FCC Radio Test Report

FCC ID: 2AOO5-BWS01A

This report concerns (check one): ☒**Original Grant** ☐**Class I Change** ☐**Class II Change**

Project No.	:	1712076
Equipment	:	Wireless Stereo System
Test Model	:	BWS-01-A
Series Model	:	N/A
Applicant	:	FAVORTRON CO., LTD.
Address	:	4F., NO.108-2,Minchiuan Rd., Shindian Dist., New Taipei City 23141,Taiwan(R.O.C.)
Date of Receipt	:	Jan. 09, 2018
Date of Test	:	Jan. 09, 2018 ~ Apr. 11, 2018
Issued Date	:	Apr. 11, 2018
Tested by	:	BTL Inc.

Testing Engineer : _____ (Kenji Lin)

Technical Manager : _____ (James Chiu)

Authorized Signatory : _____ (Andy Chiu)

BTL INC.

No.18, Ln. 171, Sec. 2, Jiuzong Rd.,
Neihu Dist., Taipei City, Taiwan (R.O.C.)
TEL:+886-2-2657-3299 FAX: +886-2-2657-3331

Testing Laboratory
0659

Declaration

BTL represents to the client that testing is done in accordance with standard procedures as applicable and that test instruments used has been calibrated with standards traceable to international standard(s) and/or national standard(s).

BTL's reports apply only to the specific samples tested under conditions. It is manufacture's responsibility to ensure that additional production units of this model are manufactured with the identical electrical and mechanical components. **BTL** shall have no liability for any declarations, inferences or generalizations drawn by the client or others from **BTL** issued reports.

The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

This report is the confidential property of the client. As a mutual protection to the clients, the public and ourselves, the test report shall not be reproduced, except in full, without our written approval.

BTL's laboratory quality assurance procedures are in compliance with the **ISO Guide 17025** requirements, and accredited by the conformity assessment authorities listed in this test report.

BTL is not responsible for the sampling stage, so the results only apply to the sample as received.

The information, data and test plan are provided by manufacturer, so it is manufacturer's responsibility to ensure that the apparatus meets the essential requirements in all the possible configurations as representative of its intended use.

Limitation

For the use of the authority's logo is limited unless the Test Standard(s)/Scope(s)/Item(s) mentioned in this test report is (are) included in the conformity assessment authorities acceptance respective.

Table of Contents Page

Table of Contents Page

Table of Contents Page

REPORT ISSUED HISTORY

Issued No.	Description	Issued Date
BTL-FCCP-1-1712076	Original Issue	Apr. 11, 2018

1. CERTIFICATION

Equipment	:	Wireless Stereo System
Brand Name	:	BOOOM
Test Model	:	BWS-01-A
Series Model	:	N/A
Applicant	:	FAVORTRON CO., LTD.
Manufacturer	:	FAVORTRON CO., LTD.
Address	:	4F., NO.108-2,Minchiuan Rd., Shindian Dist., New Taipei City 23141,Taiwan(R.O.C.)
Date of Test	:	Jan. 09, 2018 ~ Apr. 11, 2018
Test Sample	:	Engineering Sample
Standard(s)	:	FCC Part15, Subpart C (15.247)/ ANSI C63.10-2013

The above equipment has been tested and found in compliance with the requirement of the relative standards by BTL Inc.
The test data, data evaluation, and equipment configuration contained in our test report (Ref No. BTL-FCCP-1-1712076) were obtained utilizing the test procedures, test instruments, test sites that has been accredited by the Authority of TAF according to the ISO-17025 quality assessment standard and technical standard(s).

Test results included in this report is only for the 2.4G SRD part.

2. SUMMARY OF TEST RESULTS

Test procedures according to the technical standard(s):

Applied Standard(s): FCC Part15, Subpart C (15.247)			
Standard(s) Section	Test Item	Judgment	Remark
15.207	Conducted Emission	PASS	
15.247(d)	Antenna conducted Spurious Emission	PASS	
15.247 (a)(1)	Hopping Channel Separation	PASS	
15.247(a)(1)	Bandwidth	PASS	
15.247 (b)(1)	Peak Output Power	PASS	
15.247(d) 15.209	Radiated Spurious Emission	PASS	
15.247 (a)(1)(iii)	Number of Hopping Frequency	PASS	
15.247 (a)(1)(iii)	Dwell Time	PASS	
15.205	Restricted Bands	PASS	
15.203	Antenna Requirement	PASS	

Note:

(1)" N/A" denotes test is not applicable in this test report

2.1 TEST FACILITY

The test facilities used to collect the test data in this report:

Conducted emission Test:

C05: (VCCI RN: C-4742; FCC RN:674415; FCC DN:TW0659)
No. 68-1, Ln. 169, Sec. 2, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan (R.O.C.)

Radiated emission Test (Below 1 GHz):

CB15: (VCCI RN: G-20020; FCC RN:674415; FCC DN:TW0659; ISED Assigned Code:20088-5)
No. 68-1, Ln. 169, Sec. 2, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan (R.O.C.)

Radiated emission Test (Above 1 GHz):

CB15: (VCCI RN: G-20031; FCC RN:674415; FCC DN:TW0659; ISED Assigned Code:20088-5)
No. 68-1, Ln. 169, Sec. 2, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan (R.O.C.)

2.2 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2. The BTL measurement uncertainty is less than the CISPR 16-4-2 U_{cispr} requirement.

The reported uncertainty of measurement y ± U, where expanded uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95 %.

A. Conducted emission test:

Test Site	Method	Measurement Frequency Range	U,(dB)
C05	CISPR	150 kHz ~ 30MHz	2.68

B. Radiated emission test:

Test Site	Method	Measurement Frequency Range	U,(dB)
CB15 (3m)	CISPR	9kHz ~ 150kHz	2.82
		150kHz ~ 30MHz	2.58

Test Site	Method	Measurement Frequency Range	Ant.	U,(dB)
CB15 (3m)	CISPR	30MHz ~ 200MHz	V	4.20
		30MHz ~ 200MHz	H	3.64
		200MHz ~ 1,000MHz	V	4.56
		200MHz ~ 1,000MHz	H	3.90

Test Site	Method	Measurement Frequency Range	Ant.	U,(dB)
CB15 (3m)	CISPR	1GHz ~ 6GHz	V	4.46
		1GHz ~ 6GHz	H	4.40
		6GHz ~ 18GHz	V	3.88
		6GHz ~ 18GHz	H	4.00

Test Site	Method	Measurement Frequency Range	U,(dB)
CB15 (1m)	CISPR	18 ~ 26.5 GHz	4.62
		26.5 ~ 40 GHz	5.12

Our calculated Measurement Instrumentation Uncertainty is shown in the tables above.
These are our U_{lab} values in CISPR 16-4-2 terminology.
Since Table 1 of CISPR 16-4-2 has values of measurement instrumentation uncertainty, called U_{CISPR}, as follows:

Conducted Disturbance (mains port) – 150 kHz – 30 MHz: 3.6 dB
Radiated Disturbance (electric field strength on an open area test site or alternative test site) – 30 MHz – 1000 MHz: 5.2 dB

It can be seen that our U_{lab} values are smaller than U_{CISPR}.
Note: unless specifically mentioned, the uncertainty of measurement has not been taken into account to declare the compliance or non-compliance to the specification.

3. GENERAL INFORMATION

3.1 GENERAL DESCRIPTION OF EUT

Equipment	Wireless Stereo System	
Brand Name	BOOOM	
Test Model	BWS-01-A	
Series Model	N/A	
Model Difference	N/A	
Output Power (Max.)	Operation Frequency	2404 MHz ~ 2478 MHz
	Modulation Technology	GFSK
	Bit Rate of Transmitter	
	Output Power Max.	14.83 dBm
Power Source	DC Voltage supplied from AC/DC adapter.	
Power Rating	I/P: 100-240V~50/60Hz, 0.2A O/P: 5V⎓1.0A	
Products Covered	1 * Adapter: AMIGO / AMS66-0501000FU	

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	**2404**	13	2430	26	2456
01	2406	14	2432	27	2458
02	2408	15	2434	28	2460
03	2410	16	2436	29	2462
04	2412	17	2438	30	2464
05	2414	18	2440	31	2466
06	2416	**19**	**2442**	32	2468
07	2418	20	2444	33	2470
08	2420	21	2446	34	2472
09	2422	22	2448	35	2474
10	2424	23	2450	36	2476
11	2426	24	2452	**37**	**2478**
12	2428	25	2454		

The EUT supports 37 channels, but only 15 random channels has been chosen for hopping mode at the same time. The hopping rate is 416 hops/s.

3. Table for Filed Antenna

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)
1	M.gear	N02001001618	Dipole	SMA Plug Reverse	2

3.2 DESCRIPTION OF TEST MODES

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

Pretest Mode	Description
Mode 1	TX Mode **Note (1)**

The EUT system operated these modes were found to be the worst case during the pre-scanning test as following:

For Conducted Emission	
Final Test Mode	Description
Mode 1	TX Mode

For Radiated / Number of Hopping Channel / Average Time of Occupancy / Hopping Channel Separation Measurement / Bandwidth / Peak Output Power / Antenna Conducted Spurious Emission Test	
Final Test Mode	Description
Mode 1	TX Mode **Note (1)**

Note:

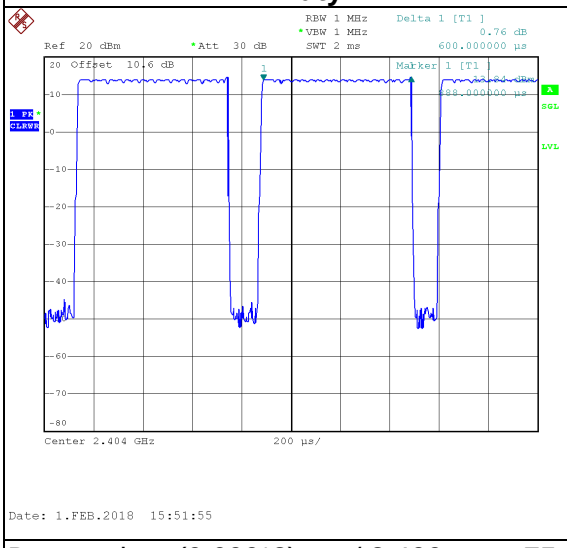
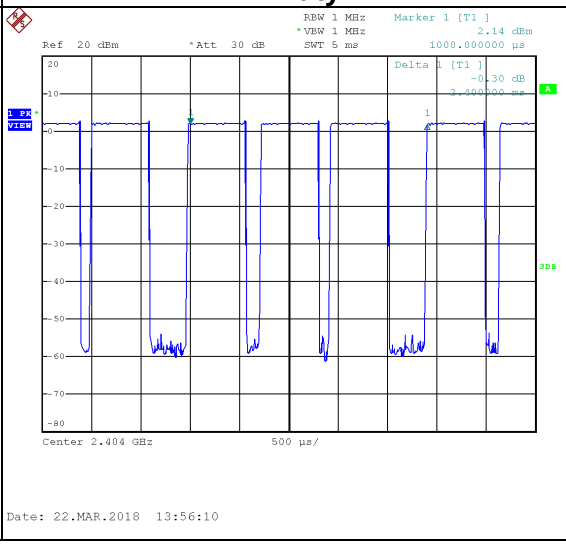
(1) The measurements are performed at the high, middle, low available channels.

3.3 TABLE OF PARAMETERS OF TEXT 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 FHSS

Test Software Version	N/A		
Frequency	2404 MHz	2442 MHz	2478 MHz
Parameters	Default	Default	Default

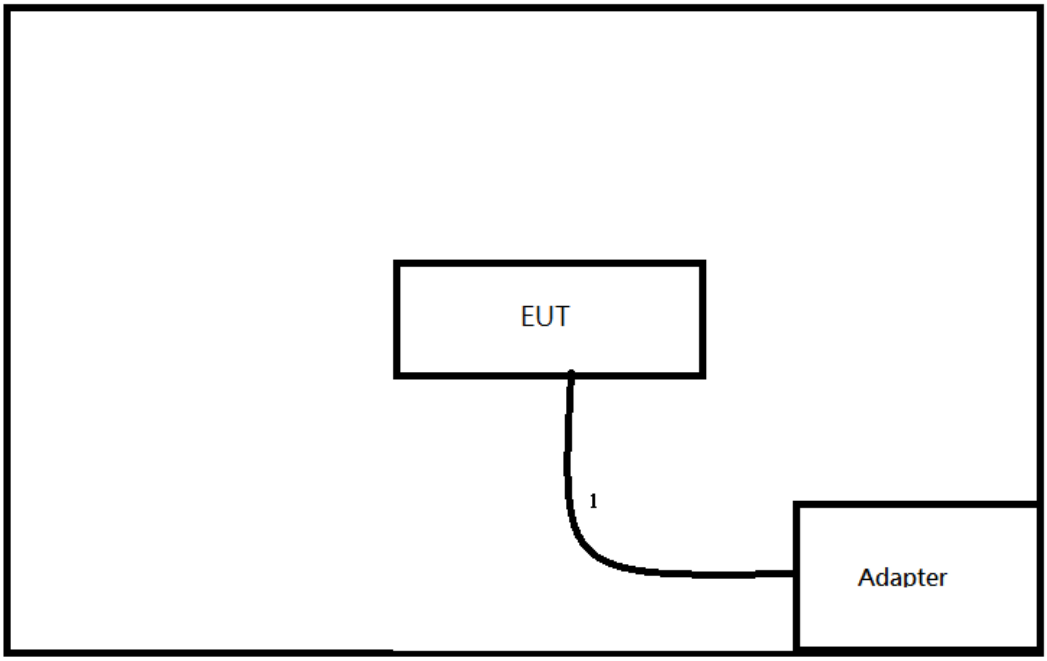
3.4 DUTY CYCLE

Duty-1	Duty-2
	
Duty cycle = (0.600*3) ms / 2.400 ms = 75.00 %	

Note:

For radiated emissions frequency above 1 GHz, the resolution bandwidth of test receiver/spectrum analyzer is 2 MHz and the video bandwidth is 3 kHz (Duty cycle < 98%).

3.5 BLOCK DIAGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED



3.6 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Item	Equipment	Mfr/Brand	Model/Type No.	FCC ID	Series No.
-	-	-	-	-	-

Item	Shielded Type	Ferrite Core	Length	Note
1	YES	NO	1.5m	Power Cable

4. EMC EMISSION TEST

4.1 CONDUCTED EMISSION MEASUREMENT

4.1.1 POWER LINE CONDUCTED EMISSION LIMITS (Frequency Range 150KHz-30MHz)

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15 -0.50	66 to 56*	56 to 46*
0.50 -5.0	56	46
5.0 -30.0	60	50

Note:

(1) The limit of " * " decreases with the logarithm of the frequency

(2) The test result calculated as following:
Measurement Value = Reading Level + Correct Factor
Correct Factor = Insertion Loss + Cable Loss + Attenuator Factor(if use)
Margin Level = Measurement Value - Limit Value

The following table is the setting of the receiver

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 KHz

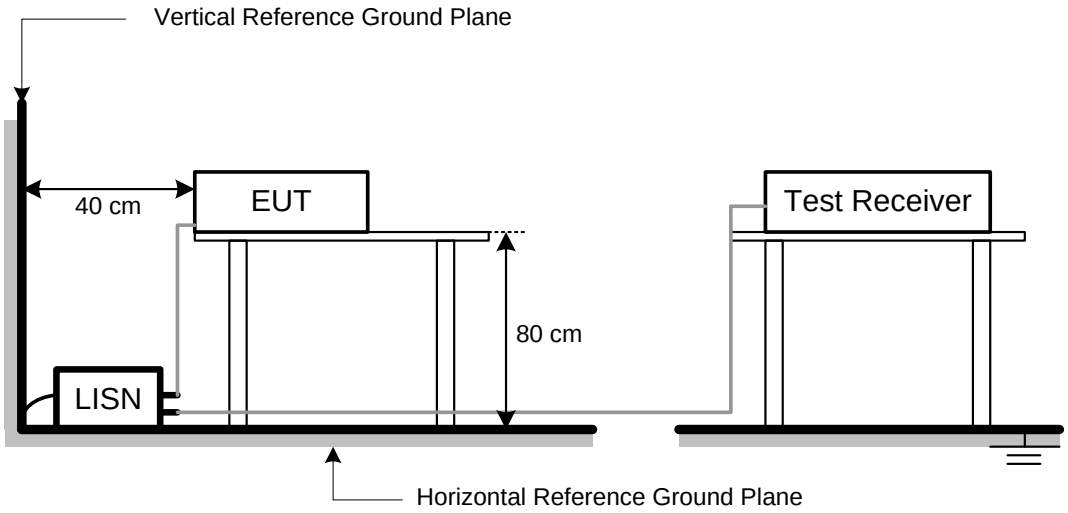
4.1.2 TEST PROCEDURE

a. 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 equipment powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
b. 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.
c. 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.
d. LISN at least 80 cm from nearest part of EUT chassis.
e. For the actual test configuration, please refer to the related Item –EUT Test Photos.

4.1.3 DEVIATION FROM TEST STANDARD

No deviation

4.1.4 TEST SETUP



4.1.5 EUT OPERATING CONDITIONS

The EUT was configured for testing in a typical function (as a customer would normally use it), EUT was programmed to be in continuously transmitting/receiving data or hopping on mode.

4.1.6 EUT TEST CONDITIONS

Temperature: 25°C
Relative Humidity: 55%
Test Voltage: AC 120V/60Hz

4.1.7 TEST RESULTS

Please refer to the Appendix A.

Remark:

(1) All readings are QP Mode value unless otherwise stated AVG in column of『Note』. If the QP Mode Measured value compliance with the QP Limits and lower than AVG Limits, the EUT shall be deemed to meet both QP & AVG Limits and then only QP Mode was measured, but AVG Mode didn't perform in this case, a "*" marked in AVG Mode column of Interference Voltage Measured.

(2) Measuring frequency range from 150KHz to 30MHz.

4.2 RADIATED EMISSION MEASUREMENT

4.2.1 RADIATED EMISSION LIMITS (Frequency Range 9KHz -1000MHz)

In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

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
960~1000	500	3

LIMITS OF RADIATED EMISSION MEASUREMENT (Above 1000MHz)

Frequency (MHz)	(dBuV/m) (at 3 meters)	
	PEAK	AVERAGE
Above 1000	74	54

Notes:

(1) The limit for radiated test was performed according to FCC PART 15C.

(2) The tighter limit applies at the band edges.

(3) Emission level (dBuV/m)=20log Emission level (uV/m).

(4) The test result calculated as following:

Measurement Value = Reading Level + Correct Factor

Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain(if use)

Margin Level = Measurement Value - Limit Value

LIMITS OF RADIATED EMISSION MEASUREMENT (Above 1000MHz)

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RBW / VBW (emission in restricted band)	1 MHz / 1 MHz for Peak, 1 MHz / 10Hz for Average

Spectrum Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9KHz ~90KHz for PK/AVG detector
Start ~ Stop Frequency	90KHz ~110KHz for QP detector
Start ~ Stop Frequency	110KHz ~490KHz for PK/AVG detector
Start ~ Stop Frequency	490KHz ~30MHz for QP detector
Start ~ Stop Frequency	30MHz~1000MHz for QP detector

4.2.2 TEST PROCEDURE

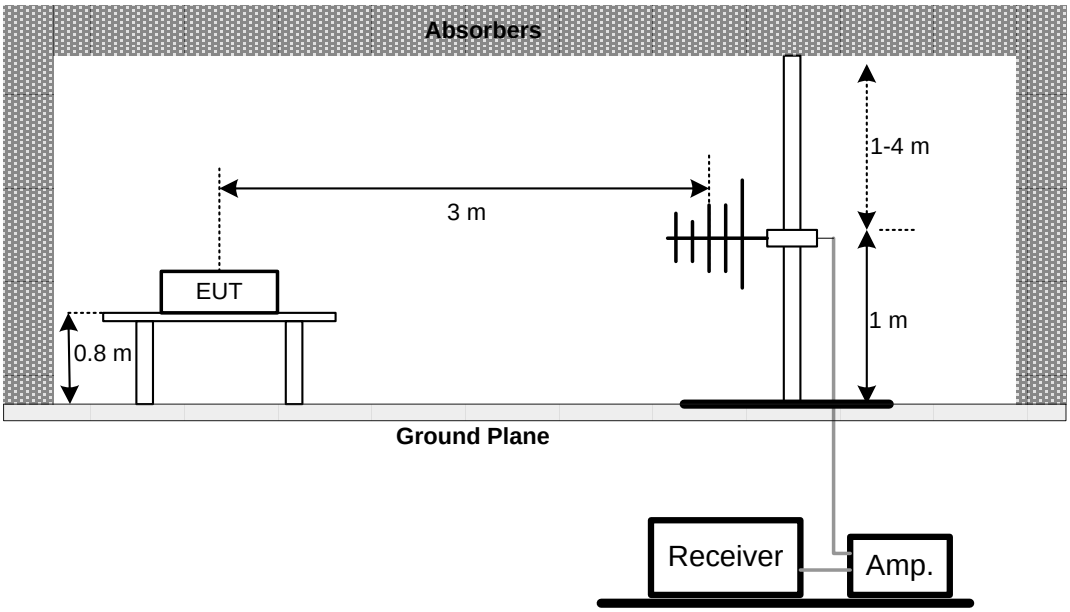
a. The measuring distance of 3 m shall be used for measurements. The EUT was placed on the top of a rotating table 0.8 meter above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.(below 1GHz)
b. The measuring distance of 3 m shall be used for measurements. The EUT was placed on the top of a rotating table 1.5 meter above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.(above 1GHz)
c. The height of the equipment or of the substitution antenna shall be 0.8m or 1.5m; the height of the test antenna shall vary between 1 m to 4 m. 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 find the maximum reading (used Bore sight function).
e. The receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1GHz.
f. The initial step in collecting radiated emission data is a receiver peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.
g. All readings are Peak unless otherwise stated QP in column of Note. Peak denotes that the Peak reading compliance with the QP Limits and then QP Mode measurement didn‘t perform. (below 1GHz)
h. All readings are Peak Mode value unless otherwise stated AVG in column of Note. If the Peak Mode Measured value compliance with the Peak Limits and lower than AVG Limits, the EUT shall be deemed to meet both Peak & AVG Limits and then only Peak Mode was measured, but AVG Mode didn‘t perform. (above 1GHz)
i. For the actual test configuration, please refer to the related Item –EUT Test Photos.

4.2.3 DEVIATION FROM TEST STANDARD

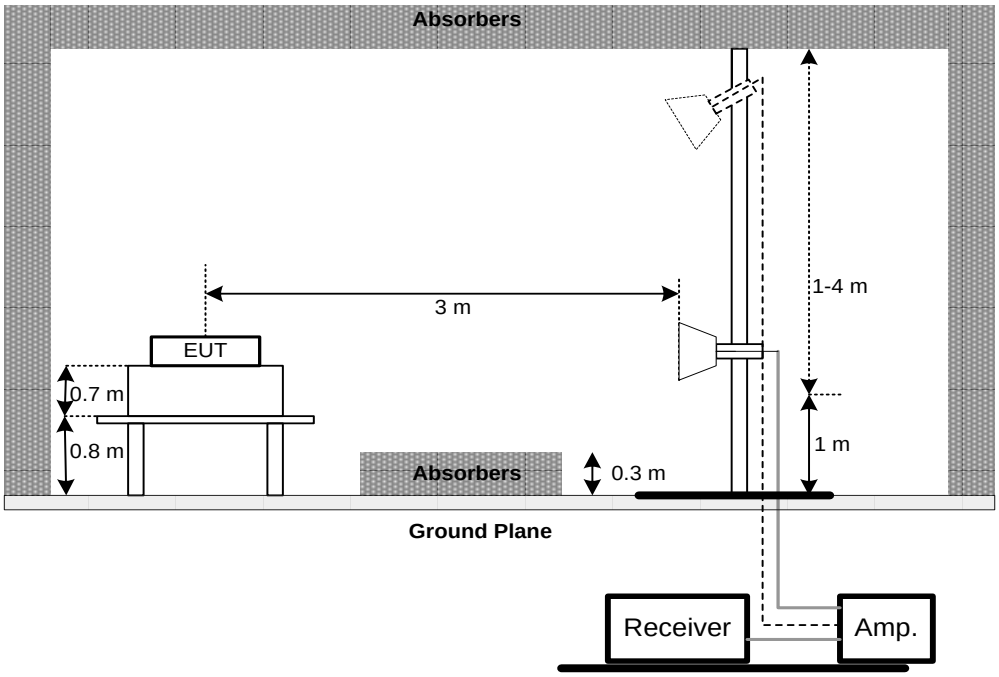
No deviation

4.2.4 TEST SETUP

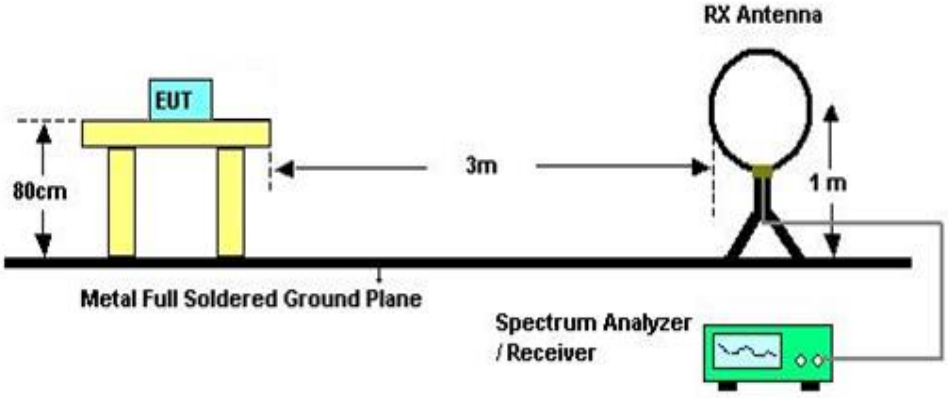
(A) Radiated Emission Test Set-Up Frequency Below 1 GHz



(B) Radiated Emission Test Set-Up Frequency Above 1 GHz



(C) For Radiated Emissions Below 30MHz



4.2.5 EUT OPERATING CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

4.2.6 EUT TEST CONDITIONS

Temperature: 25°C
Relative Humidity: 55%
Test Voltage: AC 120V/60Hz

4.2.7 TEST RESULTS (9KHZ TO 30MHZ)

Please refer to the Appendix B

Remark:

(1) The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.
(2) Distance extrapolation factor = 40 log (specific distance / test distance) (dB).
(3) Limit line = specific limits (dBuV) + distance extrapolation factor.

4.2.8 TEST RESULTS (30MHZ TO 1000 MHZ)

Please refer to the Appendix C.

4.2.9 TEST RESULTS (ABOVE 1000 MHZ)

Please refer to the Appendix D.

Remark:

(1) No limit: This is fundamental signal, the judgment is not applicable.
For fundamental signal judgment was referred to Peak output test.

5. NUMBER OF HOPPING CHANNEL

5.1 APPLIED PROCEDURES

FCC Part15 (15.247) , Subpart C			
Section	Test Item	Frequency Range (MHz)	Result
15.247(a)(1)(iii)	Number of Hopping Channel	2400-2483.5	PASS

Spectrum Parameters	Setting
Attenuation	Auto
Span Frequency	> Operating Frequency Range
RBW	100 KHz
VBW	100 KHz
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

5.1.1 TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below,
b. Spectrum Setting: RBW=100KHz, VBW=100KHz, Sweep time = Auto.

5.1.2 DEVIATION FROM STANDARD

No deviation.

5.1.3 TEST SETUP

5.1.4 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 4.1.5 unless otherwise a special operating condition is specified in the follows during the testing.

5.1.5 EUT TEST CONDITIONS

Temperature: 25°C
Relative Humidity: 55%
Test Voltage: AC 120V/60Hz

5.1.6 TEST RESULTS

Please refer to the Appendix E

6. AVERAGE TIME OF OCCUPANCY

6.1 APPLIED PROCEDURES / LIMIT

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(a)(1)(iii)	Average Time of Occupancy	0.4sec	2400-2483.5	PASS

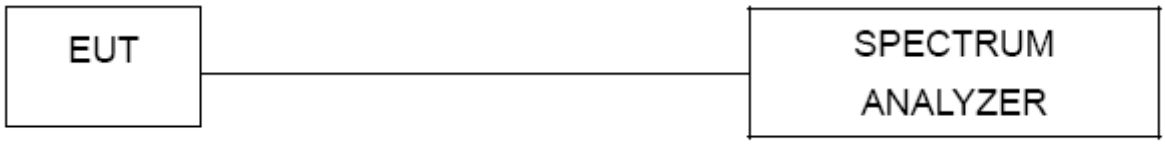
6.1.1 TEST PROCEDURE

a. The transmitter output (antenna port) was connected to the spectrum analyzer
b. Set RBW of spectrum analyzer to 1MHz and VBW to 1MHz.
c. Use a video trigger with the trigger level set to enable triggering only on full pulses.
d. Sweep Time is more than once pulse time.
e. Set the center frequency on any frequency would be measure and set the frequency span to zero span.
f. Measure the maximum time duration of one single pulse.
g. AFH: Packet permit maximum 416/16/15 = 1.733 hops per second in each channel(12 time slots Tx, 4 time slots Stop). So, the dwell time is the time duration of the pulse times 1.733 x 6 = 10.4 within 6 seconds.

6.1.2 DEVIATION FROM STANDARD

No deviation.

6.1.3 TEST SETUP



6.1.4 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 4.1.5 unless otherwise a special operating condition is specified in the follows during the testing.

6.1.5 EUT TEST CONDITIONS

Temperature: 25°C
Relative Humidity: 55%
Test Voltage: AC 120V/60Hz

6.1.6 TEST RESULTS

Please refer to the Appendix F

7. HOPPING CHANNEL SEPARATION MEASUREMENT

7.1 APPLIED PROCEDURES / 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.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	> Measurement Bandwidth or Channel Separation
RBW	30 KHz
VBW	100 KHz
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

7.1.1 TEST PROCEDURE

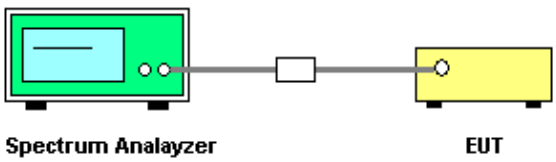
a. The EUT must have its hopping function enabled

b. Span = wide enough to capture the peaks of two adjacent channels
Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span
Video (or Average) Bandwidth (VBW) ≥ RBW
Sweep = Auto
Detector function = Peak
Trace = Max Hold

7.1.2 DEVIATION FROM STANDARD

No deviation.

7.1.3 TEST SETUP



7.1.4 EUT TEST CONDITIONS

Temperature: 25°C
Relative Humidity: 55%
Test Voltage: AC 120V/60Hz

7.1.5 TEST RESULTS

Please refer to the Appendix G

8. BANDWIDTH TEST

8.1 APPLIED PROCEDURES

FCC Part15 (15.247) , Subpart C		
Section	Test Item	Frequency Range (MHz)
15.247(a)(2)	Bandwidth	2400-2483.5

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	> Measurement Bandwidth or Channel Separation
RBW	30 KHz (20dB Bandwidth) / 30 KHz (Channel Separation)
VBW	100 KHz (20dB Bandwidth) / 100 KHz (Channel Separation)
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

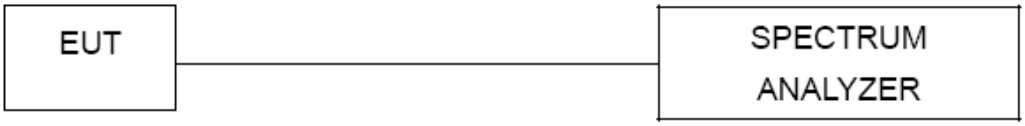
8.1.1 TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below,
b. Spectrum Setting: RBW= 30KHz, VBW=100KHz, Sweep Time = Auto.

8.1.2 DEVIATION FROM STANDARD

No deviation.

8.1.3 TEST SETUP



8.1.4 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 4.1.5 unless otherwise a special operating condition is specified in the follows during the testing.

8.1.5 EUT TEST CONDITIONS

Temperature: 25°C
Relative Humidity: 55%
Test Voltage: AC 120V/60Hz

8.1.6 TEST RESULTS

Please refer to the Appendix H

9. PEAK OUTPUT POWER TEST

9.1 APPLIED PROCEDURES / LIMIT

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(b)(1)	Peak Output Power	1 Watt or 30dBm (hopping channel >75) 0.125Watt or 21dBm (hopping channel <75	2400-2483.5	PASS

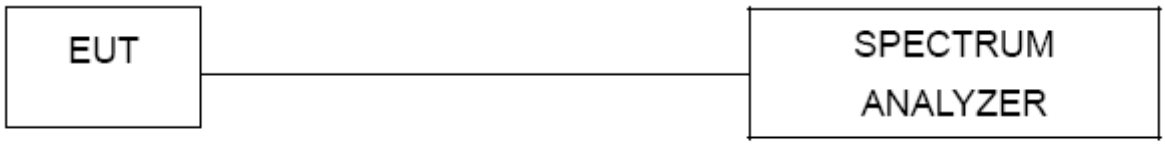
9.1.1 TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below,
b. Spectrum Setting: RBW= 1MHz/3MHz, VBW= 1MHz/3MHz, Sweep time = Auto.

9.1.2 DEVIATION FROM STANDARD

No deviation.

9.1.3 TEST SETUP



9.1.4 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 4.1.5 unless otherwise a special operating condition is specified in the follows during the testing.

9.1.5 EUT TEST CONDITIONS

Temperature: 25°C
Relative Humidity: 55%
Test Voltage: AC 120V/60Hz

9.1.6 TEST RESULTS

Please refer to the Appendix I

10. ANTENNA CONDUCTED SPURIOUS EMISSION

10.1 APPLIED PROCEDURES / LIMIT

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.

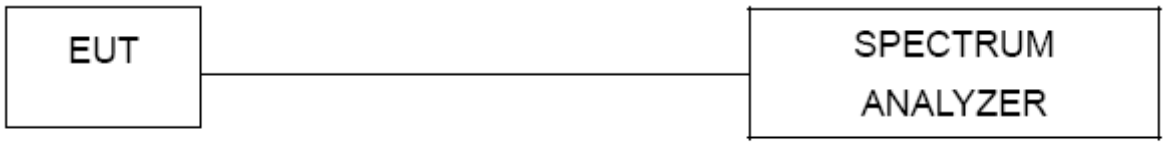
10.1.1 TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below,
b. Spectrum Setting: RBW= 100KHz, VBW=100KHz, Sweep time = Auto.
c. Offset=antenna gain+cable loss

10.1.2 DEVIATION FROM STANDARD

No deviation.

10.1.3 TEST SETUP



10.1.4 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 4.1.5 unless otherwise a special operating condition is specified in the follows during the testing.

10.1.5 EUT TEST CONDITIONS

Temperature: 25°C
Relative Humidity: 55%
Test Voltage: AC 120V/60Hz

10.1.6 TEST RESULTS

Please refer to the Appendix J

11. MEASUREMENT INSTRUMENTS LIST

Conducted Emission Measurement					
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	TWO-LINE V-NETWORK	R&S	ENV216	101050	Jan. 24, 2019
2	Test Cable	TIMES	CFD300-NL	C02	Jun. 13, 2019
3	EMI Test Receiver	R&S	ESR7	101433	Dec. 07, 2018
4	Measurement Software	EZ	EZ_EMC (Version NB-03A)	N/A	N/A

Radiated Emission Measurement					
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Preamplifier	EMCI	012645B	980267	Feb. 27, 2019
2	Preamplifier	EMCI	EMC02325	980217	Dec. 27, 2019
3	Preamplifier	EMCI	EMC2654045	980030	Feb. 13, 2019
4	Test Cable	EMCI	EMC104-SM-SM-8000	8m	Jan. 03, 2019
5	Test Cable	EMCI	EMC104-SM-SM-800	150207	Jan. 03, 2019
6	Test Cable	EMCI	EEMC104-SM-SM-3000	151205	Jan. 03, 2019
7	MXE EMI Receiver	Agilent	N9038A	MY55420127	Jan. 08, 2019
8	Signal Analyzer	Agilent	N9010A	MY52220990	Feb. 21, 2019
9	Loop Ant	EMCO	6502	42960	Nov. 23, 2018
10	Horm Ant	SCHWARZBECK	BBHA 9120D	9120D-1342	Feb. 27, 2019
11	Horm Ant	Schwarzbeck	BBHA 9170	187	Dec. 05, 2018
12	Trilog-Broadband Antenna	Schwarzbeck	VULB 9168	9168-548	Jan. 15, 2019
13	5dB Attenuator	EMCI	EMCI-N-6-05	AT-N0623	Jan. 15, 2019

Number of Hopping Channel					
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Spectrum Analyzer	R&S	R&S/FSP30	100854	May 25, 2018

Average Time of Occupancy					
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Spectrum Analyzer	R&S	R&S/FSP30	100854	May 25, 2018

Hopping Channel Separation Measurement					
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Spectrum Analyzer	R&S	R&S/FSP30	100854	May 25, 2018

Bandwidth					
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Spectrum Analyzer	R&S	R&S/FSP30	100854	May 25, 2018

Peak Output Power					
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Spectrum Analyzer	R&S	R&S/FSP30	100854	May 25, 2018
2	Power Meter	Anritsu	ML2495A	1128008	Aug. 16, 2018
3	Power Sensor	Anritsu	MA2411B	1126001	Aug. 16, 2018

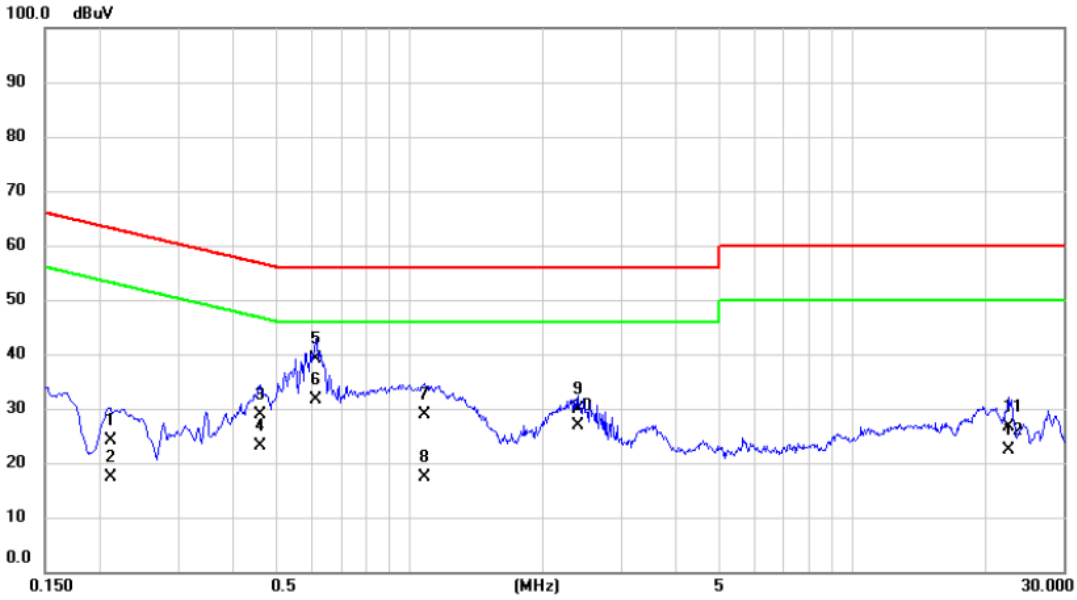
Antenna Conducted Spurious Emission					
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Spectrum Analyzer	R&S	R&S/FSP30	100854	May 25, 2018

Remark: “N/A” denotes no model name, serial no. or calibration specified.
All calibration period of equipment list is one year.

APPENDIX A - CONDUCTED EMISSION

Test Mode:	TX Mode

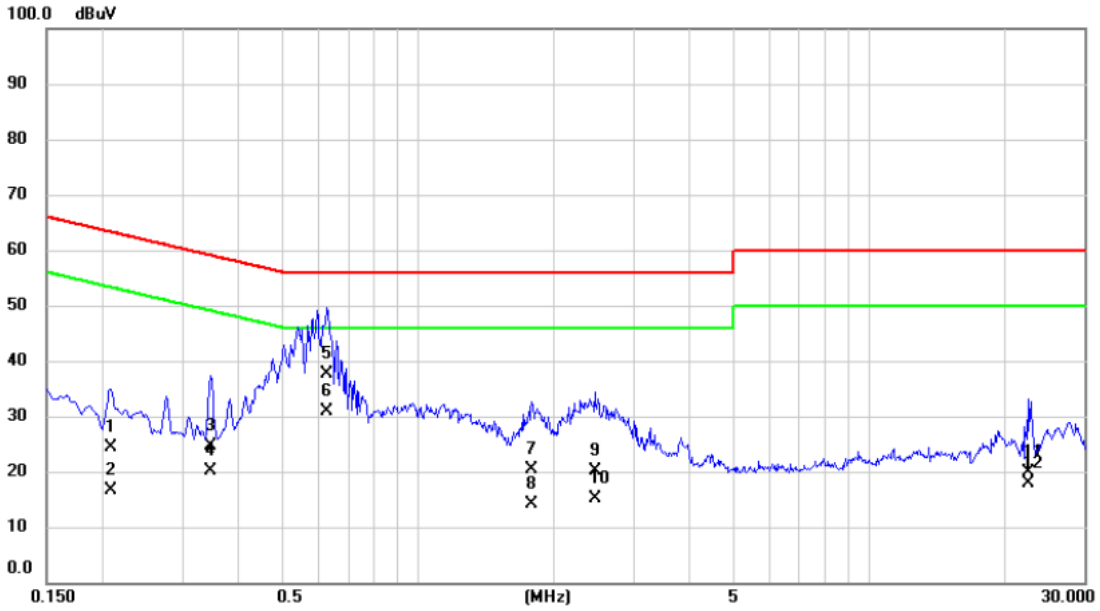
Line



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.2108	14.60	9.63	24.23	63.17	-38.94	QP	
2		0.2108	7.80	9.63	17.43	53.17	-35.74	AVG	
3		0.4582	19.20	9.66	28.86	56.73	-27.87	QP	
4		0.4582	13.40	9.66	23.06	46.73	-23.67	AVG	
5		0.6134	29.50	9.66	39.16	56.00	-16.84	QP	
6	*	0.6134	21.90	9.66	31.56	46.00	-14.44	AVG	
7		1.0770	19.20	9.67	28.87	56.00	-27.13	QP	
8		1.0770	7.60	9.67	17.27	46.00	-28.73	AVG	
9		2.3955	20.20	9.70	29.90	56.00	-26.10	QP	
10		2.3955	17.10	9.70	26.80	46.00	-19.20	AVG	
11		22.4834	16.70	9.96	26.66	60.00	-33.34	QP	
12		22.4834	12.30	9.96	22.26	50.00	-27.74	AVG	

Test Mode:	TX Mode

Neutral

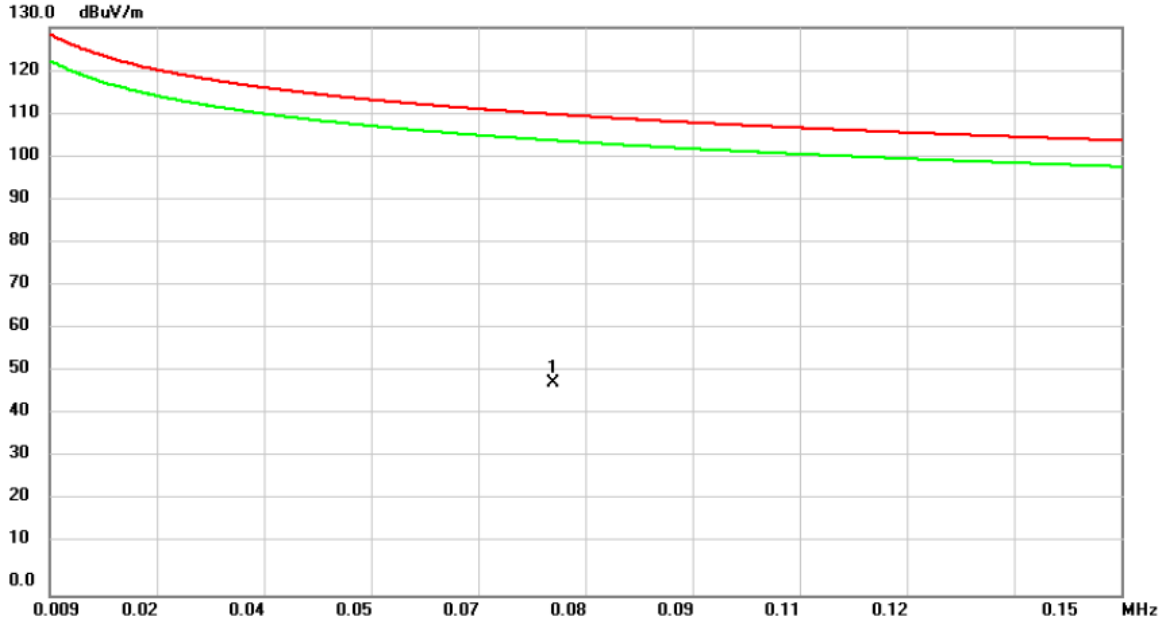


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.2085	14.70	9.61	24.31	63.26	-38.95	QP	
2		0.2085	7.10	9.61	16.71	53.26	-36.55	AVG	
3		0.3457	15.10	9.64	24.74	59.07	-34.33	QP	
4		0.3457	10.50	9.64	20.14	49.07	-28.93	AVG	
5		0.6292	28.00	9.65	37.65	56.00	-18.35	QP	
6	*	0.6292	21.30	9.65	30.95	46.00	-15.05	AVG	
7		1.7880	10.60	9.67	20.27	56.00	-35.73	QP	
8		1.7880	4.40	9.67	14.07	46.00	-31.93	AVG	
9		2.4698	10.50	9.68	20.18	56.00	-35.82	QP	
10		2.4698	5.50	9.68	15.18	46.00	-30.82	AVG	
11		22.4813	10.00	9.98	19.98	60.00	-40.02	QP	
12		22.4813	7.90	9.98	17.88	50.00	-32.12	AVG	

APPENDIX B - RADIATED EMISSION (9KHZ-30MHZ)

Test Mode:	TX Mode

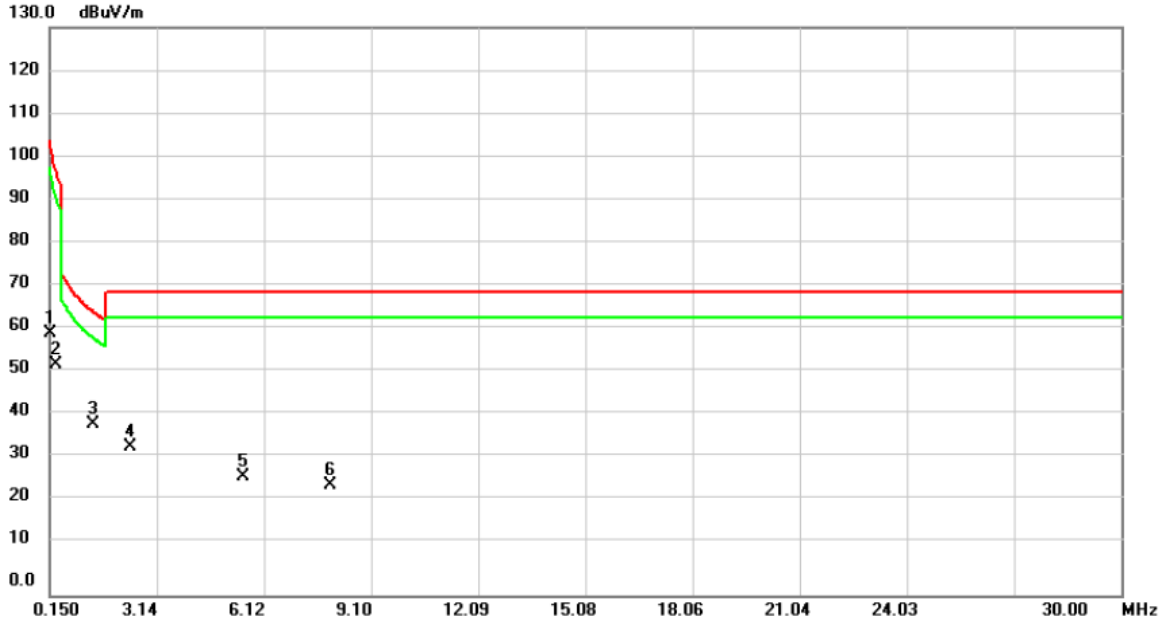
Ant 0°



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1	*	0.0752	36.20	12.55	48.75	110.08	-61.33	peak	

Test Mode:	TX Mode

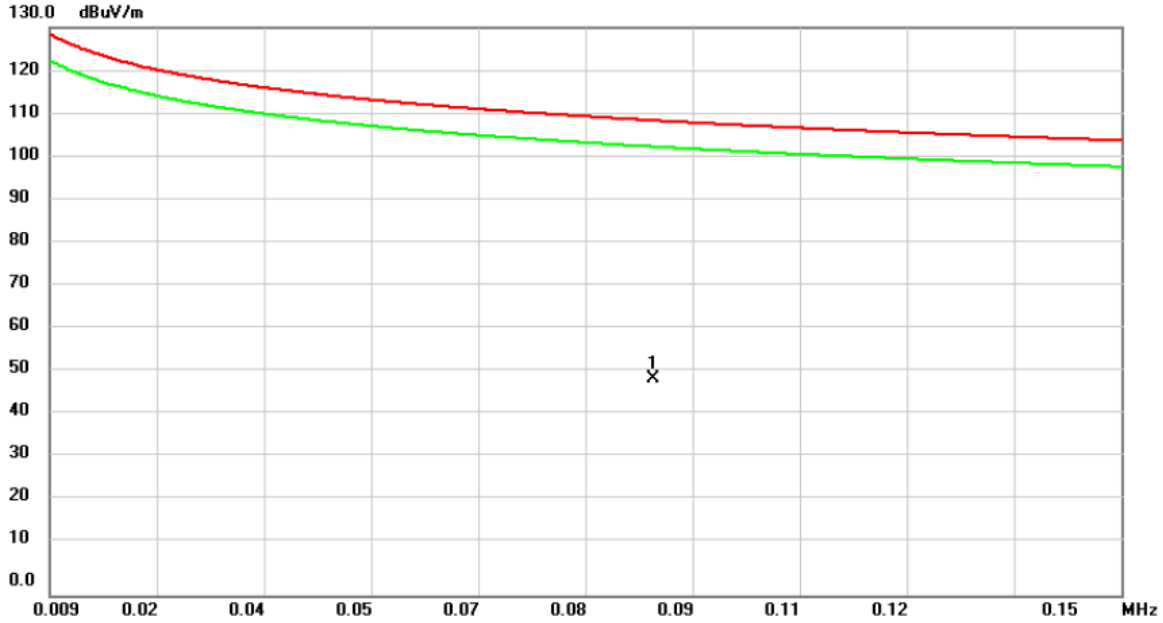
Ant 0°



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		0.1500	47.93	12.03	59.96	104.08	-44.12	peak	
2		0.3291	40.93	11.80	52.73	97.26	-44.53	peak	
3	*	1.3440	27.36	11.85	39.21	65.04	-25.83	peak	
4		2.3887	22.56	11.38	33.94	69.54	-35.60	peak	
5		5.5230	15.90	11.39	27.29	69.54	-42.25	peak	
6		7.9706	13.82	11.34	25.16	69.54	-44.38	peak	

Test Mode:	TX Mode

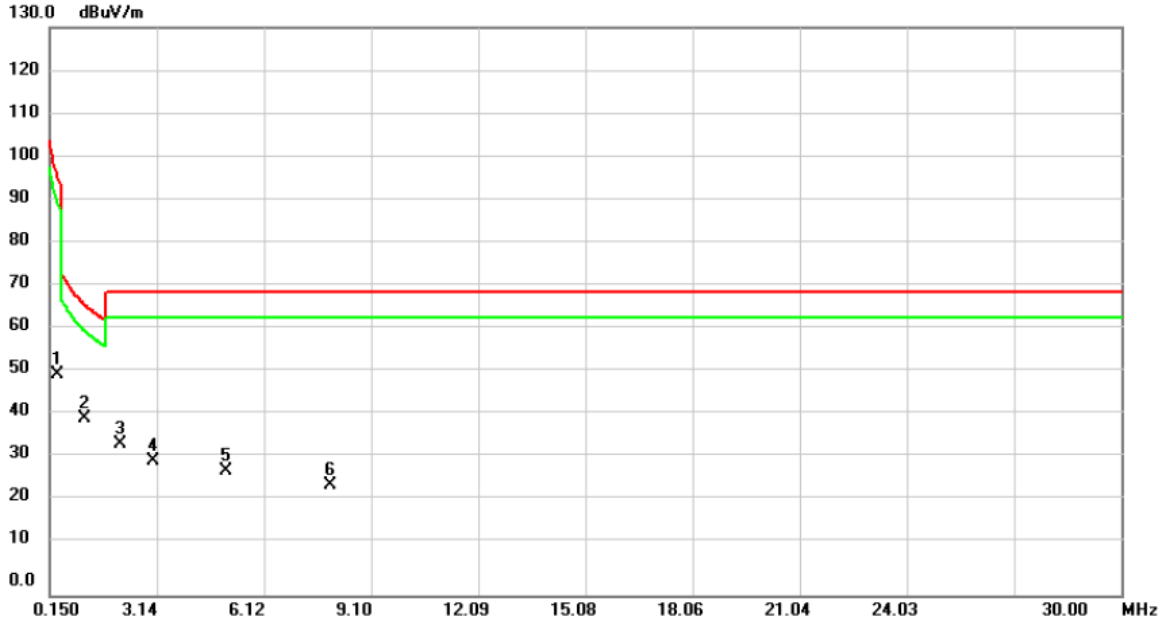
Ant 90°



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1	*	0.0884	37.28	12.31	49.59	108.68	-59.09	peak	

Test Mode:	TX Mode

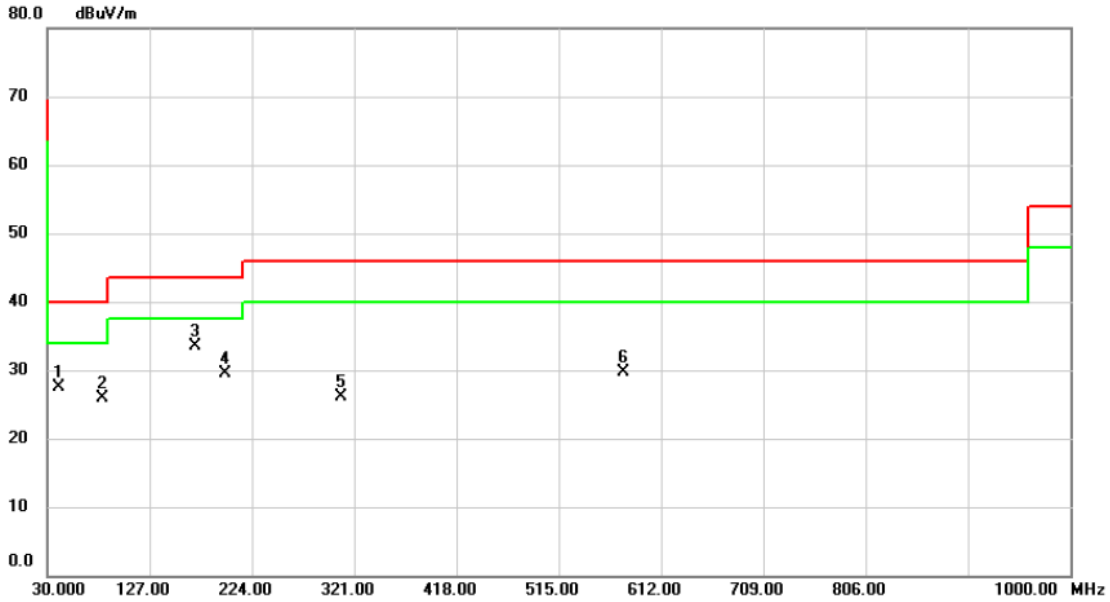
Ant 90°



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		0.3886	38.80	11.80	50.60	95.81	-45.21	peak	
2	*	1.1350	28.52	11.94	40.46	66.50	-26.04	peak	
3		2.1200	23.06	11.50	34.56	69.54	-34.98	peak	
4		3.0455	19.49	11.11	30.60	69.54	-38.94	peak	
5		5.0750	16.98	11.40	28.38	69.54	-41.16	peak	
6		7.9706	13.82	11.34	25.16	69.54	-44.38	peak	

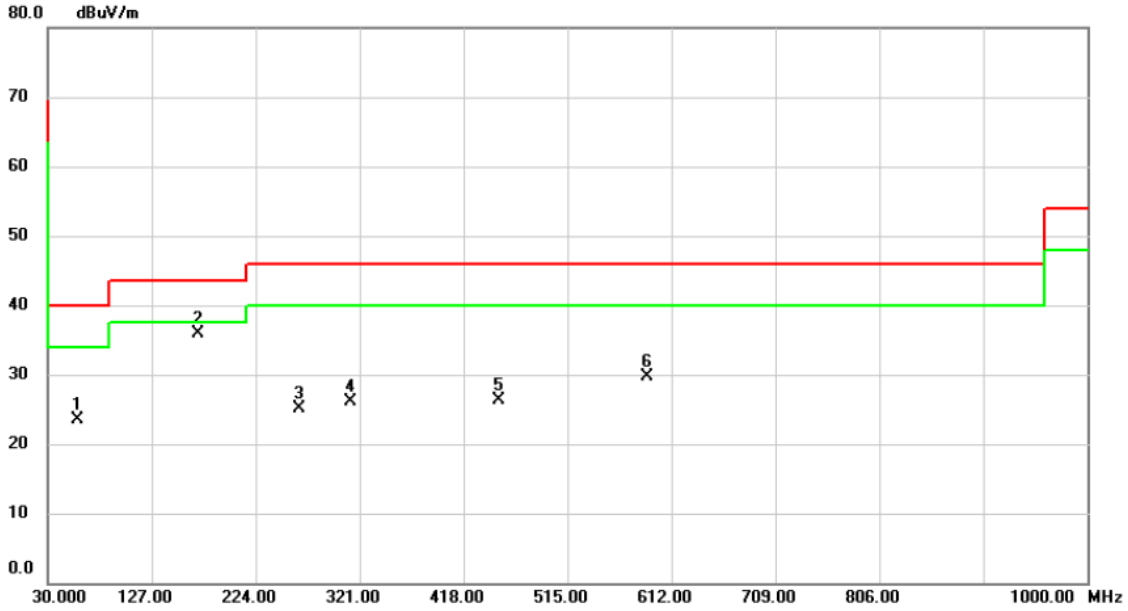
APPENDIX C - RADIATED EMISSION (30MHZ TO 1000MHZ)

Test Mode	TX 2478MHz _CH37	Polarization	Vertical



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		40.6700	36.01	-8.56	27.45	40.00	-12.55	peak	
2		82.3800	38.68	-12.83	25.85	40.00	-14.15	peak	
3	*	169.6800	42.45	-8.85	33.60	43.50	-9.90	peak	
4		198.7800	40.48	-10.90	29.58	43.50	-13.92	peak	
5		308.3900	33.44	-7.28	26.16	46.00	-19.84	peak	
6		576.1100	30.91	-1.18	29.73	46.00	-16.27	peak	

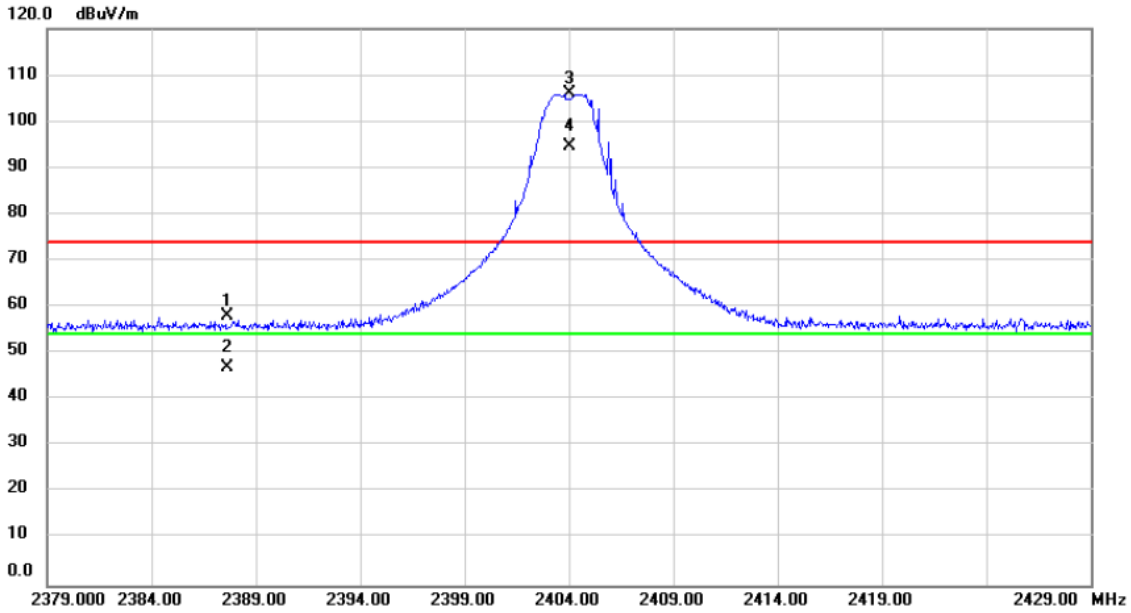
Test Mode	TX 2478MHz _CH37	Polarization	Horizontal



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		57.1600	32.03	-8.54	23.49	40.00	-16.51	peak	
2	*	169.6800	44.79	-8.85	35.94	43.50	-7.56	peak	
3		264.7400	33.41	-8.38	25.03	46.00	-20.97	peak	
4		312.2700	33.24	-7.18	26.06	46.00	-19.94	peak	
5		450.9800	30.09	-3.79	26.30	46.00	-19.70	peak	
6		588.7200	30.38	-0.77	29.61	46.00	-16.39	peak	

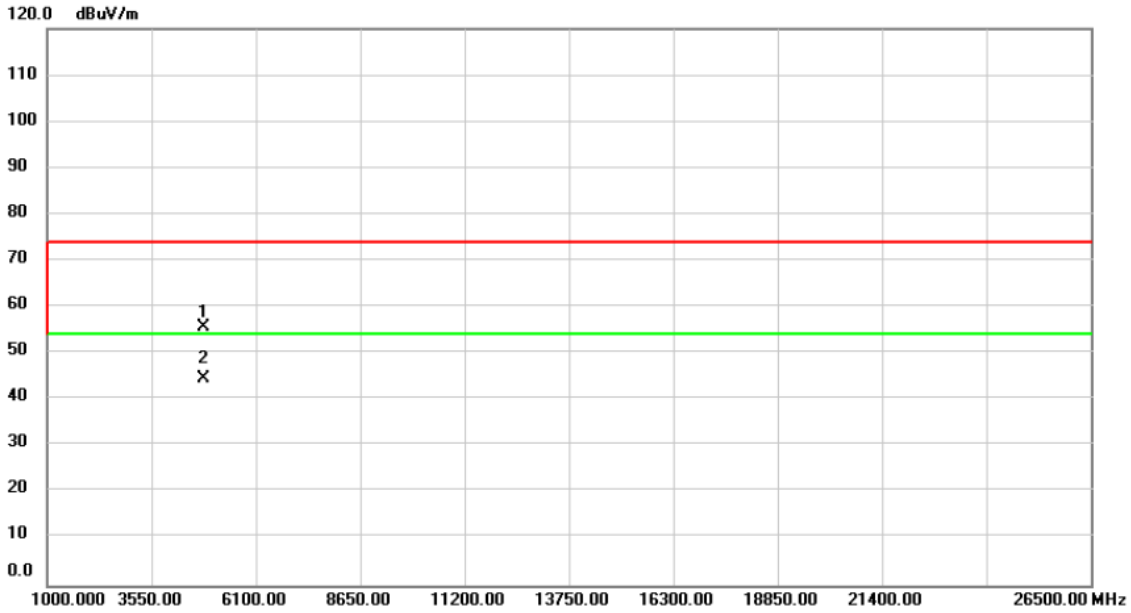
APPENDIX D - RADIATED EMISSION (ABOVE 1000MHZ)

Test Mode	TX Mode 2404MHz _CH00	Polarization	Vertical



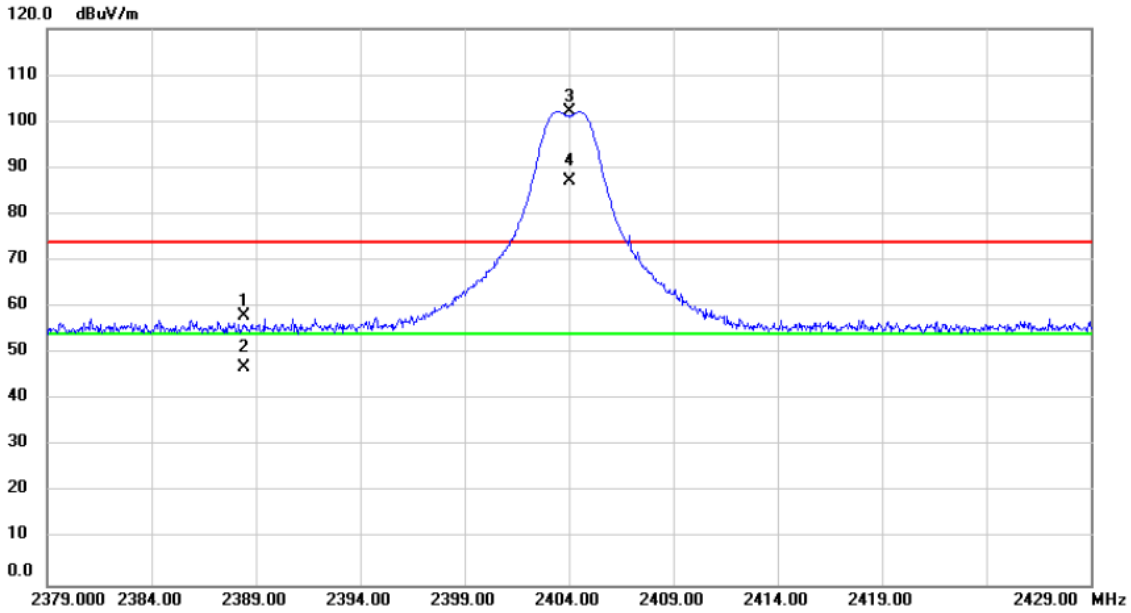
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		2387.613	26.92	31.06	57.98	74.00	-16.02	peak	
2		2387.613	15.76	31.06	46.82	54.00	-7.18	AVG	
3	X	2404.000	74.81	31.12	105.93	74.00	31.93	peak	No Limit
4	*	2404.000	63.65	31.12	94.77	54.00	40.77	AVG	No Limit

Test Mode	TX Mode 2404MHz _CH00	Polarization	Vertical



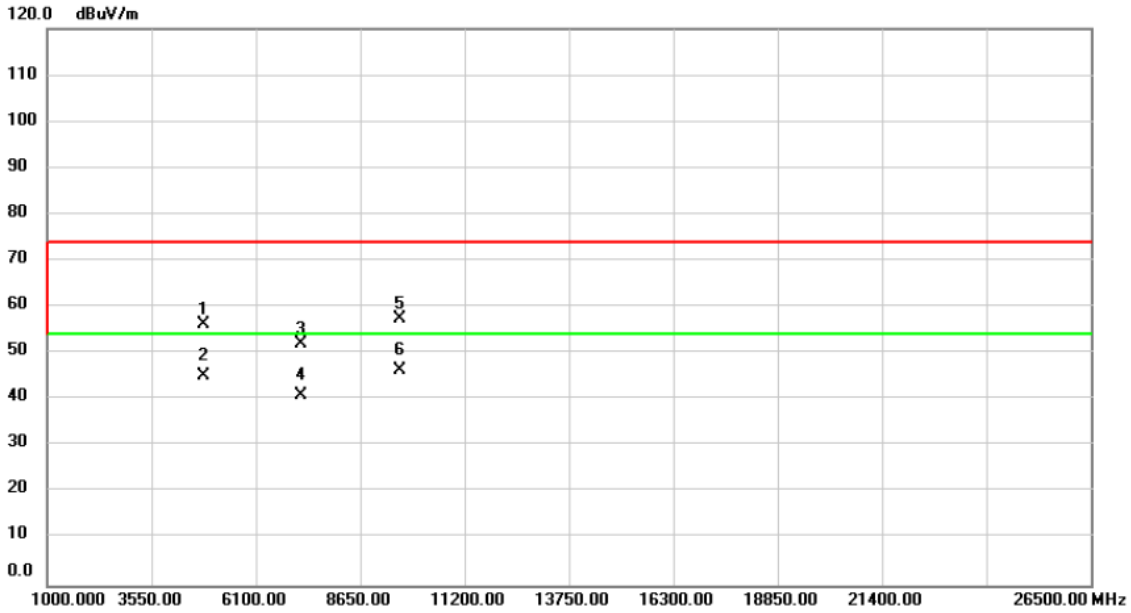
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		4808.000	67.04	-11.40	55.64	74.00	-18.36	peak	
2	*	4808.000	55.88	-11.40	44.48	54.00	-9.52	AVG	

Test Mode	TX Mode 2404MHz _CH00	Polarization	Horizontal



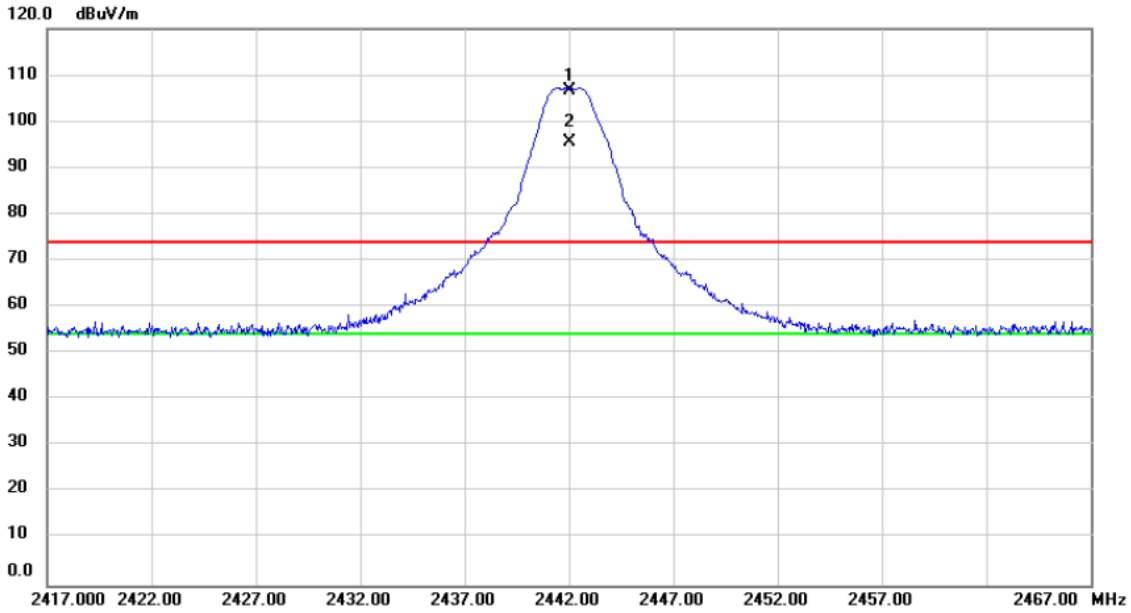
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		2388.438	27.05	31.06	58.11	74.00	-15.89	peak	
2		2388.438	15.89	31.06	46.95	54.00	-7.05	AVG	
3	X	2404.000	71.10	31.12	102.22	74.00	28.22	peak	No Limit
4	*	2404.000	55.94	31.12	87.06	54.00	33.06	AVG	No Limit

Test Mode	TX Mode 2404MHz _CH00	Polarization	Horizontal



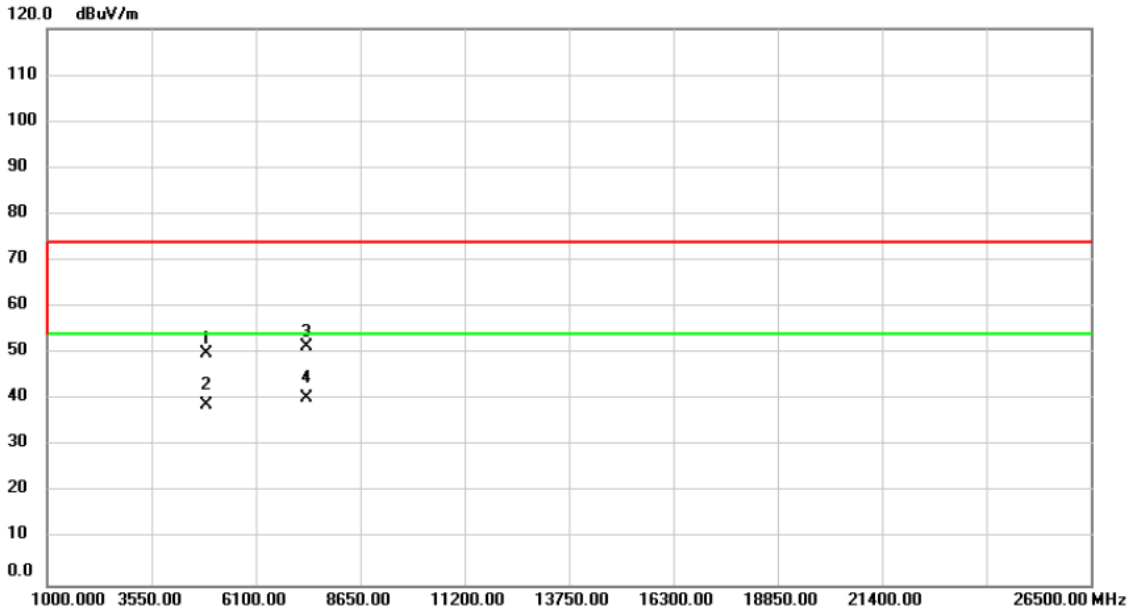
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		4808.000	66.66	-10.41	56.25	74.00	-17.75	peak	
2		4808.000	55.50	-10.41	45.09	54.00	-8.91	AVG	
3		7212.000	56.33	-4.36	51.97	74.00	-22.03	peak	
4		7212.000	45.17	-4.36	40.81	54.00	-13.19	AVG	
5		9616.000	55.75	1.76	57.51	74.00	-16.49	peak	
6	*	9616.000	44.59	1.76	46.35	54.00	-7.65	AVG	

Test Mode	TX Mode 2442MHz _CH19	Polarization	Vertical



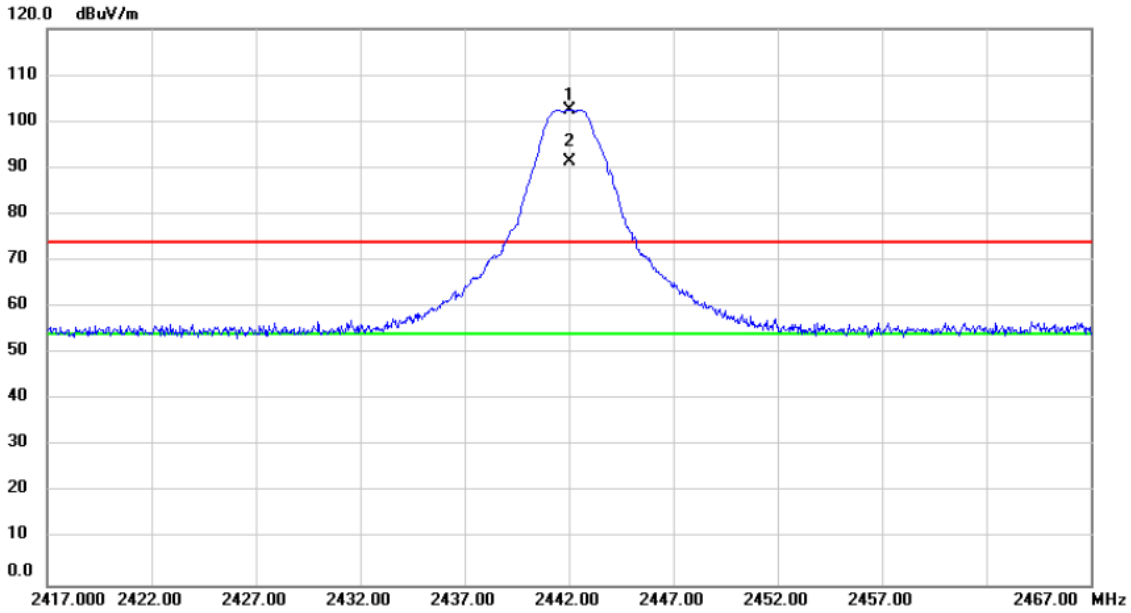
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1	X	2442.000	75.30	31.26	106.56	74.00	32.56	peak	No Limit
2	*	2442.000	64.14	31.26	95.40	54.00	41.40	AVG	No Limit

Test Mode	TX Mode 2442MHz _CH19	Polarization	Vertical



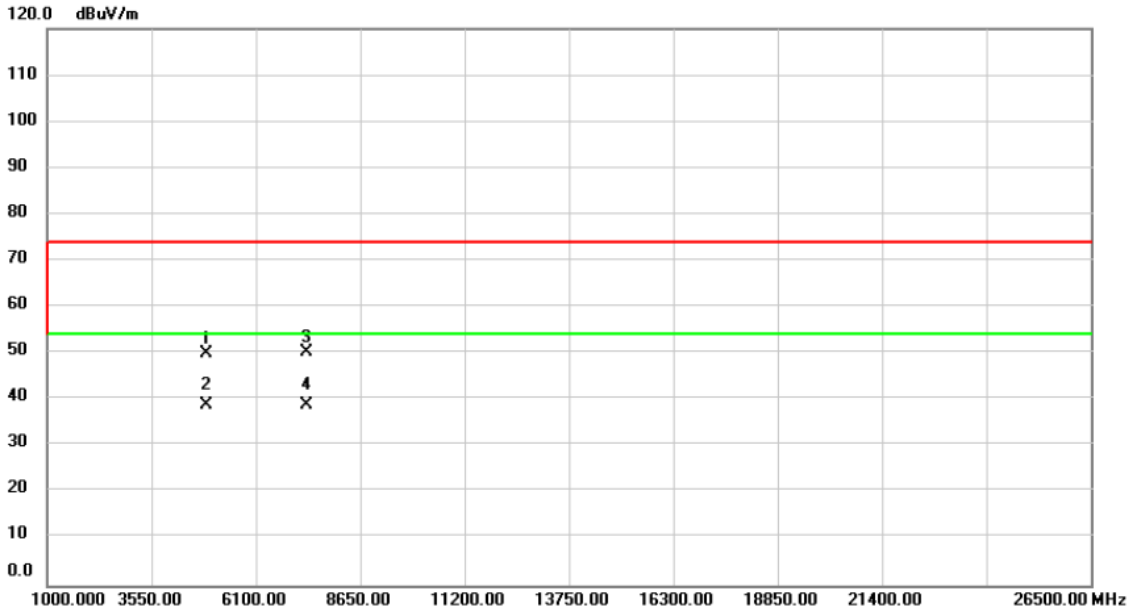
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		4884.000	61.23	-11.28	49.95	74.00	-24.05	peak	
2		4884.000	50.07	-11.28	38.79	54.00	-15.21	AVG	
3		7326.000	56.65	-5.09	51.56	74.00	-22.44	peak	
4	*	7326.000	45.49	-5.09	40.40	54.00	-13.60	AVG	

Test Mode	TX Mode 2442MHz _CH19	Polarization	Horizontal



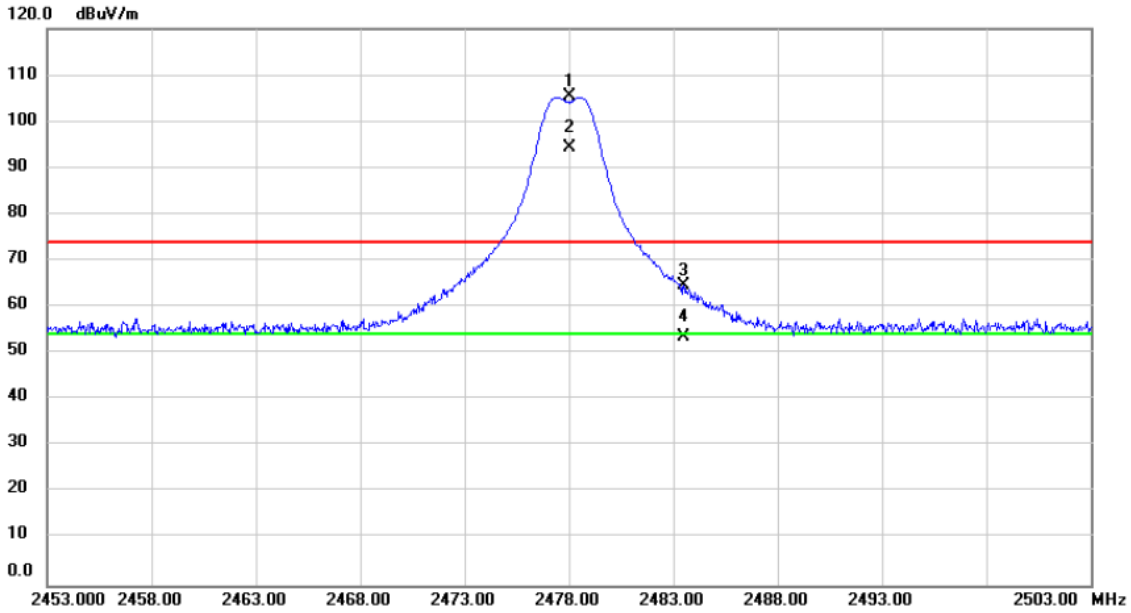
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1	X	2442.000	71.27	31.26	102.53	74.00	28.53	peak	No Limit
2	*	2442.000	60.11	31.26	91.37	54.00	37.37	AVG	No Limit

Test Mode	TX Mode 2442MHz _CH19	Polarization	Horizontal



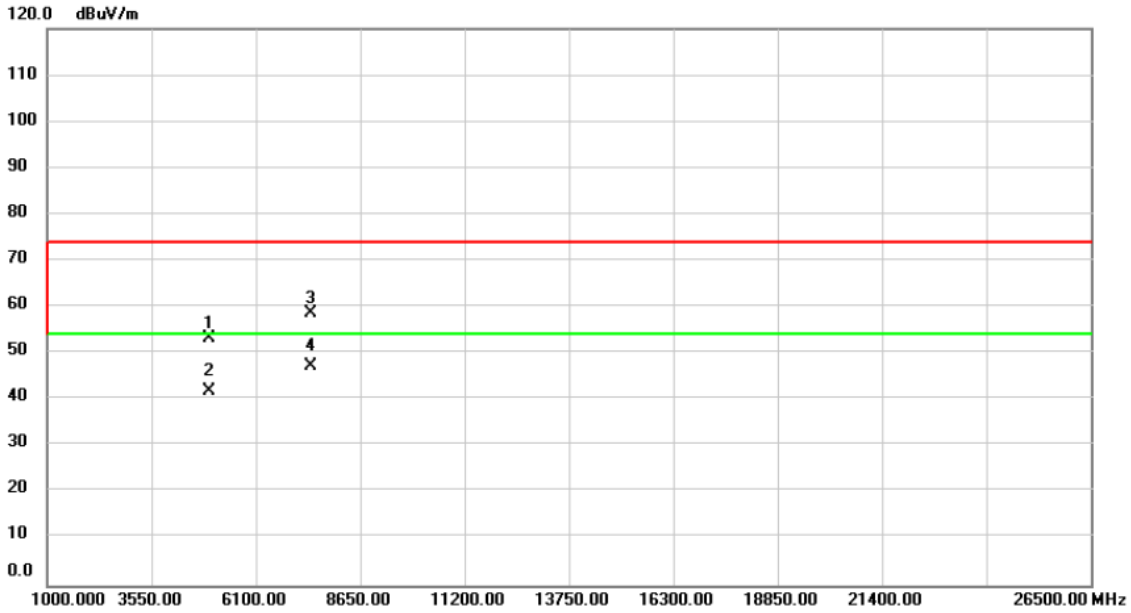
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		4884.000	61.18	-11.28	49.90	74.00	-24.10	peak	
2		4884.000	50.02	-11.28	38.74	54.00	-15.26	AVG	
3		7326.000	55.24	-5.09	50.15	74.00	-23.85	peak	
4	*	7326.000	44.08	-5.09	38.99	54.00	-15.01	AVG	

Test Mode	TX Mode 2478MHz _CH37	Polarization	Vertical



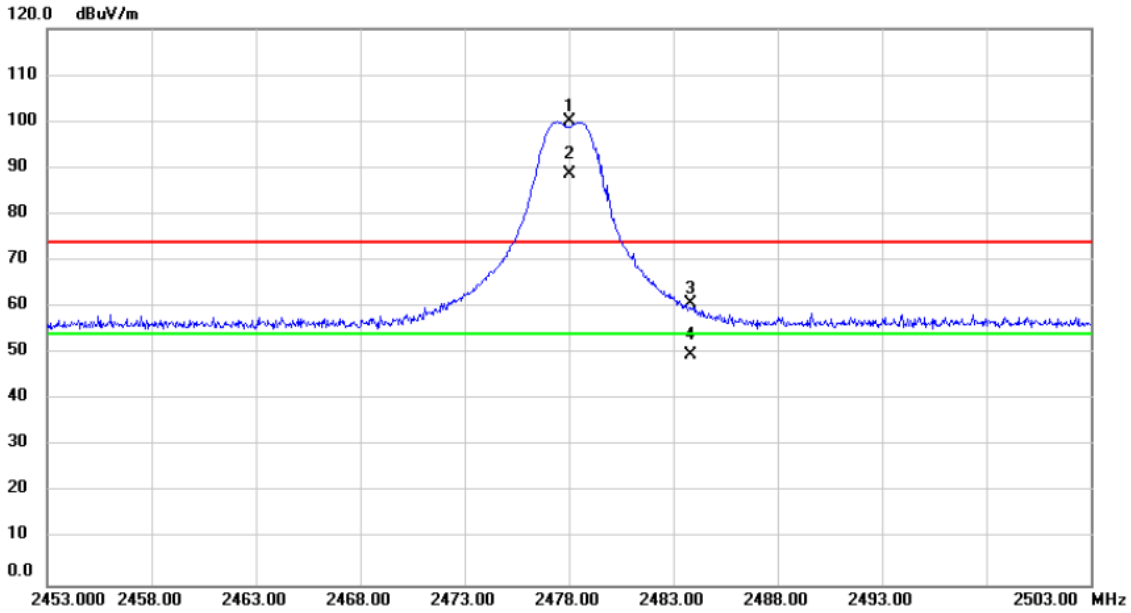
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1	X	2478.000	74.02	31.39	105.41	74.00	31.41	peak	No Limit
2	*	2478.000	62.86	31.39	94.25	54.00	40.25	AVG	No Limit
3		2483.519	33.39	31.41	64.80	74.00	-9.20	peak	
4		2483.519	22.23	31.41	53.64	54.00	-0.36	AVG	

Test Mode	TX Mode 2478MHz _CH37	Polarization	Vertical



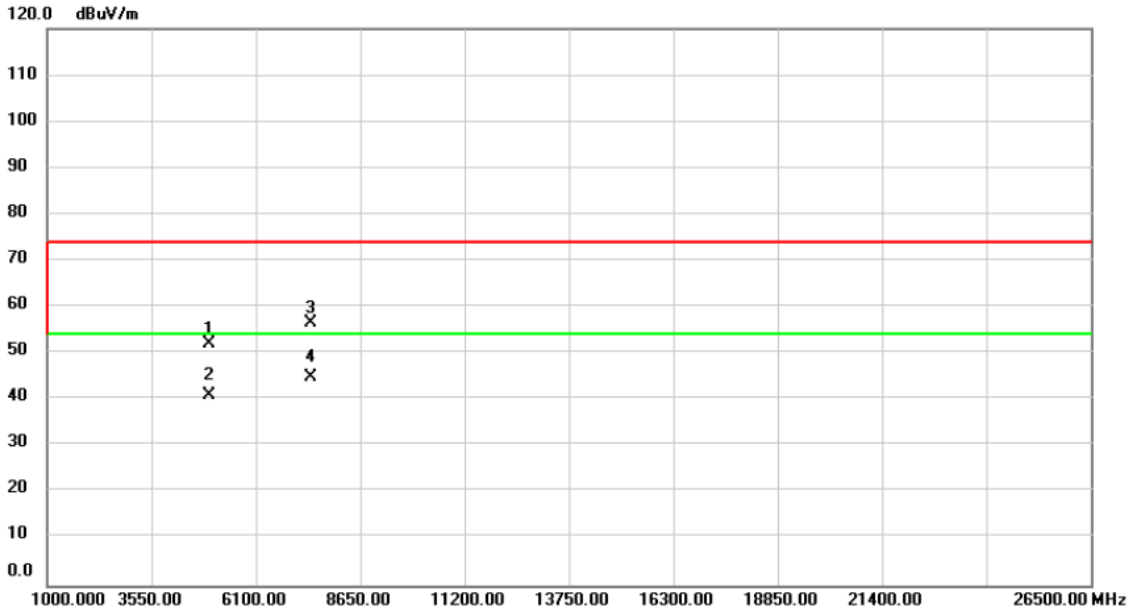
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		4956.000	63.31	-10.17	53.14	74.00	-20.86	peak	
2		4956.000	52.15	-10.17	41.98	54.00	-12.02	AVG	
3		7434.000	62.12	-3.56	58.56	74.00	-15.44	peak	
4	*	7434.000	50.96	-3.56	47.40	54.00	-6.60	AVG	

Test Mode	TX Mode 2478MHz _CH37	Polarization	Horizontal



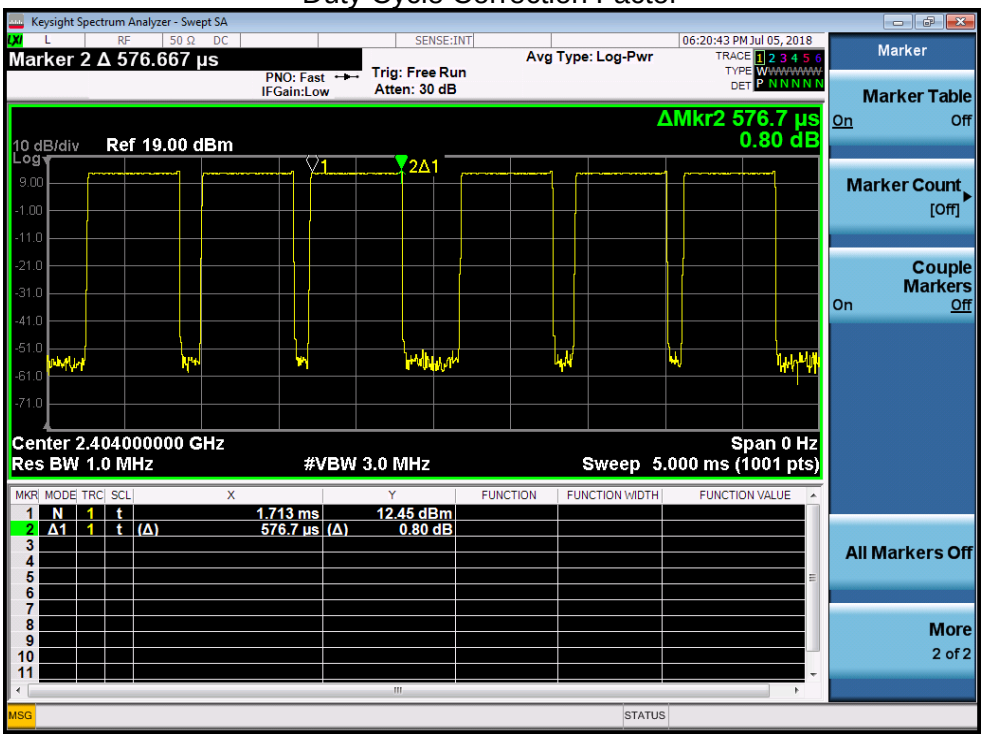
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1	X	2478.000	68.58	31.39	99.97	74.00	25.97	peak	No Limit
2	*	2478.000	57.40	31.39	88.79	54.00	34.79	AVG	No Limit
3		2483.812	29.26	31.41	60.67	74.00	-13.33	peak	
4		2483.812	18.10	31.41	49.51	54.00	-4.49	AVG	

Test Mode	TX Mode 2478MHz _CH37	Polarization	Horizontal



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		4956.000	62.35	-10.17	52.18	74.00	-21.82	peak	
2		4956.000	51.19	-10.17	41.02	54.00	-12.98	AVG	
3		7434.000	60.00	-3.56	56.44	74.00	-17.56	peak	
4	*	7434.000	48.35	-3.56	44.79	54.00	-9.21	AVG	

Duty Cycle Correction Factor



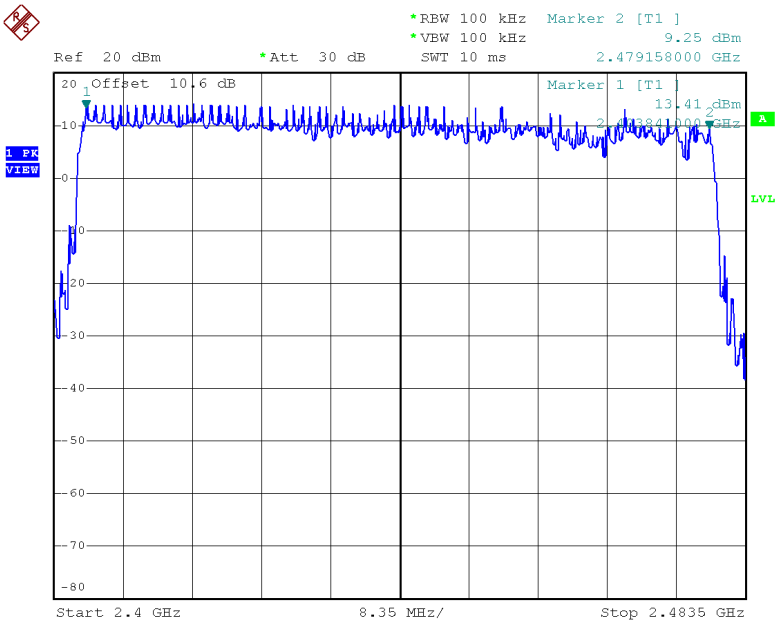
Count Pulses Plot

20log(Dwell Time/100ms)=20log(Time On*Number of hopping/100ms)			
Time On(ms)	Number of hopping	Dwell Time	20log(Dwell Time/100ms)
1.7301	16	27.6816	-11.16

The average values are:
Average = Peak value + 20log (Dwell Time/100ms).
Where the duty cycle correction factor is calculated from flowing formula:
20log (Dwell Time/100ms) = 20log (27.6816/100) = -11.16
Please see as below for plotted duty.

APPENDIX E - NUMBER OF HOPPING CHANNEL

Test Mode	Hopping Mode
Number of Hopping Channel	38



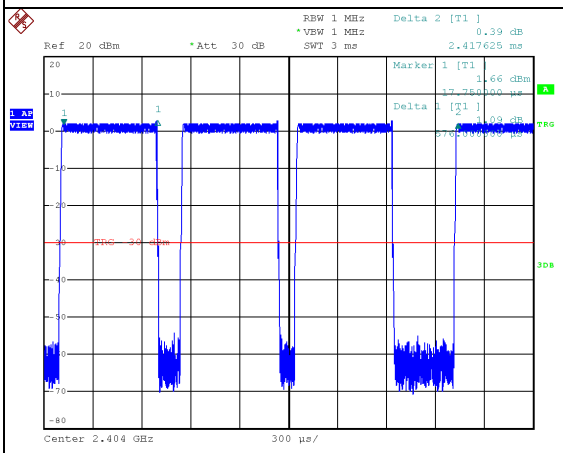
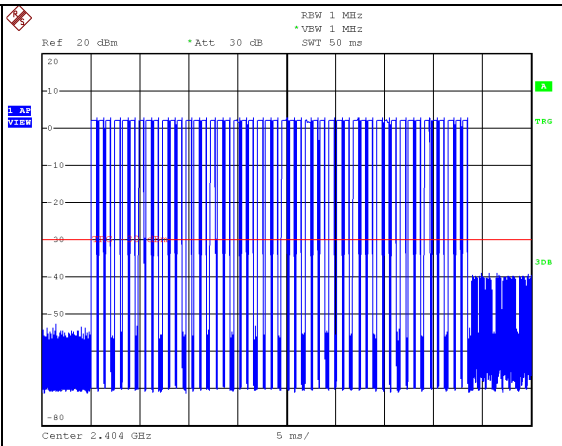
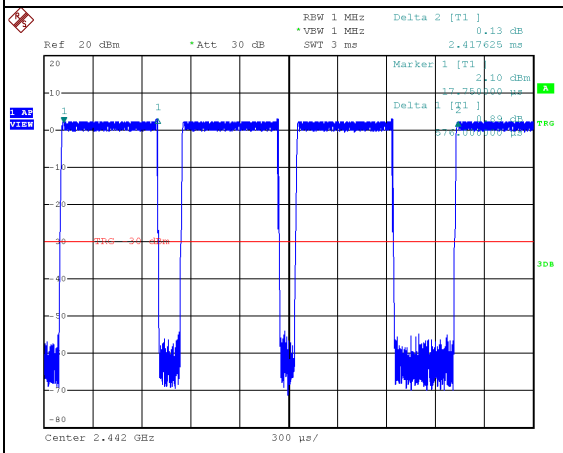
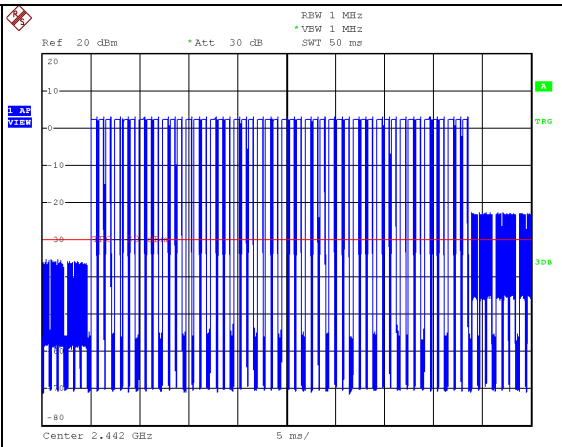
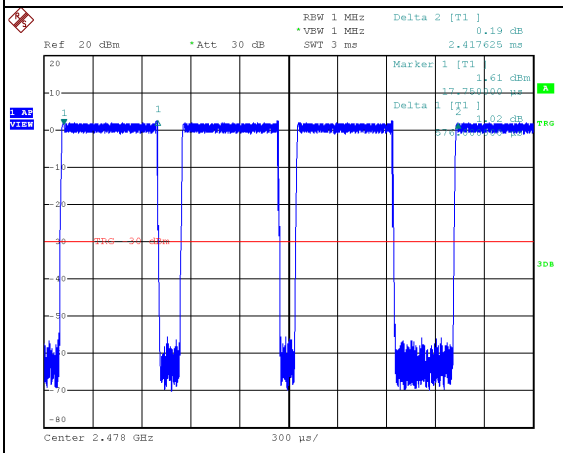
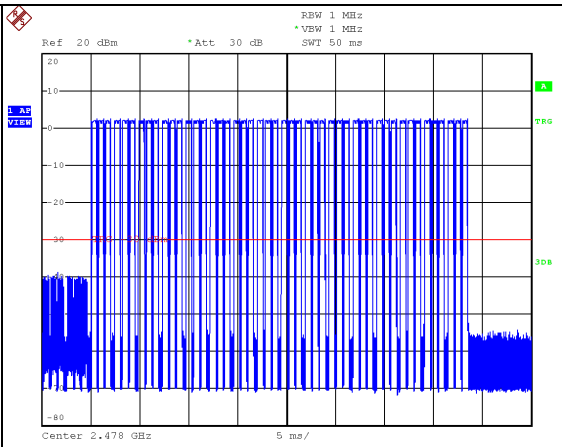
Date: 1.FEB.2018 14:09:36

APPENDIX F - AVERAGE TIME OF OCCUPANCY

Test Mode :	TX Mode

Data Packet	Frequency (MHz)	Pulse Duration (ms)	Dwell Time (s)	Limits (s)	Test Result
-	2404	27.6480	0.2880	0.4000	Pass
-	2442	27.6480	0.2880	0.4000	Pass
-	2478	27.6480	0.2880	0.4000	Pass

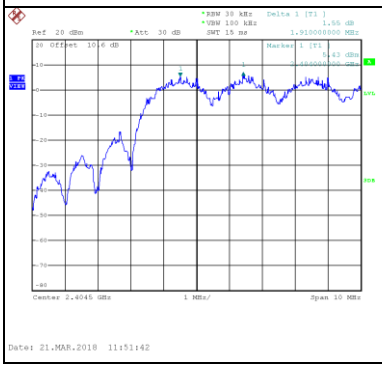
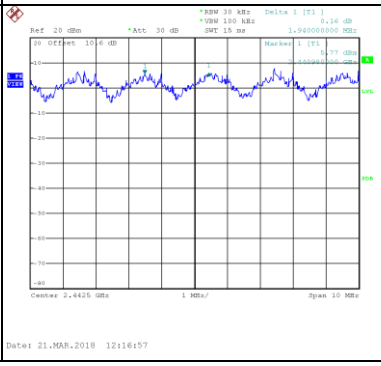
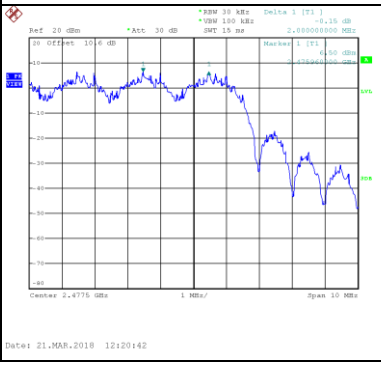
Dwell Time = Pulse Time(s)* Channel hopping rate* Occupancy Time Limit
Occupancy Time Limit = 0.4* Channel
EX BWS-01-A:
416 hops/s with 16 slot in 15 hopping channel
Dwell Time = Pulse Time(s)* 416/16/15 * 0.4*15

Dwell Time	2404 Dwell Time 1Pulse No of Slot
2404	
	
Date: 28.MAR.2018 15:14:48	Date: 28.MAR.2018 15:08:49
2442	
	
Date: 28.MAR.2018 15:13:57	Date: 28.MAR.2018 15:10:10
2478	
	
Date: 28.MAR.2018 15:13:10	Date: 28.MAR.2018 15:10:41

APPENDIX G - HOPPING CHANNEL SEPARATION MEASUREMENT

Test Mode :	Hopping on

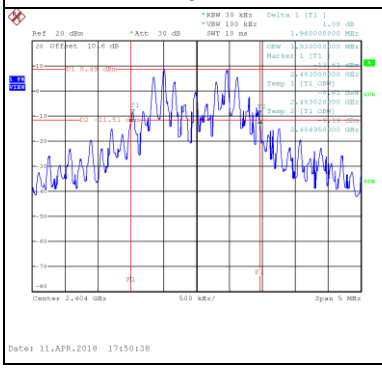
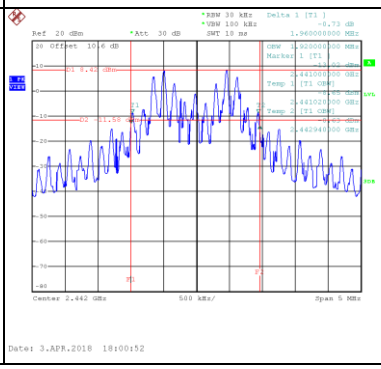
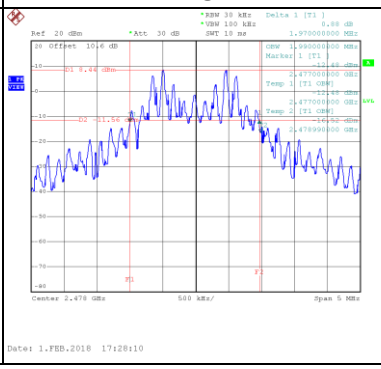
Frequency (MHz)	Channel Separation (MHz)	2/3 of 20dB Bandwidth (MHz)	Test Result
2404	1.910	1.313	Pass
2442	1.940	1.307	Pass
2478	2.000	1.313	Pass

2404 MHz	2442 MHz	2478 MHz
		

APPENDIX H - BANDWIDTH

Test Mode :	TX Mode

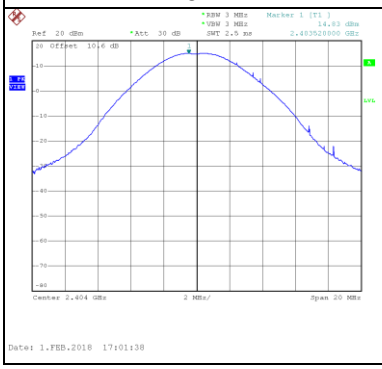
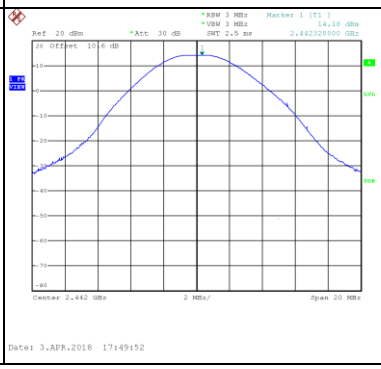
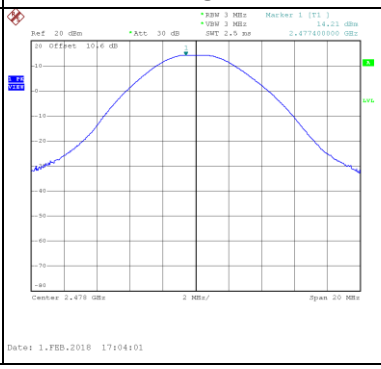
Frequency (MHz)	20dB Bandwidth (MHz)	99% Occupied BW (MHz)	Test Result
2404	1.960	1.930	Pass
2442	1.960	1.920	Pass
2478	1.970	1.990	Pass

2404 MHz	2442 MHz	2478 MHz
		

APPENDIX I - PEAK OUTPUT POWER

Test Mode :	TX Mode

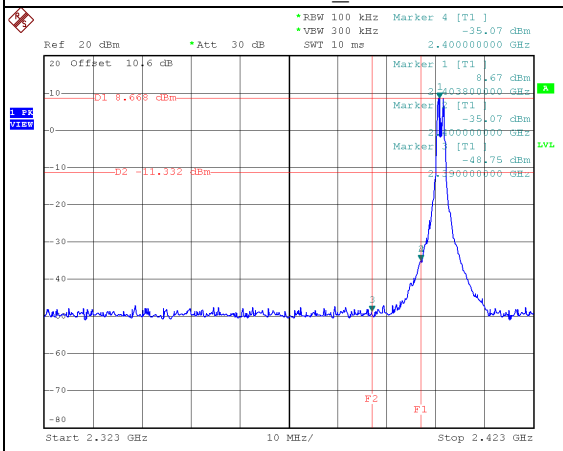
Frequency (MHz)	Conducted Power (dBm)	Conducted Power (W)	Max. Limit (dBm)	Max. Limit (W)	Test Result
2404	14.83	0.0304	30.00	1.00	Pass
2442	14.18	0.0262	30.00	1.00	Pass
2478	14.21	0.0264	30.00	1.00	Pass

2404 MHz	2442 MHz	2478 MHz
		

APPENDIX J - ANTENNA CONDUCTED SPURIOUS EMISSION

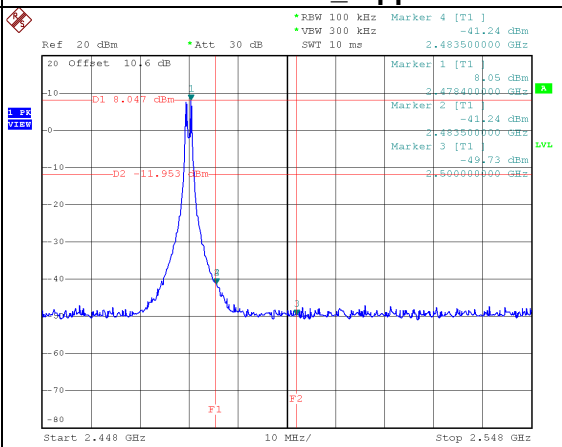
Test Mode : TX Mode

2404 MHz_ Lower



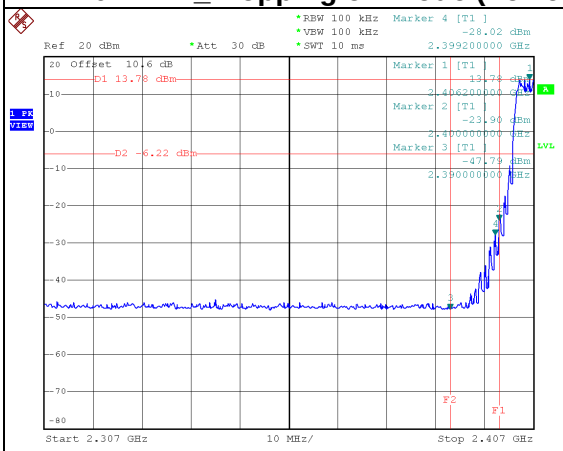
Date: 31.JAN.2018 16:17:01

2478 MHz_ Upper



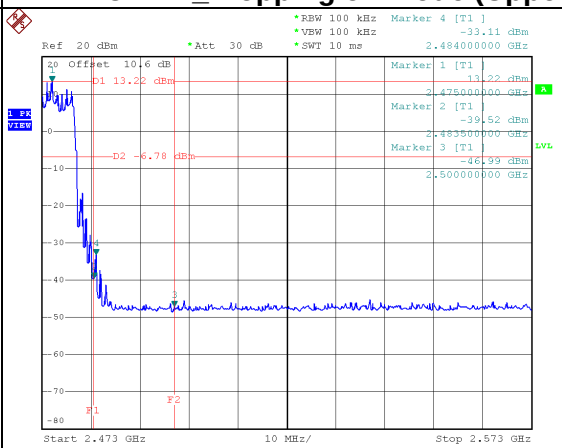
Date: 31.JAN.2018 16:52:59

2404 MHz_ Hopping on mode (Lower)



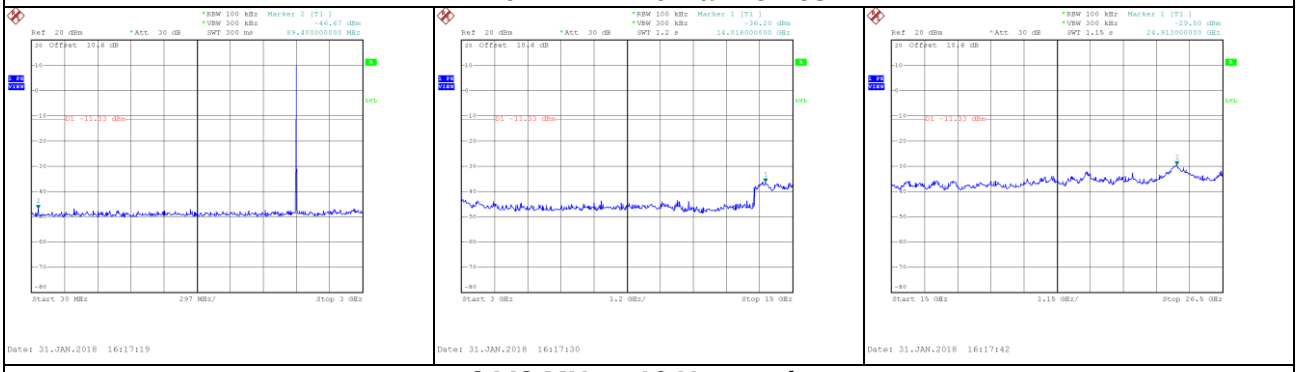
Date: 1.FEB.2018 15:23:11

2478 MHz_ Hopping on mode (Upper)

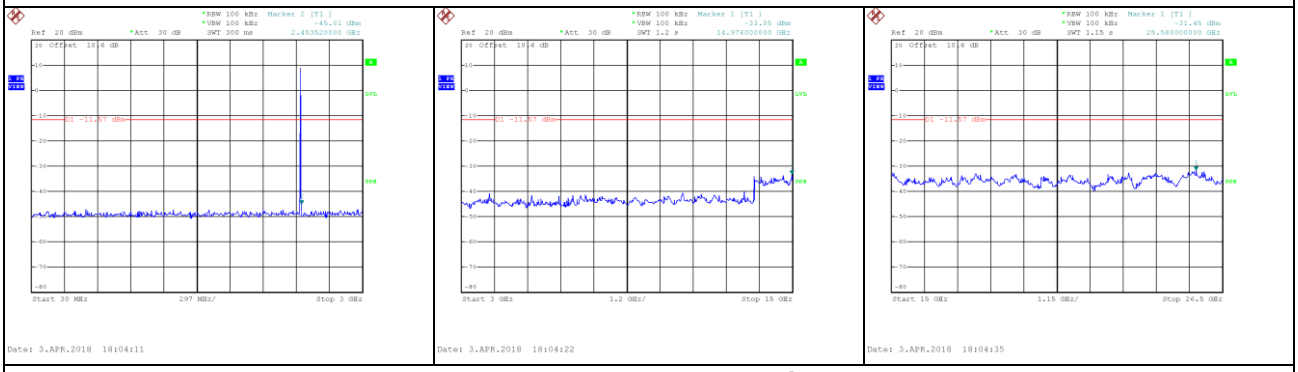


Date: 1.FEB.2018 15:34:24

2404 MHz – 10 Harmonics



2442 MHz – 10 Harmonics



2478 MHz – 10 Harmonics