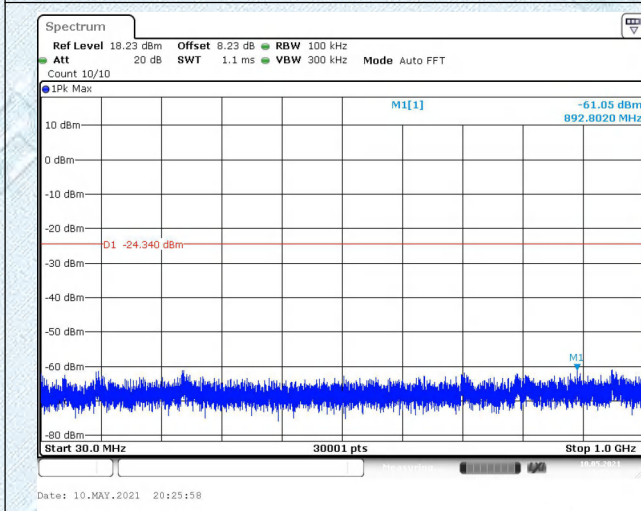


CH78-Bandedge

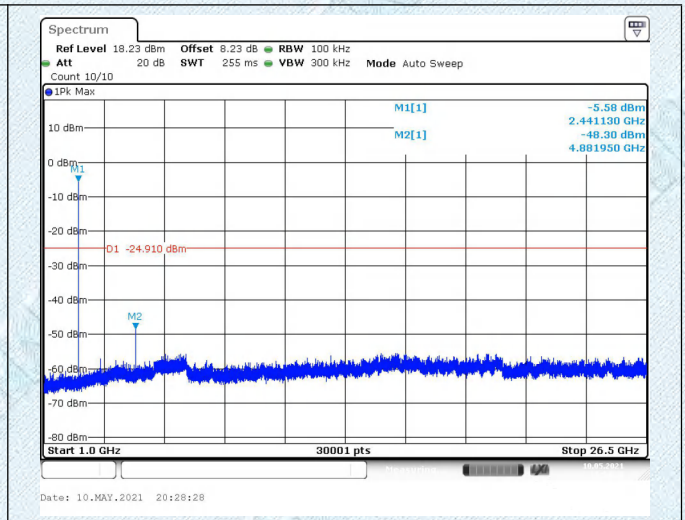
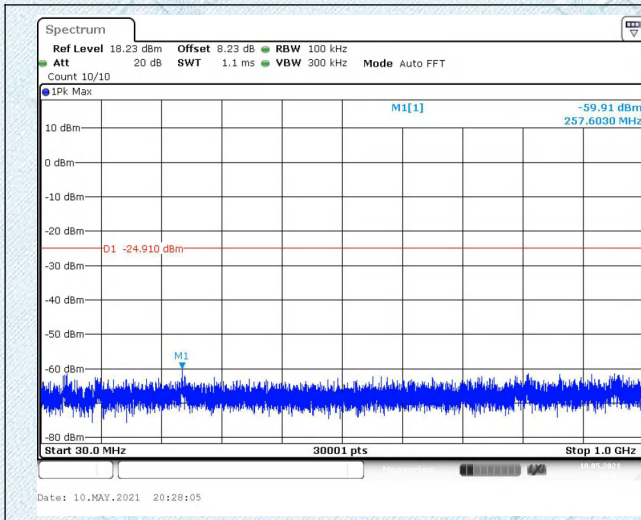


2DH5

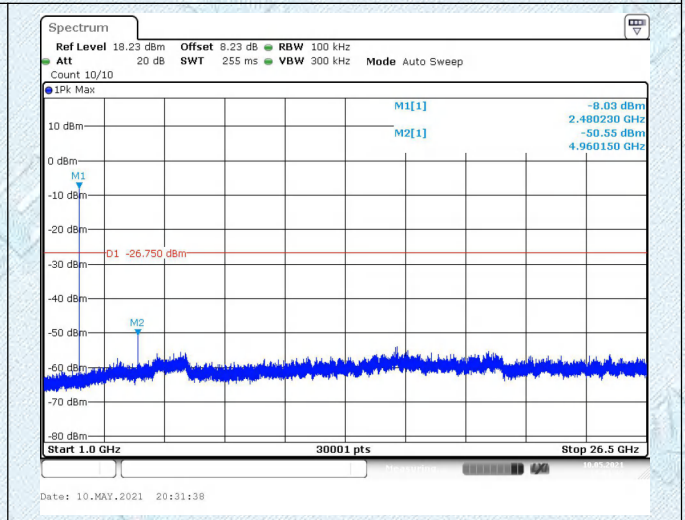
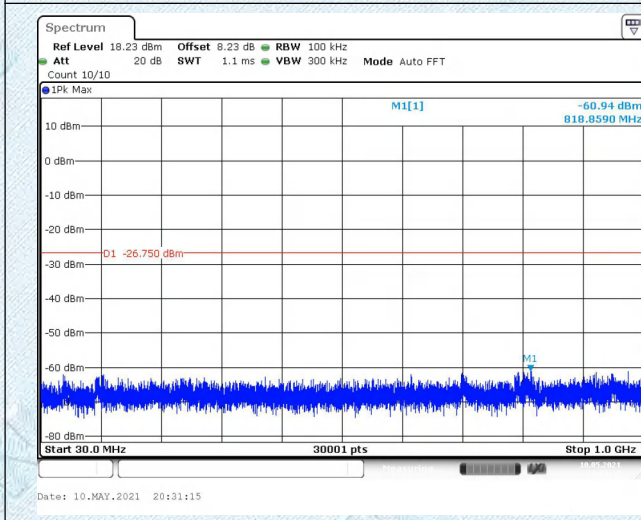
CH00-SE



CH39-SE

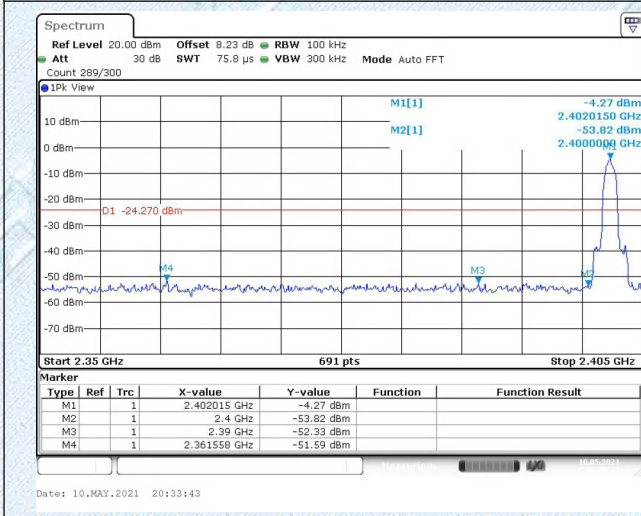


CH78-SE

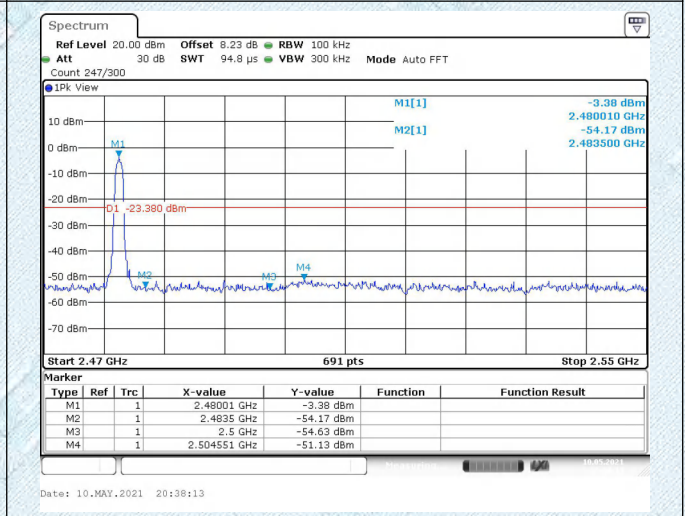


3DH5

CH00-Bandedge

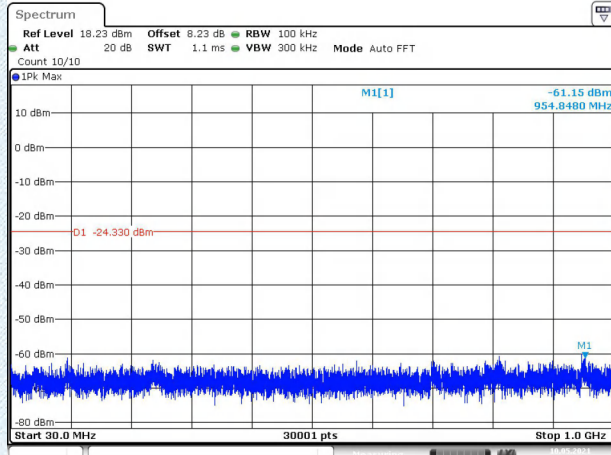


CH78-Bandedge

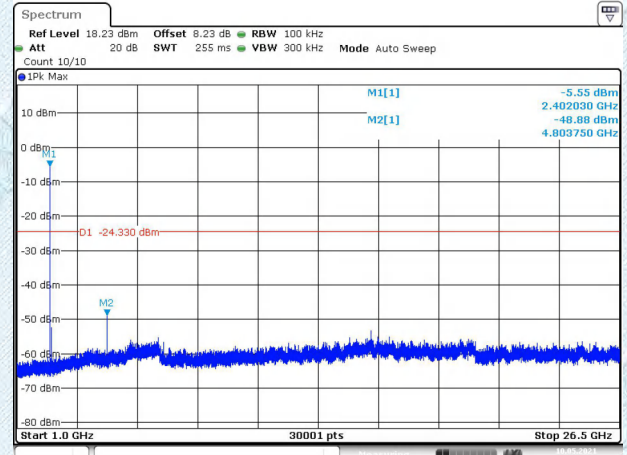


3DH5

CH00-SE

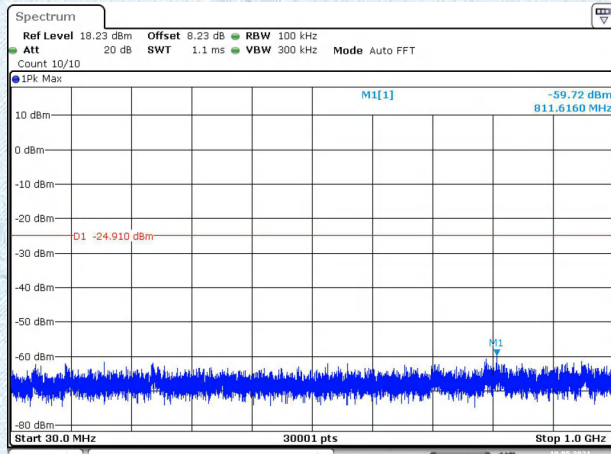


Date: 10.MAY.2021 20:34:34

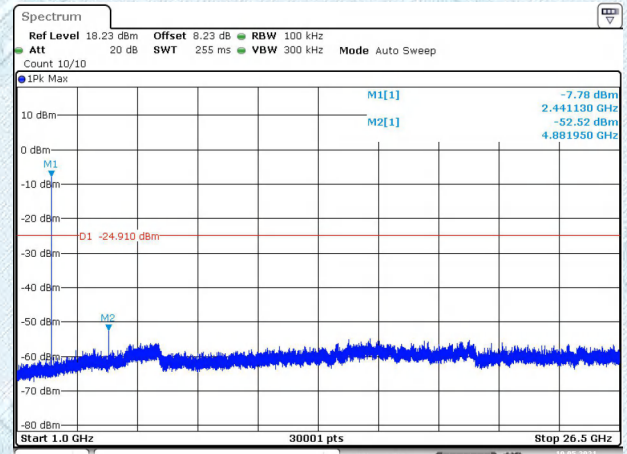


Date: 10.MAY.2021 20:34:57

CH39-SE

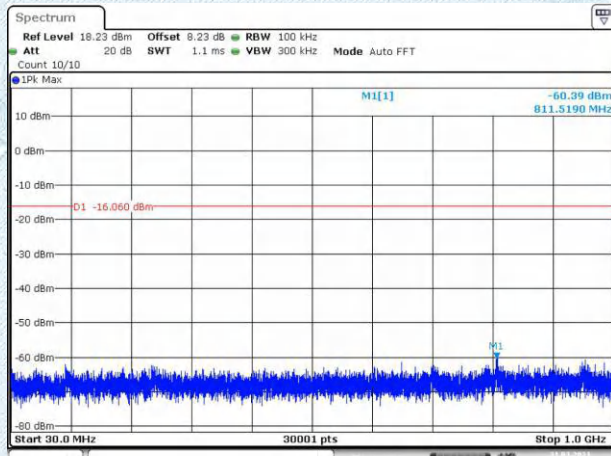


Date: 10.MAY.2021 20:36:29

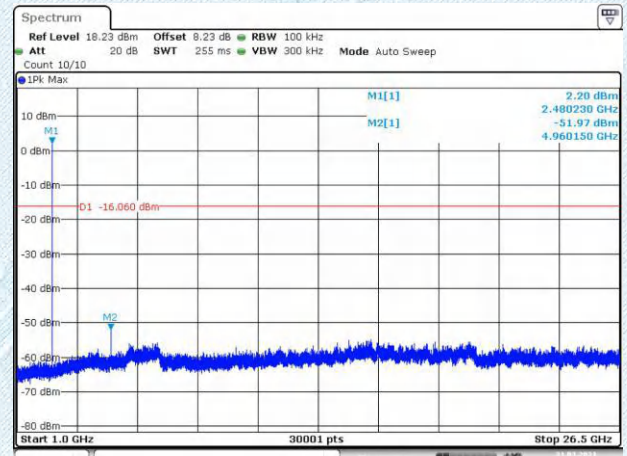


Date: 10.MAY.2021 20:36:52

CH78-SE



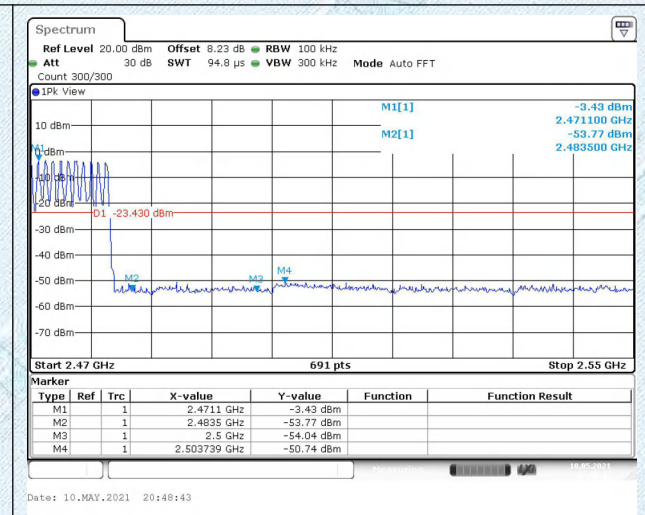
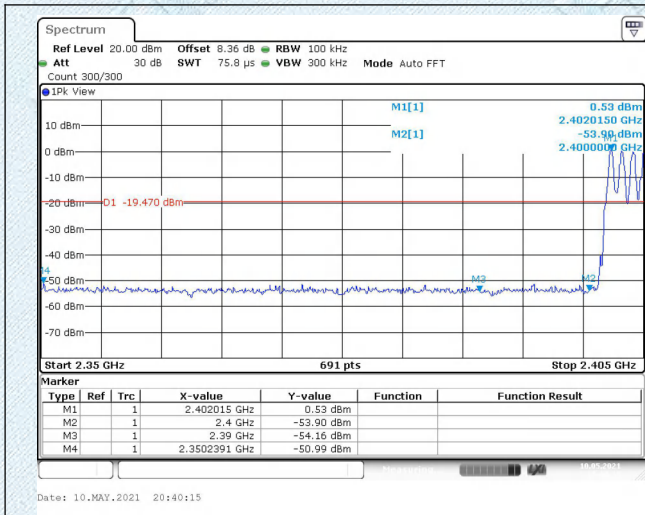
Date: 31.MAR.2021 18:22:48



Date: 31.MAR.2021 18:23:11

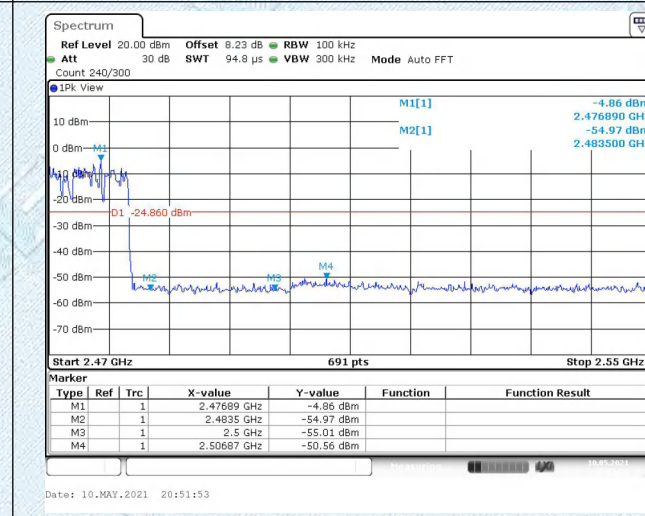
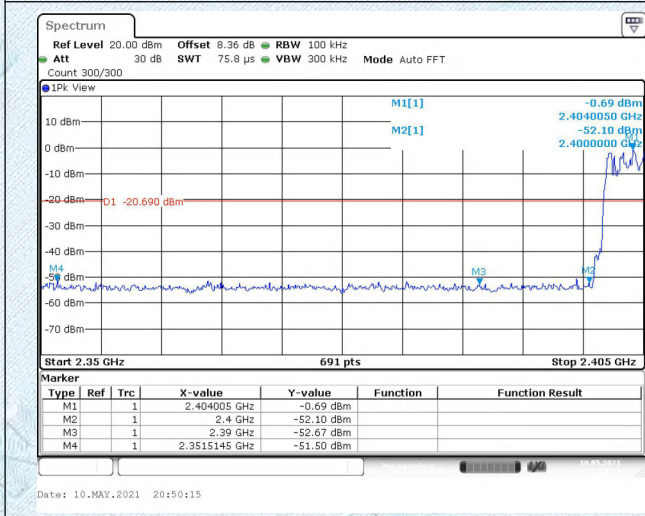
DH5(2402)-Hopping on

DH5(2480)-Hopping on



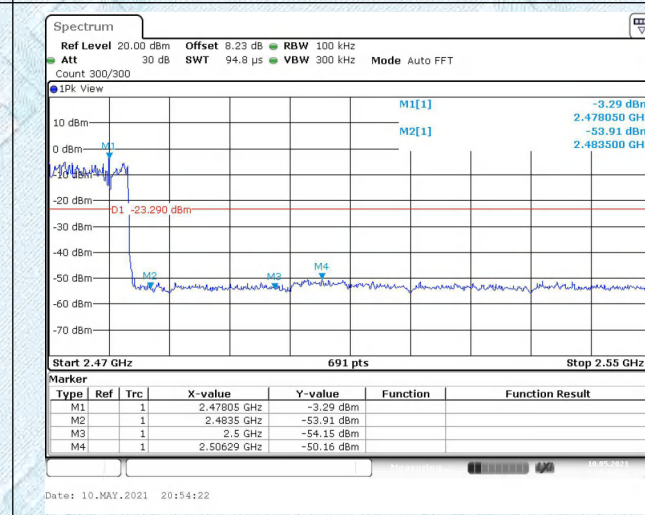
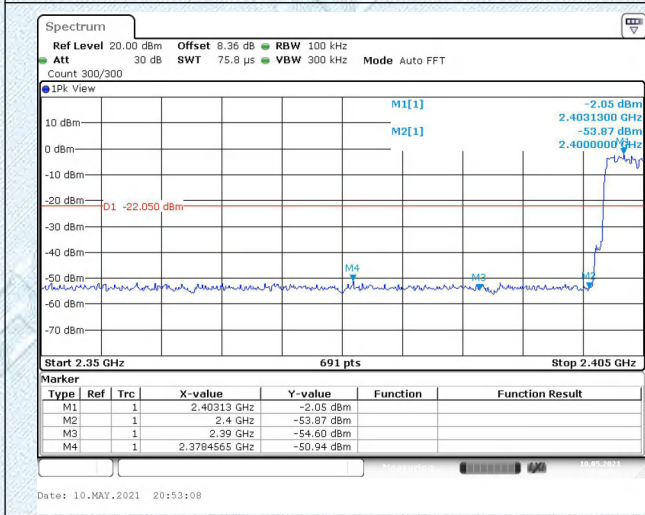
2DH5(2402)-Hopping on

2DH5(2480)-Hopping on



3DH5(2402)-Hopping on

3DH5(2480)-Hopping on



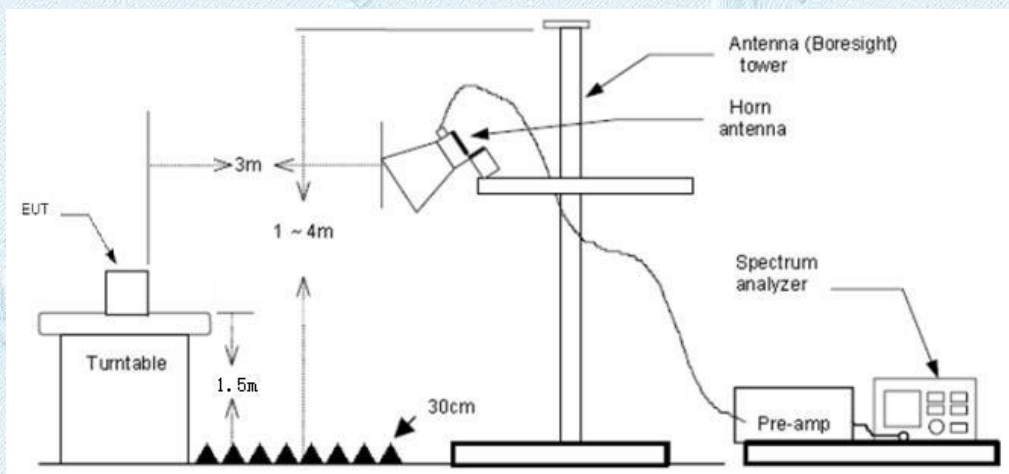
3.9. Band Edge Emissions(Radiated)

Limit

Restricted Frequency Band (MHz)	(dBuV/m)(at 3m)	
	Peak	Average
2310 ~2390	74	54
2483.5 ~2500	74	54

Note: All restriction bands have been tested, only the worst case is reported.

Test Configuration



Test Procedure

1. The EUT was setup and tested according to ANSI C63.10:2013 requirements.
2. The EUT is placed on a turn table which is 1.5 meter above ground. The turn table is rotated 360 degrees to determine the position of the maximum emission level.
3. The EUT was positioned such that the distance from antenna to the EUT was 3 meters.
4. The antenna is scanned from 1 meter to 4 meters to find out the maximum emission level. This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10:2013 on radiated measurement.
5. The receiver set as follow:
 RBW=1MHz, VBW=3MHz PEAK detector for Peak value.
 RBW=1MHz, VBW=10Hz with PEAK Detector for Average Value.

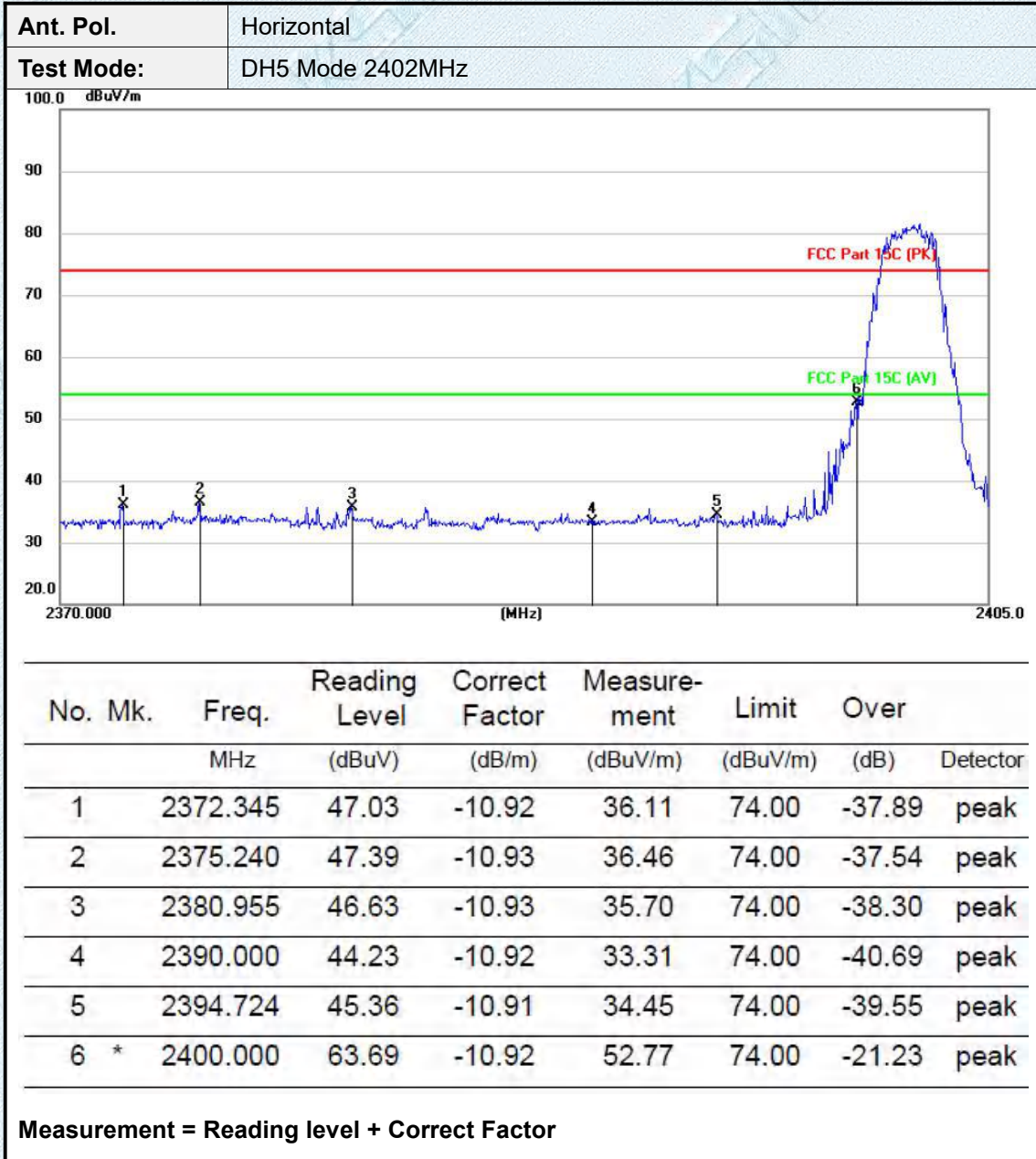
Test Mode

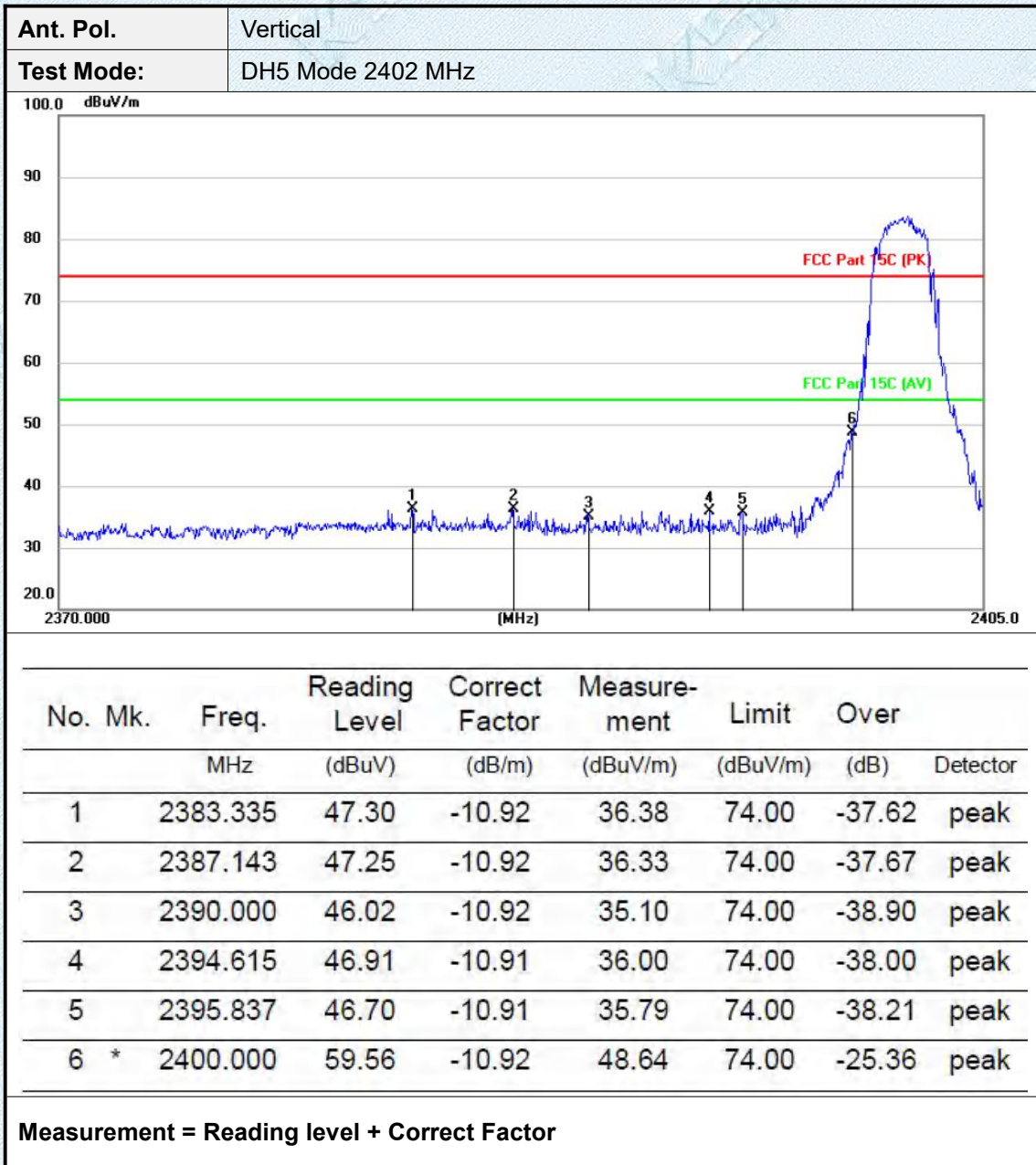
Please refer to the clause 2.3.

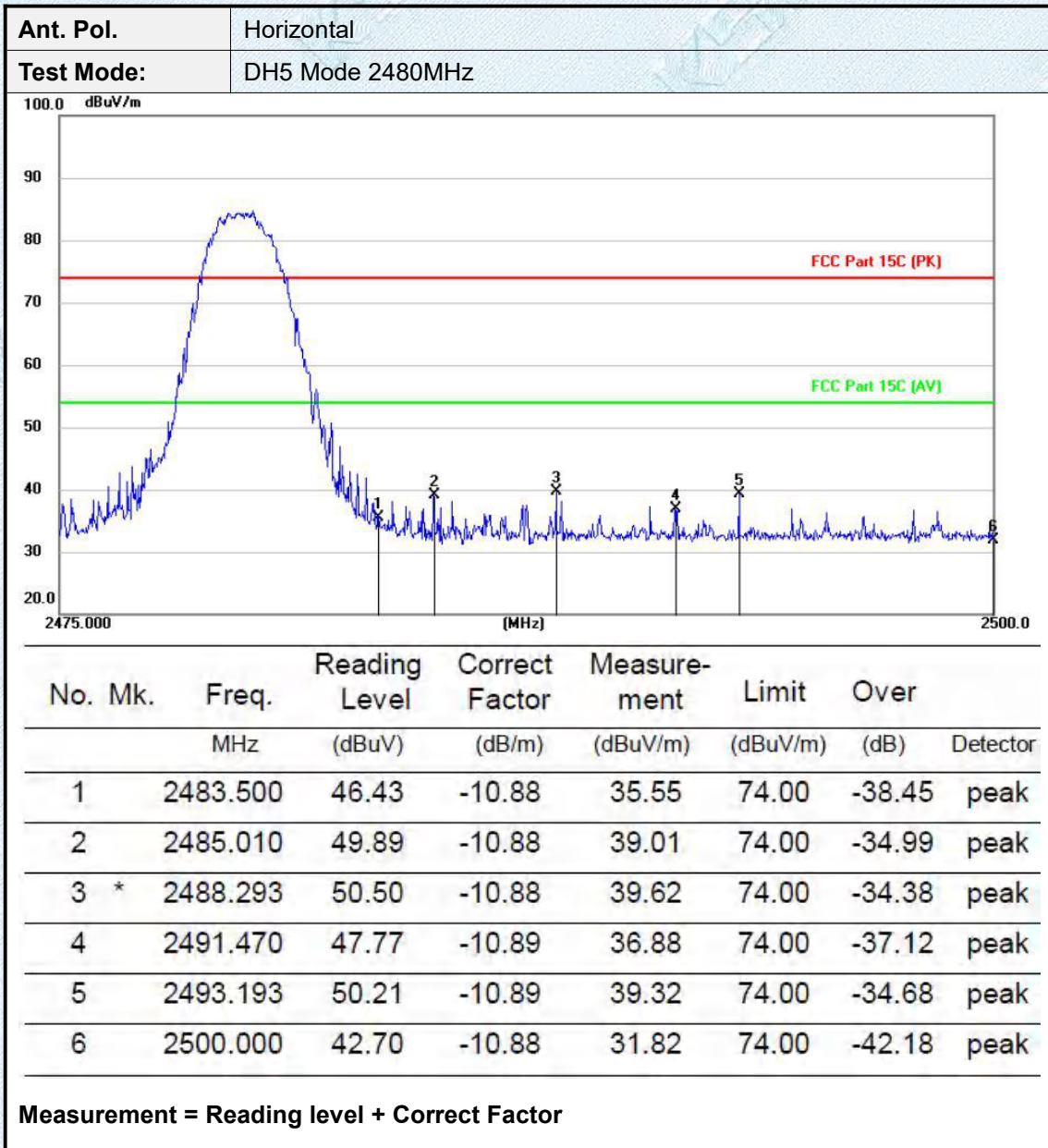
Test Results

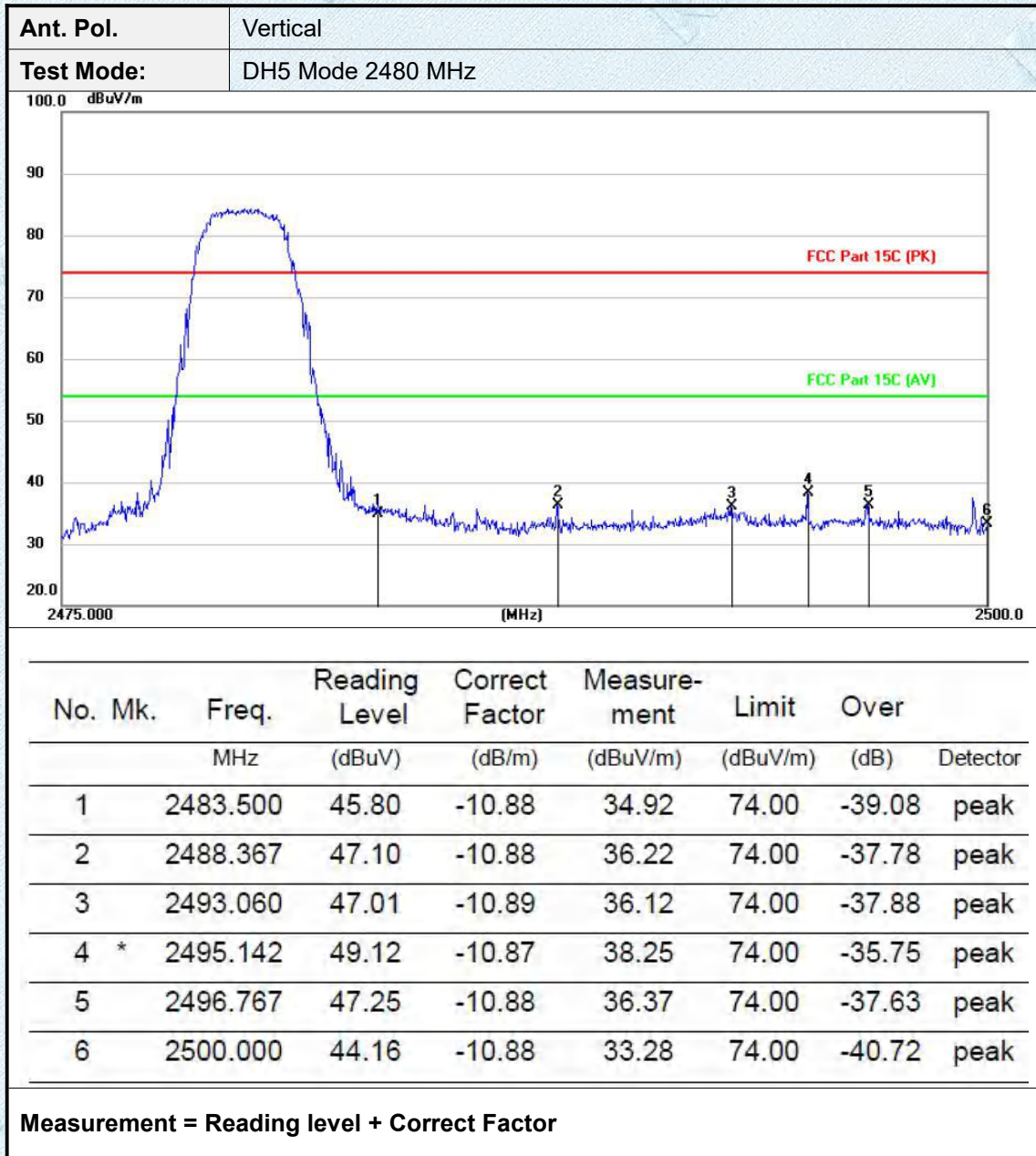
Note:

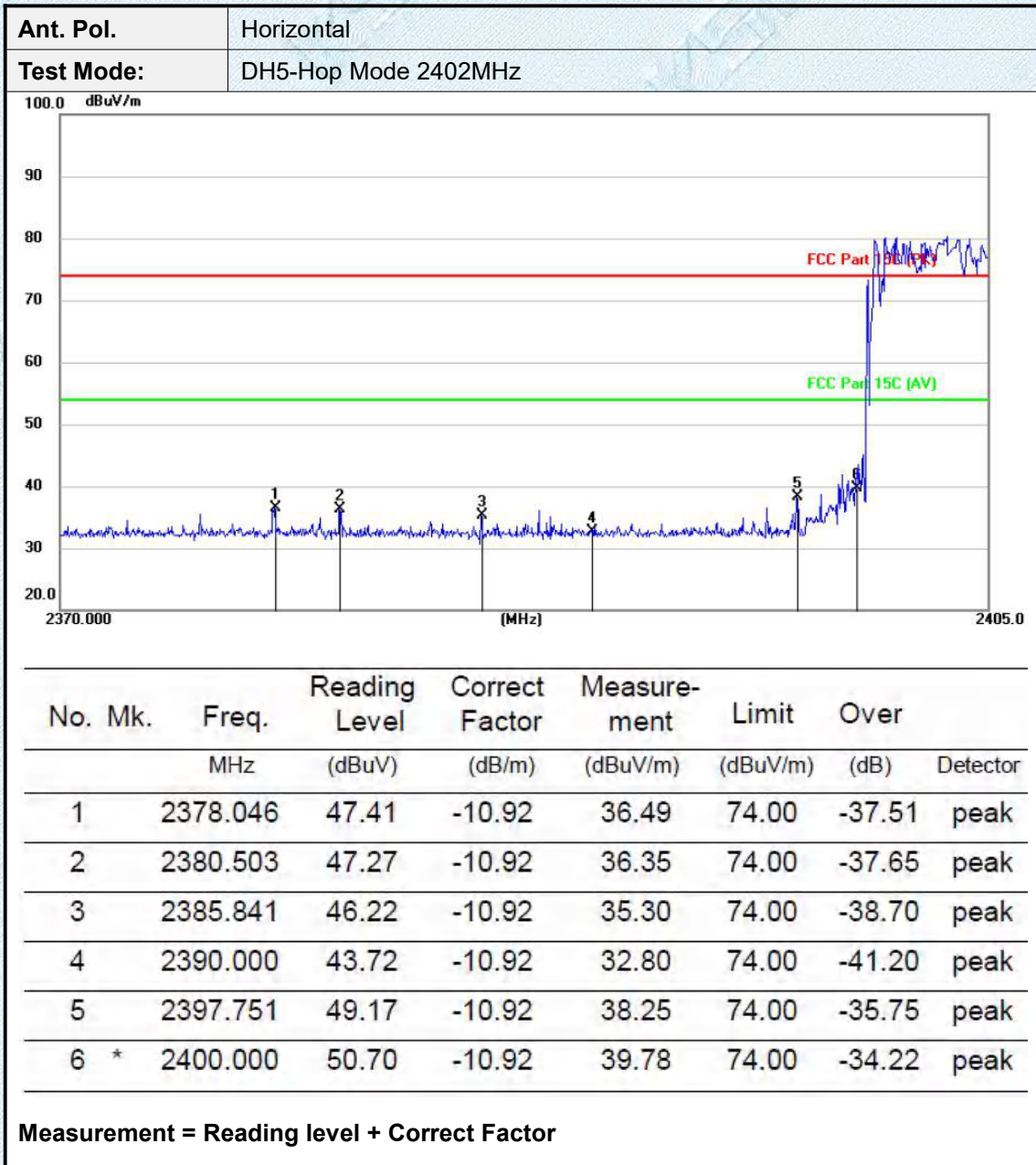
- 1.Measurement = Reading level + Correct Factor
 Correct Factor=Antenna Factor + Cable Loss -Preamplifier Factor
- 2.Pre-scan DH5, 2DH5 and 3DH5 modulation, and found the DH5 modulation which it is worse case, so only show the test data for worse case.

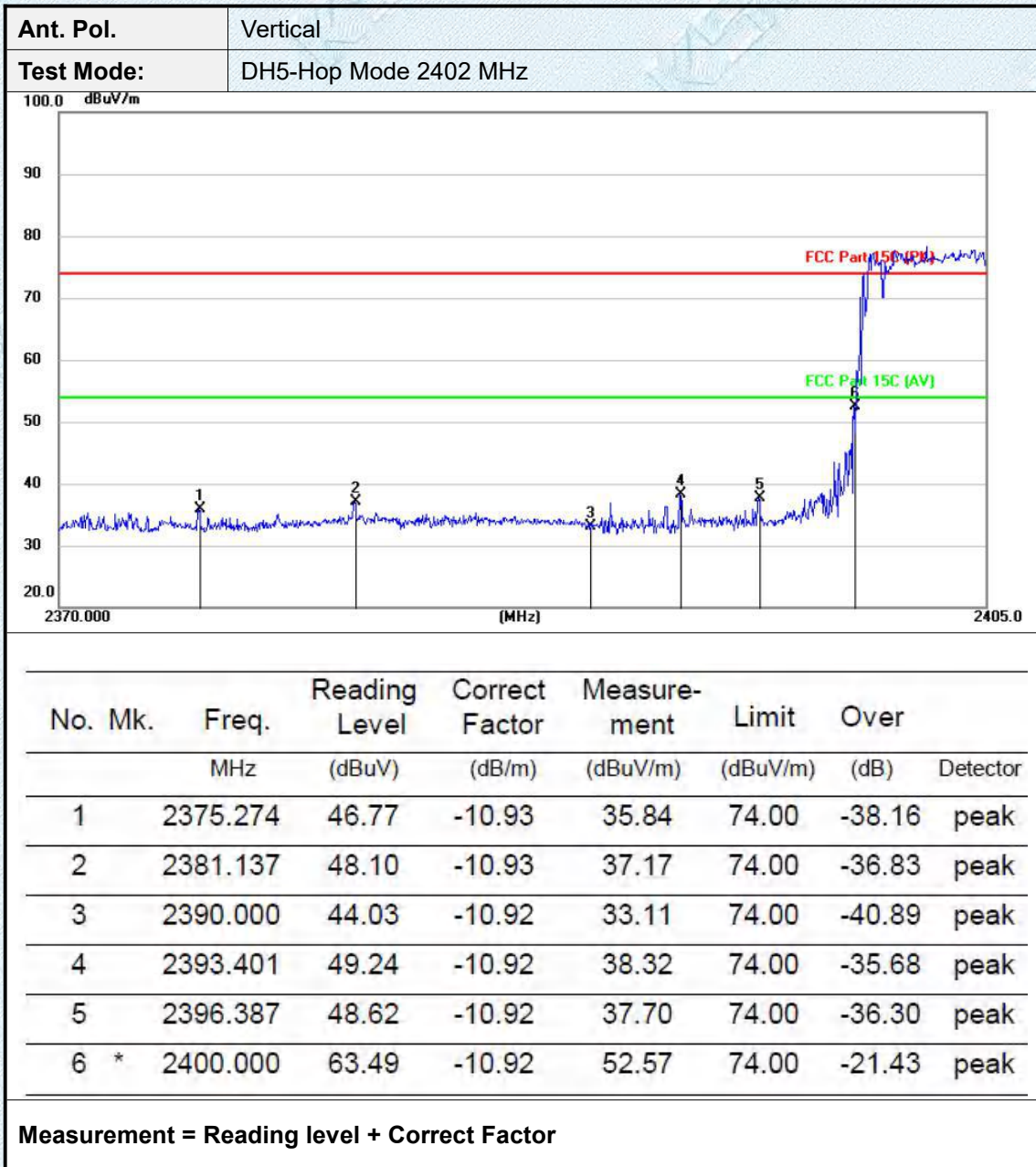


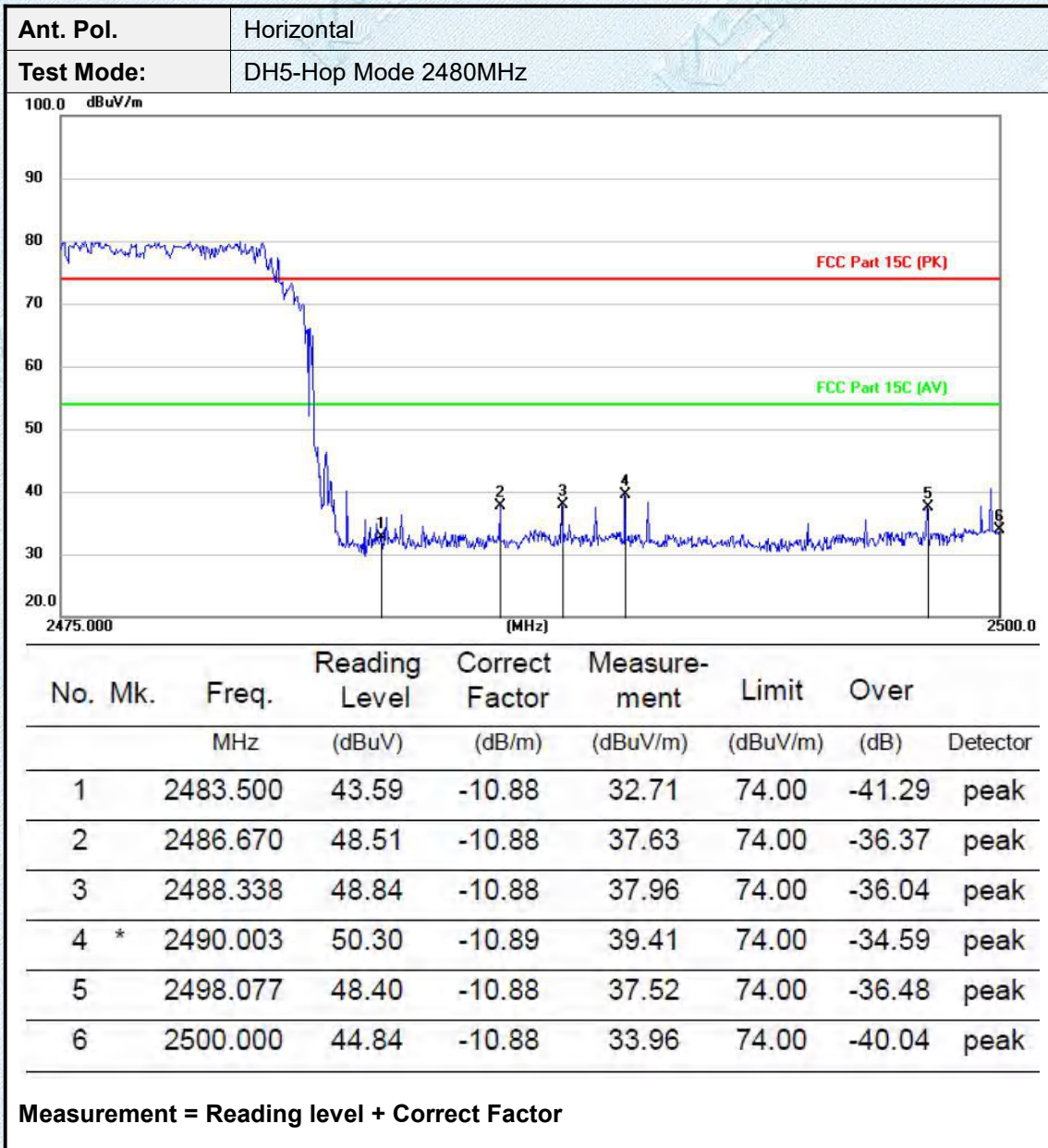


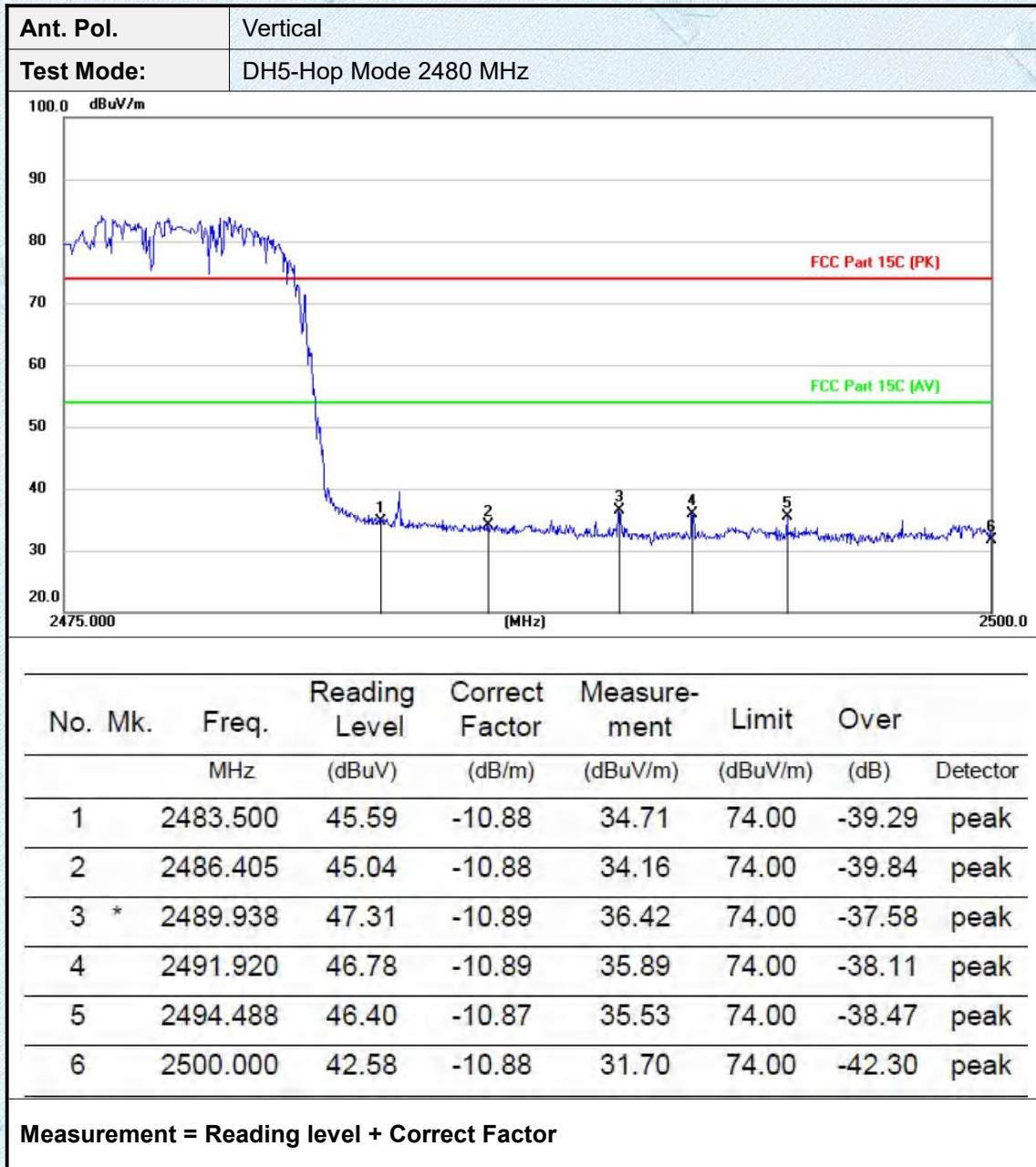












3.10. Radiated Spurious Emissions

Limit

Radiated Emission Limits (9 kHz~1000 MHz)

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
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

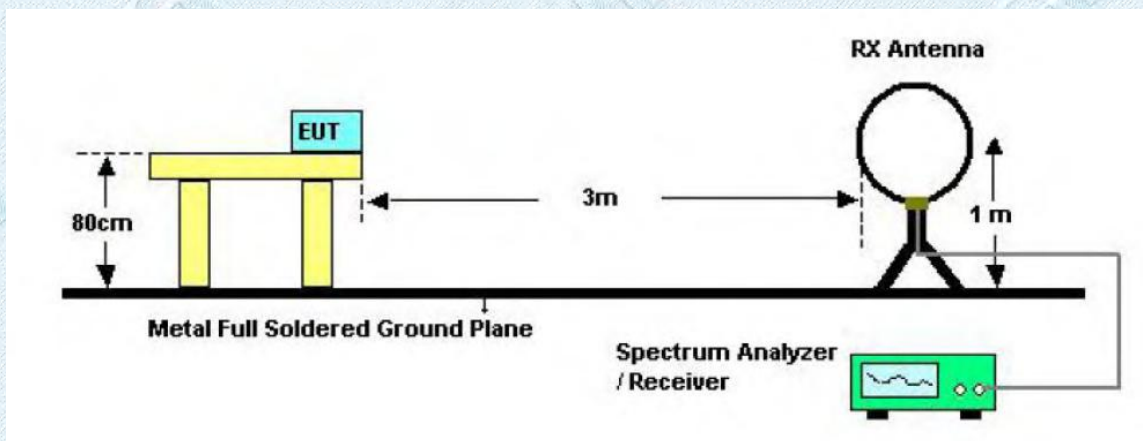
Radiated Emission Limit (Above 1000MHz)

Frequency (MHz)	Distance Meters(at 3m)	
	Peak	Average
Above 1000	74	54

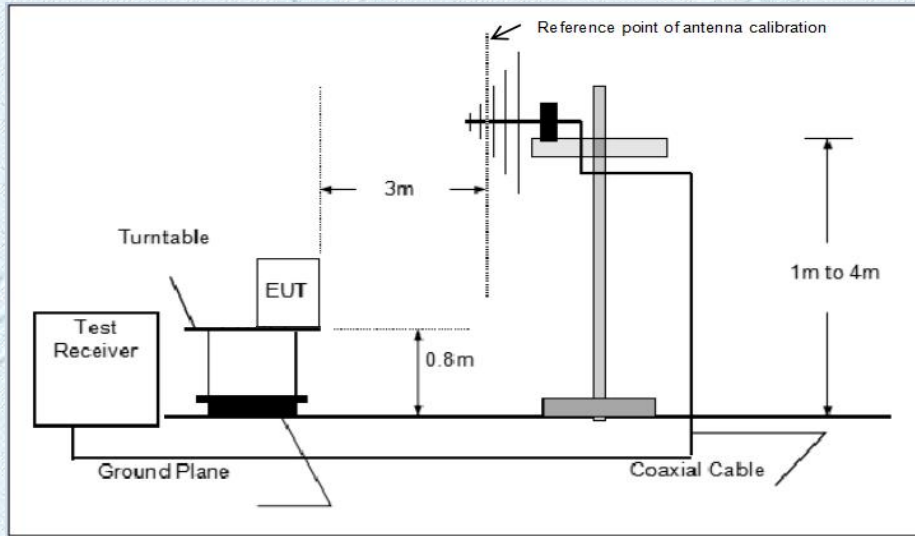
Note:

- (1) The tighter limit applies at the band edges.
- (2) Emission Level (dBuV/m)=20log Emission Level (uV/m).

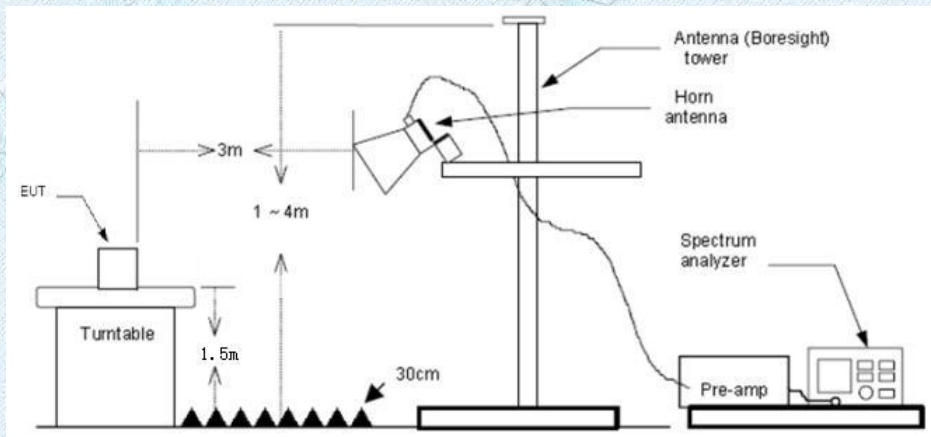
Test Configuration



Below 30MHz Test Setup



Below 1000MHz Test Setup



Above 1GHz Test Setup

Test Procedure

1. The EUT was setup and tested according to ANSI C63.10:2013
2. The EUT is placed on a turn table which is 0.8 meter above ground for below 1 GHz, and 1.5 m for above 1 GHz. The turn table is rotated 360 degrees to determine the position of the maximum emission level.
3. The EUT was set 3 meters from the receiving antenna, which was mounted on the top of a variable height antenna tower.
4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
5. Set to the maximum power setting and enable the EUT transmit continuously.
6. Use the following spectrum analyzer settings
 - (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Below 1 GHz:
 RBW=120 kHz, VBW=300 kHz, Sweep=auto, Detector function=peak, Trace=max hold;
 If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
 - (3) From 1 GHz to 10th harmonic:
 RBW=1MHz, VBW=3MHz Peak detector for Peak value.
 RBW=1MHz, VBW=10Hz Peak detector for Average value.

Test Mode

Please refer to the clause 2.3.

Test Result**9 KHz~30 MHz and 18GHz~25GHz**

From 9 KHz~30 MHz and 18GHz~25GHz: Conclusion: PASS

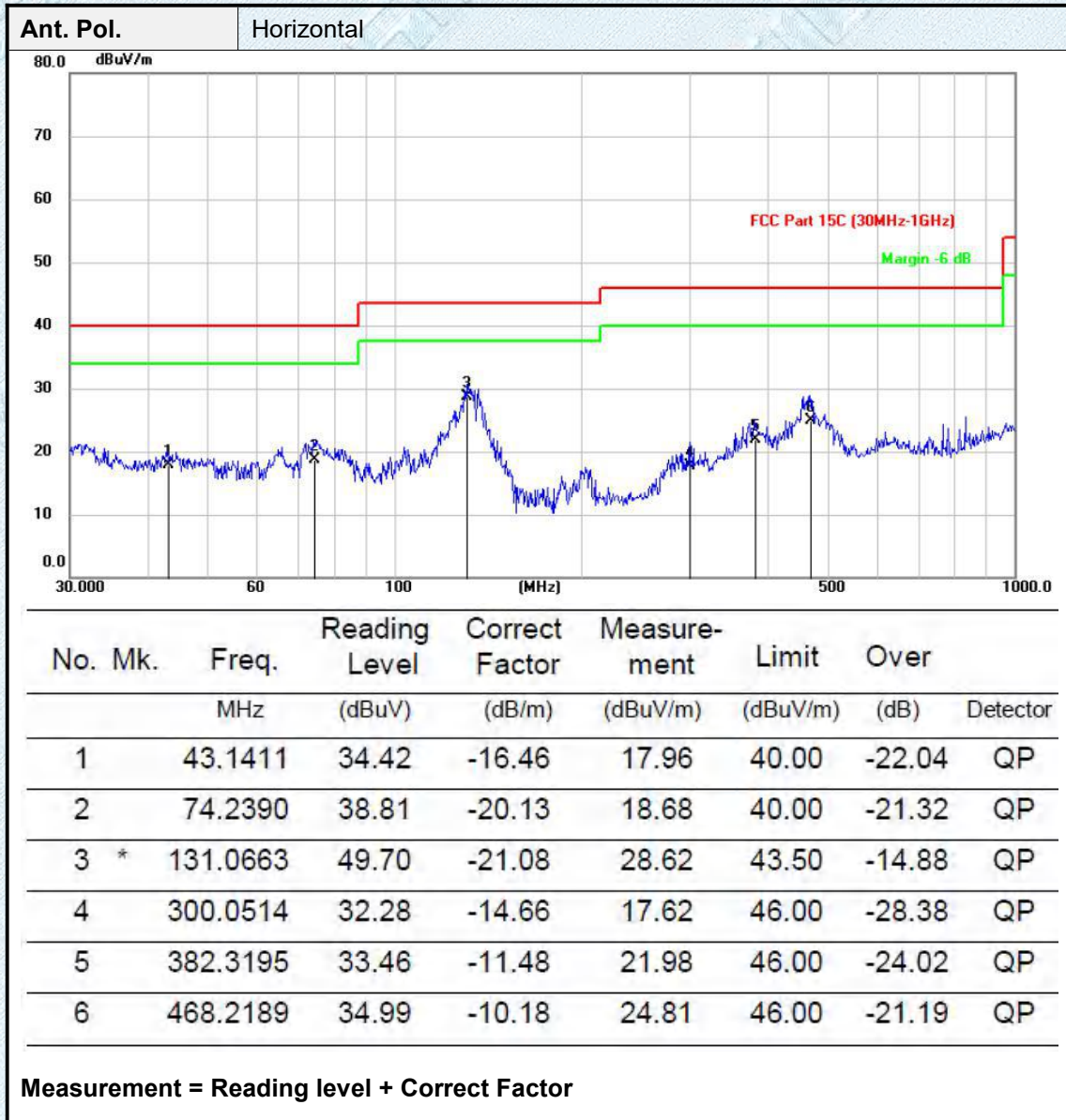
Note:

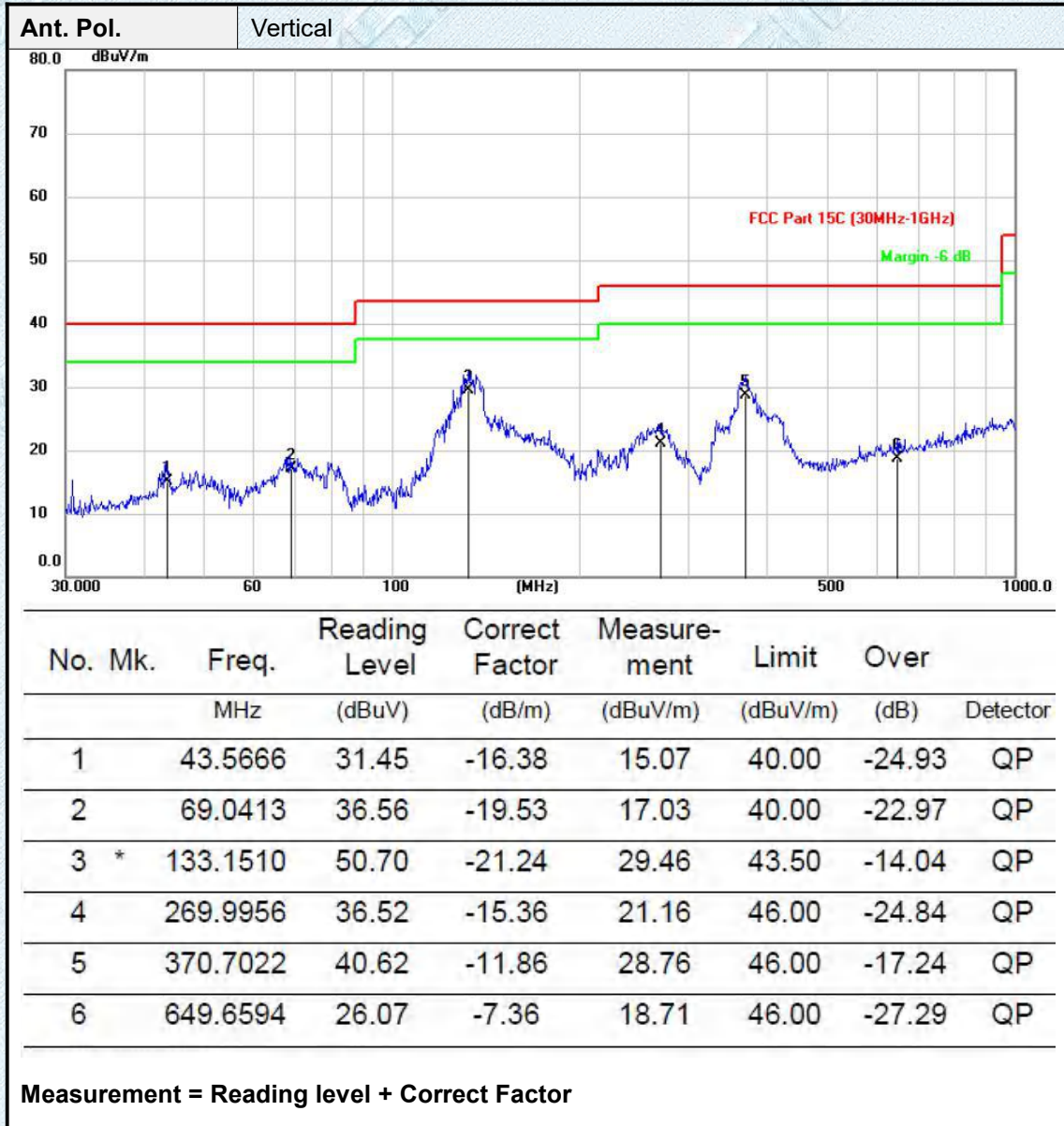
- 1) Measurement = Reading level + Correct Factor
Correct Factor=Antenna Factor + Cable Loss -Preamplifier Factor
- 2) The peak level is lower than average limit(54 dBuV/m), this data is the too weak instrument of signal is unable to test.
- 3) The emission levels of other frequencies are very lower than the limit and not show in test report.
- 4) The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.
- 5) Pre-scan DH5, 2DH5 and 3DH5 modulation, and found the DH5 modulation 2402MHz which it is worse case for 30MHz-1GHz , so only show the test data for worse case.
- 6) Pre-scan DH5, 2DH5 and 3DH5 modulation, and found the DH5 modulation which it is worse case for above 1GHz, so only show the test data for worse case.

RADIATED EMISSION BELOW 30MHZ

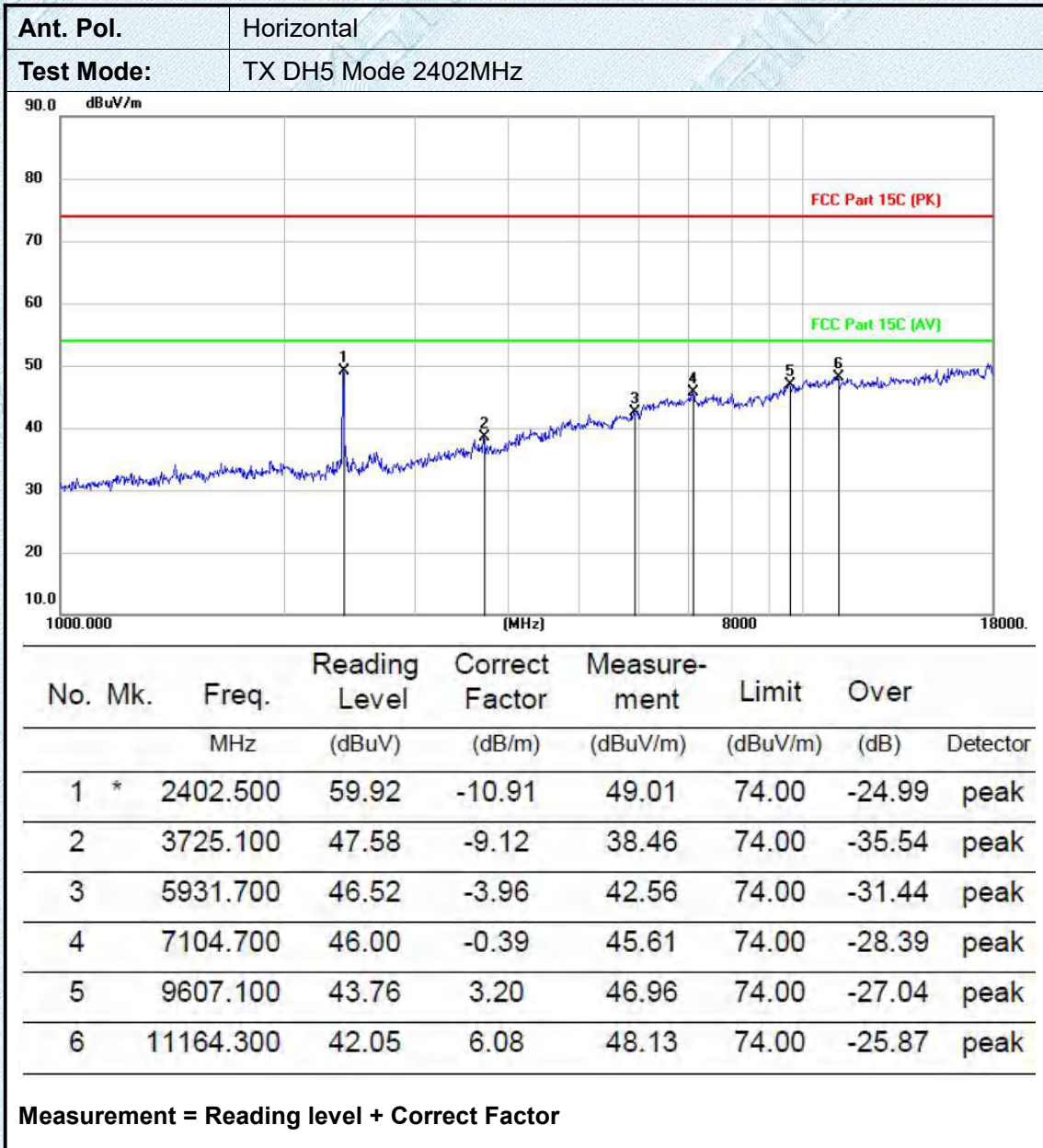
No emission found between lowest internal used/generated frequencies to 30MHz.

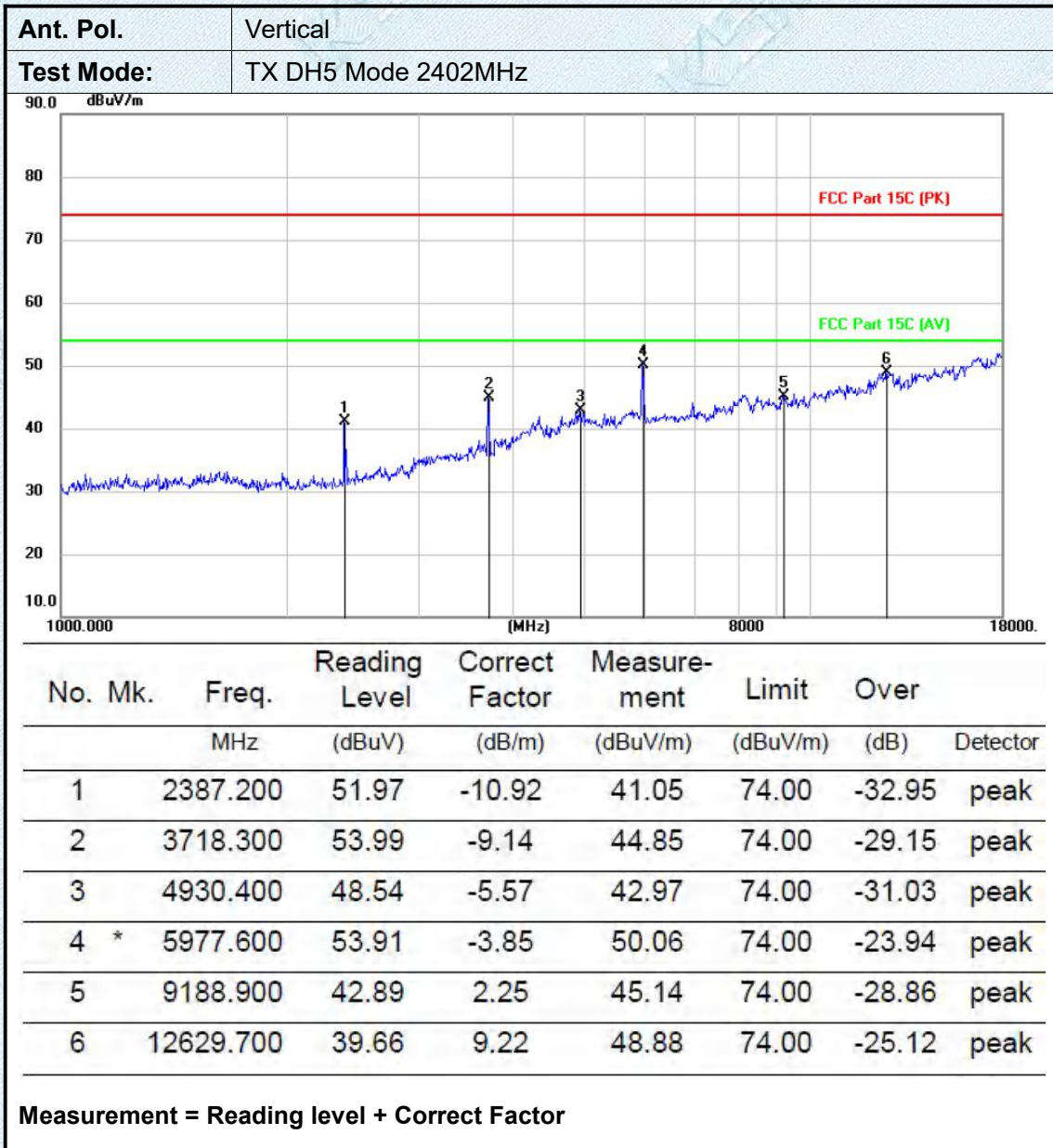
30MHz-1GHz

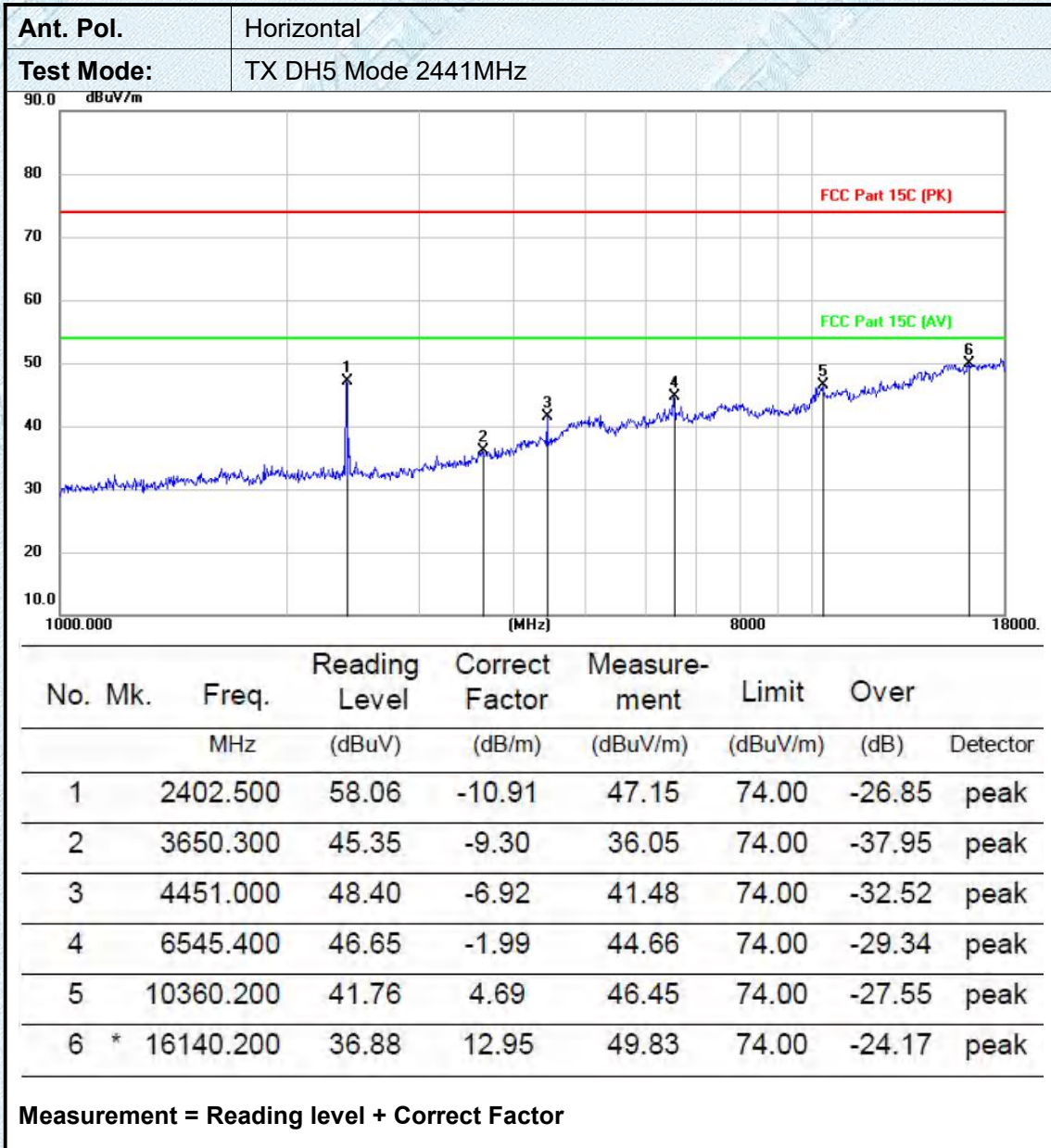


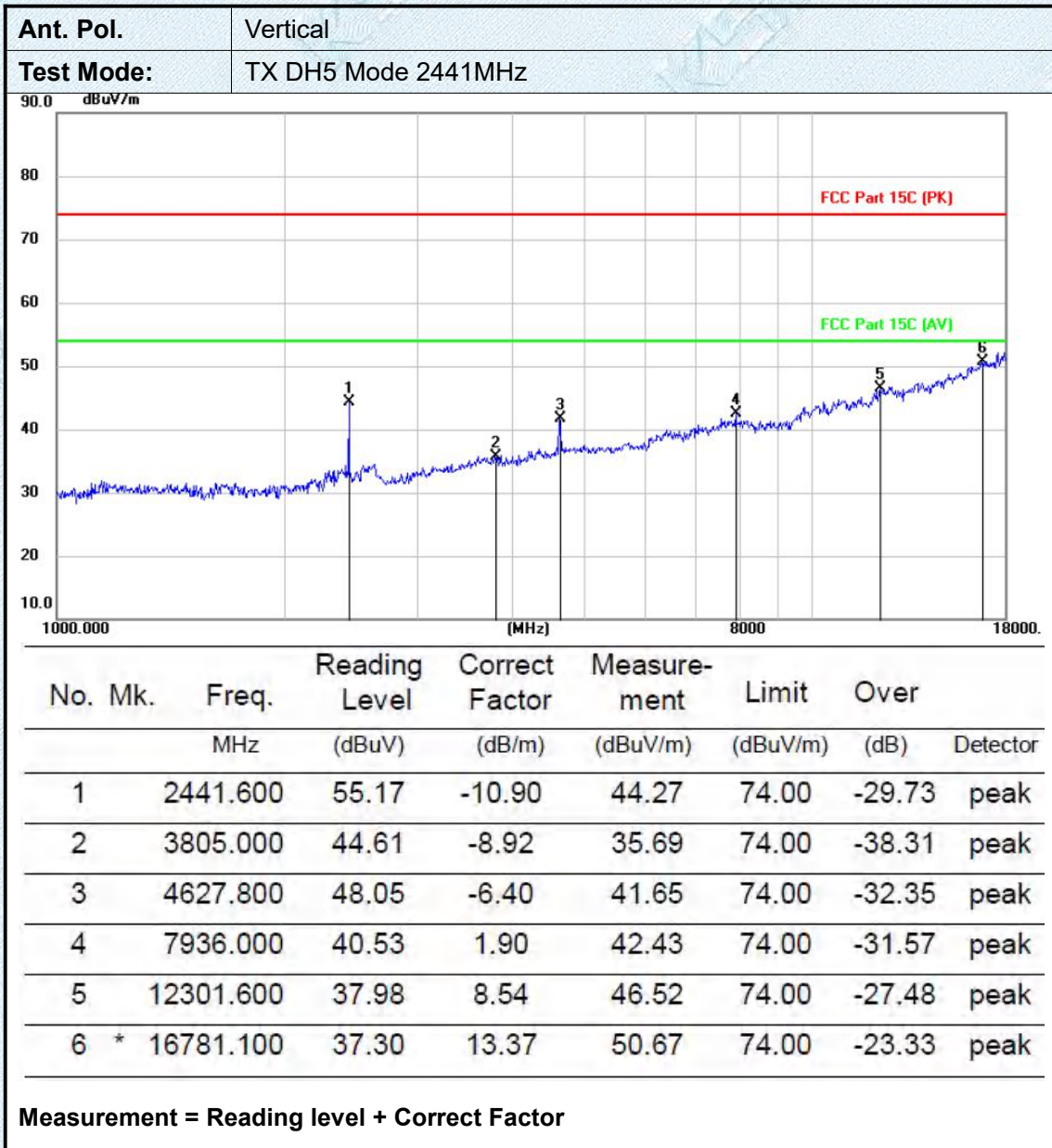


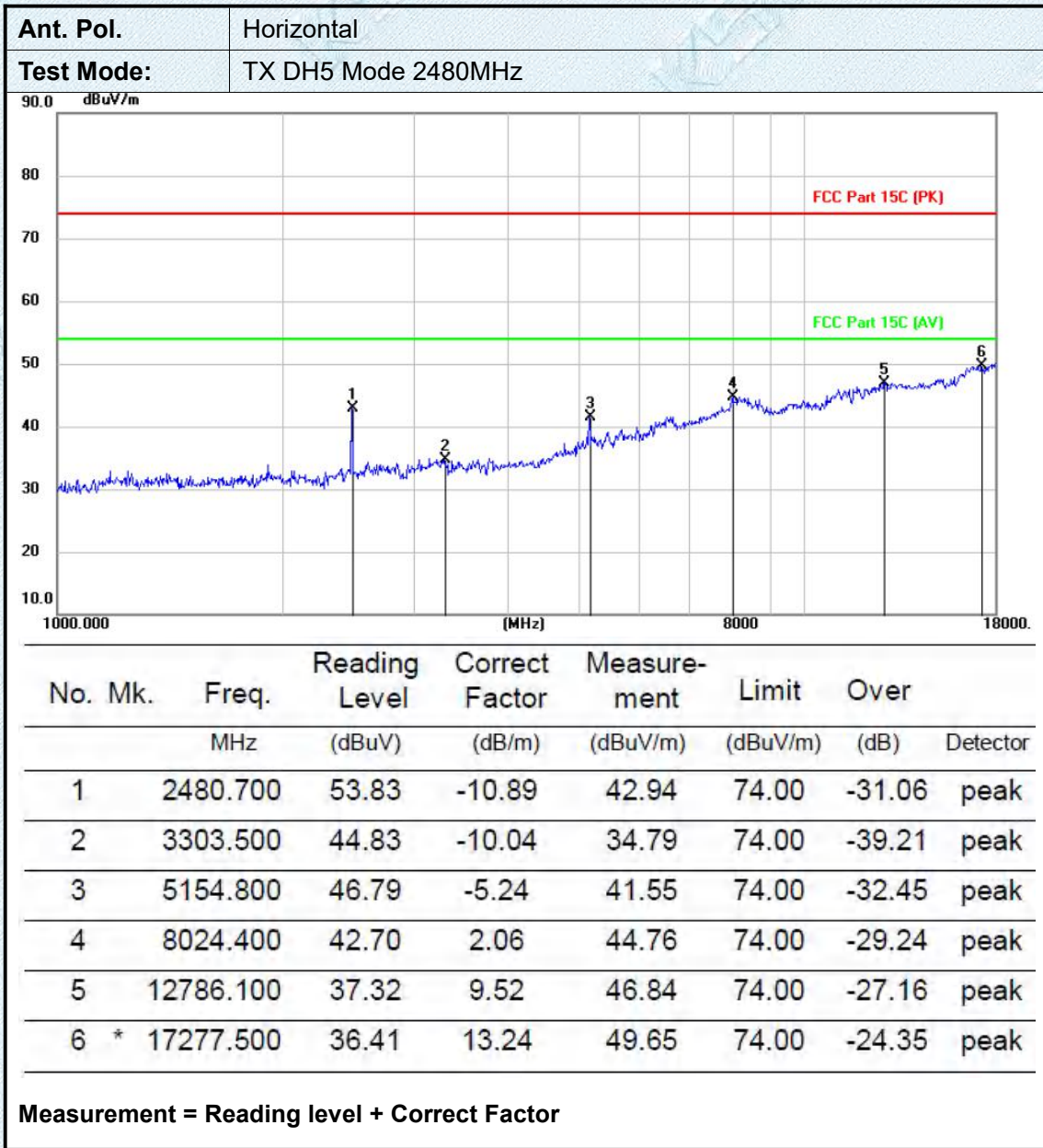
Adobe 1GHz

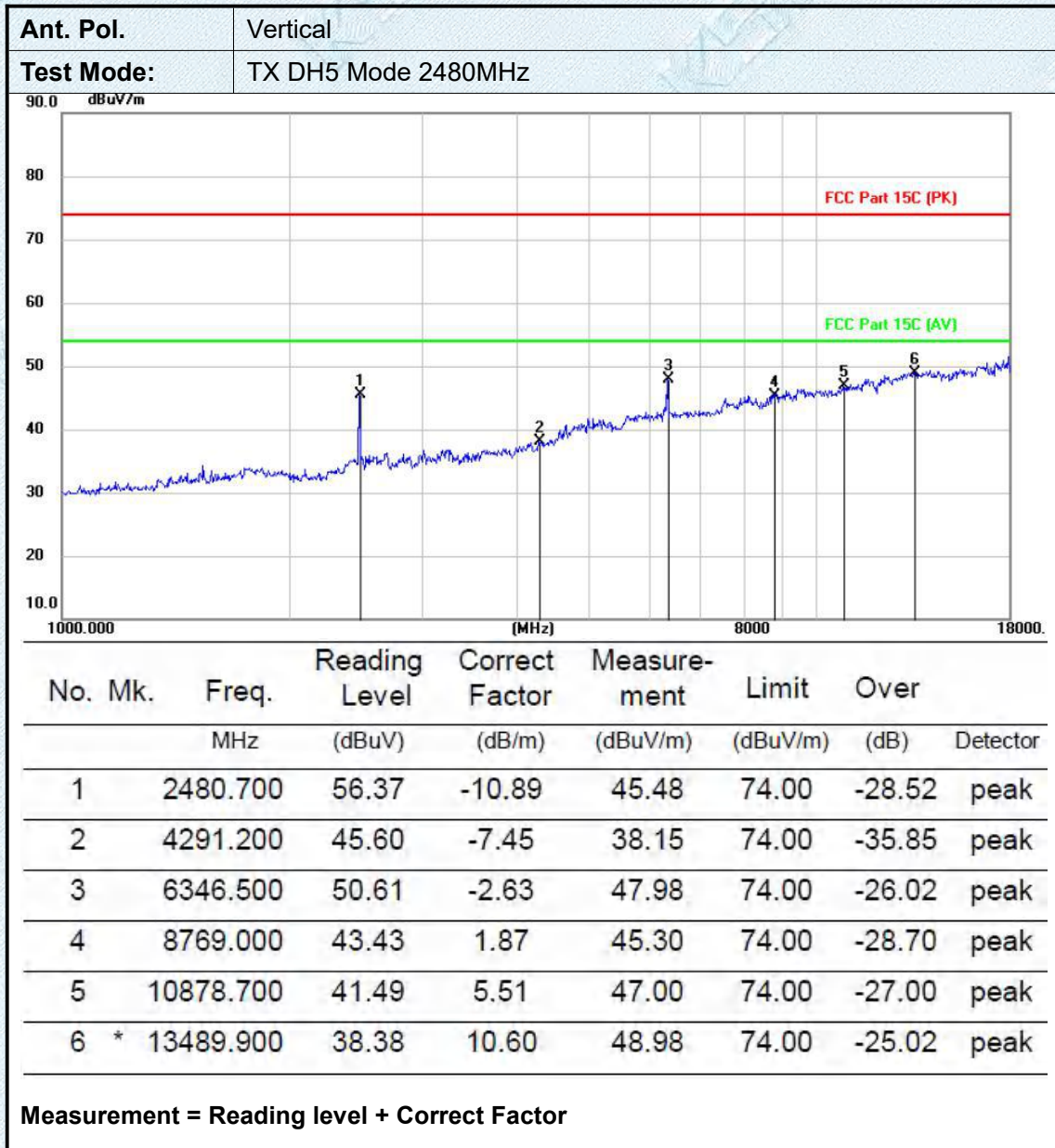












Note:

- 1.All test modes had been tested. The GFSK modulation is the worst case and recorded in the report.
- 2.The main frequency has been screened by the filter .

3.11. Pseudorandom Frequency Hopping Sequence

LIMIT

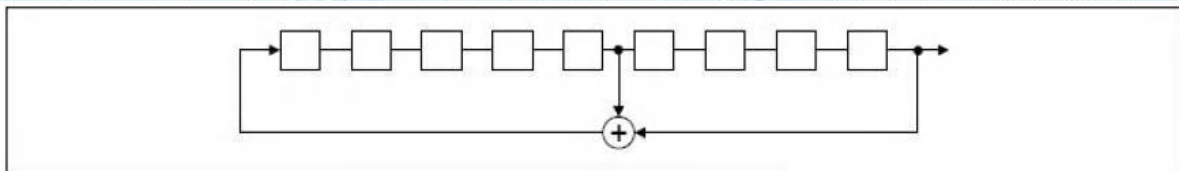
FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):

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 pseudo randomly 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.

TEST RESULTS

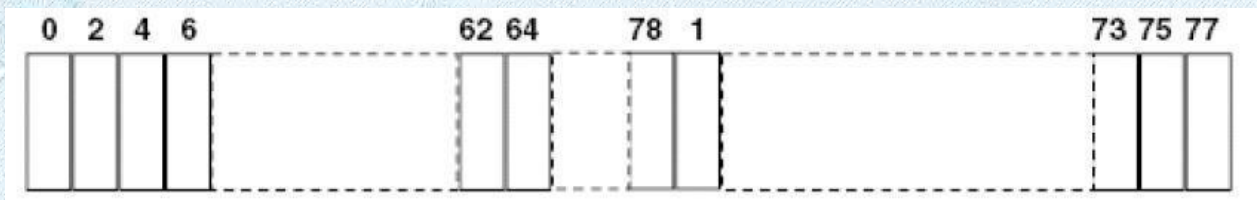
The pseudorandom frequency hopping sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones, for example: the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: $2^9 - 1 = 511$ bits
- Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of pseudorandom frequency hopping sequence as follows:



Each frequency used equally one the average by each transmitter.

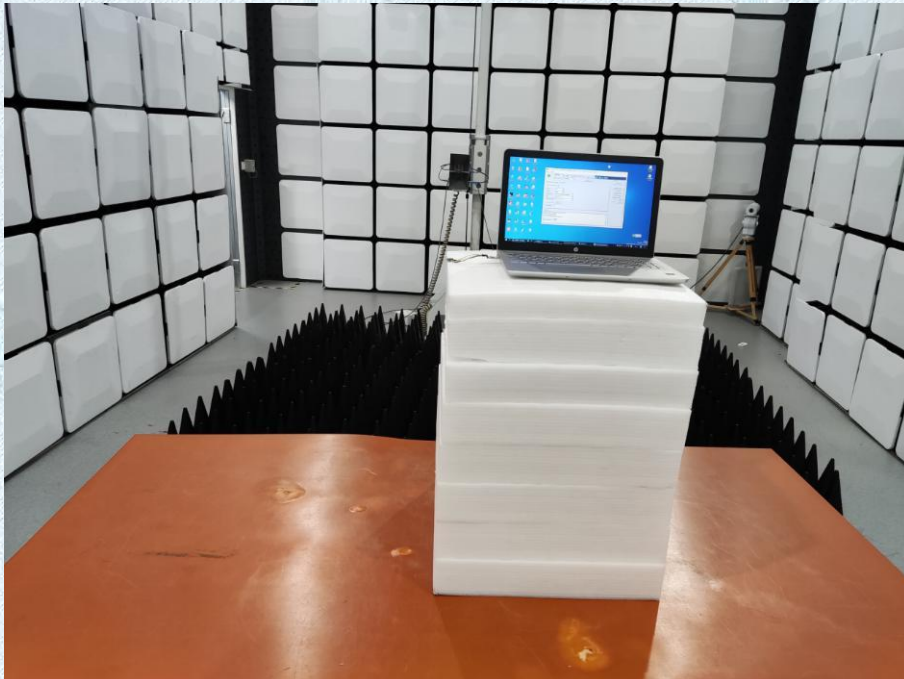
The system receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitter and shift frequencies in synchronization with the transmitted signals.

4.EUT TEST PHOTOS

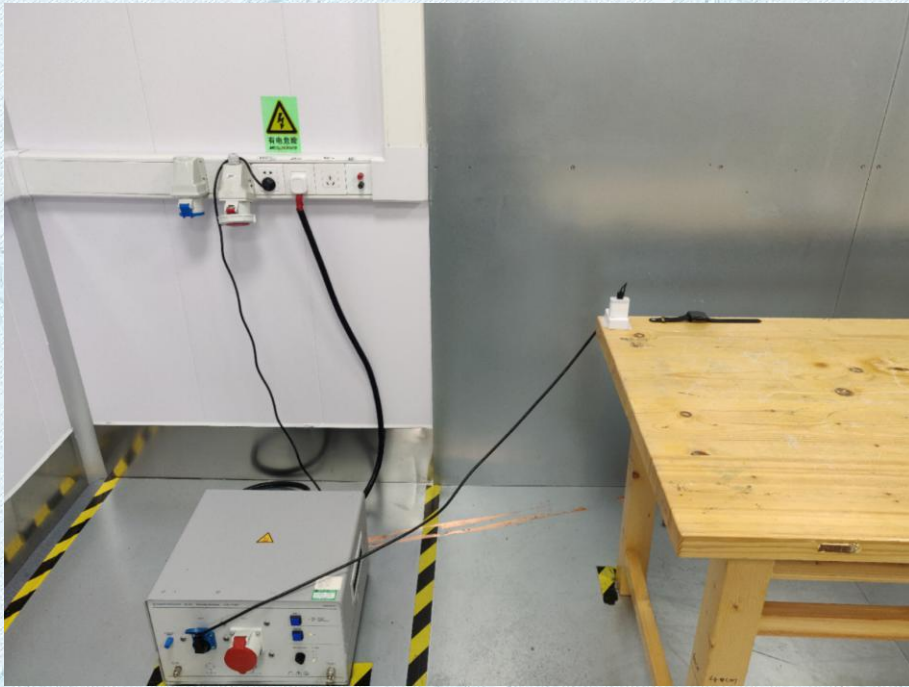
Radiated Measurement (Below 1GHz)



Radiated Measurement (Above 1GHz)

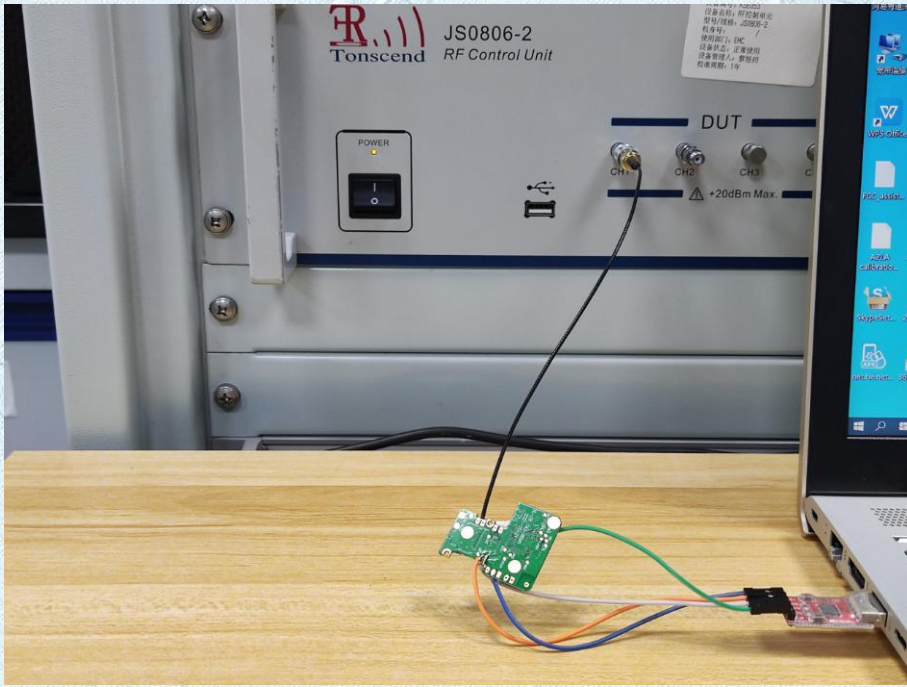


CONDUCTED EMISSION TEST SETUP



RF Conducted





5. PHOTOGRAPHS OF EUT CONSTRUCTIONAL

Please refer to the attached external photos and internal photos

*****THE END*****