

## 9. Restricted Band of Operation

### 9.1 Measurement procedure

[FCC 15.247(d), 15.205, 15.209, KDB 558074 D01 v04, Section 12.0]

Test was applied by following conditions.

Test method	:	ANSI C63.10
Test place	:	3m Semi-anechoic chamber
EUT was placed on	:	Styrofoam table / (W)1.0m x (D)1.0m x (H)0.8m (below 1GHz) Styrofoam table / (W)0.6m x (D)0.6m x(H)1.5m (above 1GHz)
Antenna distance	:	3m
Spectrum analyzer setting	:	
- Peak	:	RBW=1MHz, VBW=3MHz, Span=Arbitrary setting, Sweep=auto
- Average	:	RBW=1MHz, VBW=10Hz, Span=Arbitrary setting, Sweep=auto Display mode=Linear

#### Average Measurement Setting [VBW]

Mode	Duty Cycle (%)	T <sub>on</sub> (us)	T <sub>off</sub> (us)	Determined VBW Setting
IEEE802.11b	99.22	1024	8	10Hz (Duty Cycle $\geq$ 98%)
IEEE802.11g	99.27	1362	10	10Hz (Duty Cycle $\geq$ 98%)
IEEE802.11n(HT20)	99.22	1274	10	10Hz (Duty Cycle $\geq$ 98%)
IEEE802.11n(HT20)	98.45	636	10	10Hz (Duty Cycle $\geq$ 98%)

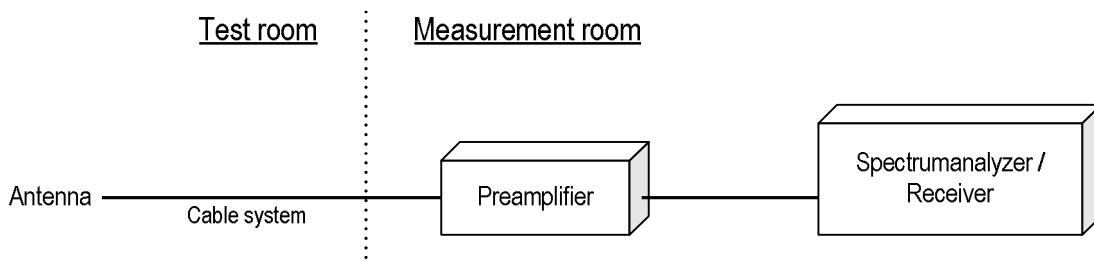
Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30 m open are test site.

Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 937606.

Radiated emission measurements are performed at 3m distance with the broadband antenna (Double ridged guide antenna). The antenna is positioned both the horizontal and vertical planes of polarization and height is varied 1m to 4m and stopped at height producing the maximum emission.

The EUT is Placed on a turntable, which is 0.8m/1.5m above ground plane. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level. The test results represent the worst case emission for each emission with manipulating the EUT, support equipment, interconnecting cables and varying the mode of operation. Sufficient time for the EUT, support equipment, and test equipment are allowed in order for them to warm up to their normal operating condition.

- Test configuration



## 9.2 Limit

Emission at the boundary of the restricted band provided by 15.205 shall be lower than 15.209 limit.

## 9.3 Measurement Result

### [IEEE802.11b, IEEE802.11g, IEEE802.11n (HT20)]

Channel	Frequency [MHz]	Results Chart	Result
Low	2412	See the Trace Data	Pass
High	2462	See the Trace Data	Pass

### [IEEE802.11n (HT40)]

Channel	Frequency [MHz]	Results Chart	Result
Low	2422	See the Trace Data	Pass
High	2452	See the Trace Data	Pass

## 9.4 Test data

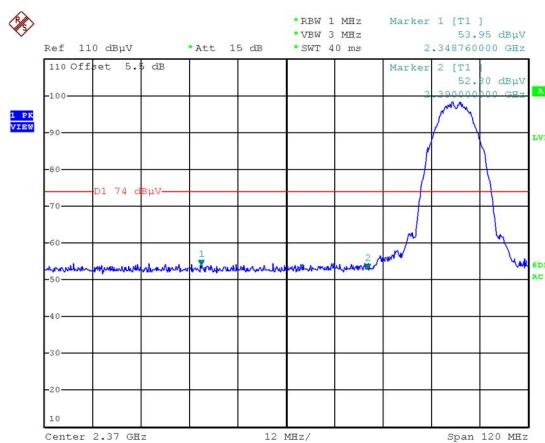
Date : December 5, 2017  
 Temperature : 23.8 [°C]  
 Humidity : 32.1 [%]  
 Test place : 3m Semi-anechoic chamber

Test engineer :

Taiki Watanabe

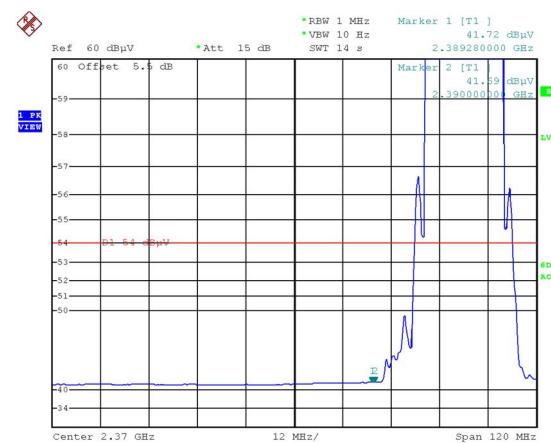
[IEEE802.11b]

## Channel Low Horizontal Peak



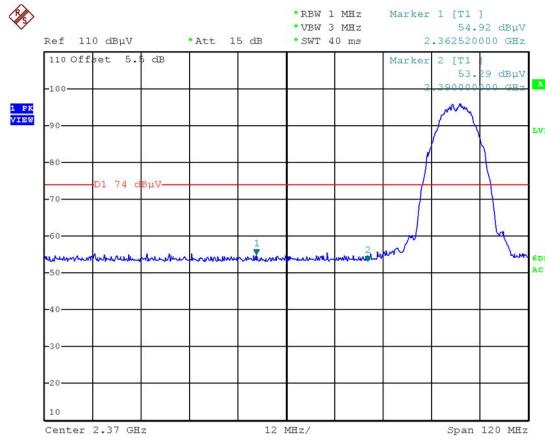
Date: 5.DEC.2017 15:27:00

## Average



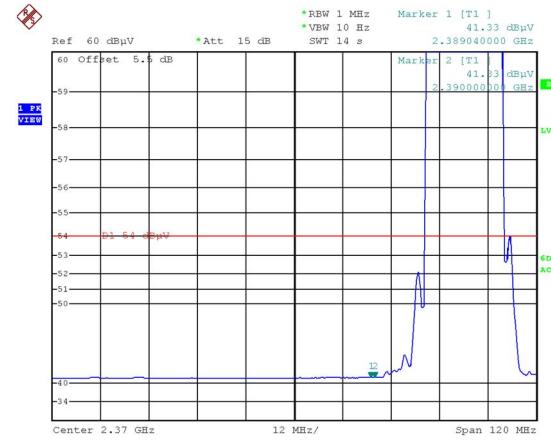
Date: 5.DEC.2017 15:28:22

## Vertical Peak



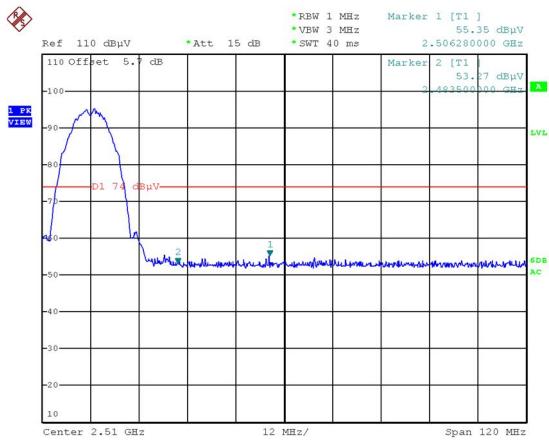
Date: 5.DEC.2017 15:52:02

## Average



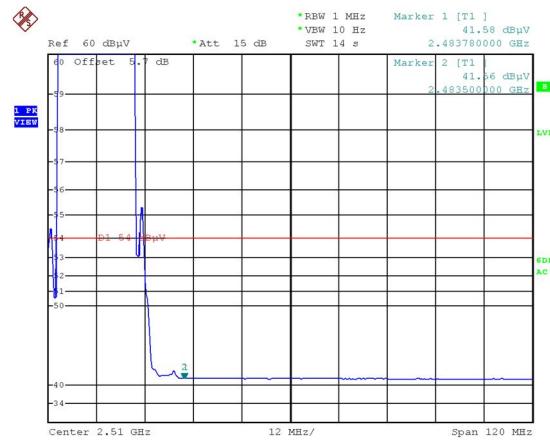
Date: 5.DEC.2017 15:54:04

## Channel High Horizontal Peak



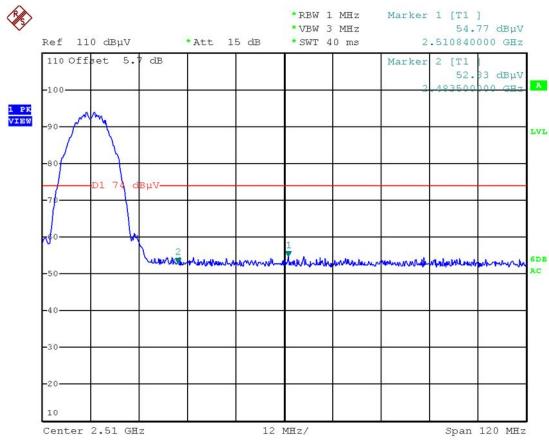
Date: 5.DEC.2017 16:03:05

## Average



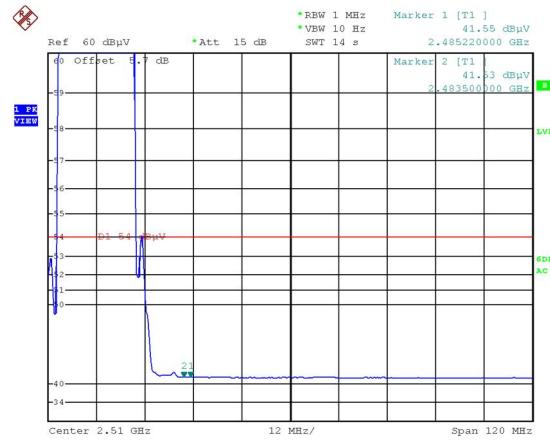
Date: 5.DEC.2017 16:04:31

## Vertical Peak



Date: 5.DEC.2017 16:07:05

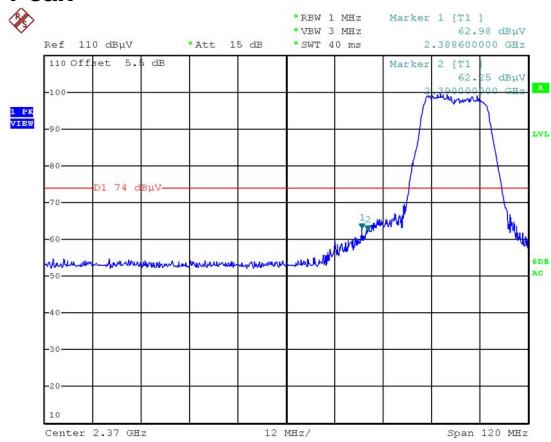
## Average



Date: 5.DEC.2017 16:08:22

## [IEEE802.11g]

## Channel Low Horizontal Peak



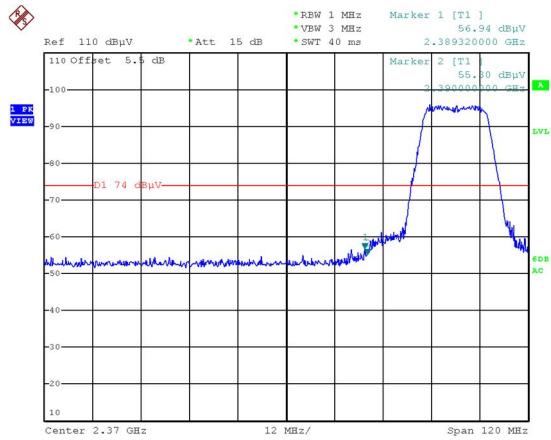
Date: 5.DEC.2017 14:40:02

## Average



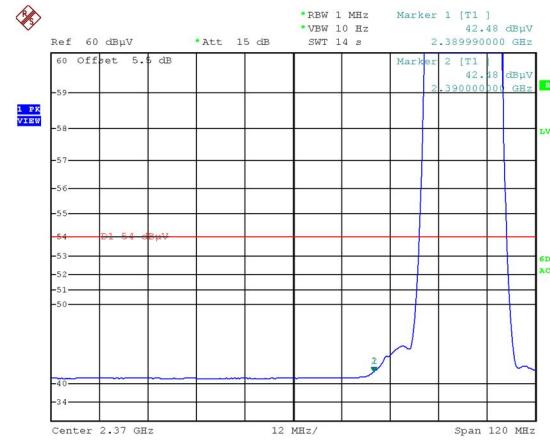
Date: 5.DEC.2017 14:41:34

## Vertical Peak



Date: 5.DEC.2017 14:46:07

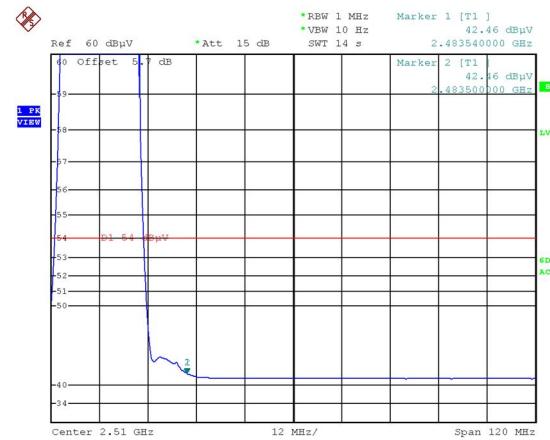
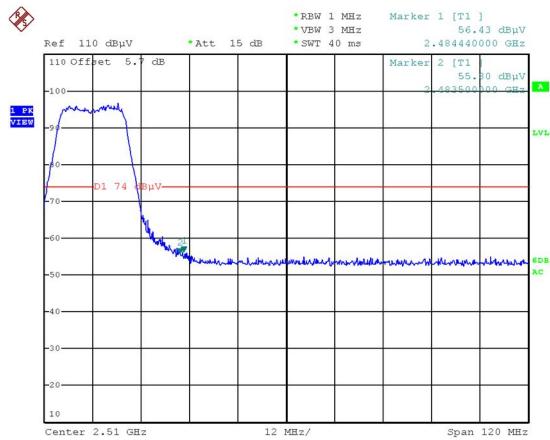
## Average



Date: 5.DEC.2017 14:46:59

## Channel High Horizontal Peak

### Average

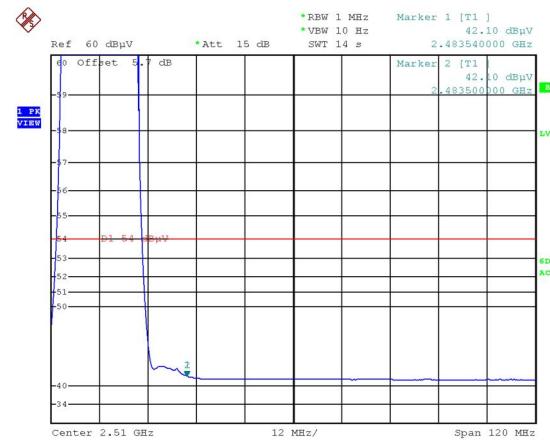
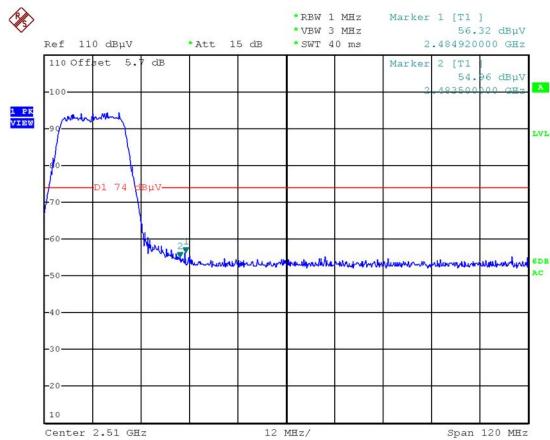


Date: 5.DEC.2017 14:57:43

Date: 5.DEC.2017 15:02:45

## Vertical Peak

### Average

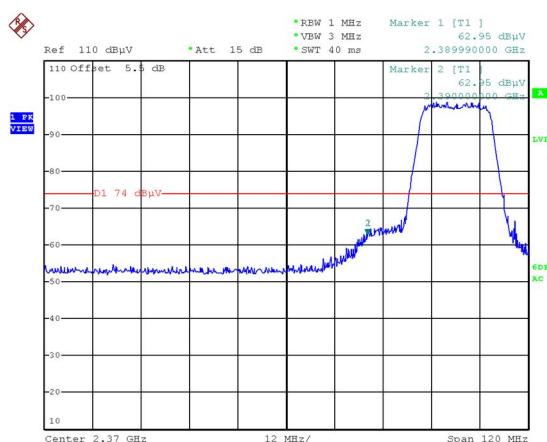


Date: 5.DEC.2017 15:06:16

Date: 5.DEC.2017 15:18:26

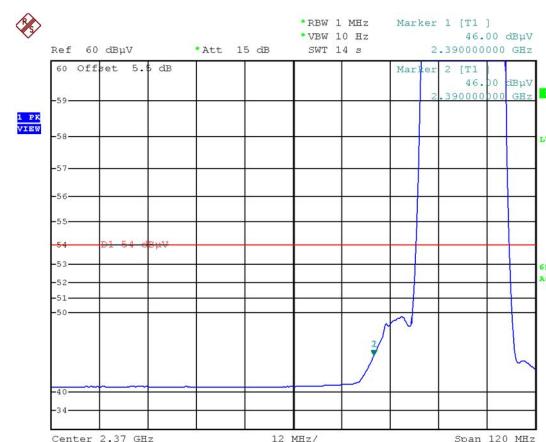
## [IEEE802.11n (HT20)]

### Channel Low Horizontal Peak



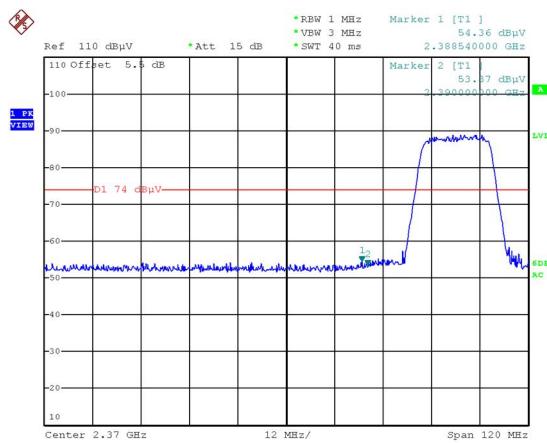
Date: 5.DEC.2017 13:51:02

### Average



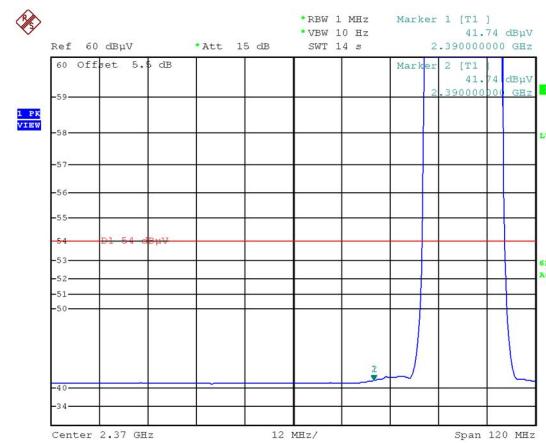
Date: 5.DEC.2017 13:52:09

### Vertical Peak



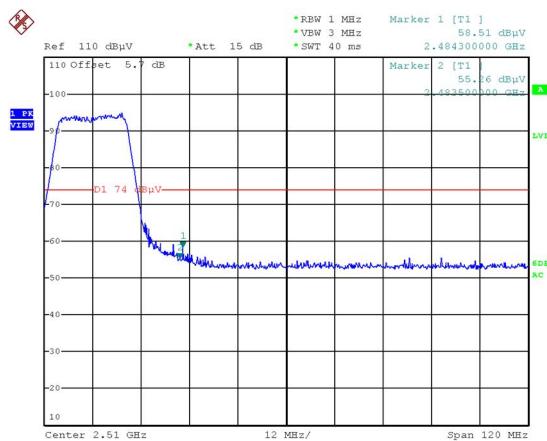
Date: 5.DEC.2017 13:57:26

### Average



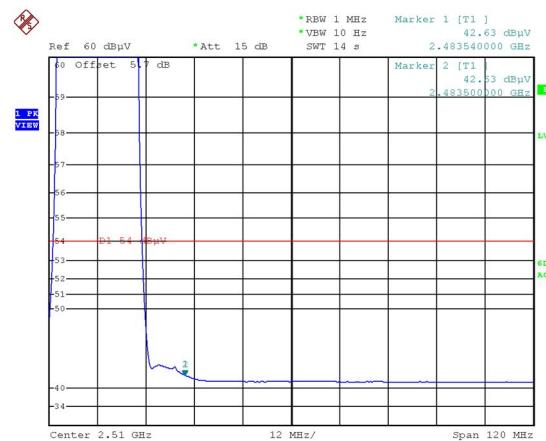
Date: 5.DEC.2017 13:58:49

## Channel High Horizontal Peak



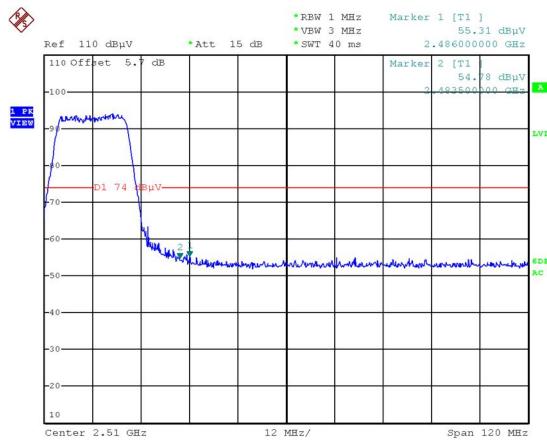
Date: 5.DEC.2017 14:07:08

## Average



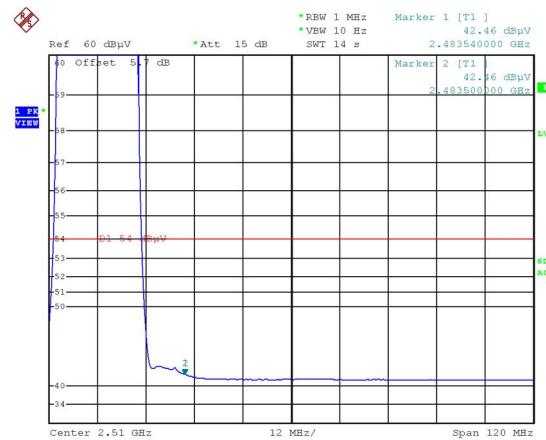
Date: 5.DEC.2017 14:08:59

## Vertical Peak



Date: 5.DEC.2017 14:13:19

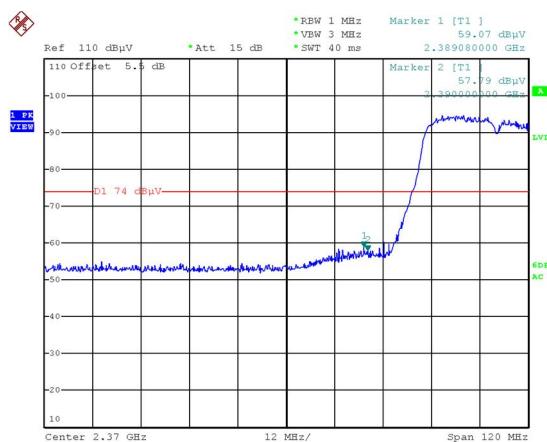
## Average



Date: 5.DEC.2017 14:13:56

## [IEEE802.11n (HT40)]

### Channel Low Horizontal Peak



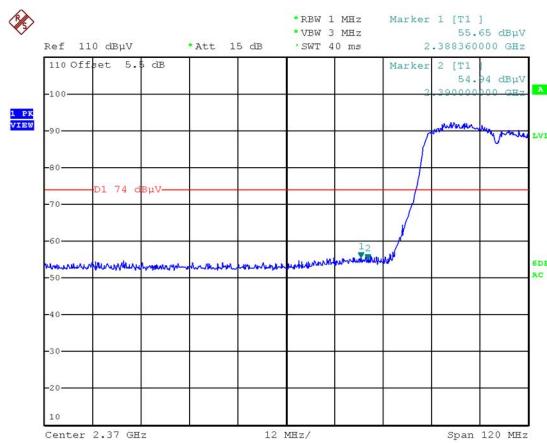
Date: 5.DEC.2017 13:17:49

### Average



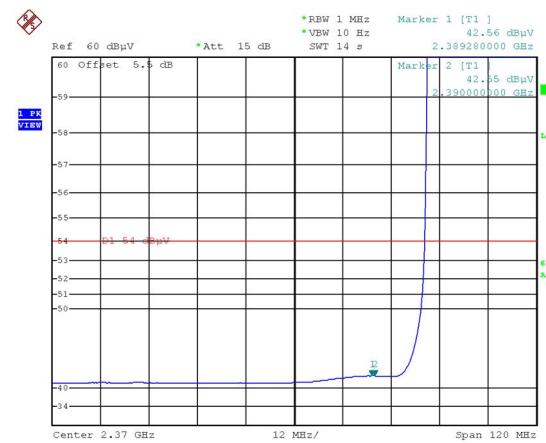
Date: 5.DEC.2017 13:19:17

### Vertical Peak



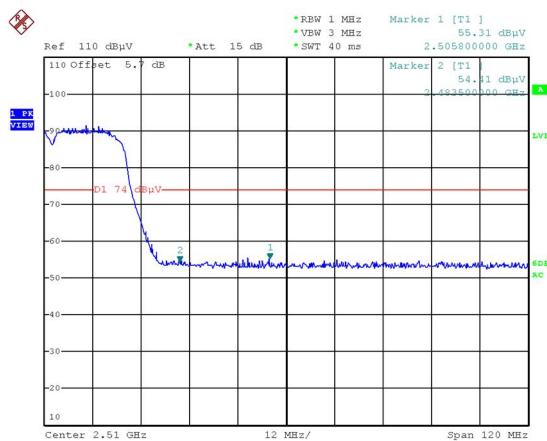
Date: 5.DEC.2017 13:13:39

### Average



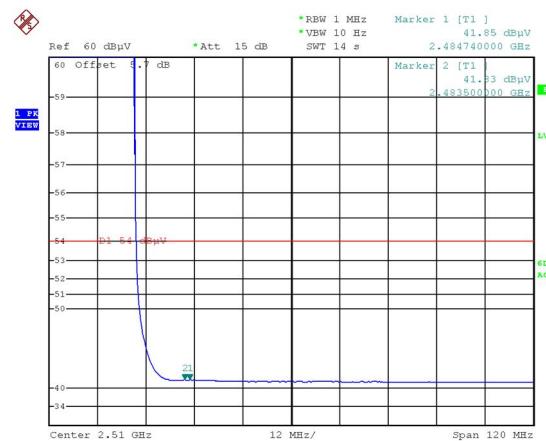
Date: 5.DEC.2017 13:13:10

## Channel High Horizontal Peak



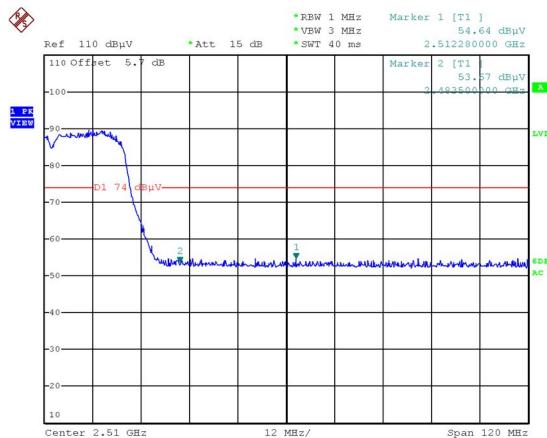
Date: 5.DEC.2017 13:27:20

## Average



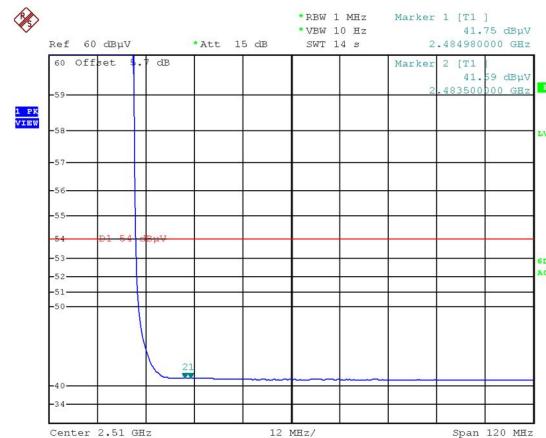
Date: 5.DEC.2017 13:28:38

## Vertical Peak



Date: 5.DEC.2017 13:33:59

## Average



Date: 5.DEC.2017 13:35:09

## 10. Transmitter Power Spectral Density

### 10.1 Measurement procedure

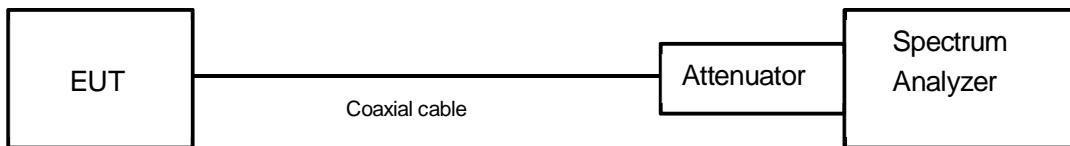
[FCC 15.247(e), KDB 558074 D01 v04, Section 10.2]

The peak power is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency.

The spectrum analyzer is set to;

- a) Span = 1.5 times the 6 dB bandwidth.
- b) RBW = 3kHz - 100kHz.
- c) VBW  $\geq$  3 x RBW.
- d) Sweep time = auto-couple.
- e) Detector = peak.
- f) Trace mode = max hold.

- Test configuration



### 10.2 Limit

The peak power spectral density shall not be greater than 8dBm in any 3kHz band.

### 10.3 Measurement result

Date : November 28, 2017  
 Temperature : 23.5 [°C]  
 Humidity : 36.2 [%]  
 Test place : Shielded room No.4

Test engineer :

Chiaki Kanno

## [IEEE802.11b]

Channel	Center Frequency (MHz)	Reading (dBm)	Factor (dB)	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
Low	2412	-19.32	10.52	-8.80	8.00	16.80	PASS
Middle	2437	-18.42	10.52	-7.90	8.00	15.90	PASS
High	2462	-18.56	10.52	-8.04	8.00	16.04	PASS

Calculation;

$$\text{Transmitter Power Spectral Density Level (Margin)} = \text{Limit} - (\text{Reading} + \text{Factor})$$

## [IEEE802.11g]

Channel	Center Frequency (MHz)	Reading (dBm)	Factor (dB)	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
Low	2412	-23.94	10.52	-13.42	8.00	21.42	PASS
Middle	2437	-21.99	10.52	-11.47	8.00	19.47	PASS
High	2462	-24.84	10.52	-14.32	8.00	22.32	PASS

Calculation;

$$\text{Transmitter Power Spectral Density Level (Margin)} = \text{Limit} - (\text{Reading} + \text{Factor})$$

## [IEEE802.11n (HT20)]

Channel	Center Frequency (MHz)	Reading (dBm)	Factor (dB)	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
Low	2412	-24.30	10.52	-13.78	8.00	21.78	PASS
Middle	2437	-22.06	10.52	-11.54	8.00	19.54	PASS
High	2462	-24.34	10.52	-13.82	8.00	21.82	PASS

Calculation;

$$\text{Transmitter Power Spectral Density Level (Margin)} = \text{Limit} - (\text{Reading} + \text{Factor})$$

## [IEEE802.11n (HT40)]

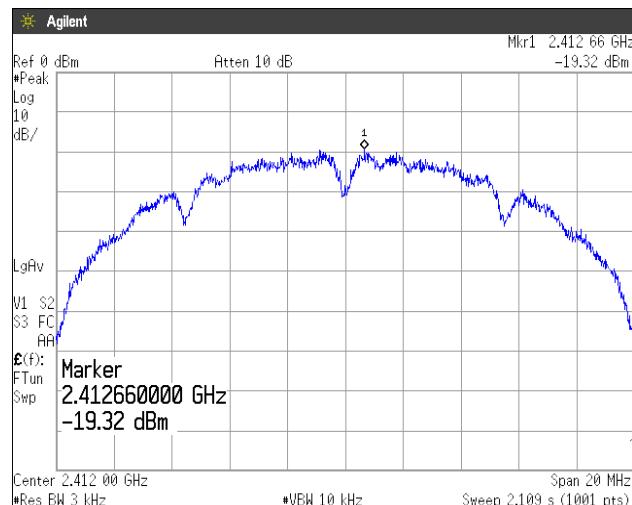
Channel	Center Frequency (MHz)	Reading (dBm)	Factor (dB)	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
Low	2422	-28.87	10.52	-18.35	8.00	26.35	PASS
Middle	2437	-26.97	10.52	-16.45	8.00	24.45	PASS
High	2452	-29.15	10.52	-18.63	8.00	26.63	PASS

Calculation;

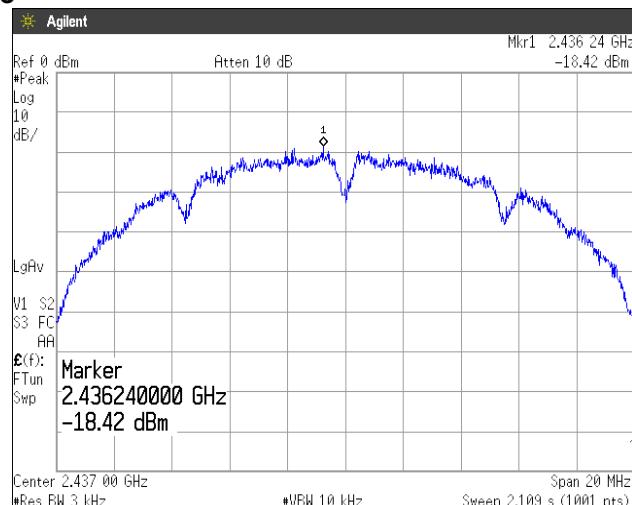
$$\text{Transmitter Power Spectral Density Level (Margin)} = \text{Limit} - (\text{Reading} + \text{Factor})$$

## 10.4 Trace data [IEEE802.11b]

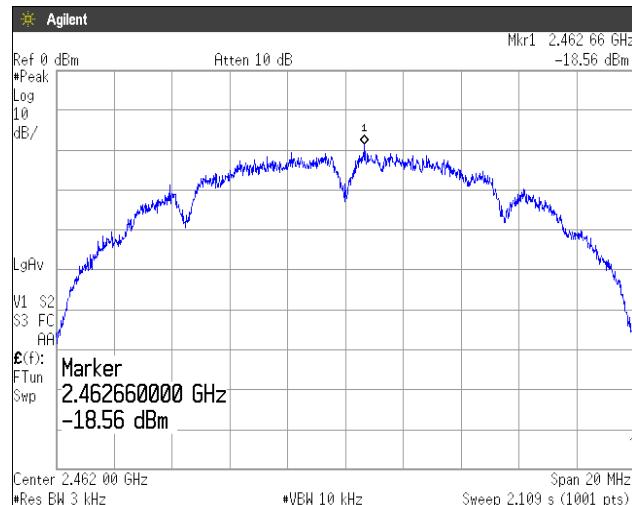
### Channel Low



### Channel Middle

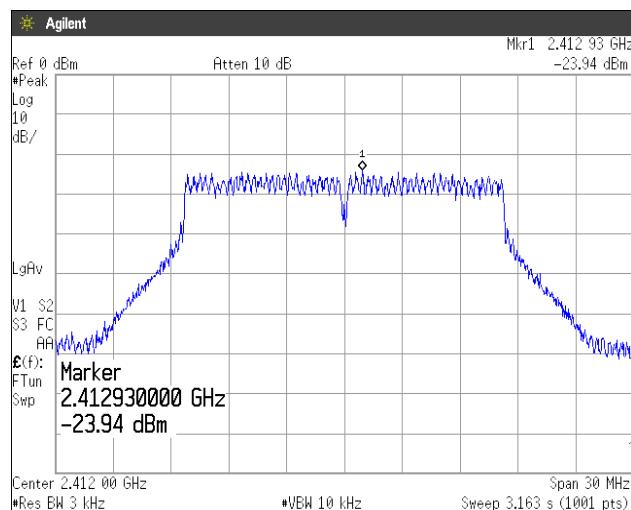


### Channel High

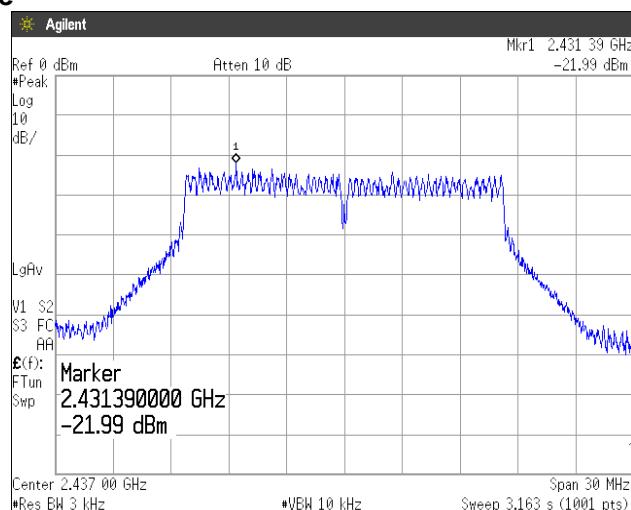


## [IEEE802.11g]

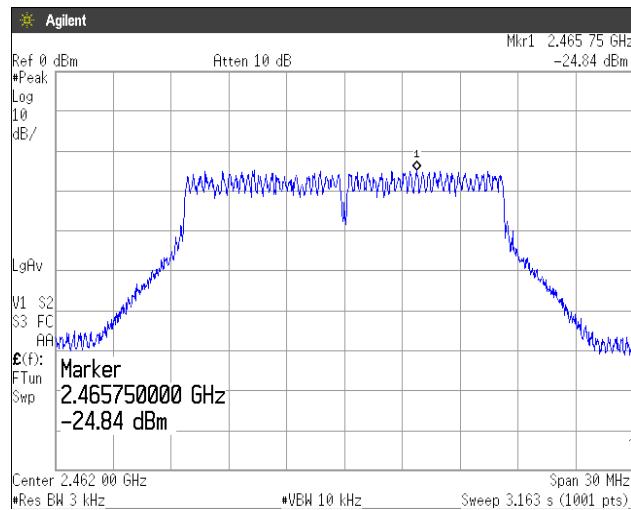
## Channel Low



## Channel Middle

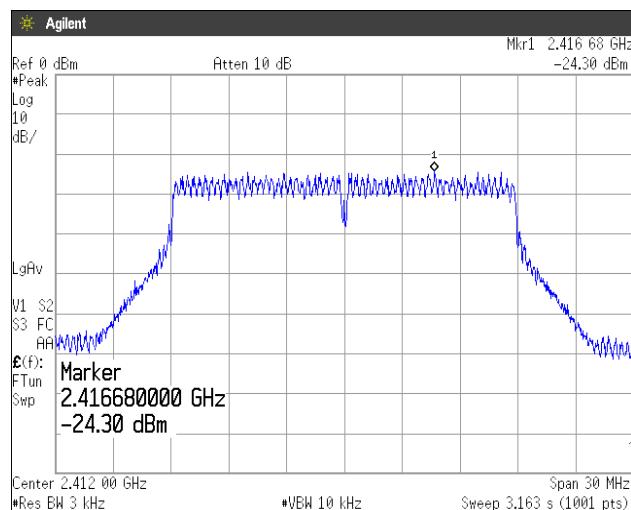


## Channel High

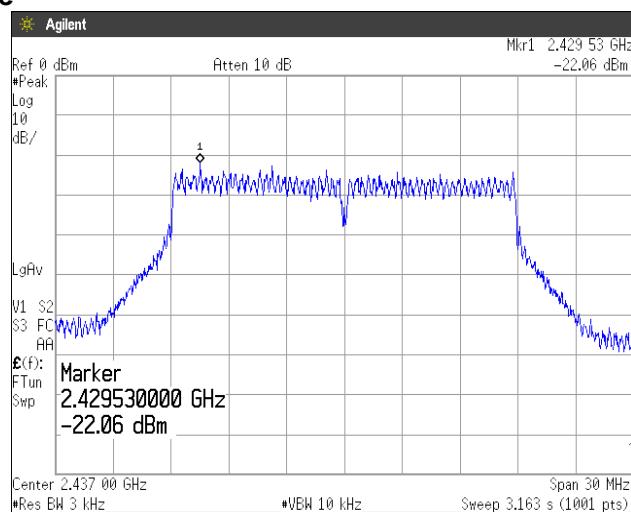


## [IEEE802.11n (HT20)]

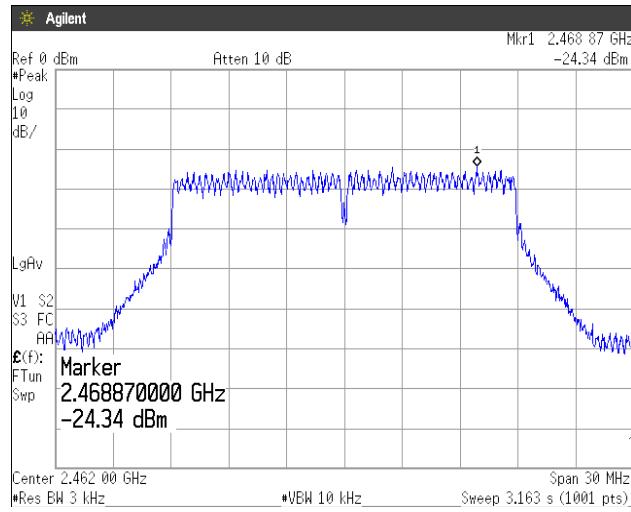
## Channel Low



## Channel Middle

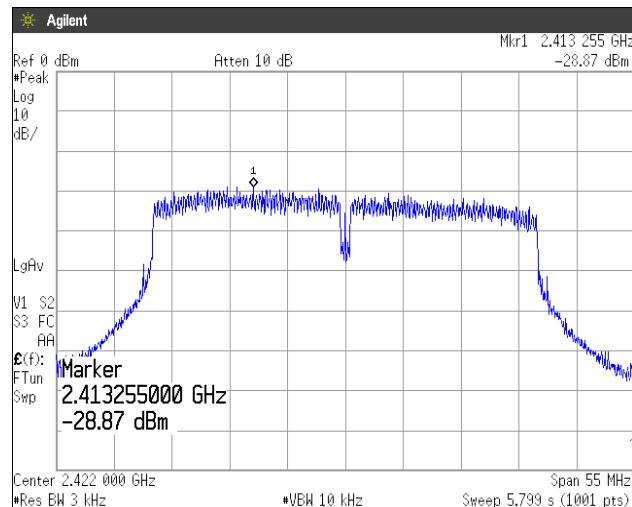


## Channel High

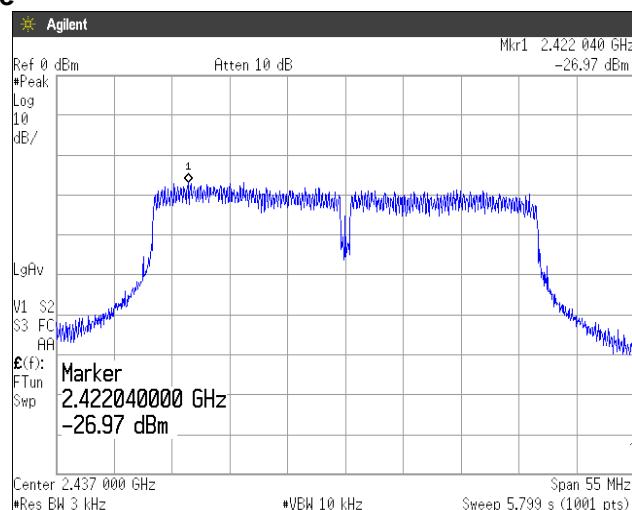


### [IEEE802.11n (HT40)]

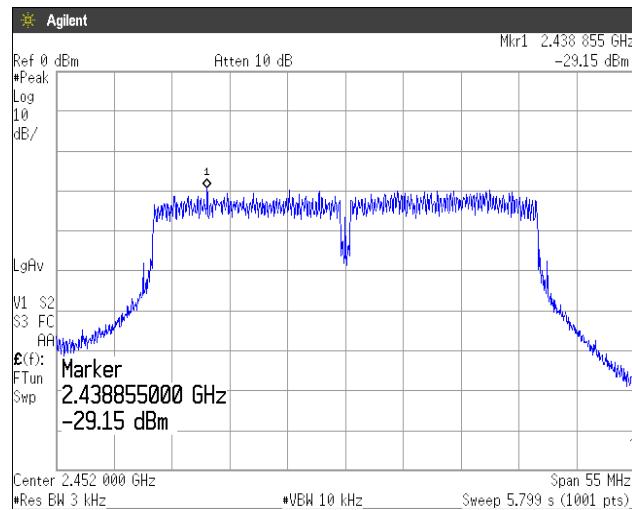
#### Channel Low



#### Channel Middle



#### Channel High



## 11. AC Power Line Conducted Emissions

### 11.1 Measurement procedure [FCC 15.207]

Test was applied by following conditions.

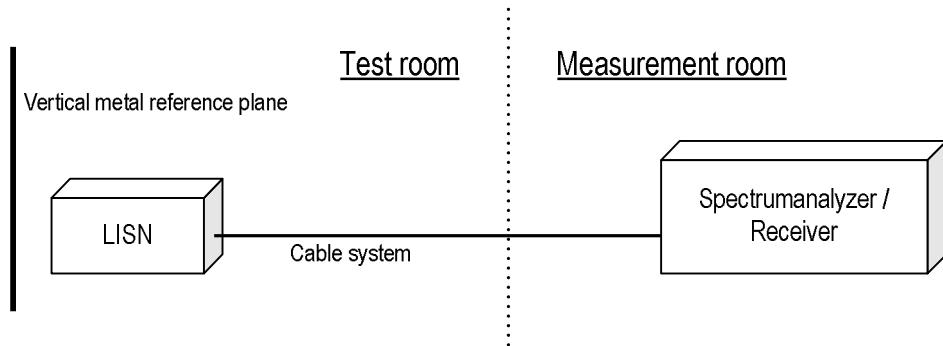
Test method	:	ANSI C63.10
Frequency range	:	0.15MHz to 30MHz
Test place	:	3m Semi-anechoic chamber
EUT was placed on	:	FRP table / (W)2.0m x (D)1.0m x (H)0.8m
Vertical Metal Reference Plane	:	(W)2.0m x (H)2.0m 0.4m away from EUT
Test receiver setting		
- Detector	:	Quasi-peak, Average
- Bandwidth	:	9kHz

EUT and peripherals are connected to  $50\Omega/50\mu\text{H}$  Line Impedance Stabilization Network (LISN) which are connected to reference ground plane, and are placed 80cm away from EUT. Excess of AC power cable is bundled in center.

LISN for peripheral is terminated in  $50\Omega$ .

EUT operating mode is selected to emit the maximum noise. Overall frequency range is investigated with spectrum analyzer using peak detector. Maximum emission configuration is determined by manipulating the EUT, peripherals, interconnecting cables. Then, emission measurements are performed with test receiver in above setting to each current-carrying conductor of the mains port. Sufficient time for EUT, peripherals and test equipment is provided in order for them to warm up to their normal operating condition. If the average limit is met when using a quasi-peak detector receiver, the EUT shall be deemed to meet both limits.

#### - Test configuration



### 11.2 Calculation method

Emission level = Reading + (LISN. Factor + Cable system loss)  
Margin = Limit – Emission level

Example:

Limit @ 0.403MHz : 57.8dB $\mu$ V(Quasi-peak)  
: 47.8dB $\mu$ V(Average)

(Quasi peak) Reading = 22.7dB $\mu$ V c.f = 10.4dB

Emission level = 22.7 + 10.4 = 33.1dB $\mu$ V

Margin = 57.8 – 33.1 = 24.7dB

(Average) Reading = 6.5dB $\mu$ V c.f = 10.4dB

Emission level = 6.5 + 10.4 = 16.9dB $\mu$ V

Margin = 47.8 – 16.9 = 30.9dB

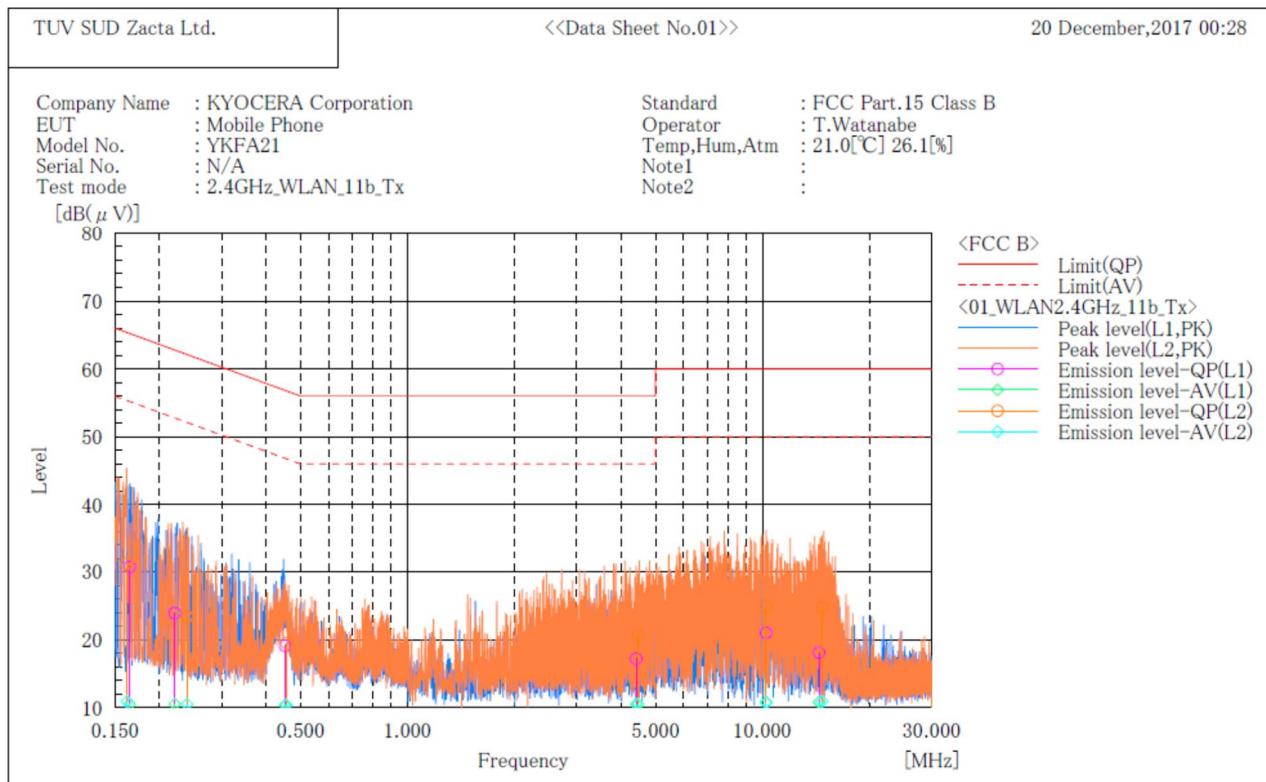
### 11.3 Limit

Frequency [MHz]	Limit	
	QP [dBuV]	AV [dBuV]
0.15-0.5	66-56*	56-46*
0.5-5	56	46
5-30	60	50

\*: The limit decreases linearly with the logarithm of the frequency in the range 0.15MHz to 0.5MHz.

### 11.4 Test data

\*\*\*\*\* CONDUCTED EMISSION at MAINS PORT \*\*\*\*\*  
[ 3m Semi-anechoic chamber ]



#### Final Result

--- L1 Phase ---											
No.	Frequency [MHz]	Reading QP [dB(μV)]	Reading AV [dB(μV)]	c. f	Result QP [dB(μV)]	Result AV [dB(μV)]	Limit QP [dB(μV)]	Limit AV [dB(μV)]	Margin QP [dB]	Margin AV [dB]	
1	0.165	20.3	0.1	10.4	30.7	10.5	65.2	55.2	34.5	44.7	
2	0.221	13.6	0.2	10.3	23.9	10.5	62.8	52.8	38.9	42.3	
3	0.452	8.8	0.1	10.3	19.1	10.4	56.8	46.8	37.7	36.4	
4	4.411	6.8	0.1	10.4	17.2	10.5	56.0	46.0	38.8	35.5	
5	10.243	10.4	0.2	10.6	21.0	10.8	60.0	50.0	39.0	39.2	
6	14.443	7.4	0.1	10.7	18.1	10.8	60.0	50.0	41.9	39.2	

--- L2 Phase ---											
No.	Frequency [MHz]	Reading QP [dB(μV)]	Reading AV [dB(μV)]	c. f	Result QP [dB(μV)]	Result AV [dB(μV)]	Limit QP [dB(μV)]	Limit AV [dB(μV)]	Margin QP [dB]	Margin AV [dB]	
1	0.162	20.8	0.5	10.4	31.2	10.9	65.4	55.4	34.2	44.5	
2	0.239	13.1	0.2	10.3	23.4	10.5	62.1	52.1	38.7	41.6	
3	0.456	9.2	0.1	10.3	19.5	10.4	56.8	46.8	37.3	36.4	
4	4.469	10.3	0.1	10.4	20.7	10.5	56.0	46.0	35.3	35.5	
5	10.246	14.3	0.1	10.6	24.9	10.7	60.0	50.0	35.1	39.3	
6	14.749	14.0	0.2	10.7	24.7	10.9	60.0	50.0	35.3	39.1	

## **12. Antenna requirement**

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According to FCC section 15.203, 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 antenna is a special antenna mounted inside of the EUT. Therefore, the EUT complies with the antenna requirement of FCC section 15.203.

## 13. Uncertainty of measurement

Expanded uncertainties stated are calculated with a coverage Factor k=2.

Please note that these results are not taken into account when measurement uncertainty considerations contained in ETSI TR 100 028-0011 determining compliance or non-compliance with test result.

Test item	Measurement uncertainty
Conducted emission, AMN (9kHz – 150kHz)	±3.8dB
Conducted emission, AMN (150kHz – 30MHz)	±3.3dB
Radiated emission (9kHz – 30MHz)	±3.0dB
Radiated emission (30MHz – 1000MHz)	±4.7dB
Radiated emission (1GHz – 6GHz)	±4.9dB
Radiated emission (6GHz – 18GHz)	±5.2dB
Radiated emission (18GHz – 40GHz)	±5.8dB

## 14. Laboratory Information

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### 1. Location

Name: Yonezawa Testing Center  
 Address: 5-4149-7, Hachimanpara, Yonezawa-shi, Yamagata, 992-1128 Japan  
 Phone: +81-238-28-2881  
 Fax: +81-238-28-2888

### 2. Accreditation and Registration

1) VLAC  
Accreditation No.: VLAC-013

2) NVLAP  
LAB CODE: 200306-0

3) BSMI  
Laboratory Code: SL2-IN-E-6018, SL2-A1-E-6018

4) Industry Canada

Site number	Facility	Expiration date
4224A-4	3m Semi-anechoic chamber	2020-11-27
4224A-5	10m Semi-anechoic chamber No.1	2020-11-27
4224A-6	10m Semi-anechoic chamber No.2	2019-12-14

5) VCCI Council

Registration number	Expiration date
A-0166	2019-07-03

## Appendix A. Test equipment

### Antenna port conducted test

Equipment	Company	Model No.	Serial No.	Cal. Due	Cal. Date
Spectrum analyzer	Agilent Technologies	E4440A	US44302655	Jun. 30, 2018	Jun. 28, 2017
Attenuator	Weinschel	56-10	J4993	Nov. 30, 2017	Nov. 1, 2016
				Dec. 31, 2018	Dec. 4, 2017
Power meter	ROHDE&SCHWARZ	NRP2	103269	Jul. 31, 2018	Jul. 11, 2017
Power sensor	ROHDE&SCHWARZ	NRP-Z81	102459	Jul. 31, 2018	Jul. 11, 2017

### Radiated emission

Equipment	Company	Model No.	Serial No.	Cal. Due	Cal. Date
EMI Receiver	ROHDE&SCHWARZ	ESCI	100765	Sep. 30, 2018	Sep. 13, 2017
Spectrum analyzer	Agilent Technologies	E4447A	MY46180188	Mar. 31, 2018	Mar. 15, 2017
Spectrum analyzer	Agilent Technologies	E4440A	US40420937	Oct. 31, 2018	Oct. 19, 2017
Preamplifier	ANRITSU	MH648A	M96057	Feb. 28, 2018	Feb. 1, 2017
Loop antenna	ROHDE&SCHWARZ	HFH2-Z2	100515	Feb. 28, 2018	Feb. 17, 2017
Attenuator	TDC	TAT-43B-06	N/A(S209)	May 31, 2018	May 23, 2017
Biconical antenna	Schwarzbeck	VHA9103/BBA9106	2155	Jul. 31, 2018	Jul. 18, 2017
Log periodic antenna	Schwarzbeck	UHALP9108A	0560	Jul. 31, 2018	Jul. 18, 2017
Attenuator	TME	CFA-01NPJ-6	N/A(S275)	Feb. 28, 2018	Feb. 3, 2017
Attenuator	TME	CFA-01NPJ-3	N/A(S272)	Feb. 28, 2018	Feb. 2, 2017
Preamplifier	TSJ	MLA-100M18-B02-40	1929118	Feb. 28, 2018	Feb. 3, 2017
Attenuator	AEROFLEX	26A-10	081217-08	May 31, 2018	May 24, 2017
Double ridged guide antenna	ETS LINDGREN	3117	00052315	Feb. 28, 2018	Feb. 23, 2017
Attenuator	Agilent Technologies	8491B	MY39268633	Feb. 28, 2018	Feb. 2, 2017
Double ridged guide antenna	A.H.Systems Inc.	SAS-574	469	Aug. 31, 2018	Aug. 8, 2017
Preamplifier	TSJ	MLA-1840-B03-35	1240332	Aug. 31, 2018	Aug. 8, 2017
Notch filter	Micro-Tronics	BRM50702	045	Apr. 30, 2018	Apr. 26, 2017
Microwave cable	HUBER+SUHNER	SUCOFLEX104/9m	MY30037/4	Feb. 28, 2018	Feb. 3, 2017
		SUCOFLEX104/1m	my24610/4	Feb. 28, 2018	Feb. 3, 2017
		SUCOFLEX104/8m	SN MY30031/4	Feb. 28, 2018	Feb. 2, 2017
		SUCOFLEX104/1.5m	MY32976/4	Dec. 31, 2017	Dec. 2, 2016
		SUCOFLEX104/1.5m	MY19309/4	Feb. 28, 2018	Feb. 3, 2017
		SUCOFLEX104/7m	41625/6	Feb. 28, 2018	Feb. 3, 2017
PC	DELL	DIMENSION E521	75465BX	N/A	N/A
Software	TOYO Corporation	EP5/RE-AJ	0611193/V5.6.0	N/A	N/A
Absorber	RIKEN	PFP30	N/A	N/A	N/A
3m Semi an-echoic Chamber	TOKIN	N/A	N/A(9002-NSA)	May 31, 2018	May 30, 2017
3m Semi an-echoic Chamber	TOKIN	N/A	N/A(9002-SVSWR)	May 31, 2018	May 31, 2017

### Conducted emission at mains port

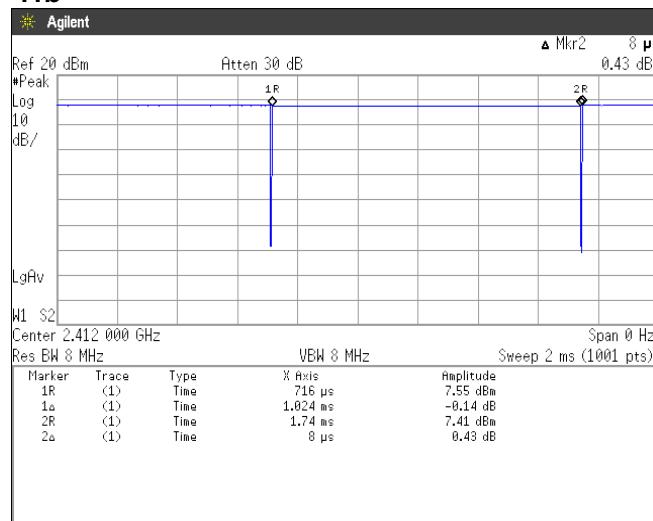
Equipment	Company	Model No.	Serial No.	Cal. Due	Cal. Date
EMI Receiver	ROHDE&SCHWARZ	ESCI	100765	Sep. 30, 2018	Sep. 13, 2017
Attenuator	HUBER+SUHNER	6810.01.A	N/A (S411)	Feb. 28, 2018	Feb. 2, 2017
Line impedance stabilization network for EUT	Kyoritsu Electrical Works, Ltd.	KNW-407F2	12-17-110-2	Apr. 30, 2018	Apr. 25, 2017
Coaxial cable	FUJIKURA	5D-2W/4m	N/A (S350)	Feb. 28, 2018	Feb. 2, 2017
Coaxial cable	FUJIKURA	5D-2W/1m	N/A (S193)	Feb. 28, 2018	Feb. 3, 2017
Coaxial cable	HUBER+SUHNER	RG214/U/10m	N/A (S194)	Feb. 28, 2018	Feb. 3, 2017
PC	DELL	DIMENSION	75465BX	N/A	N/A
Software	TOYO Corporation	EP5/CE-AJ	0611193/V5.4.11	N/A	N/A

\*: The calibrations of the above equipment are traceable to NIST or equivalent standards of the reference organizations.

## Appendix B. Duty Cycle

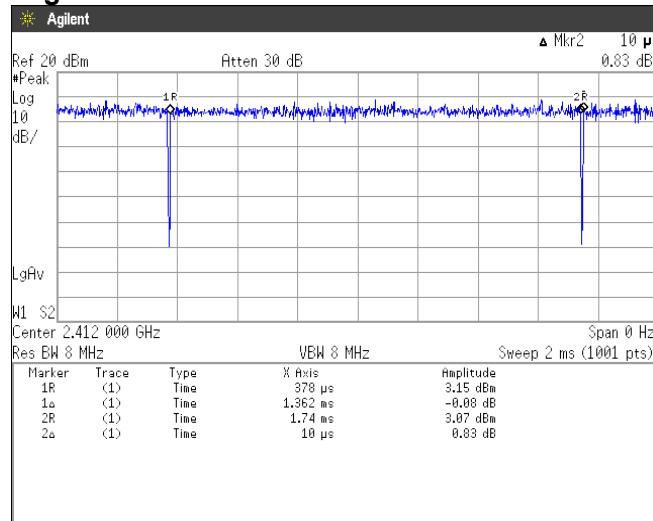
### [Plot & Calculation]

11b



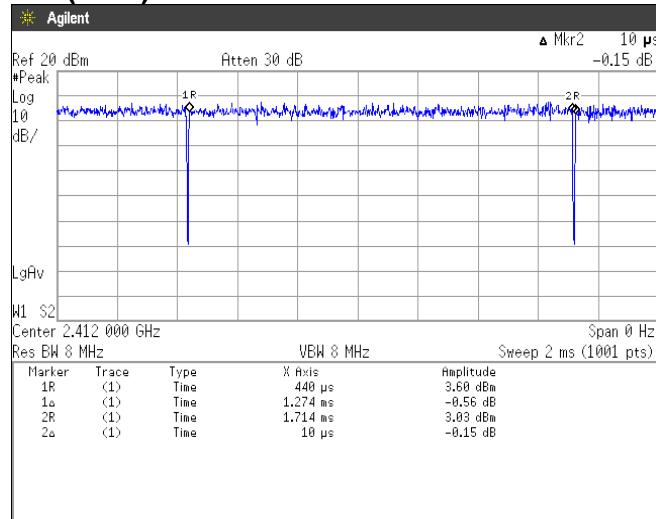
$$\text{Duty Cycle} = \text{Ton} / (\text{Ton} + \text{Toff}) = 1024[\mu\text{s}] / (1024[\mu\text{s}] + 8[\mu\text{s}]) = 99.22\%$$

11g



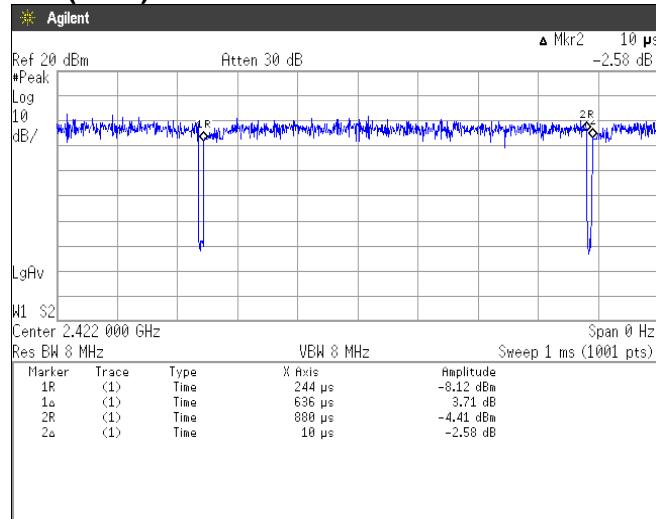
$$\text{Duty Cycle} = \text{Ton} / (\text{Ton} + \text{Toff}) = 1362[\mu\text{s}] / (1362[\mu\text{s}] + 10[\mu\text{s}]) = 99.27\%$$

### 11n (HT20)



$$\text{Duty Cycle} = \text{Ton} / (\text{Ton} + \text{Toff}) = 1274[\mu\text{s}] / (1274[\mu\text{s}] + 10[\mu\text{s}]) = 99.22[\%]$$

### 11n (HT40)



$$\text{Duty Cycle} = \text{Ton} / (\text{Ton} + \text{Toff}) = 636[\mu\text{s}] / (636[\mu\text{s}] + 10[\mu\text{s}]) = 98.45[\%]$$