Zacta

TEST REPORT

Report number : Z101C-15115
Issue date : December 9, 2015

The device, as described herewith, was tested pursuant to applicable test procedure and complies with the requirements of;

FCC Part15 Subpart C
IC RSS-210

The test results are traceable to the international or national standards.

Applicant	:	HOKUBU Communication & Industrial Co., Ltd.
Equipment under test (EUT)	:	TX Module
Model number	:	Model EP
FCC ID	:	2AGF8-TXMEPA
IC Certification Number	:	20931-TXMEPA

Date of test	:	November 19-21, 25, 26, 2015
Test place	:	TÜV SÜD Zacta Ltd. Yonezawa Testing Center 4149-7 Hachimanpara 5-chome Yonezawa-shi Yamagata 992-1128 Japan Phone: +81-238-28-2880 Fax: +81-238-28-2888
Test results	:	Complied

The results in this report are applicable only to the equipment tested.
This report shall not be re-produced except in full without the written approval of TÜV SÜD Zacta Ltd.
This test report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government.

Tested by : Taiki Watanabe

Authorized by : Eiji Akiba
Deputy General Manager of EMC Technical Department

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1. Summary of Test

1.1 Purpose of test

It is the original test in order to verify conformance to FCC Part 15 Subpart C and IC RSS-210.

1.2 Standards

CFR47 FCC Part 15 Subpart C
IC RSS-210

1.2.1 Test Methods

ANSI C63.10-2009

1.2.2 Deviation from standards

None

1.3 List of applied test to the EUT

Test items Section	Test items	Condition	Result
RSS-Gen 4.6.1	Occupied Bandwidth	Conducted	PASS
15.249(a), (b), (c), (d), (e) RSS-210 A2.9(a), (b)	Spurious Emissions (Field Strength of Fundamental and Harmonics)	Radiated	PASS
15.249(c), (d) RSS-210 A2.9(b)	Restricted Bands of Operation	Radiated	PASS
15.207	AC Power Line Conducted Emissions	Conducted	PASS

1.3.1 Test set up

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1.4 Modification to the EUT by laboratory

None

2. Equipment Under Test

2.1 General Description of equipment

EUT is the TX Module.

2.2 EUT information

Applicant	:	HOKUBU Communication & Industrial Co., Ltd. 27-1, Fushi-o-gami, Fukushima-shi Fukushima 960-8154, Japan Phone: +81-24-545-2237 Fax: +81-24-545-2491
Equipment under test	:	TX Module
Trade name	:	HOKUBU TSUSHIN
Model number	:	Model EP
Serial number	:	1510041
EUT condition	:	Pre-Production
Power ratings	:	DC 3.0V
Size	:	(W) 29.0 × (D) 6.0 × (H) 25.0 mm
Environment	:	Indoor and Outdoor use
Terminal limitation	:	-15˚C to 65˚C
RF Specification		
Frequency range	:	2402MHz-2478MHz
Number of RF Channels	:	77 Channels
Modulation method/ Data rate	:	GFSK (1Mbps, 250kbps)
Channel separation	:	1MHz
Output power	:	107.6dBuV/m
Antenna type	:	Internal antenna
Antenna gain	:	0dBi

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2.3 Variation of the family model(s)

Not applicable

2.4 Operating channels and frequencies

Channel	Frequency [MHz]	Channel	Frequency [MHz]
2	2402	41	2441
3	2403	42	2442
4	2404	43	2443
5	2405	44	2444
6	2406	45	2445
7	2407	46	2446
8	2408	47	2447
9	2409	48	2448
10	2410	49	2449
11	2411	50	2450
12	2412	51	2451
13	2413	52	2452
14	2414	53	2453
15	2415	54	2454
16	2416	55	2455
17	2417	56	2456
18	2418	57	2457
19	2409	58	2458
20	2420	59	2459
21	2421	60	2460
22	2422	61	2461
23	2423	62	2462
24	2424	63	2463
25	2425	64	2464
26	2426	65	2465
27	2427	66	2466
28	2428	67	2467
29	2429	68	2468
30	2430	69	2469
31	2431	70	2470
32	2432	71	2471
33	2433	72	2472
34	2434	73	2473
35	2435	74	2474
36	2436	75	2475
37	2437	76	2476
38	2438	77	2477
39	2439	78	2478
40	2440		

2.5 Operating mode

The EUT had been tested under operating condition.
There are three channels have been tested as following:

Tested Channel	Frequency [MHz]
Low	2402
Middle	2440
High	2478

The pre-test has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates.

Tested Channel	Modulation Type	Data Rate
Low, Middle, High	GFSK	1Mbps, 250kbps

The field strength of spurious emissions was measured at each position of all three axis X, Y and Z to compare the level, and the maximum noise.
The worst emission was found in X axis and the worst case recorded.

2.6 Operating flow

[Tx mode]
i) Test program setup to the PARAS
ii) Select a Test mode
Operating frequency: Channel Low: 2402MHz, Channel Middle: 2440MHz, Channel High: 2478MHz
Data rate: EL-SPEED 1Mbps, EL-NORMAL 250kbps
iii) Start test mode

[Rx mode]
i) Test program setup to the PARAS
ii) Select a Test mode
Operating frequency: Channel Low: 2402MHz, Channel Middle: 2440MHz, Channel High: 2478MHz
iii) Start test mode

3. Configuration of equipment

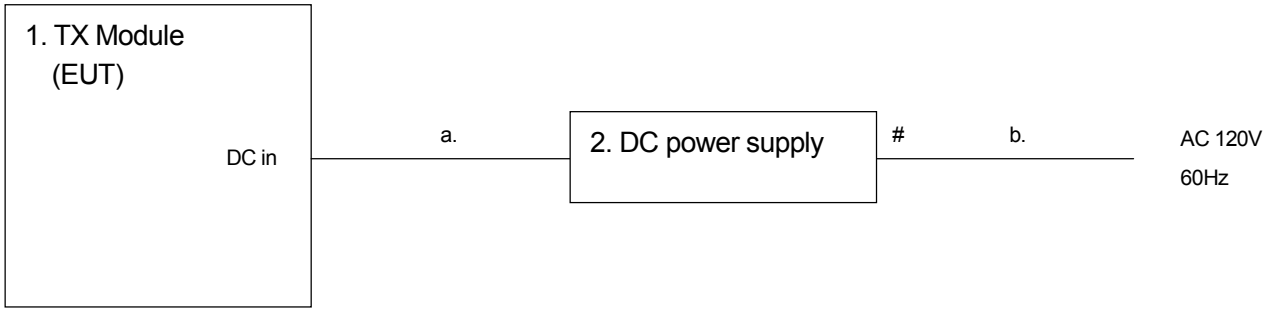
3.1 Equipment(s) used

No.	Equipment	Company	Model No.	Serial No.	FCC ID / DoC	Comment
1	TX Module	HOKUBU	Model EP	1510041	2AGF8-TXMEPA	EUT
2	Stabilized DC power	KIKUSUI	PAB32-2	47306490	-	-

3.2 Cable(s) used

No.	Cable	Length[m]	Shield	Connector	Comment
a	DC cable	4.0	No	Plastic	-
b	AC power cord	2.0	No	Plastic	-

3.3 System configuration



: Un-detachable cable

Note1: Numbers assigned to equipment or cables on this diagram correspond to the list in “3.1 Equipment(s) used” and “3.2 Cable(s) used”.

4. Occupied Bandwidth

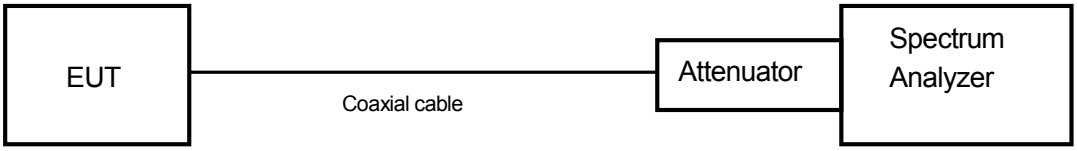
4.1 Measurement procedure
[RSS-Gen 4.6.1]

The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99% bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

The EUT was set to operate with following conditions.
- Channel Low: 2402MHz, Channel Middle: 2440MHz, Channel High: 2478MHz

The test mode of EUT is as follows.
- Tx mode

- Test configuration



4.2 Limit

None

4.3 Measurement result

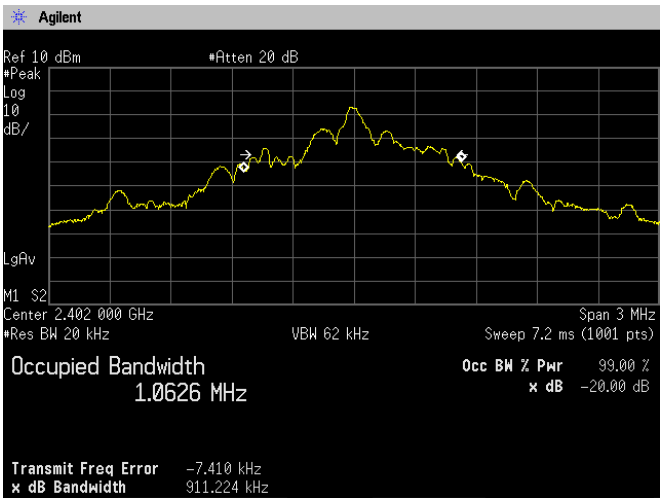
Date : November 25, 2015
Temperature : 23.4 [˚C]
Humidity : 45.3 [%]
Test place : Shielded room No.4
Test engineer : Taiki Watanabe

Channel	Frequency [MHz]	Occupied bandwidth [MHz]	
		1Mbps	250kbps
Low	2402	1.0626	0.7514
Middle	2440	1.1831	0.9643
High	2478	1.1357	0.936

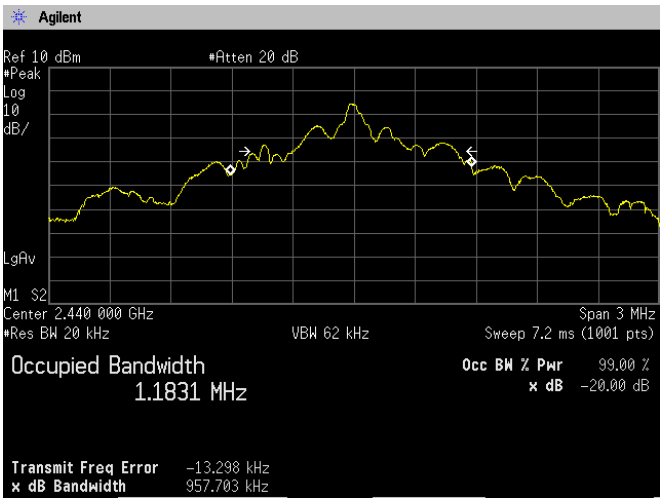
4.4 Trace data

<1Mbps>

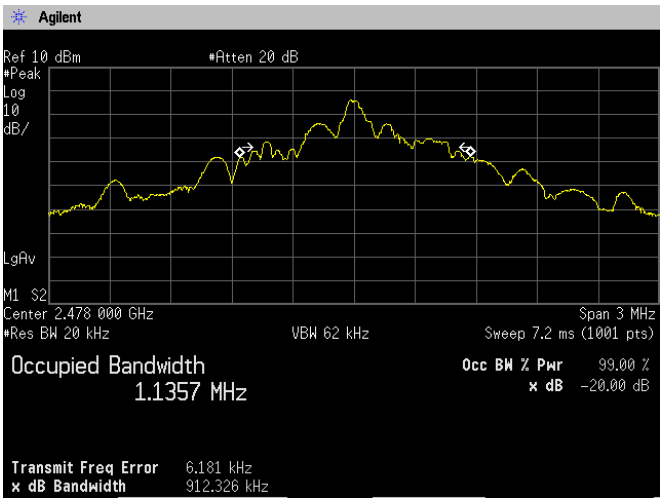
Channel Low



Channel Middle

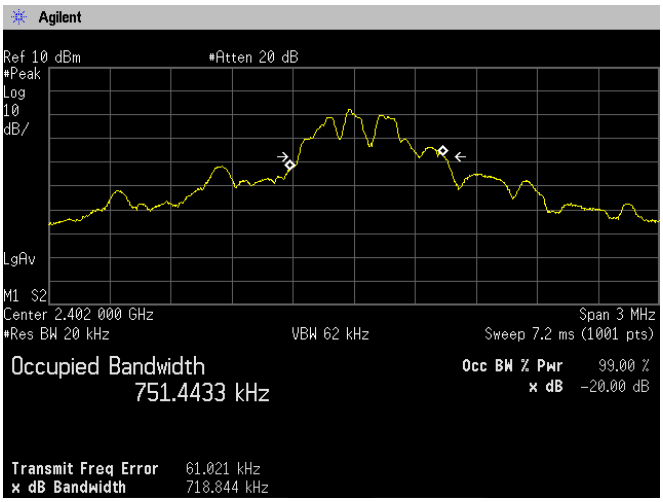


Channel High

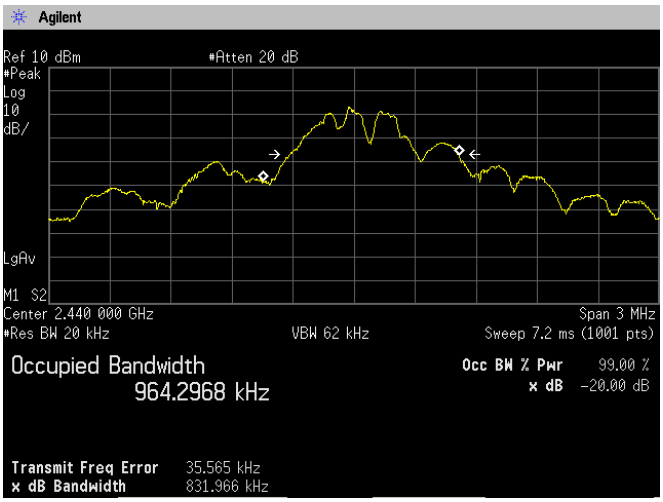


<250kbps>

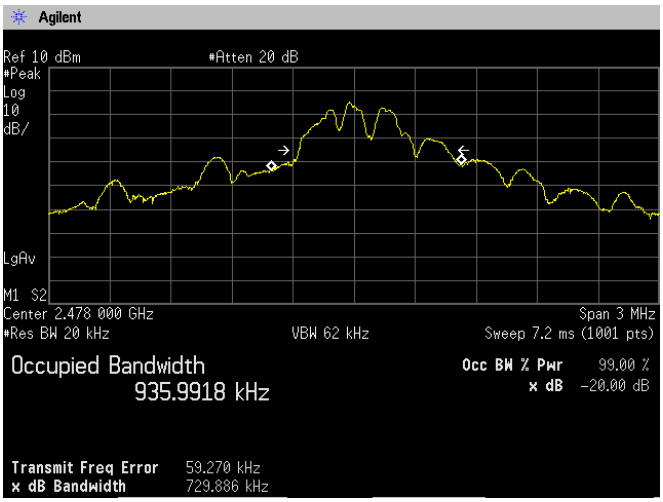
Channel Low



Channel Middle



Channel High



5. Spurious Emissions - Field Strength of Fundamental and Harmonics -

5.1 Measurement procedure
[FCC 205/209/249(a), (b), (c), (d), (e), 15.35(b), IC RSS-210 A2.9(a), (b), RSS-Gen 4.9, 4.10]

Test was applied by following conditions.

Test method	:	ANSI C63.10
Frequency range	:	9kHz to 25GHz
Test place	:	3m Semi-anechoic chamber
EUT was placed on	:	FRP table / (W)2.0m × (D)1.0m × (H)0.8m
Antenna distance	:	3m
Test receiver setting		Below 1GHz
- Detector	:	Average (9kHz-90kHz, 110kHz-490kHz), Quasi-peak
- Bandwidth	:	200Hz, 120kHz
Spectrum analyzer setting		Above 1GHz
- Peak	:	RBW=1MHz, VBW=3MHz, Span=0Hz, Sweep=auto
- Average	:	Peak reading + DCF

Average Measurement [DCF]

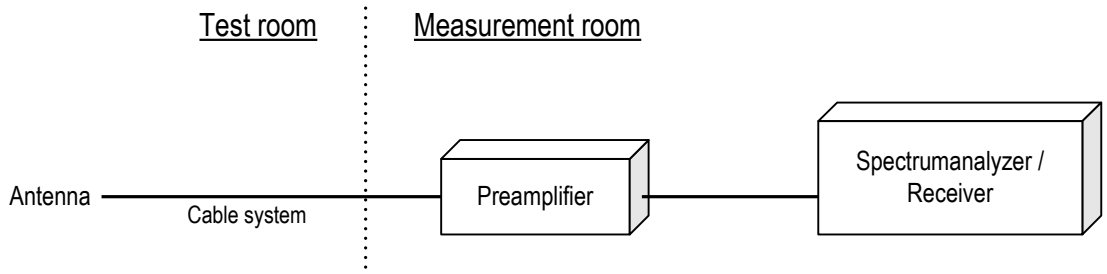
Data rate	Duty cycle (%)	T_{on} (ms)	100ms window	$1/T_{on}$ (kHz)	Duty cycle factor 20log (Dc %) (dB)
1Mbps	3.4	0.340	10	2.941	-29.4 (-20)
250kbps	12.4	1.240	10	0.806	-18.1

Radiated emission measurements are performed at 3m distance with the broadband antenna (Loop antenna, Biconical antenna, Log periodic antenna, Double ridged guide antenna and Broad-band horn 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. As for the Loop antenna, it is positioned with its plane vertical, and the center of the Loop antenna is 1m above the ground plane.
The EUT is Placed on a turntable, which is 0.8m 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.

The EUT was set to operate with following conditions.
- Channel Low: 2402MHz, Channel Middle: 2440MHz, Channel High: 2478MHz

The test mode of EUT is as follows.
- Tx mode, Rx mode

- Test configuration



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5.2 Calculation method

[9kHz to 150kHz]
Emission level = Reading + (Ant. factor + Cable system loss)
Margin = Limit – Emission level

[150kHz to 25GHz]
Emission level = Reading + (Ant. factor + Cable system loss – Amp. Gain)
Margin = Limit – Emission level

Example:
Limit @ 4804.0MHz : 74.0dBuV/m (Peak Limit)
S.A Reading = 39.9dBuV Cable system loss = 8.3dB
Result = 39.9 + 8.3 = 48.2dBuV/m
Margin = 74.0 – 48.2 = 25.8dB

5.3 Limit

Fundamental Frequency [MHz]	Field strength of fundamental		Field strength of harmonics		Distance [m]
	[mV/m]	[dBuV/m]	[mV/m]	[dBuV/m]	
2400-2483.5	50	20logE [uV/m]	500	20logE [uV/m]	3

Frequency [MHz]	Field strength		Distance [m]
	[uV/m]	[dBuV/m]	
0.009-0.490	2400 / F [kHz]	20logE [uV/m]	300
0.490-1.705	24000 / F [kHz]	20logE [uV/m]	30
1.705-30	30	29.5	30
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

Note:
1. The lower limit shall apply at the transition frequencies.
2. Emission level [dBuV/m] = 20log Emission [uV/m]
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition modulation.

5.4 Test data

Date : November 20, 2015
Temperature : 24.2 [˚C]
Humidity : 29.9 [%] Test engineer : Taiki Watanabe
Test place : 3m Semi-anechoic chamber

Date : November 21, 2015
Temperature : 22.6 [˚C]
Humidity : 32.6 [%] Test engineer : Taiki Watanabe
Test place : 3m Semi-anechoic chamber

<1Mbps>
Channel Low
Peak

(P)	Frequency [MHz]	Reading [dBμV/m]	c.f [dB(1/m)]	Duty cycle factor [dB(1/m)]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]
H	2402	95.6	2.3	-	97.9	114.0	16.1
V	2402	99.3	2.3	-	101.6	114.0	12.4
H	4804	52.8	8.3	-	61.1	74.0	12.9
V	4804	54.6	8.3	-	62.9	74.0	11.1
H	7206	51.0	14.3	-	65.3	74.0	8.7
V	7206	51.4	14.3	-	65.7	74.0	8.3
H	9608	47.6	19.7	-	67.3	74.0	6.7
V	9608	47.4	19.7	-	67.1	74.0	6.9
V	12010	46.9	21.5	-	68.4	74.0	5.6

Average

(P)	Frequency [MHz]	Reading [dBμV/m]	c.f [dB(1/m)]	Duty cycle factor [dB(1/m)]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]
H	2402	95.6	2.3	-20.0	77.9	94.0	16.1
V	2402	99.3	2.3	-20.0	81.6	94.0	12.4
H	4804	52.8	8.3	-20.0	41.1	54.0	12.9
V	4804	54.6	8.3	-20.0	42.9	54.0	11.1
H	7206	51.0	14.3	-20.0	45.3	54.0	8.7
V	7206	51.4	14.3	-20.0	45.7	54.0	8.3
H	9608	47.6	19.7	-20.0	47.3	54.0	6.7
V	9608	47.4	19.7	-20.0	47.1	54.0	6.9
V	12010	46.9	21.5	-20.0	48.4	54.0	5.6

Channel Middle
Peak

(P)	Frequency [MHz]	Reading [dBμV/m]	c.f [dB(1/m)]	Duty cycle factor [dB(1/m)]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]
H	2440	100.2	2.5	-	102.7	114.0	11.3
V	2440	101.9	2.5	-	104.4	114.0	9.6
H	4880	55.8	8.7	-	64.5	74.0	9.5
V	4880	53.7	8.7	-	62.4	74.0	11.6
H	7320	51.1	14.6	-	65.7	74.0	8.3
V	7320	54.3	14.6	-	68.9	74.0	5.1
H	9760	48.0	19.8	-	67.8	74.0	6.2
V	9760	49.2	19.8	-	69.0	74.0	5.0
H	12200	49.1	20.7	-	69.8	74.0	4.2
V	12200	49.9	20.7	-	70.6	74.0	3.4

Average

(P)	Frequency [MHz]	Reading [dBµV/m]	c.f [dB(1/m)]	Duty cycle factor [dB(1/m)]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]
H	2440	100.2	2.5	-20.0	82.7	94.0	11.3
V	2440	101.9	2.5	-20.0	84.4	94.0	9.6
H	4880	55.8	8.7	-20.0	44.5	54.0	9.5
V	4880	53.7	8.7	-20.0	42.4	54.0	11.6
H	7320	51.1	14.6	-20.0	45.7	54.0	8.3
V	7320	54.3	14.6	-20.0	48.9	54.0	5.1
H	9760	48.0	19.8	-20.0	47.8	54.0	6.2
V	9760	49.2	19.8	-20.0	49.0	54.0	5.0
H	12200	49.1	20.7	-20.0	49.8	54.0	4.2
V	12200	49.9	20.7	-20.0	50.6	54.0	3.4

Channel High
Peak

(P)	Frequency [MHz]	Reading [dBµV/m]	c.f [dB(1/m)]	Duty cycle factor [dB(1/m)]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]
H	2478	103.0	2.6	-	105.6	114.0	8.4
V	2478	105.0	2.6	-	107.6	114.0	6.4
H	4956	58.0	8.8	-	66.8	74.0	7.2
V	4956	52.8	8.8	-	61.6	74.0	12.4
H	7434	51.5	15.0	-	66.5	74.0	7.5
V	7434	54.8	15.0	-	69.8	74.0	4.2
H	9912	49.5	20.0	-	69.5	74.0	4.5
V	9912	51.0	20.0	-	71.0	74.0	3.0
H	12390	48.3	19.8	-	68.1	74.0	5.9
V	12390	50.5	19.8	-	70.3	74.0	3.7

Average

(P)	Frequency [MHz]	Reading [dBµV/m]	c.f [dB(1/m)]	Duty cycle factor [dB(1/m)]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]
H	2478	103.0	2.6	-20.0	85.6	94.0	8.4
V	2478	105.0	2.6	-20.0	87.6	94.0	6.4
H	4956	58.0	8.8	-20.0	46.8	54.0	7.2
V	4956	52.8	8.8	-20.0	41.6	54.0	12.4
H	7434	51.5	15.0	-20.0	46.5	54.0	7.5
V	7434	54.8	15.0	-20.0	49.8	54.0	4.2
H	9912	49.5	20.0	-20.0	49.5	54.0	4.5
V	9912	51.0	20.0	-20.0	51.0	54.0	3.0
H	12390	48.3	19.8	-20.0	48.1	54.0	5.9
V	12390	50.5	19.8	-20.0	50.3	54.0	3.7

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 9kHz to 1000MHz at the 3 meters distance.
3. No emission was detected in the receive mode.

Date : November 19, 2015
Temperature : 24.2 [˚C]
Humidity : 29.9 [%] Test engineer :
Test place : 3m Semi-anechoic chamber Taiki Watanabe

Date : November 21, 2015
Temperature : 22.6 [˚C]
Humidity : 32.6 [%] Test engineer :
Test place : 3m Semi-anechoic chamber Taiki Watanabe

<250kbps>
Channel Low
Peak

(P)	Frequency [MHz]	Reading [dBμV/m]	c.f [dB(1/m)]	Duty cycle factor [dB(1/m)]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]
H	2402	97.1	2.3	-	99.4	114.0	14.6
V	2402	98.8	2.3	-	101.1	114.0	12.9
H	4804	52.3	8.3	-	60.6	74.0	13.4
V	4804	54.3	8.3	-	62.6	74.0	11.4
H	7206	51.5	14.3	-	65.8	74.0	8.2
V	7206	52.0	14.3	-	66.3	74.0	7.7
H	9608	47.4	19.7	-	67.1	74.0	6.9
V	9608	48.9	19.7	-	68.6	74.0	5.4
H	12010	46.6	21.5	-	68.1	74.0	5.9
V	12010	48.2	21.5	-	69.7	74.0	4.3

Average

(P)	Frequency [MHz]	Reading [dBμV/m]	c.f [dB(1/m)]	Duty cycle factor [dB(1/m)]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]
H	2402	97.1	2.3	-18.1	81.3	94.0	12.7
V	2402	98.8	2.3	-18.1	83.0	94.0	11.0
H	4804	52.3	8.3	-18.1	42.5	54.0	11.5
V	4804	54.3	8.3	-18.1	44.5	54.0	9.5
H	7206	51.5	14.3	-18.1	47.7	54.0	6.3
V	7206	52.0	14.3	-18.1	48.2	54.0	5.8
H	9608	47.4	19.7	-18.1	49.0	54.0	5.0
V	9608	48.9	19.7	-18.1	50.5	54.0	3.5
H	12010	46.6	21.5	-18.1	50.0	54.0	4.0
V	12010	48.2	21.5	-18.1	51.6	54.0	2.4

Channel Middle
Peak

(P)	Frequency [MHz]	Reading [dBμV/m]	c.f [dB(1/m)]	Duty cycle factor [dB(1/m)]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]
H	2440	99.7	2.5	-	102.2	114.0	11.8
V	2440	102.3	2.5	-	104.8	114.0	9.2
H	4880	55.2	8.7	-	63.9	74.0	10.1
V	4880	52.7	8.7	-	61.4	74.0	12.6
H	7320	50.2	14.6	-	64.8	74.0	9.2
V	7320	54.2	14.6	-	68.8	74.0	5.2
H	9760	47.6	19.8	-	67.4	74.0	6.6
V	9760	49.8	19.8	-	69.6	74.0	4.4
H	12200	46.9	20.7	-	67.6	74.0	6.4
V	12200	49.6	20.7	-	70.3	74.0	3.7

Average

(P)	Frequency [MHz]	Reading [dBµV/m]	c.f [dB(1/m)]	Duty cycle factor [dB(1/m)]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]
H	2440	99.7	2.5	-18.1	84.1	94.0	9.9
V	2440	102.3	2.5	-18.1	86.7	94.0	7.3
H	4880	55.2	8.7	-18.1	45.8	54.0	8.2
V	4880	52.7	8.7	-18.1	43.3	54.0	10.7
H	7320	50.2	14.6	-18.1	46.7	54.0	7.3
V	7320	54.2	14.6	-18.1	50.7	54.0	3.3
H	9760	47.6	19.8	-18.1	49.3	54.0	4.7
V	9760	49.8	19.8	-18.1	51.5	54.0	2.5
H	12200	46.9	20.7	-18.1	49.5	54.0	4.5
V	12200	49.6	20.7	-18.1	52.2	54.0	1.8

Channel High
Peak

(P)	Frequency [MHz]	Reading [dBµV/m]	c.f [dB(1/m)]	Duty cycle factor [dB(1/m)]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]
H	2478	103.9	2.6	-	106.5	114.0	7.5
V	2478	104.8	2.6	-	107.4	114.0	6.6
H	4956	56.1	8.8	-	64.9	74.0	9.1
V	4956	52.2	8.8	-	61.0	74.0	13.0
H	7434	52.1	15.0	-	67.1	74.0	6.9
V	7434	55.3	15.0	-	70.3	74.0	3.7
H	9912	49.5	20.0	-	69.5	74.0	4.5
V	9912	51.4	20.0	-	71.4	74.0	2.6
H	12390	49.1	19.8	-	68.9	74.0	5.1
V	12390	50.4	19.8	-	70.2	74.0	3.8

Average

(P)	Frequency [MHz]	Reading [dBµV/m]	c.f [dB(1/m)]	Duty cycle factor [dB(1/m)]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]
H	2478	103.9	2.6	-18.1	88.4	94.0	5.6
V	2478	104.8	2.6	-18.1	89.3	94.0	4.7
H	4956	56.1	8.8	-18.1	46.8	54.0	7.2
V	4956	52.2	8.8	-18.1	42.9	54.0	11.1
H	7434	52.1	15.0	-18.1	49.0	54.0	5.0
V	7434	55.3	15.0	-18.1	52.2	54.0	1.8
H	9912	49.5	20.0	-18.1	51.4	54.0	2.6
V	9912	51.4	20.0	-18.1	53.3	54.0	0.7
H	12390	49.1	19.8	-18.1	50.8	54.0	3.2
V	12390	50.4	19.8	-18.1	52.1	54.0	1.9

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 9kHz to 1000MHz at the 3 meters distance.
3. No emission was detected in the receive mode.

6. Restricted Band of Operation

6.1 Measurement procedure
[FCC 15.205, 15.209, 15.249(c), (d), IC RSS-210 A2.9(b)]

Test was applied by following conditions.

Test method	:	ANSI C63.10
Test place	:	3m Semi-anechoic chamber
EUT was placed on	:	FRP table / (W)2.0m × (D)1.0m × (H)0.8m
Antenna distance	:	3m

Spectrum analyzer setting

- Peak	:	RBW=1MHz, VBW=3MHz, Span=10MHz, Sweep=auto
- Delta	:	RBW=300kHz, VBW=300kHz, Span=40MHz, Sweep=auto
- Average	:	RBW=1MHz, VBW=1kHz/3kHz, Span=40MHz, Sweep=auto

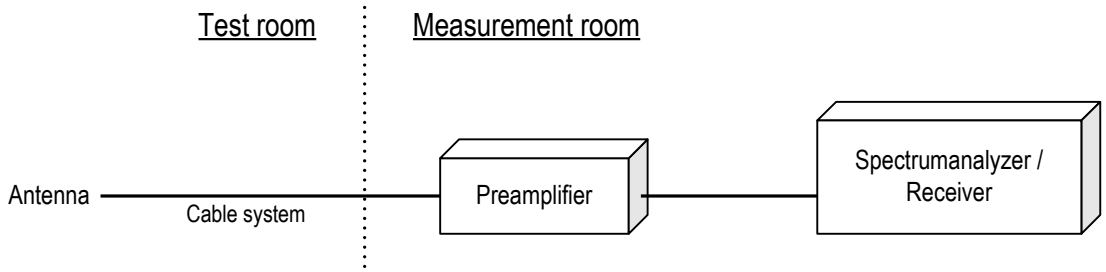
Average Measurement Setting [VBW]

Data rate	Duty Cycle (%)	T_{on} (us)	T_{off} (us)	$1/T_{on}$ (kHz)	Determined VBW Setting
1Mbps	3.4	0.340	5.100	2.941	3kHz
250kbps	12.4	1.240	4.920	0.806	1kHz

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 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.
The EUT was set to operate with following conditions.
- Channel Low: 2402MHz, Channel High: 2478MHz

The test mode of EUT is as follows.
- Tx mode

- Test configuration



6.2 Limit

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

6.3 Measurement Result

Channel	Frequency [MHz]	Results Chart	Result
Low	2402	See the Trace Data	Pass
High	2478	See the Trace Data	Pass

6.4 Test data

Date : November 21, 2015
Temperature : 23.3 [˚C]
Humidity : 20.3 [%]
Test place : 3m Semi-anechoic chamber
Test engineer : Taiki Watanabe

<1Mbps>
Peak

(P)	Frequency [MHz]	Reading [dBμV/m]	c.f [dB(1/m)]	Marker Delta [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]
H	2390.0	98.0	2.3	45.9	54.4	74.0	19.6
V	2390.0	99.4	2.3	46.5	55.2	74.0	18.8
H	2483.5	104.4	2.6	38.8	68.2	74.0	5.8
V	2483.5	105.1	2.6	38.5	69.2	74.0	4.8

Average

(P)	Frequency [MHz]	Reading [dBμV/m]	c.f [dB(1/m)]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]
H	2390.0	41.6	2.3	43.9	54.0	10.1
V	2390.0	42.1	2.3	44.4	54.0	9.6
H	2483.5	49.7	2.6	52.3	54.0	1.7
V	2483.5	50.3	2.6	52.9	54.0	1.1

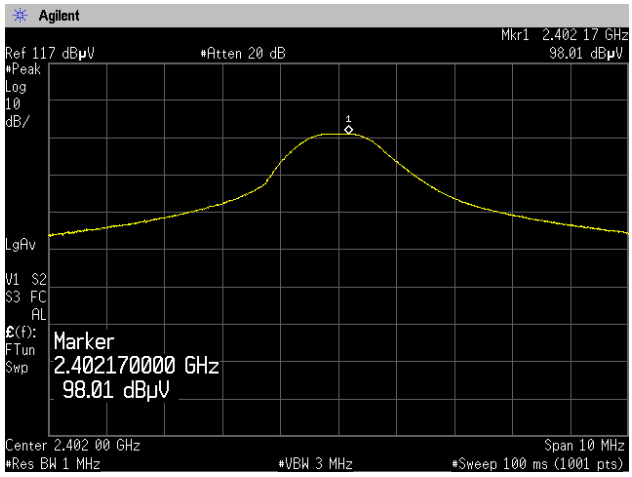
<250kbps>
Peak

(P)	Frequency [MHz]	Reading [dBμV/m]	c.f [dB(1/m)]	Marker Delta [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]
H	2390.0	97.4	2.3	46.1	53.5	74.0	20.5
V	2390.0	98.7	2.3	45.6	55.4	74.0	18.6
H	2483.5	104.3	2.6	38.8	68.1	74.0	5.9
V	2483.5	104.9	2.6	38.1	69.3	74.0	4.7

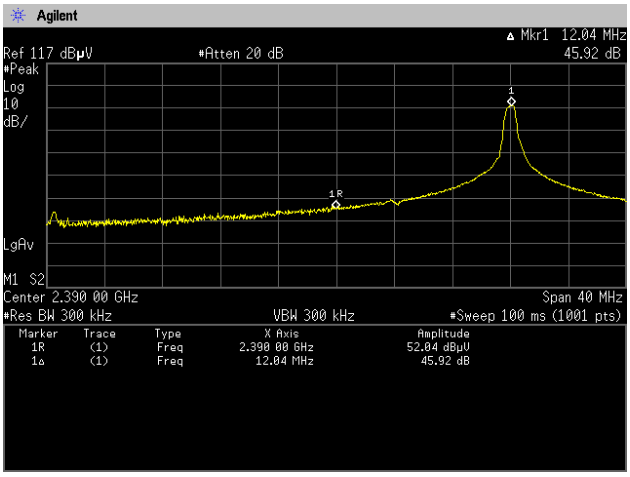
Average

(P)	Frequency [MHz]	Reading [dBμV/m]	c.f [dB(1/m)]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]
H	2390.0	38.1	2.3	40.4	54.0	13.6
V	2390.0	38.7	2.3	41.0	54.0	13.0
H	2483.5	46.2	2.6	48.8	54.0	5.2
V	2483.5	46.1	2.6	48.7	54.0	5.3

<1Mbps>
Channel Low
Horizontal
Peak



Maker Delta



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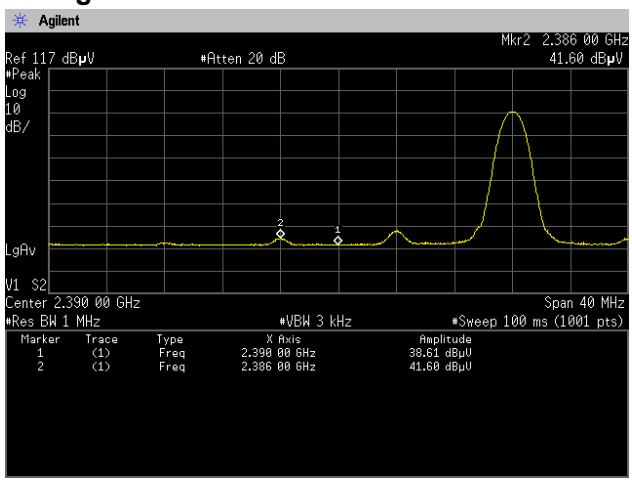
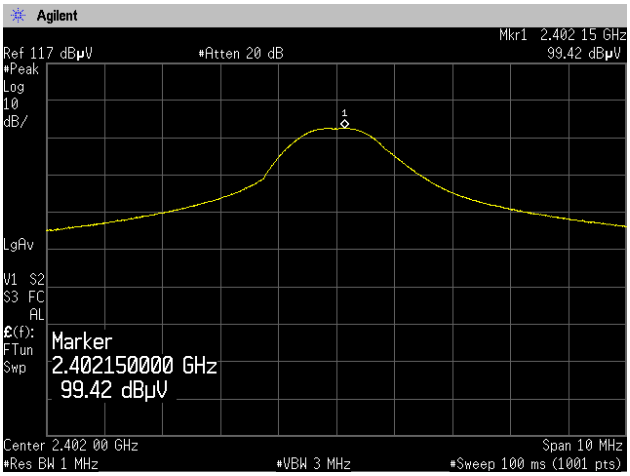
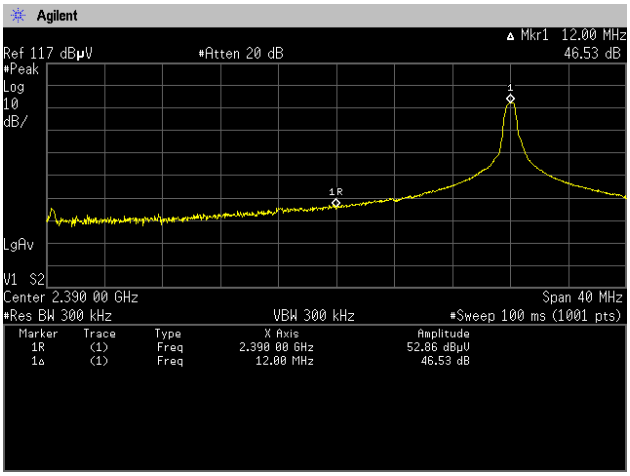


Channel Low
Vertical
Peak



Maker Delta



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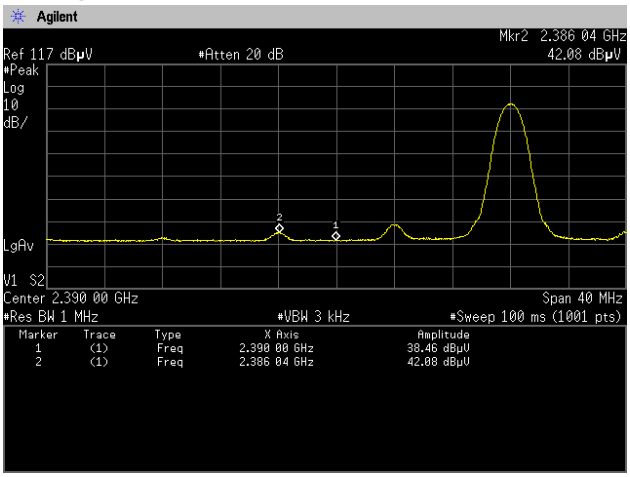
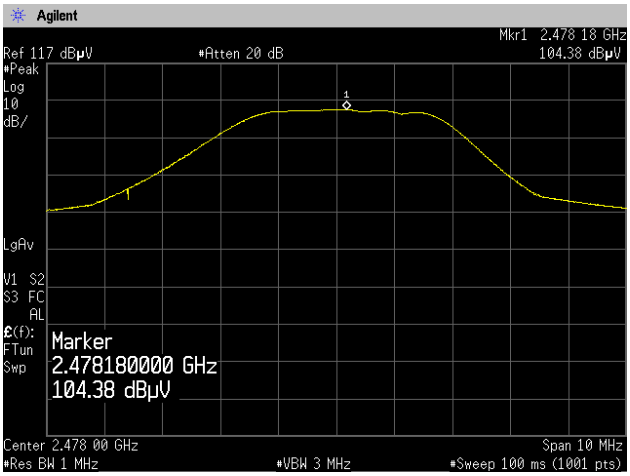
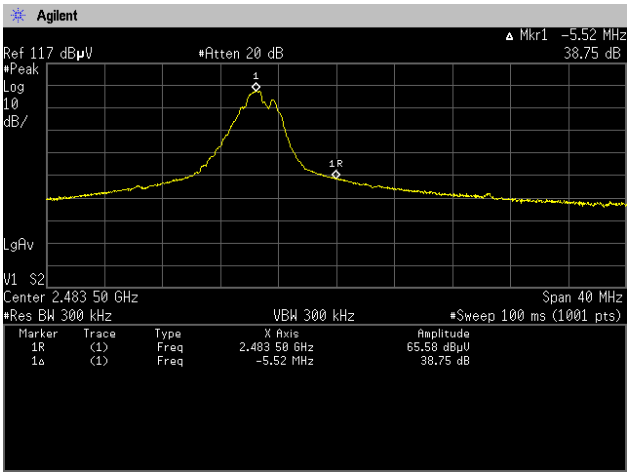


Channel High
Horizontal
Peak



Marker Delta



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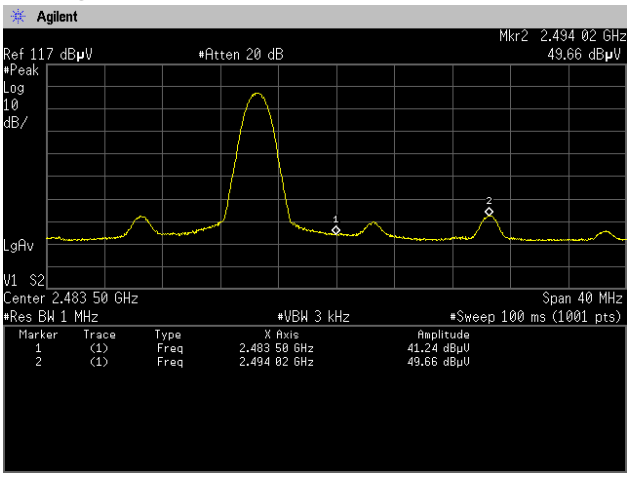
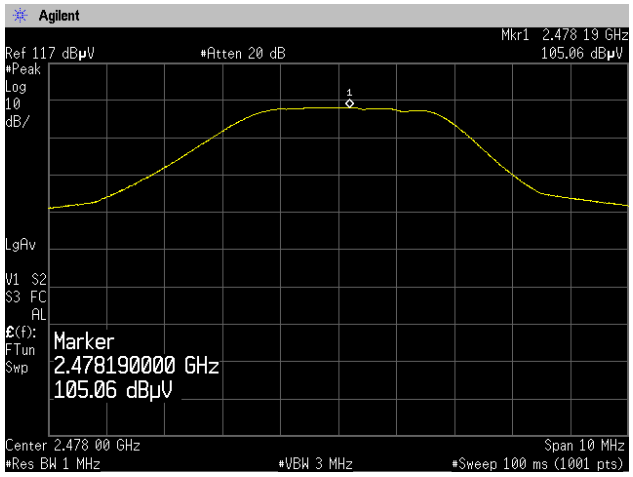
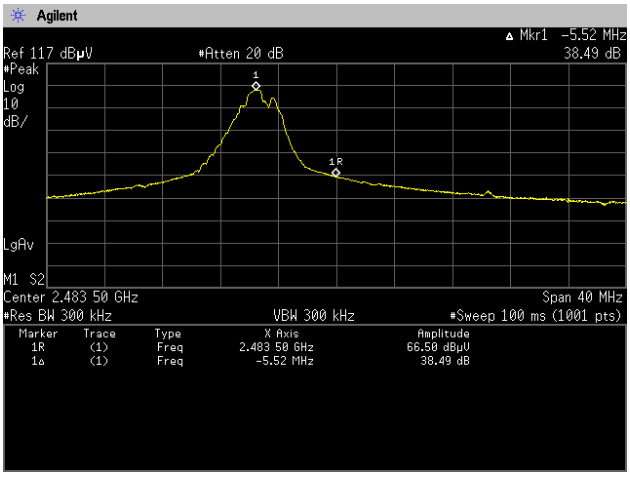


Channel High
Vertical
Peak



Marker Delta



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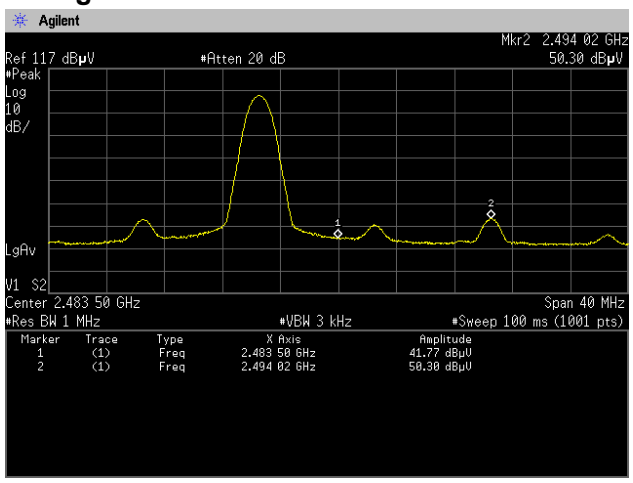
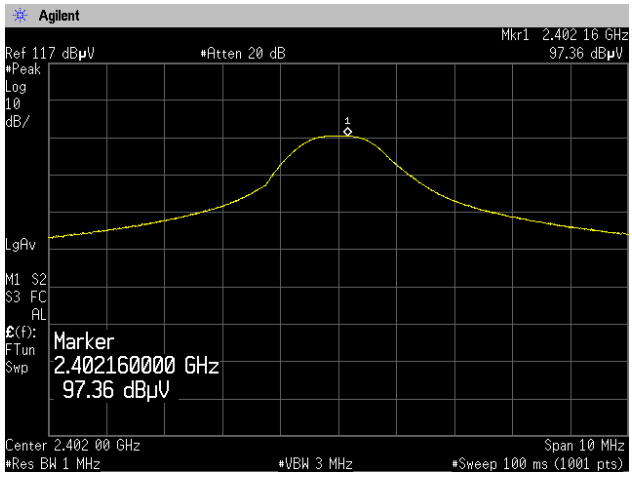
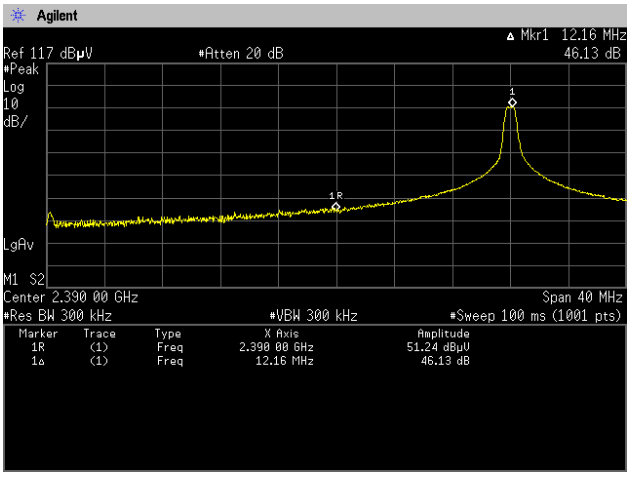


<250kbps>
Channel Low
Horizontal

Peak



Maker Delta



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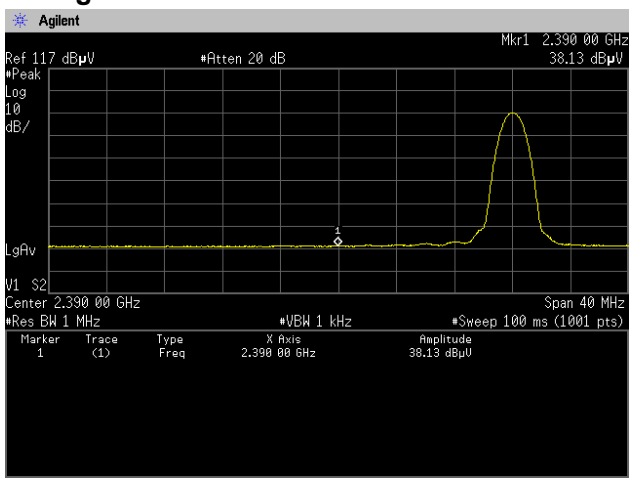
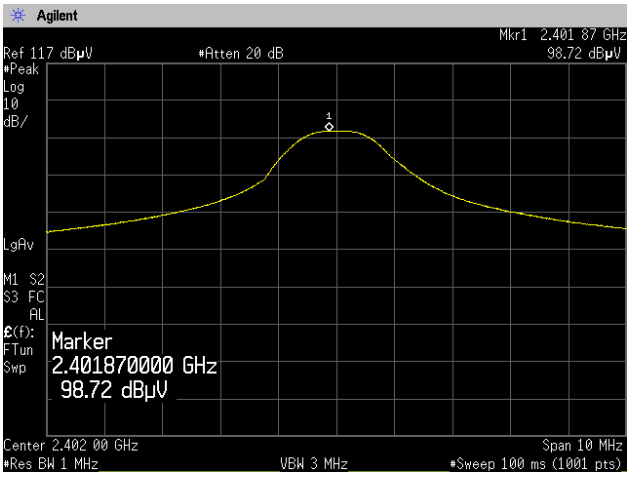
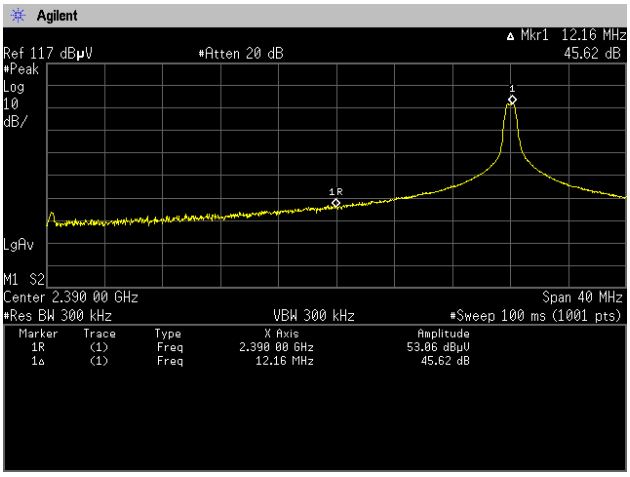


Channel Low
Vertical
Peak



Maker Delta



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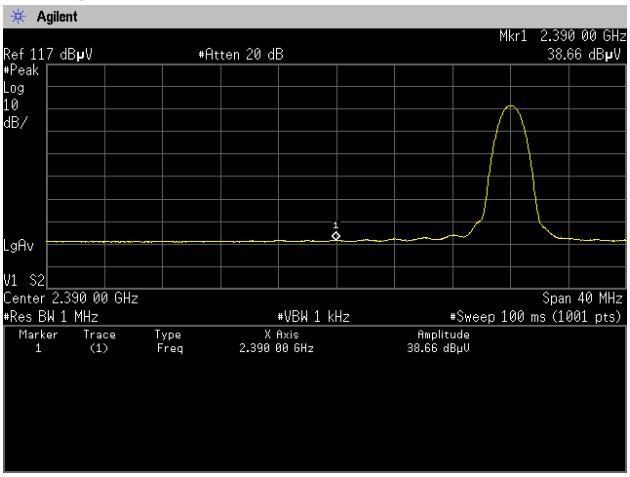
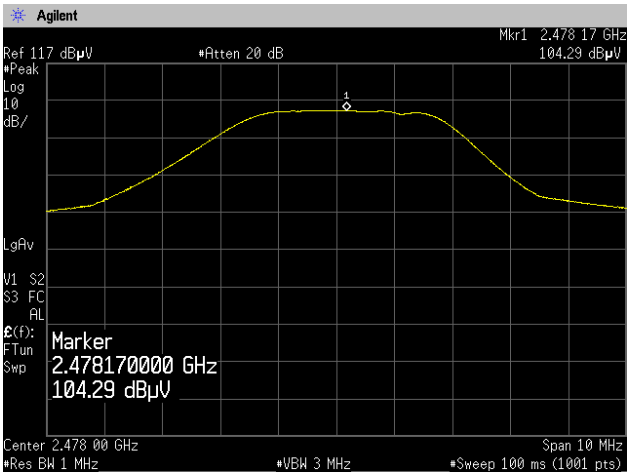
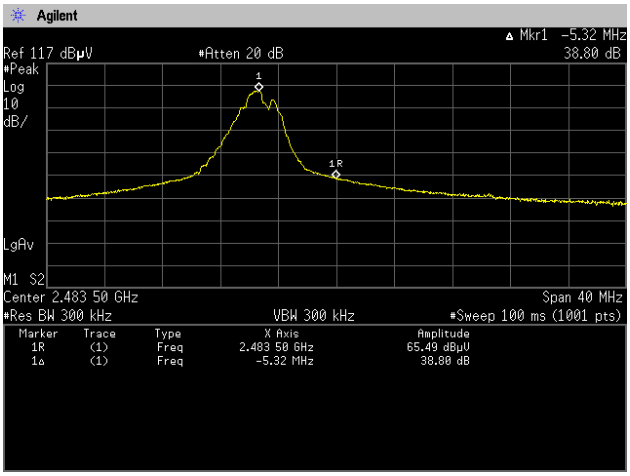


Channel High
Horizontal
Peak



Marker Delta



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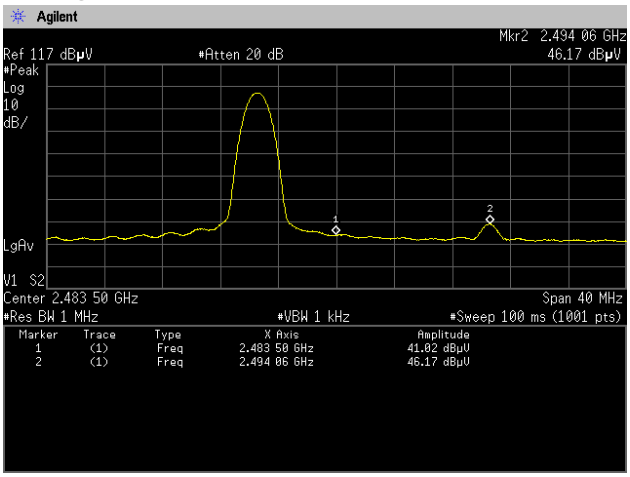
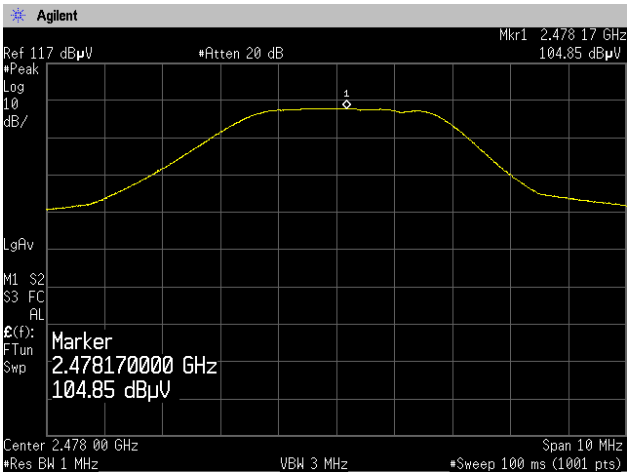


Channel High
Vertical
Peak



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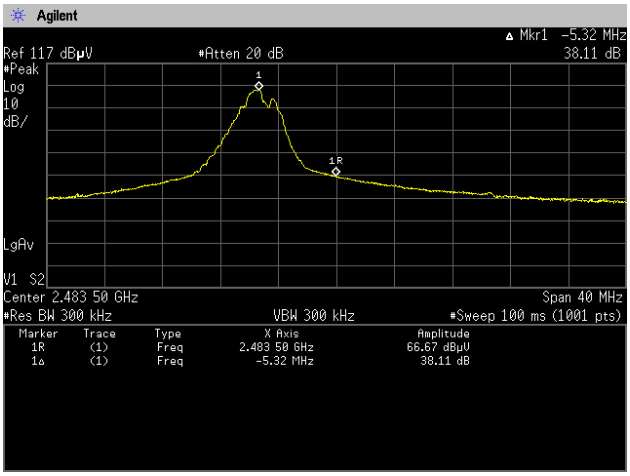

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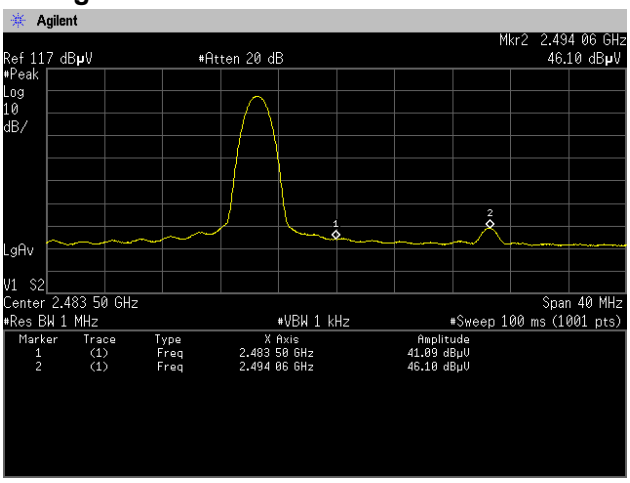


7. AC Power Line Conducted Emissions

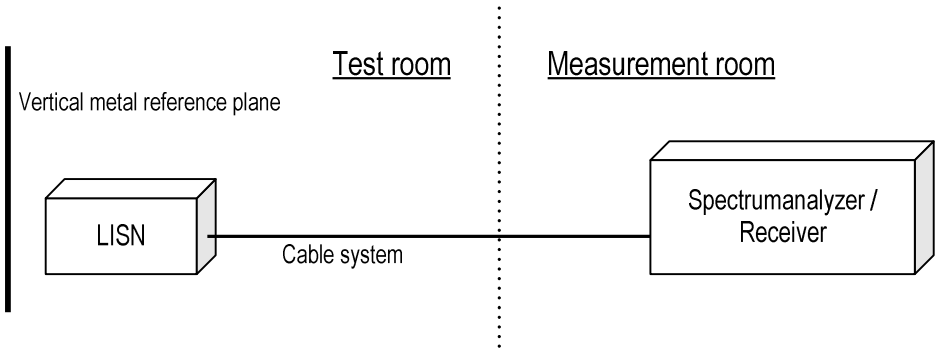
7 Measurement procedure
[FCC 15.207]

Test was applied by following conditions.

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

EUT and peripherals are connected to 50Ω/50μH 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 50Ω.
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



7.2 Calculation method

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

7.3 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

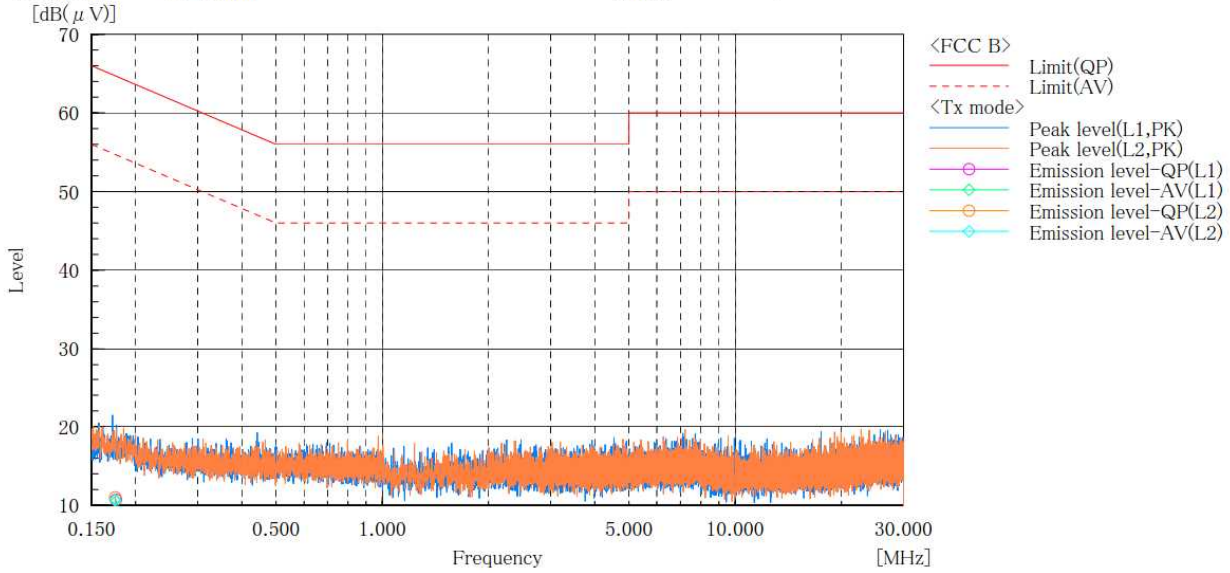
*: The limit decreases linearly with the logarithm of the frequency in the range 0.15MHz to 0.5MHz.

7.4 Test data

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

TUV SUD Zacta Ltd. <<Data Sheet No.01>> 26 November,2015 08:38

Company Name	: HOKUBU Communication	Standard	: FCC Part.15 Subpart C
EUT	: TX Module	Operator	: T.Watanabe
Model No.	: Model EP	Temp.Hum.	: 23.3[℃] 20.3[%]
Serial No.	: 1510041	Note1	:
Test mode	: Tx mode	Note2	:



Final Result

--- L1 Phase ---

No.	Frequency [MHz]	Reading QP [dB(μV)]	Reading AV [dB(μV)]	c.f [dB]	Result QP [dB(μV)]	Result AV [dB(μV)]	Limit QP [dB(μV)]	Limit AV [dB(μV)]	Margin QP [dB]	Margin AV [dB]
1	0.176	0.3	0.1	10.4	10.7	10.5	64.7	54.7	54.0	44.2

--- L2 Phase ---

No.	Frequency [MHz]	Reading QP [dB(μV)]	Reading AV [dB(μV)]	c.f [dB]	Result QP [dB(μV)]	Result AV [dB(μV)]	Limit QP [dB(μV)]	Limit AV [dB(μV)]	Margin QP [dB]	Margin AV [dB]
1	0.175	0.4	0.1	10.6	11.0	10.7	64.7	54.7	53.7	44.0

Note: No emission were observed during Conducted testing.

8. Antenna requirement

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.

9. 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 determining compliance or non-compliance with test result.

Test item	Measurement uncertainty
Conducted emission at mains port	±3.0dB
Radiated emission (9kHz – 30MHz)	±4.4dB
Radiated emission (30MHz – 1000MHz)	±4.5dB
Radiated emission (1000MHz – 26GHz)	±3.9dB

Zacta

10. Laboratory description

1. Location:

TÜV SÜD Zacta Ltd. Yonezawa Testing Center
4149-7 Hachimanpara 5-chome Yonezawa-shi Yamagata 992-1128 Japan
Phone: +81-238-28-2880 Fax: +81-238-28-2888

2. Facility filing information:

1) NVLAP accreditation: NVLAP Lab. code: 200306-0

2) VLAC accreditation: Lab. code: VLAC-013

Site name	Radiated emission	Conducted emission for mains port	Conducted emission for telecom port	Radiated emission (CMAD)	Expiry Date
3m Semi-anechoic chamber	VLAC-013			-	Jul. 3, 2017
10m Semi-anechoic chamber No.1				VLAC-013	
10m Semi-anechoic chamber No.2					
Shielded room No.1	-	VLAC-013		-	

3) FCC filing:

Site name	Registration Number	Expiry Date
Site 3	91065	Oct. 1, 2017
3m Semi-anechoic chamber	540072	Feb. 20, 2017
10m Semi-anechoic chamber No.1		
10m Semi-anechoic chamber No.2		
Shielded room No.1		

4) Industry Canada Oats site filing:

Site name	Sites on file: Oats 3m/10m	Expiry Date
Site 3	4224A-3	Dec. 3, 2017
3m Semi-anechoic chamber	4224A-4	
10m Semi-anechoic chamber No.1	4224A-5	
10m Semi-anechoic chamber No.2	4224A-6	Jan. 15, 2017

5) VCCI site filing:

Site name	Radiated emission	Conducted emission for mains port	Conducted emission for telecom port	Expiry Date
Site 3	R-138	C-134	T-1222	Nov. 16, 2017
3m Semi-anechoic chamber	A-0166			Jul. 3, 2017
10m Semi-anechoic chamber No.1				
10m Semi-anechoic chamber No.2				
Shielded room No.1	-	A-0166		

6) TÜV SÜD PS authorization:
Authorized as an EMC test laboratory

7) TÜV Rheinland authorization:
Authorized as an EMC test laboratory

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, 2016	Jun. 11, 2015
Microwave cable	RS	YH_13S5	N/A (S403)	May 31, 2016	May 10, 2015
Attenuator	Weinschel	56-10	J4993	Nov. 30, 2015	Nov. 12, 2014

Radiated emission

Equipment	Company	Model No.	Serial No.	Cal. Due	Cal. Date
EMI Receiver	ROHDE&SCHWARZ	ESCI	100764	Aug. 31, 2016	Aug. 21, 2015
Preamplifier	ANRITSU	MH648A	M96057	Jun. 30, 2016	Jun. 30, 2015
Loop antenna	ROHDE&SCHWARZ	HFH2-Z2	892246/010	Apr. 30, 2016	Apr. 2, 2015
Attenuator	TDC	TAT-43B-06	N/A (S209)	Apr. 30, 2016	Apr. 16, 2015
Biconical antenna	Schwarzbeck	VHA9103/BBA9106	2155	Jun. 30, 2016	Jun. 4, 2015
Log periodic antenna	Schwarzbeck	UHALP9108A	0560	Jun. 30, 2016	Jun. 4, 2015
Attenuator	TME	CFA-01NPJ-6	N/A (S275)	Jun. 30, 2016	Jun. 23, 2015
Attenuator	TME	CFA-01NPJ-3	N/A (S272)	Jun. 30, 2016	Jun. 23, 2015
Spectrum analyzer	Agilent Technologies	E4440A	US40420937	Jul. 31, 2016	Jul. 23, 2015
Preamplifier	Agilent Technologies	8449B	3008A1008	Dec. 31, 2015	Dec. 5, 2014
Double ridged guide antenna	EMCO	3115	5205	Feb. 29, 2016	Feb. 16, 2015
Attenuator	Agilent Technologies	8491B	MY39268633	Feb. 29, 2016	Feb. 1, 2015
Broad-Band Horn Antenna	Schwarzbeck	BBHA9170	BBHA9170189	Jun. 30, 2016	Jun. 16, 2015
Preamplifier	TSJ	MLA-1ooM18-B02-40	1929118	May 31, 2016	May 1, 2015
Notch filter	Micro-Tronics	BRM50702	045	Nov. 30, 2015	Nov. 12, 2014
Microwave cable	SUHNER	SUCOFLEX104/9m	346316/4	Oct. 31, 2016	Oct. 23, 2015
		SUCOFLEX104/1m	322084/4	Oct. 31, 2016	Oct. 23, 2015
		SUCOFLEX104/1.5m	317226/4	Oct. 31, 2016	Oct. 23, 2015
		SUCOFLEX104/7m	41625/6	Oct. 31, 2016	Oct. 23, 2015
PC	DELL	DIMENSION E521	75465BX	N/A	N/A
Software	TOYO Corporation	EP5/RE-AJ	0611193/V5.3.61	N/A	N/A
3m Semi-anechoic chamber	TOKIN	N/A	N/A (9002-NSA)	Apr. 30, 2016	Apr. 27, 2015
3m Semi-anechoic chamber	TOKIN	N/A	N/A (9002-SVSWR)	Apr. 30, 2016	Apr. 27, 2015

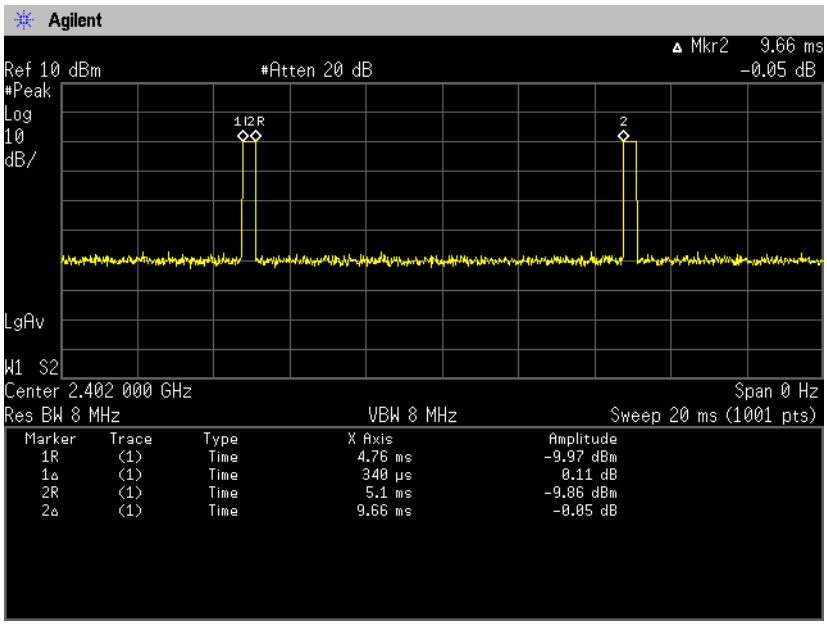
Conducted emission at mains port

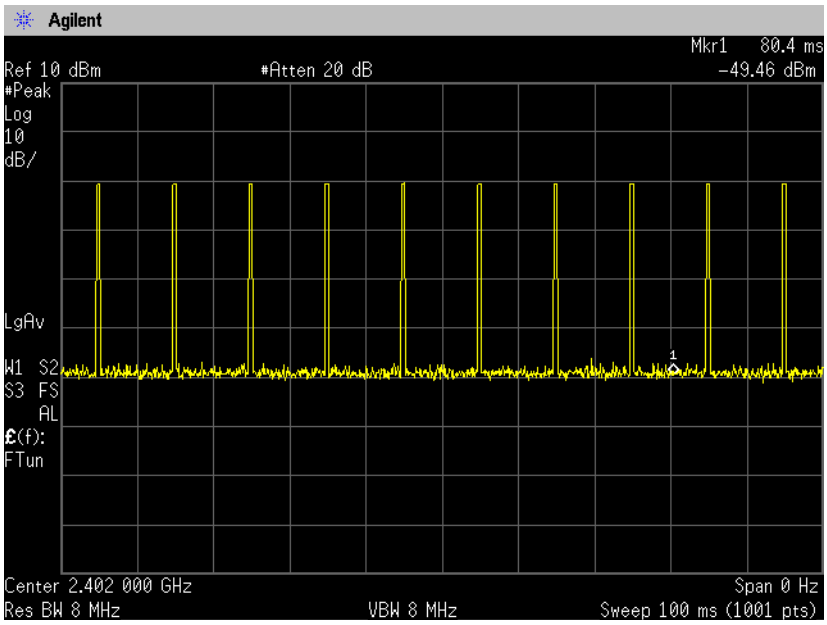
Equipment	Company	Model No.	Serial No.	Cal. due	Cal. date
EMI Receiver	ROHDE&SCHWARZ	ESCI	100764	Aug. 31, 2016	Aug. 21, 2015
Attenuator	HUBER+SUHNER	6810.01.A	N/A (S411)	Feb. 29, 2016	Feb. 5, 2015
Line impedance stabilization network for EUT	Kyoritsu Electrical Works, Ltd.	KNW-407F	8-2003-1	Mar. 31, 2016	Mar. 5, 2015
Coaxial cable	FUJIKURA	5D-2W/4m	N/A (S330)	Feb. 29, 2016	Feb. 5, 2015
Coaxial cable	FUJIKURA	5D-2W/1m	N/A (S193)	Feb. 29, 2016	Feb. 5, 2015
Coaxial cable	SUHNER	RG214/U/10m	N/A (S194)	Feb. 29, 2016	Feb. 5, 2015
PC	DELL	DIMENSION	75465BX	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]
<1Mbps>





Duty Cycle Factor Calculation

RF duty cycle factor: Calculation according to RF burst Para 15.35 (c)

Pulse width is 0.340ms

There are 10 pulses in 100ms window

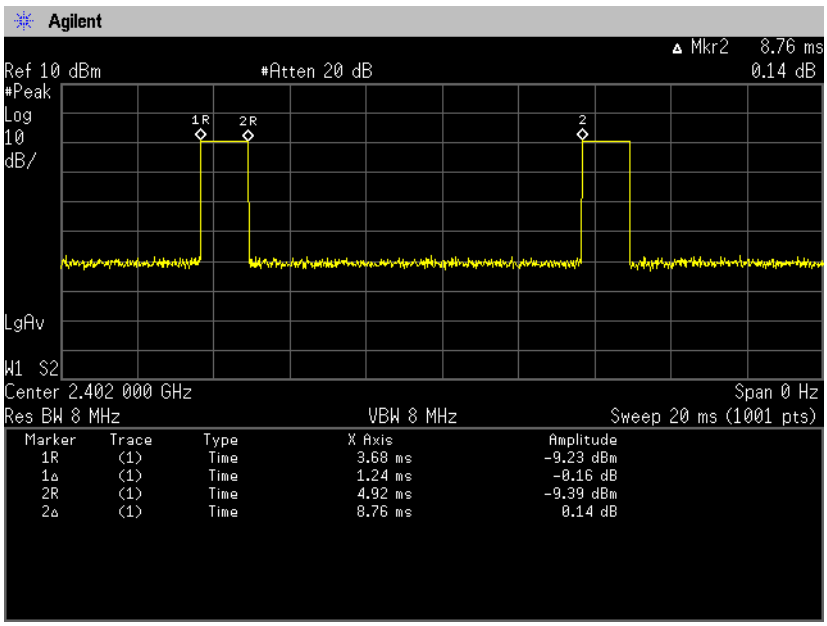
0.340ms x 10 = 3.4ms, It is 3.4ms in 100ms

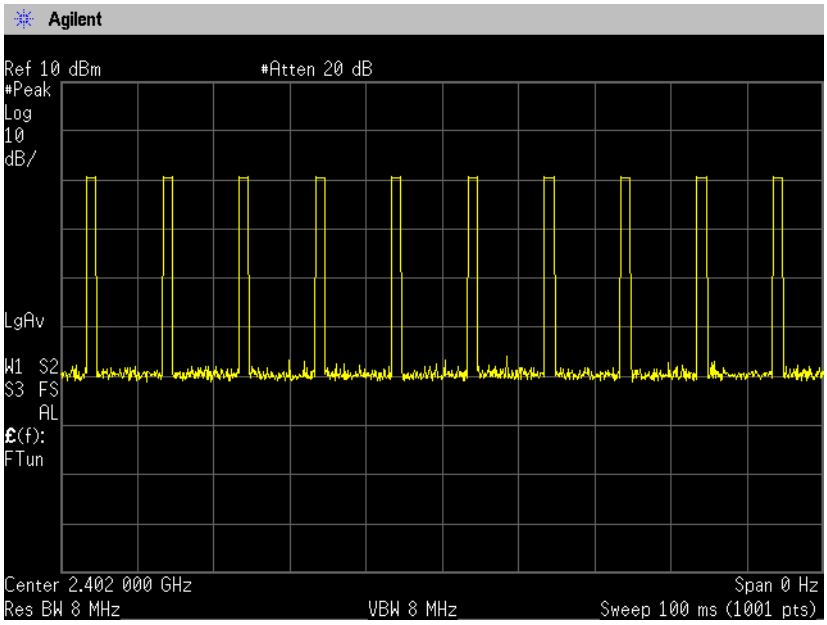
Duty cycle: 3.4/100 = 0.034

Duty cycle factor: 20log (0.034) = -29.37dB

Maximum is used duty cycle according to Para 15.35 (b): 20dB

<250kbps>





Duty Cycle Factor Calculation

RF duty cycle factor: Calculation according to RF burst Para 15.35 (c)

Pulse width is 1.24ms

There are 10 pulses in 100ms window

0.340ms x 10 = 12.4ms, It is 12.4ms in 100ms

Duty cycle: 12.4/100 = 0.124

Duty cycle factor: 20log (0.124) = -18.1dB

Maximum is used duty cycle according to Para 15.35 (b): 20dB