Report on the RF Testing of:

KYOCERA Corporation
Mobile Phone, Model: EB1090
FCC ID: JOYEB1090

In accordance with FCC Part 15 Subpart C

Japan

Add value.
Inspire trust.

Prepared for: KYOCERA Corporation
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Document Number: JPD-TR-21155-0

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EXECUTIVE SUMMARY – Result: Complied
A sample of this product was tested and the result above was confirmed in accordance with FCC Part 15 Subpart C.

ACCREDITED
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1 Summary of Test

1.1 Modification history of the test report

Document Number	Modification History	Issue Date
JPD-TR-21155-0	First Issue	Refer to the cover page

1.2 Standards

CFR47 FCC Part 15 Subpart C

1.3 Test methods

ANSI C63.10-2013

1.4 Deviation from standards

None

1.5 List of applied test(s) of the EUT

Test item section	Test item	Condition	Result	Remark
15.247(a)(1)	20dB Bandwidth	Conducted	PASS	-
15.247(a)(1)	Carrier Frequency Separation	Conducted	PASS	-
15.247(a)(1)(iii)	Number of Hopping Frequencies	Conducted	PASS	-
15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Conducted	PASS	-
15.247(b)(1)	Maximum Peak Output Power	Conducted	PASS	-
15.247(d)	Band Edge Compliance of RF Conducted Emissions	Conducted	PASS	-
15.247(d) 15.205 15.209	Spurious Emissions	Conducted	PASS	-
		Radiated	PASS	-
15.247(d) 15.205 15.209	Restricted Bands of Operation	Radiated	PASS	-
15.207	AC Power Line Conducted Emissions	Conducted	PASS	-

1.6 Test information

None

1.7 Test set up

Table-top

1.8 Test period

26-July-2021 - 30-July-2021

2 Equipment Under Test

All information in this chapter was provided by the applicant.

2.1 EUT information

Applicant	KYOCERA Corporation Yokohama Office 2-1-1 Kagahara, Tsuzuki-ku Yokohama-shi, Kanagawa, Japan Phone: +81-45-943-6253 Fax: +81-45-943-6314
Equipment Under Test (EUT)	Mobile Phone
Model number	EB1090
Serial number	N/A
Trade name	Kyocera
Number of sample(s)	1
EUT condition	Pre-Production
Power rating	Battery: DC 3.8 V
Size	(W) 57.1 mm × (D) 25.4 mm × (H) 125.6 mm
Environment	Indoor and Outdoor use
Terminal limitation	-20 ˚C to 60 ˚C
Hardware version	DMT
Software version	0.140PR.0035.a
Firmware version	Not applicable
RF Specification	
Protocol	Bluetooth 4.2 + EDR
Frequency range	2402 MHz-2480 MHz
Number of RF Channels	79 Channels
Modulation method/Data rate	FHSS: GFSK (1 Mbps), π/4-DQPSK (2 Mbps), 8-DPSK (3 Mbps)
Channel separation	1 MHz
Conducted power	11.437 mW (DH5) 15.212 mW (3-DH5)
Antenna type	Internal antenna
Antenna gain	2.81 dBi

2.2 Modification to the EUT

The table below details modifications made to the EUT during the test project.

Modification State	Description of Modification	Modification fitted by	Date of Modification
Model: EB1090, Serial Number: N/A			
0	As supplied by the applicant	Not Applicable	Not Applicable

2.3 Variation of family model(s)

2.3.1 List of family model(s)

Not applicable

2.3.2 Reason for selection of EUT

Not applicable

2.4 Operating channels and frequencies

Channel	Frequency [MHz]	Channel	Frequency [MHz]	Channel	Frequency [MHz]
0	2402	27	2429	54	2456
1	2403	28	2430	55	2457
2	2404	29	2431	56	2458
3	2405	30	2432	57	2459
4	2406	31	2433	58	2460
5	2407	32	2434	59	2461
6	2408	33	2435	60	2462
7	2409	34	2436	61	2463
8	2410	35	2437	62	2464
9	2411	36	2438	63	2465
10	2412	37	2439	64	2466
11	2413	38	2440	65	2467
12	2414	39	2441	66	2468
13	2415	40	2442	67	2469
14	2416	41	2443	68	2470
15	2417	42	2444	69	2471
16	2418	43	2445	70	2472
17	2419	44	2446	71	2473
18	2420	45	2447	72	2474
19	2421	46	2448	73	2475
20	2422	47	2449	74	2476
21	2423	48	2450	75	2477
22	2424	49	2451	76	2478
23	2425	50	2452	77	2479
24	2426	51	2453	78	2480
25	2427	52	2454		
26	2428	53	2455		

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	2441
High	2480

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

Tested Channel	Modulation Technology	Modulation Type	Packet Type
Low, Middle, High	FHSS	GFSK	DH5
Low, Middle, High	FHSS	8-DPSK	3-DH5

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, Open and the worst case recorded.
Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports.

2.6 Operating flow

[Tx mode]
i) Test program setup to the DM tool
ii) Select a Test mode
Operating frequency: Channel Low: 2402 MHz, Channel Middle: 2441 MHz, Channel High: 2480 MHz
iii) Start test mode

[Rx mode]
i) Test program setup to the DM tool
ii) Select a Test mode
Operating frequency: Channel Low: 2402 MHz, Channel Middle: 2441 MHz, Channel High: 2480 MHz
iii) Start test mode

3 Configuration of Equipment

Numbers assigned to equipment on the diagram in “3.3 System configuration” correspond to the list in “3.1 Equipment used” and “3.2 Cable(s) used”.
This test configuration is based on the manufacture’s instruction.
Cabling and setup(s) were taken into consideration and test data was taken under worse case condition.

3.1 Equipment used

No.	Equipment	Company	Model No.	Serial No.	FCC ID/DoC	Comment
1	Mobile Phone	KYOCERA	EB1090	N/A	JOYEB1090	EUT
2	AC Adapter	KDDI	0301PQA	N/A	N/A	*

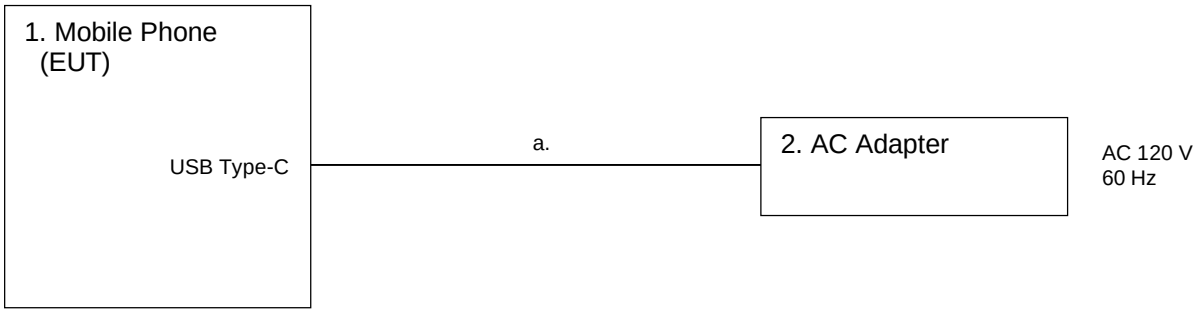
*:AC power line Conducted Emission Test.

3.2 Cable(s) used

No.	Equipment	Length[m]	Shield	Connector	Comment
a	USB cable (for AC Adapter)	1.0	Yes	Metal	*

*:AC power line Conducted Emission Test.

3.3 System configuration



4 Test Result

4.1 20dB Bandwidth

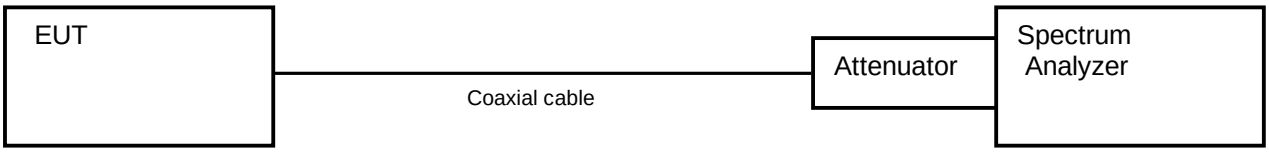
4.1.1 Measurement procedure

[FCC 15.247(a)(1)]

The bandwidth at 6 dB down from the highest inband spectral density is measured with 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 = 2-3 times the 20 dB bandwidth
b) RBW ≥ 1% of the 20 dB bandwidth
c) VBW ≥ RBW
d) Sweep time = auto-couple
e) Detector = peak
f) Trace mode = max hold

- Test configuration



4.1.2 Limit

None

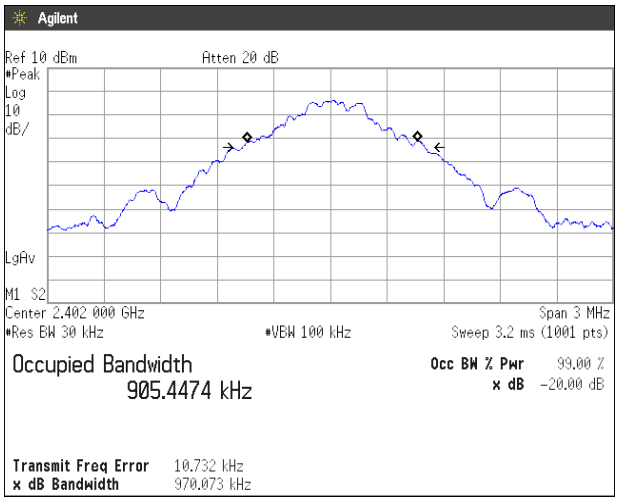
4.1.3 Measurement result

Date : 30-July-2021
Temperature : 24.6 [˚C]
Humidity : 60.8 [%]
Test place : Shielded room No.4
Test engineer : Chiaki Kanno

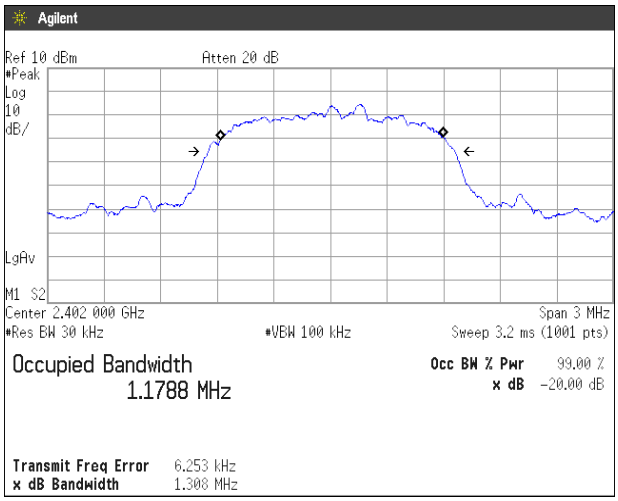
Channel	Frequency (MHz)	20dB bandwidth [MHz]	
		DH5	3DH5
Low	2402	0.970	1.308
Middle	2441	0.968	1.306
High	2480	0.972	1.306

4.1.4 Trace data

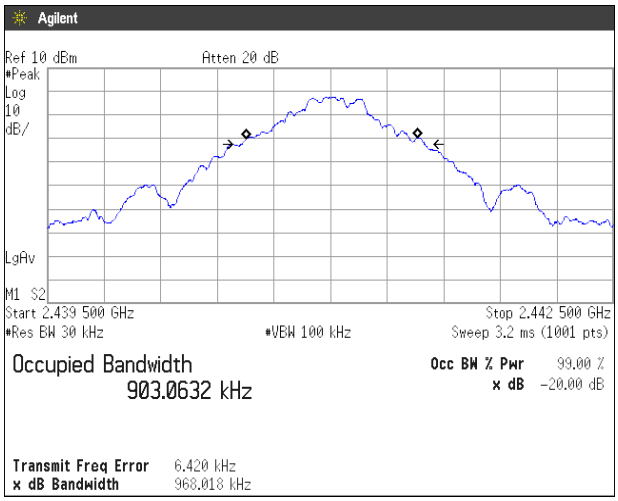
[DH5]
Channel Low



[3-DH5]



[DH5]
Channel Middle



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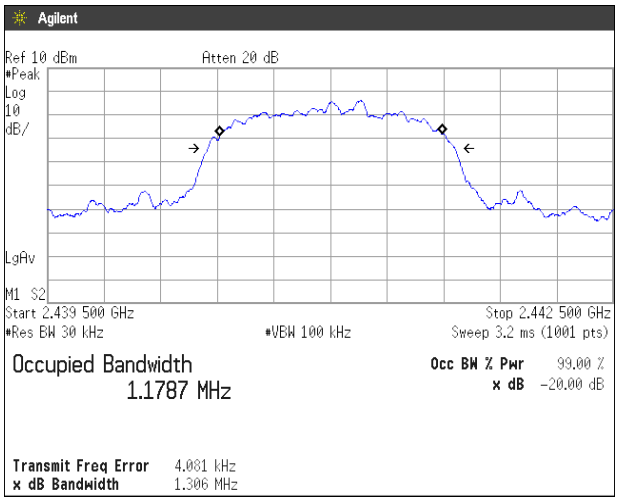
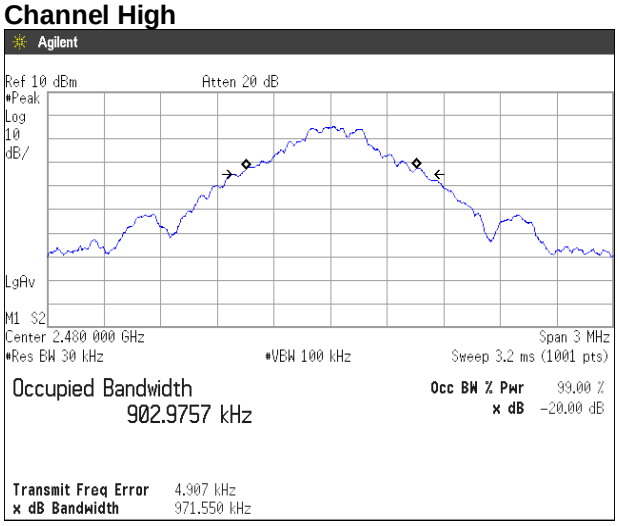
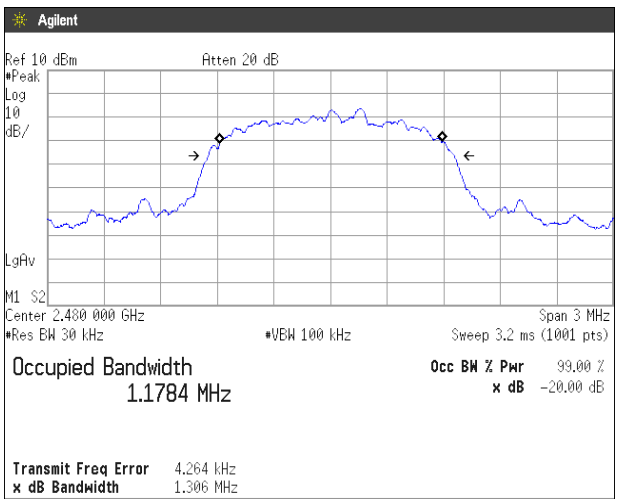


[DH5]
Channel High



[3-DH5]



4.2 Carrier Frequency Separation

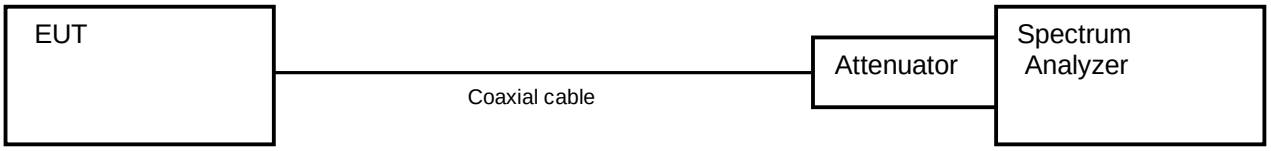
4.2.1 Measurement procedure

[FCC 15.247(a)(1)]

The adjacent channel interval 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;
g) Span = wide enough to capture the peaks of two adjacent channels
h) RBW ≥ 1% of the span
i) VBW ≥ RBW
j) Sweep time = auto-couple
k) Detector = peak
l) Trace mode = max hold

- Test configuration



4.2.2 Limit

System shall have hopping channel carrier frequencies separated by a minimum of, 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

4.2.3 Measurement result

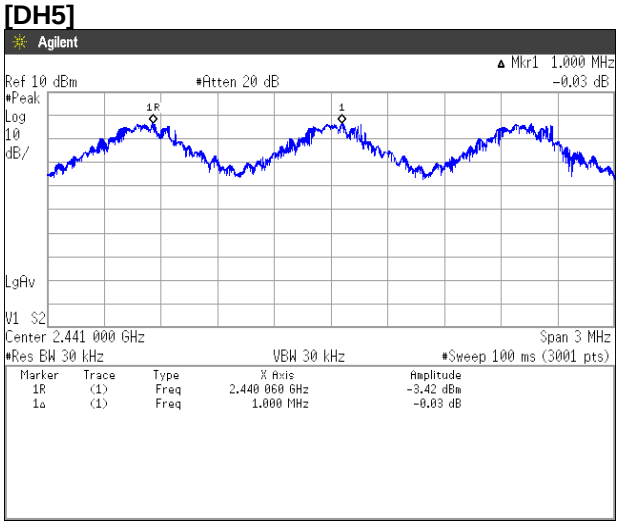
Date : 30-July-2021
Temperature : 24.6 [˚C]
Humidity : 60.8 [%]
Test place : Shielded room No.4
Test engineer : Chiaki Kanno

Battery Full

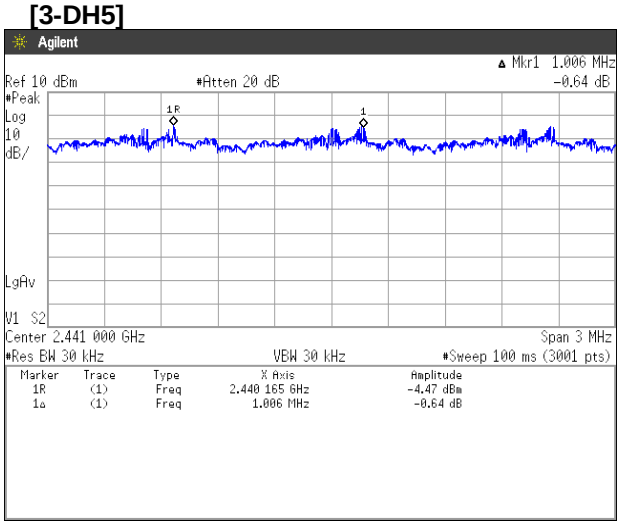
Packet type	Channel separation (MHz)	Limit (MHz)	Result
DH5	1.000	>two-thirds of the 20dB Bandwidth = 648kHz	PASS
3-DH5	1.006	>two-thirds of the 20dB Bandwidth = 872kHz	PASS
DH5(AFH)	1.001	>two-thirds of the 20dB Bandwidth = 648kHz	PASS
3-DH5(AFH)	1.006	>two-thirds of the 20dB Bandwidth = 872kHz	PASS

4.2.4 Trace data

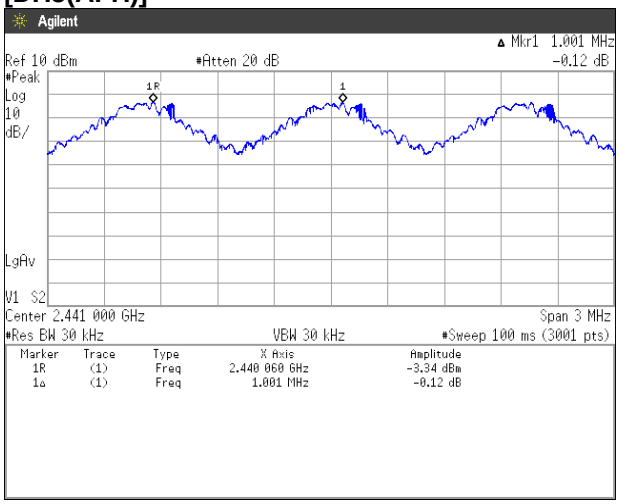
[DH5]



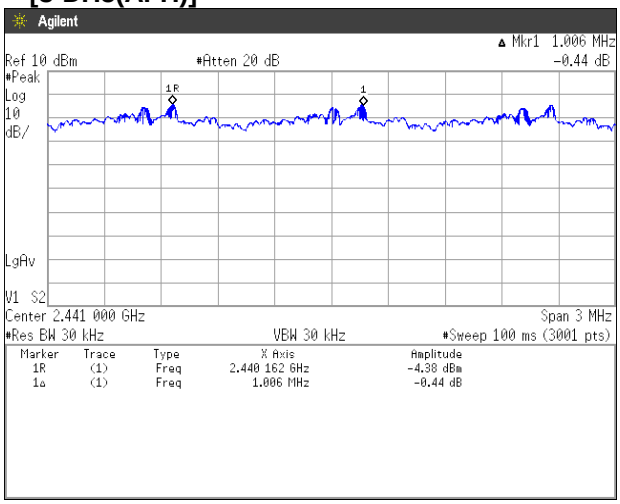
[3-DH5]



[DH5(AFH)]



[3-DH5(AFH)]



4.3 Number of Hopping Frequencies

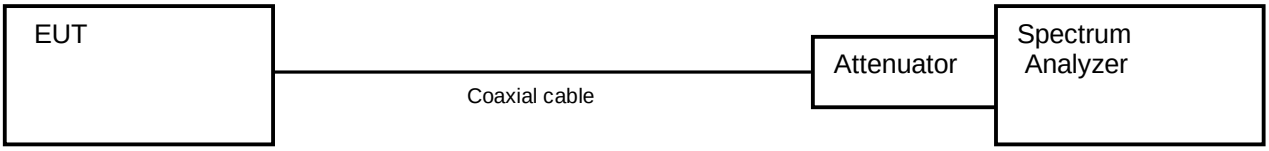
4.3.1 Measurement procedure

[FCC 15.247(a)(1)(iii)]

The number of hopping channels 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 = the frequency band of operation
b) RBW ≥ 1% of the Span
c) VBW ≥ RBW
d) Sweep time = auto-couple
e) Detector = peak
f) Trace mode = max hold

- Test configuration



4.3.2 Limit

Shall have more than 15 channels.

4.3.3 Measurement result

Date : 27-July-2021
Temperature : 24.6 [˚C]
Humidity : 60.8 [%]
Test place : Shielded room No.4
Test engineer : Chiaki Kanno

FHSS

Number of channels	Limit	Result
79	≥15 channel	PASS

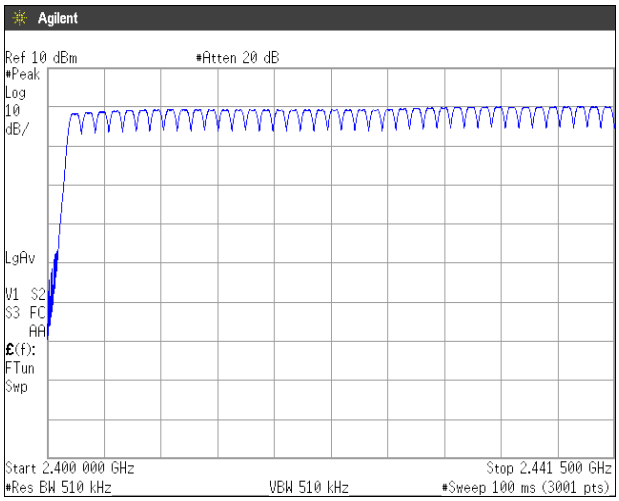
AFH

Channel	Number of channels	Limit	Result
Low	20	≥15 channel	PASS
Middle	20	≥15 channel	PASS
High	20	≥15 channel	PASS

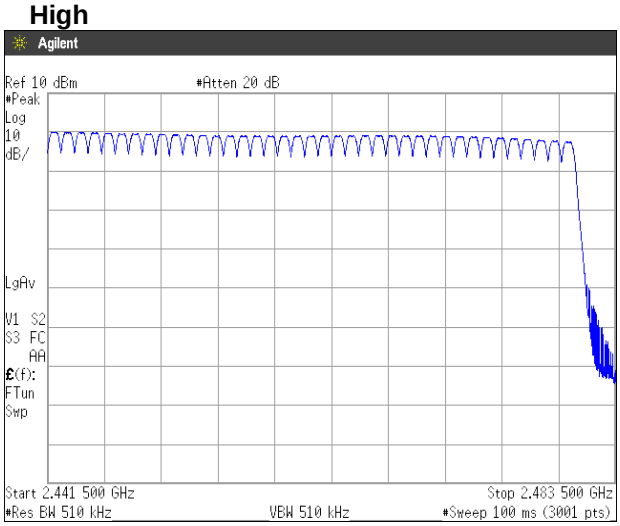
4.3.4 Trace data

[DH5]

Low

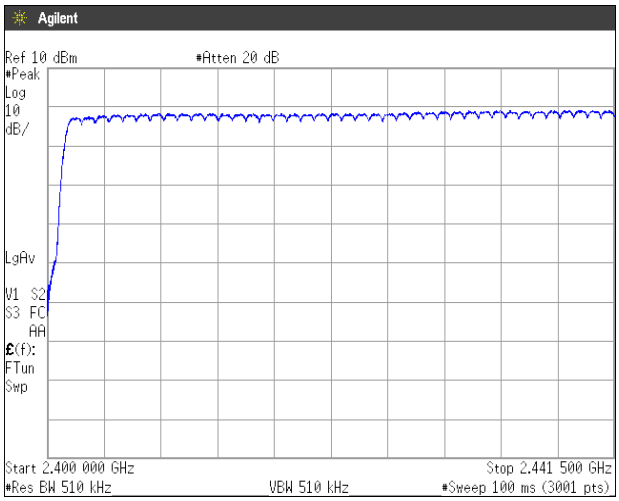


High

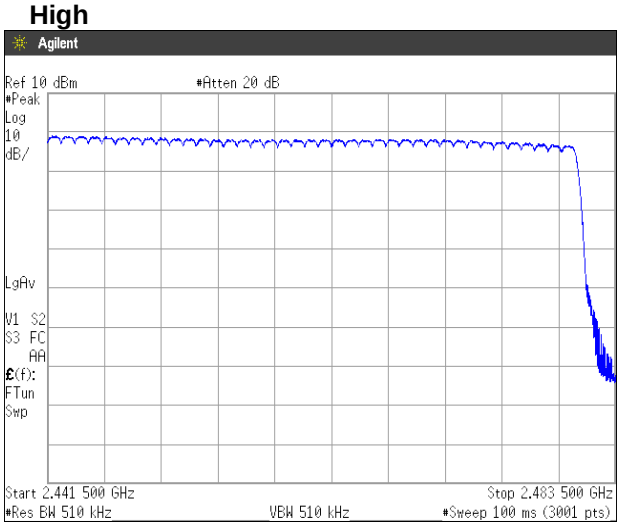


[3-DH5]

Low

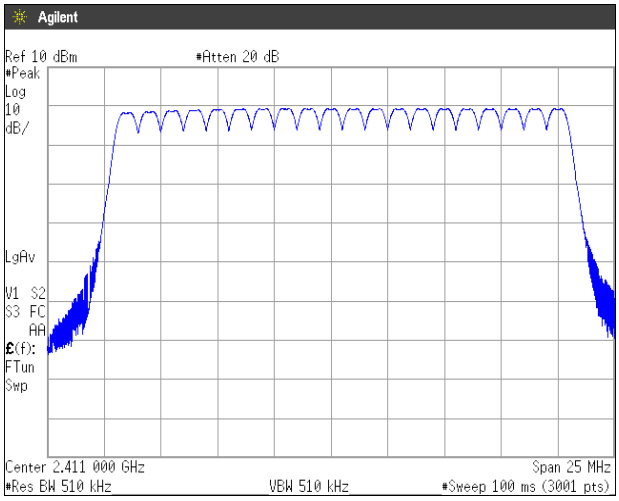


High

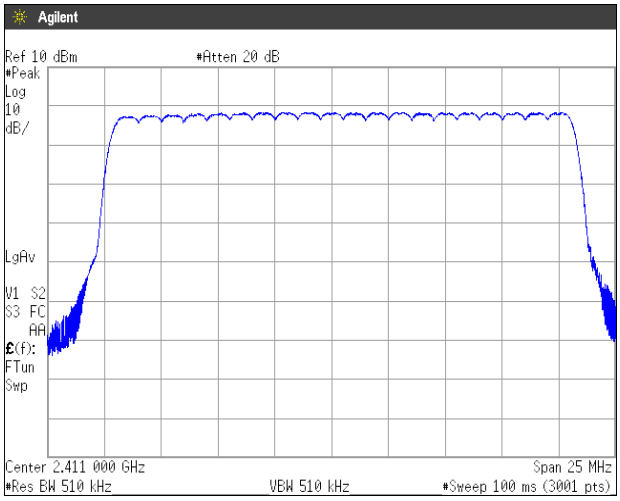


[DH5(AFH)]

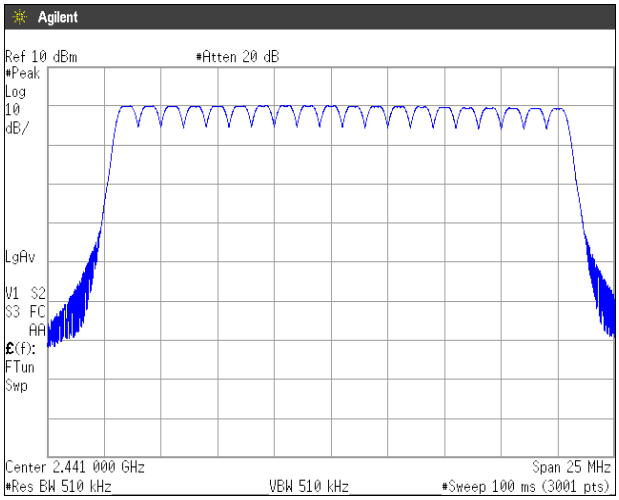
Low

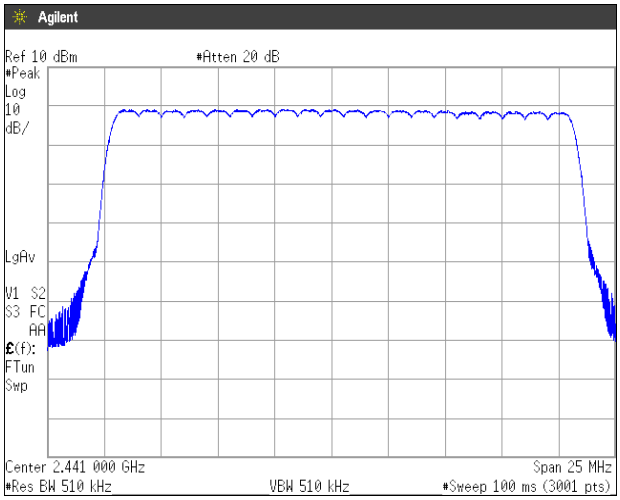


[3-DH5(AFH)]

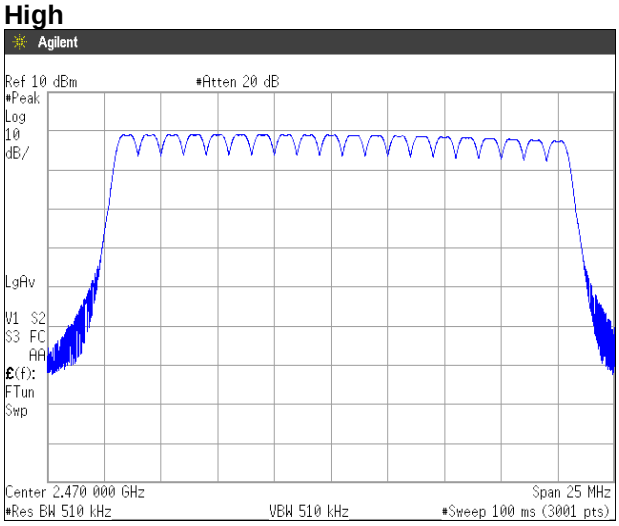


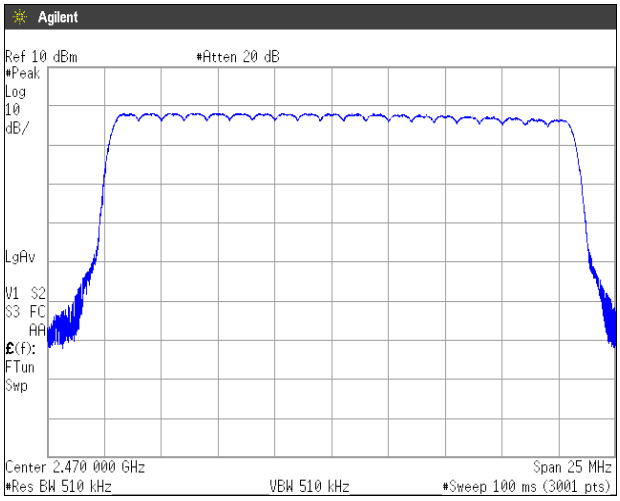
Middle





High





4.4 Time of Occupancy (Dwell Time)

4.4.1 Measurement procedure

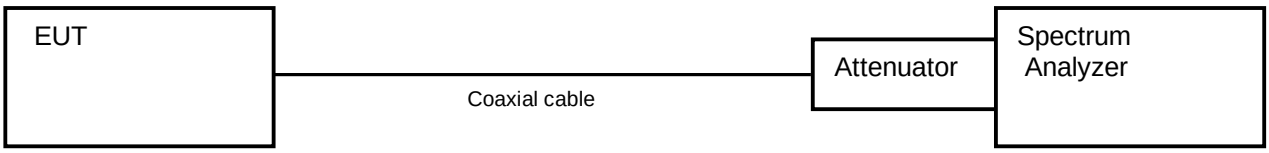
[FCC 15.247(a)(1)(iii)]

The time occupancy of hopping channel 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 = Zero span, centered on a hopping channel
b) RBW = 1 MHz
c) VBW ≥ RBW
d) Sweep time = auto-couple
e) Detector = peak
f) Trace mode = Single

- Test configuration



4.4.2 Limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

4.4.3 Measurement result

Date : 30-July-2021
Temperature : 24.6 [˚C]
Humidity : 60.8 [%]
Test place : Shielded room No.4

Test engineer : Chiaki Kanno

FHSS

Packet type	Channel	Frequency (MHz)	Dwell time (ms)	Occupancy time of 31.6 seconds (s)	Limit	Result
DH5	Low	2402.0	2.880	0.307	<0.4s	PASS
	Middle	2441.0	2.880	0.307	<0.4s	PASS
	High	2480.0	2.880	0.307	<0.4s	PASS
3-DH5	Low	2402.0	2.890	0.308	<0.4s	PASS
	Middle	2441.0	2.890	0.308	<0.4s	PASS
	High	2480.0	2.880	0.307	<0.4s	PASS

AFH

Packet type	Channel	Frequency (MHz)	Dwell time (ms)	Occupancy time of 8 seconds (s)	Limit	Result
DH5(AFH)	Low	2402.0	2.890	0.154	<0.4s	PASS
	Middle	2441.0	2.880	0.154	<0.4s	PASS
	High	2480.0	2.880	0.154	<0.4s	PASS
3-DH5(AFH)	Low	2402.0	2.890	0.154	<0.4s	PASS
	Middle	2441.0	2.890	0.154	<0.4s	PASS
	High	2480.0	2.890	0.154	<0.4s	PASS

FHSS
DH5/3-DH5 = Dwell time (ms) x 1600 / 6 / 79 x 31.6

AFH
DH5/3-DH5 = Dwell time (ms) x 800 / 6 / 20 x 8

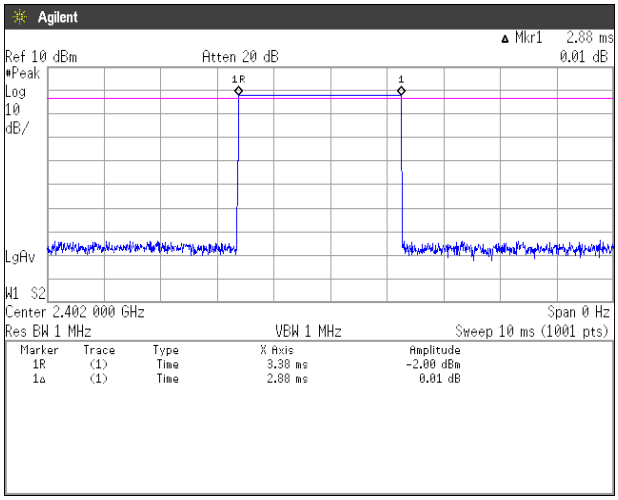
The hopping rates of Bluetooth devices change with different types of payload. The longer the payload is, the slower the hopping rate. The hopping rate scenario is defined in Bluetooth core specification.
Calculation:
Occupancy time of 31.6 seconds* = time domain slot length x hop rate / number of hopper channel / 79 /x 31.6
Ex.) for FHSS mode Channel Low,3- DH5 = 2.880ms x 1600 / 6/ 79 x 31.6 = 307ms

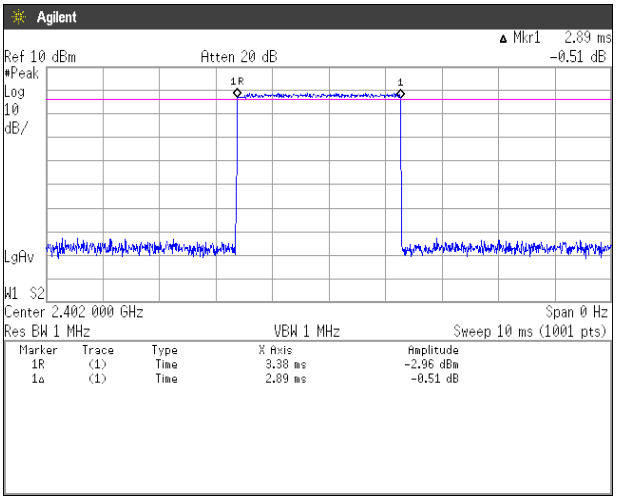
4.4.4 Trace data

FHSS

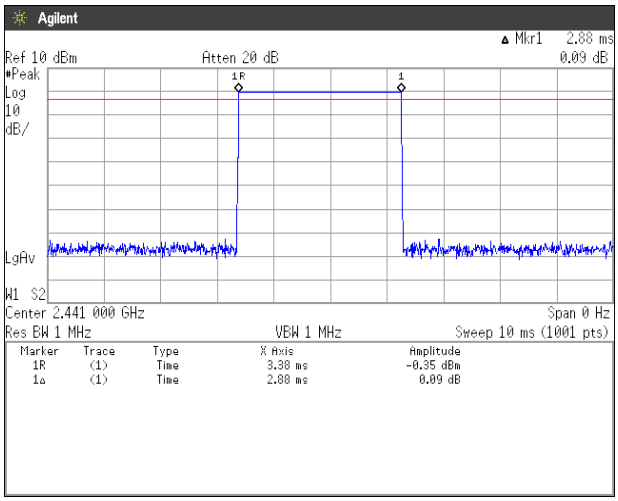
[DH5] **[3-DH5]**

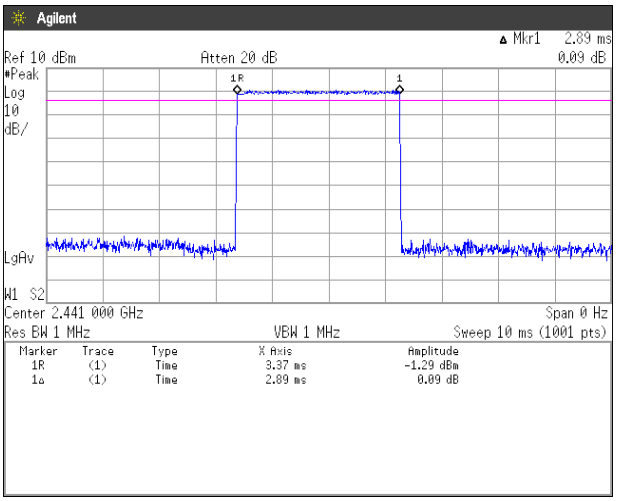
Channel: Low



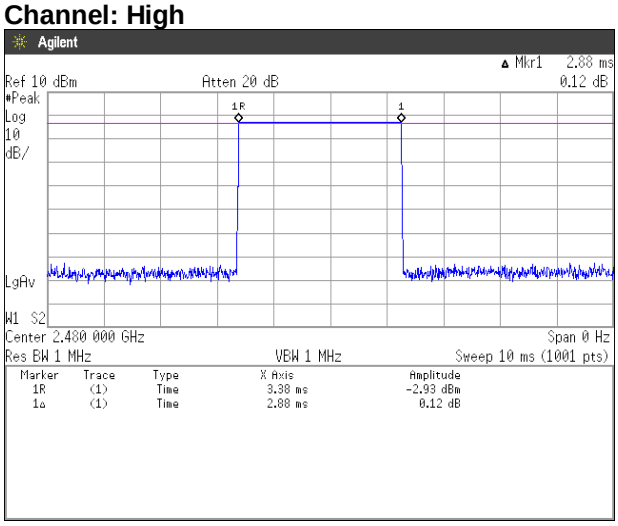


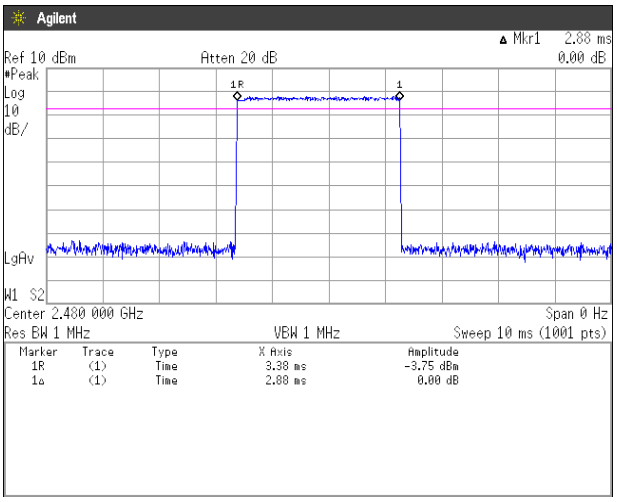
Channel: Middle





Channel: High



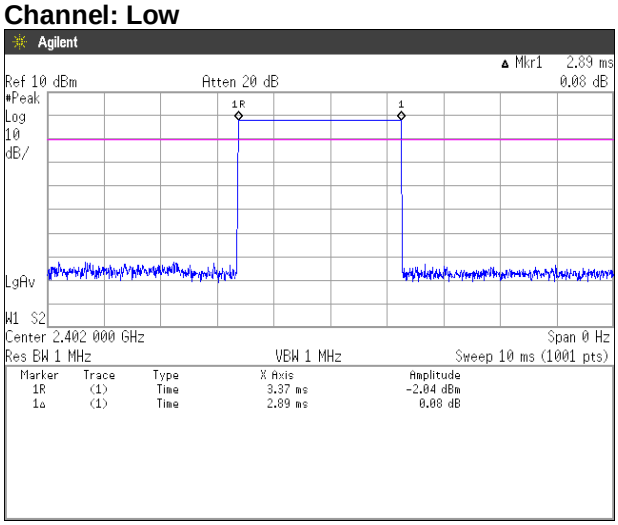


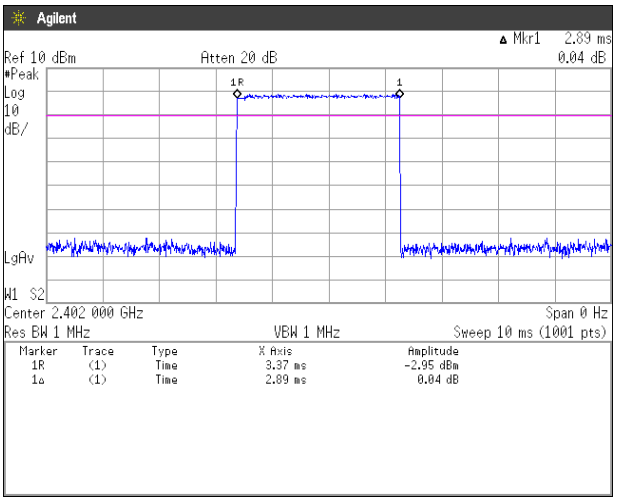
FHSS_AFH

[DH5]

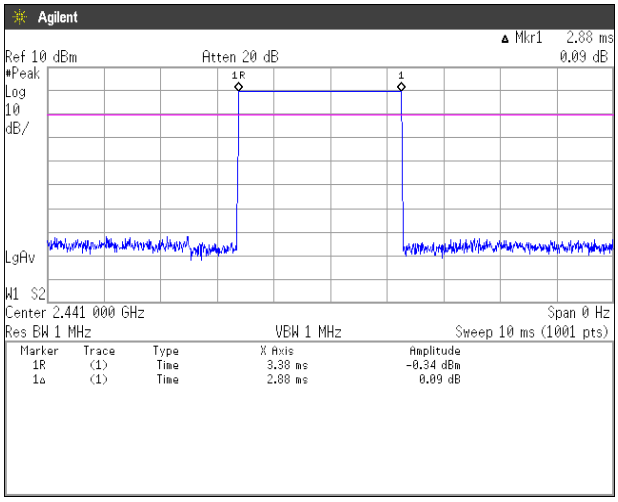
[3-DH5]

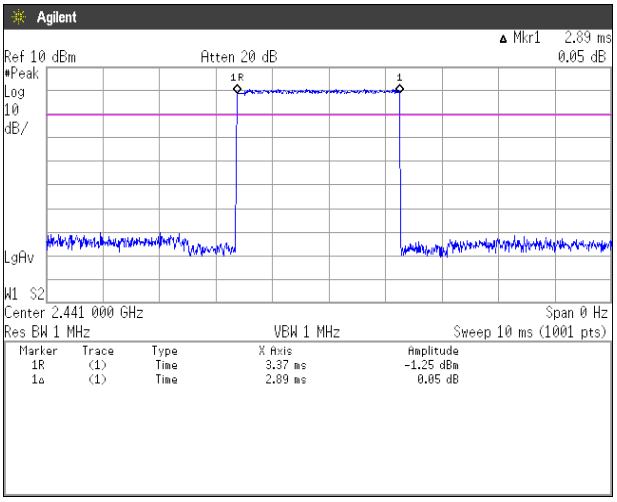
Channel: Low



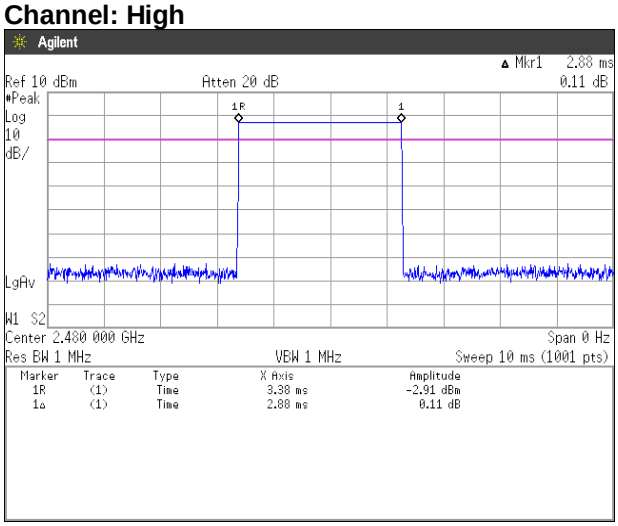


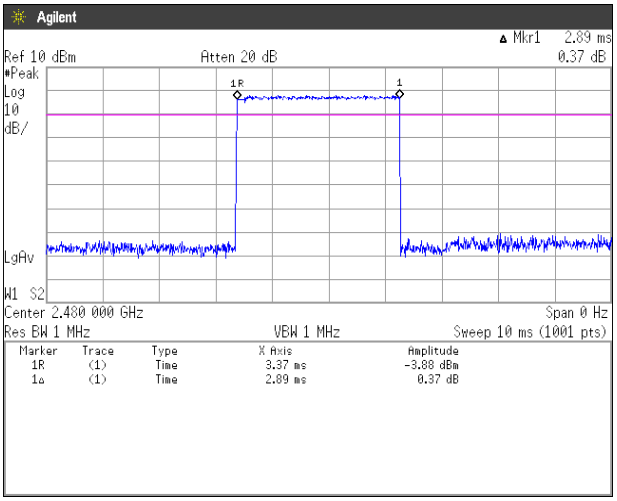
Channel: Middle





Channel: High





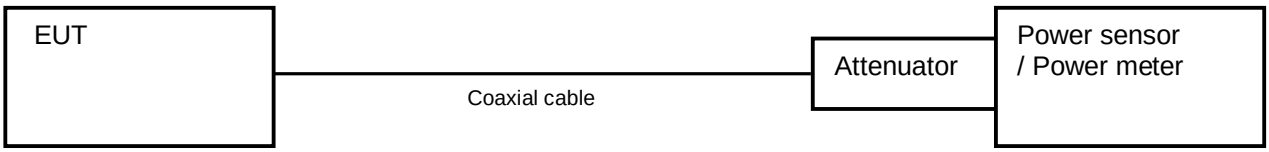
4.5 Maximum Peak Output Power

4.5.1 Measurement procedure

[FCC 15.247(b)(1)]

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

- Test configuration



4.5.2 Limit

0.125 W or less

4.5.3 Measurement result

Date : 30-July-2021
Temperature : 24.6 [˚C]
Humidity : 60.8 [%]
Test place : Shielded room No.4

Test engineer : Chiaki Kanno

Battery Full

Packet type	Channel	Center Frequency (MHz)	Reading (dBm)	Factor (dB)	Level (dBm)	Peak Output Power (mW)	Limit (mW)	Result
DH5	Low	2402	-1.57	10.49	8.92	7.791	≦125	PASS
	Middle	2440	0.09	10.49	10.58	11.437	≦125	PASS
	High	2480	-2.43	10.49	8.06	6.394	≦125	PASS
3-DH5	Low	2402	-0.40	10.49	10.09	10.205	≦125	PASS
	Middle	2440	1.33	10.49	11.82	15.212	≦125	PASS
	High	2480	-1.18	10.49	9.31	8.533	≦125	PASS

Calculation;
Reading (dBm) + Factor (dB) = Level (dBm)
10logP = Level (dBm)
$P = 10^{(\text{Maximum Peak Output Power} / 10)}$ (mW)

4.6 Band Edge Compliance of RF Conducted Emissions

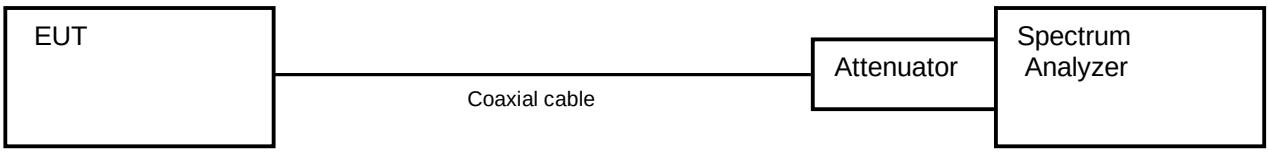
4.6.1 Measurement procedure

[FCC 15.247(d)]

The Band Edge 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 = Arbitrary setting.(Setting suitable for measurement.)
b) RBW = 1 % of the span
c) VBW ≥ RBW
d) Sweep time = auto-couple
e) Detector = peak
f) Trace mode = max hold

- Test configuration



4.6.2 Limit

In any 100kHz bandwidth outside the frequency band the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power.

4.6.3 Measurement result

Date : 30-July-2021
Temperature : 24.6 [˚C]
Humidity : 60.8 [%]
Test place : Shielded room No.4
Test engineer : Chiaki Kanno

[Hopping]

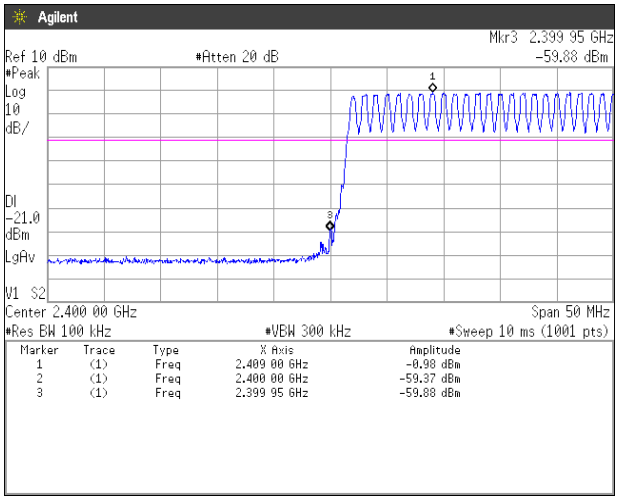
Packet type	Channel	Frequency (MHz)	RF Power Level (dBm)	Band-edge Frequency (MHz)	Band-edge Level (dBm)	Difference Level (dBm)	Limit (dBm)	Result
DH5	Low	2402.00	-0.98	2399.95	-59.88	58.90	At least 20dB below from peak of RF	PASS
	High	2480.00	-1.55	2483.55	-69.89	68.34	At least 20dB below from peak of RF	PASS
3-DH5	Low	2402.00	-1.90	2399.85	-63.31	61.41	At least 20dB below from peak of RF	PASS
	High	2480.00	-2.16	2484.70	-69.35	67.19	At least 20dB below from peak of RF	PASS

[No Hopping]

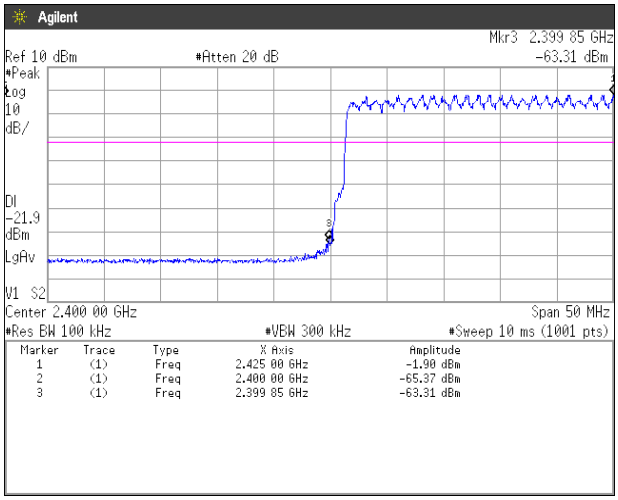
Packet type	Channel	Frequency (MHz)	RF Power Level (dBm)	Band-edge Frequency (MHz)	Band-edge Level (dBm)	Difference Level (dBm)	Limit (dBm)	Result
DH5	Low	2402.00	-1.94	2399.90	-58.63	56.69	At least 20dB below from peak of RF	PASS
	High	2480.00	-2.86	2483.60	-68.11	65.25	At least 20dB below from peak of RF	PASS
3-DH5	Low	2402.00	-3.65	2399.95	-60.42	56.77	At least 20dB below from peak of RF	PASS
	High	2480.00	-3.83	2484.20	-68.28	64.45	At least 20dB below from peak of RF	PASS

4.6.4 Trace data

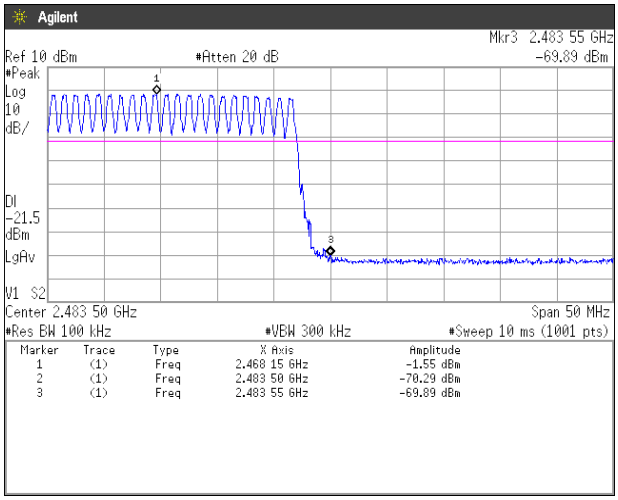
[Hopping]
Channel Low
DH5



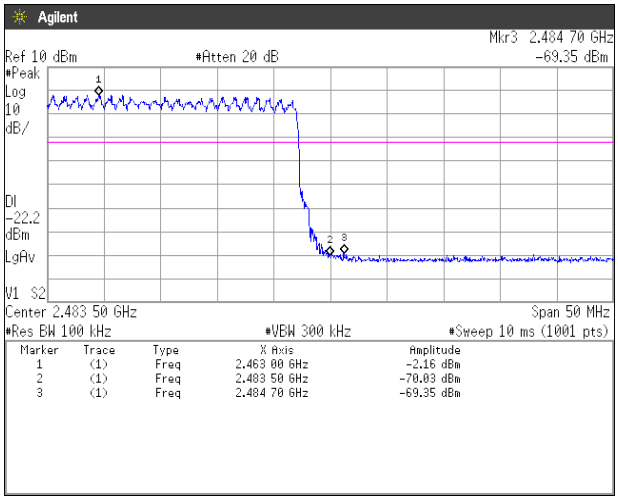
3-DH5



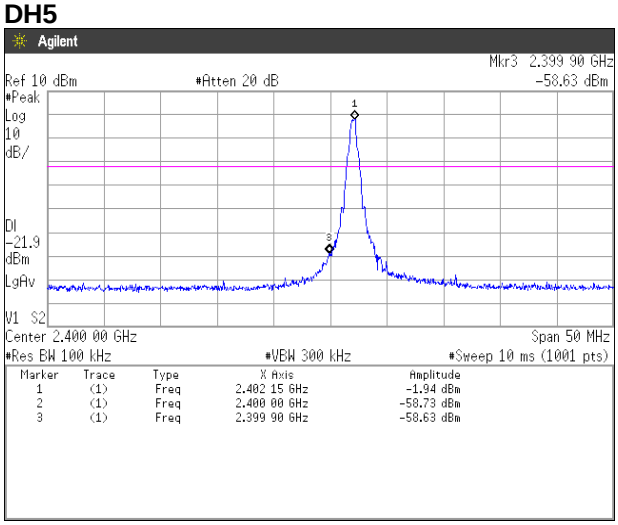
Channel High
DH5



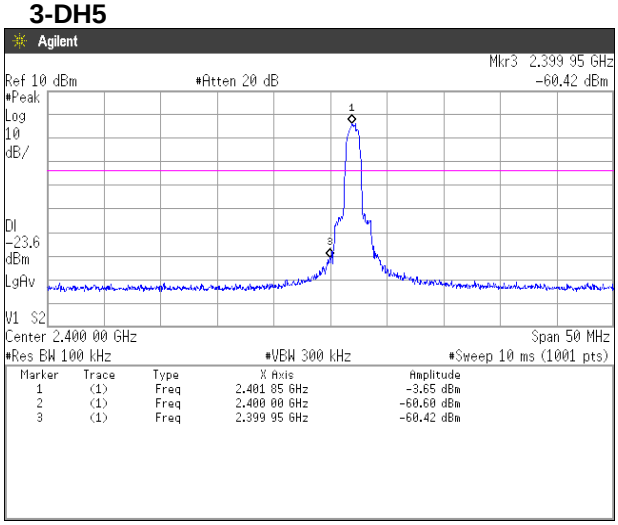
3-DH5



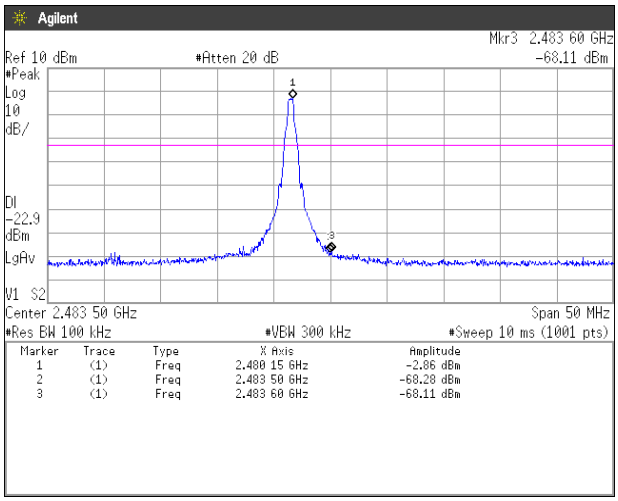
[No Hopping]
Channel Low
DH5



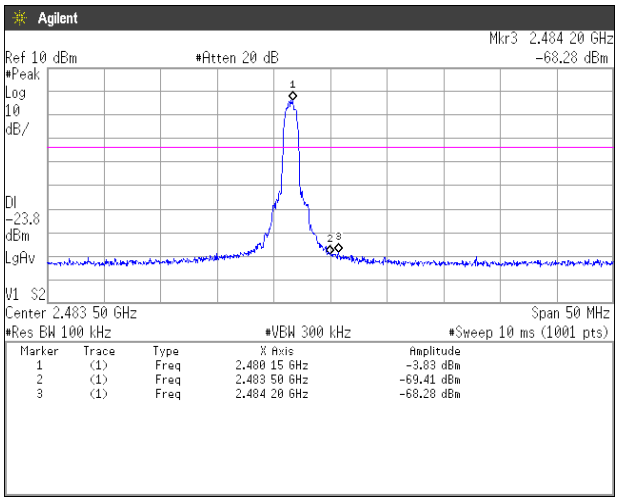
3-DH5



Channel High
DH5



3-DH5



4.7 Spurious emissions - Conducted -

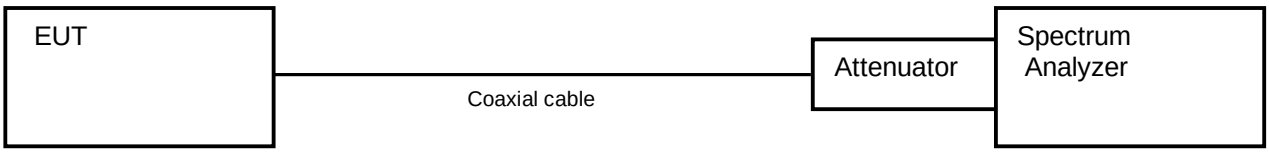
4.7.1 Measurement procedure

[FCC 15.247(d)]

The Spurious emissions (Conducted) are 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 = wide enough to fully capture the emission being measured
b) RBW = 100 kHz
c) VBW ≥ RBW
d) Sweep time = auto-couple
e) Detector = peak
f) Trace mode = max hold

- Test configuration



4.7.2 Limit

In any 100kHz bandwidth outside the frequency band the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power.

4.7.3 Measurement result

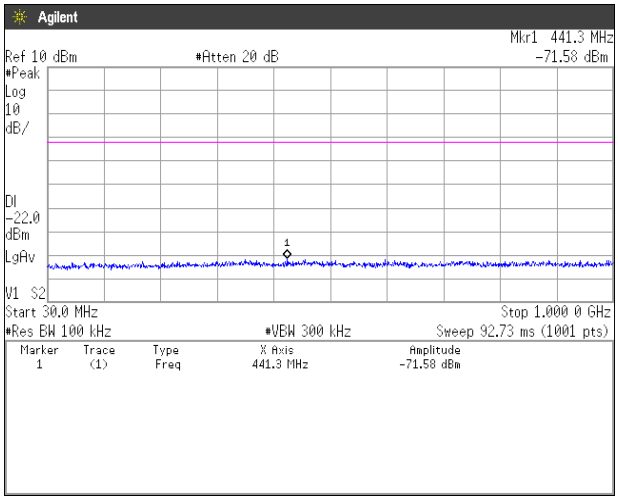
Date : 30-July-2021
Temperature : 24.6 [˚C]
Humidity : 60.8 [%]
Test place : Shielded room No.4
Test engineer : Chiaki Kanno

Channel	Frequency [MHz]	Limit [dB]	Results Chart	Result
Low	2402	At least 20dB below from peak of RF	See the trace Data	PASS
Middle	2441	At least 20dB below from peak of RF	See the trace Data	PASS
High	2480	At least 20dB below from peak of RF	See the trace Data	PASS

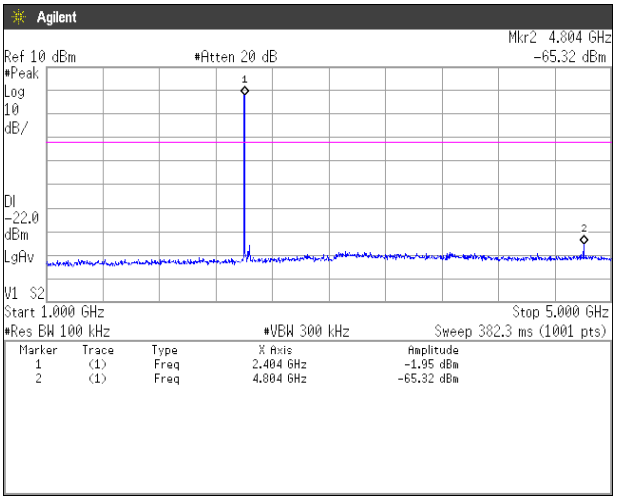
4.7.4 Trace data

[DH5]
Channel Low

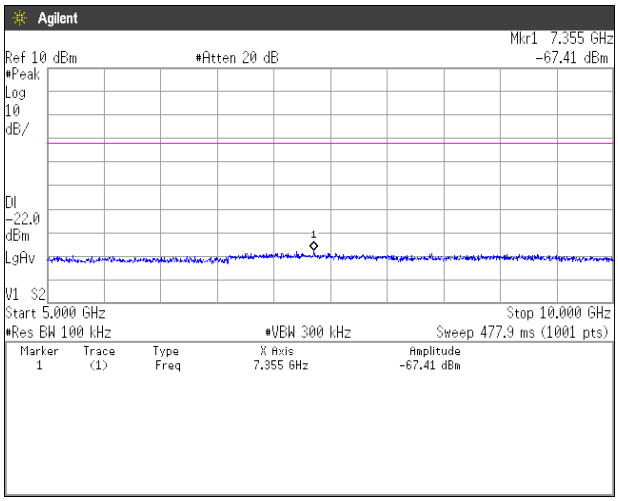
30 MHz-1 GHz



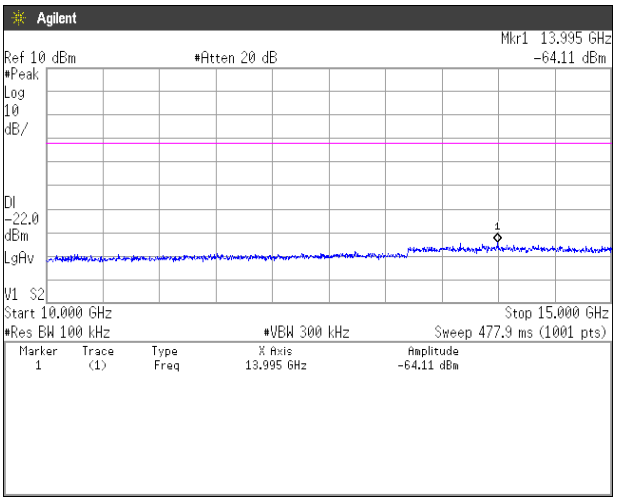
1 GHz-5 GHz



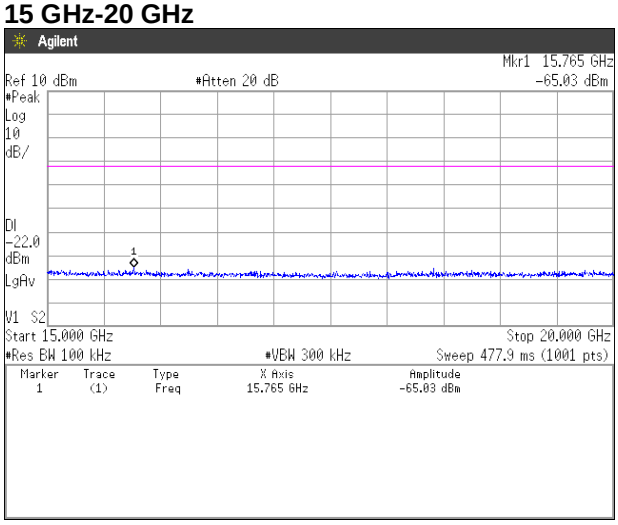
5 GHz-10 GHz



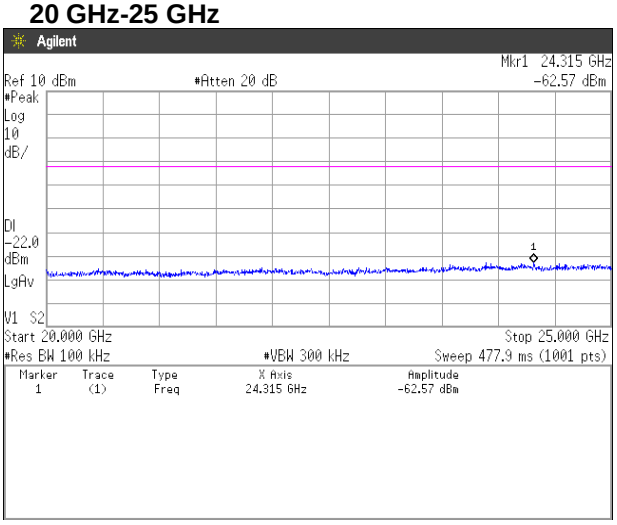
10 GHz-15 GHz



15 GHz-20 GHz



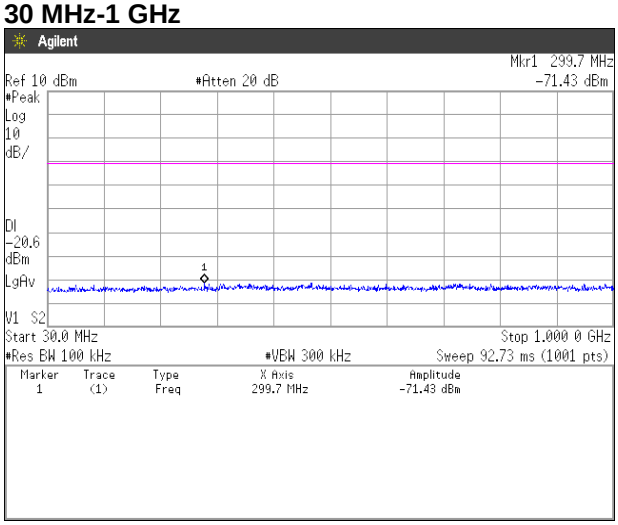
20 GHz-25 GHz



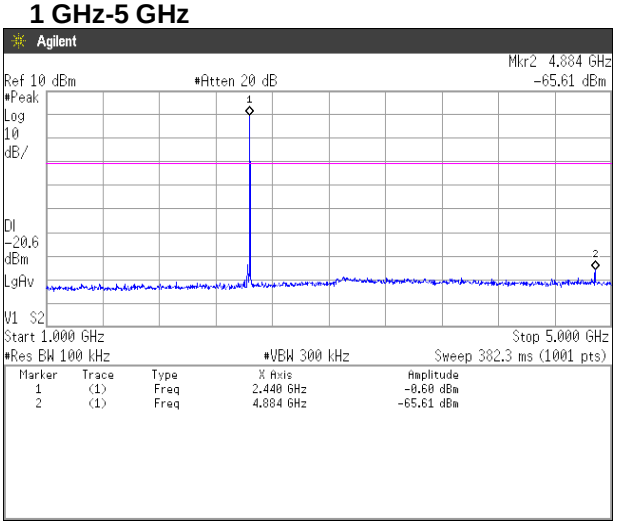
Japan

Channel Middle

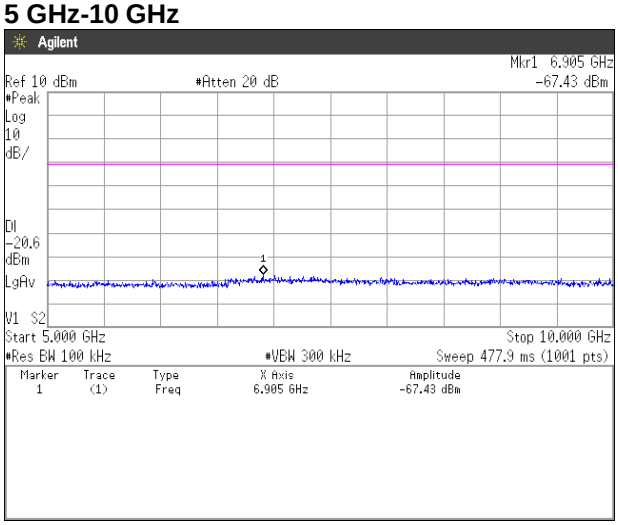
30 MHz-1 GHz



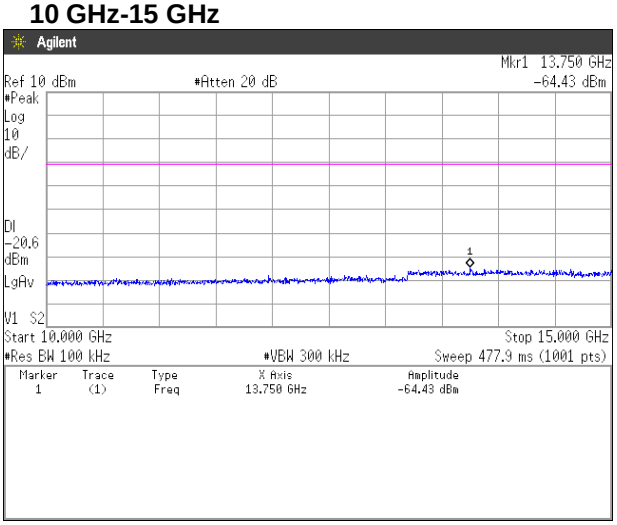
1 GHz-5 GHz



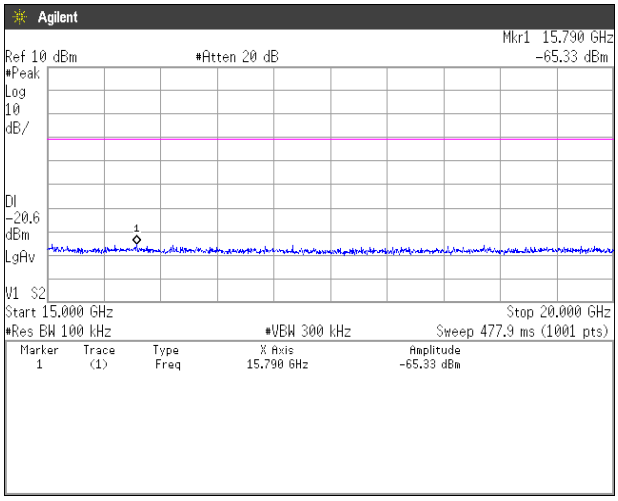
5 GHz-10 GHz



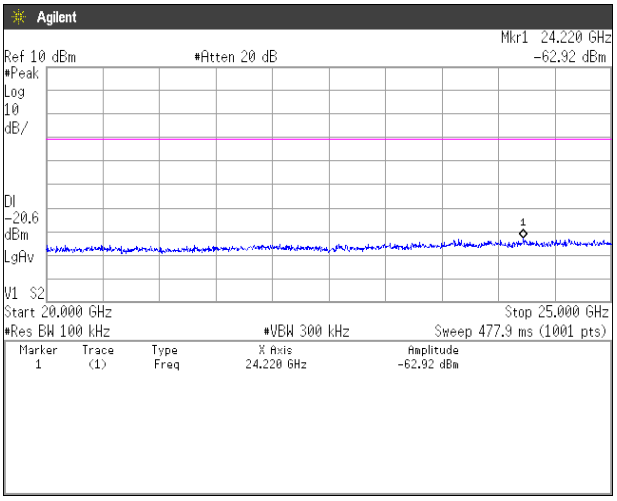
10 GHz-15 GHz



15 GHz-20 GHz

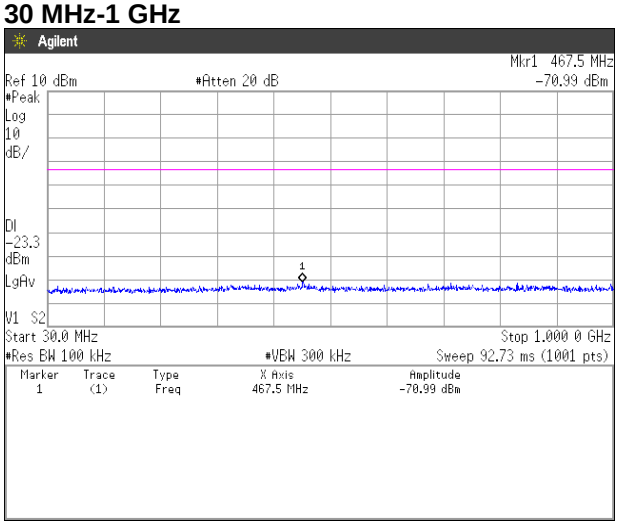


20 GHz-25 GHz

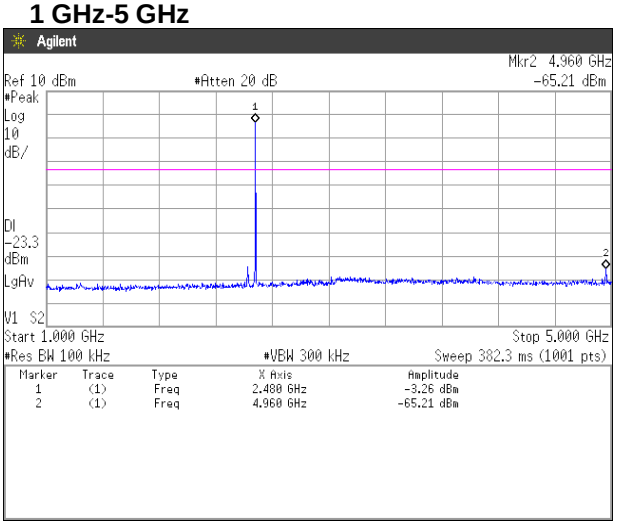


Channel High

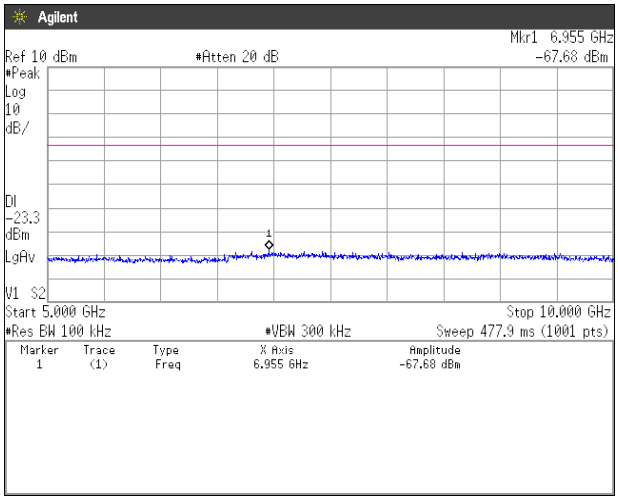
30 MHz-1 GHz



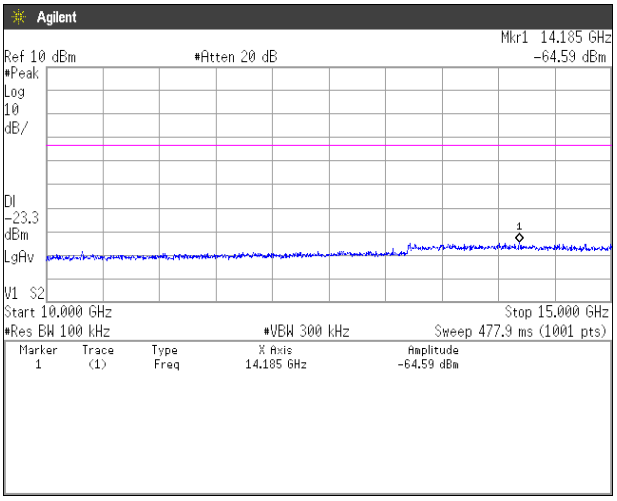
1 GHz-5 GHz



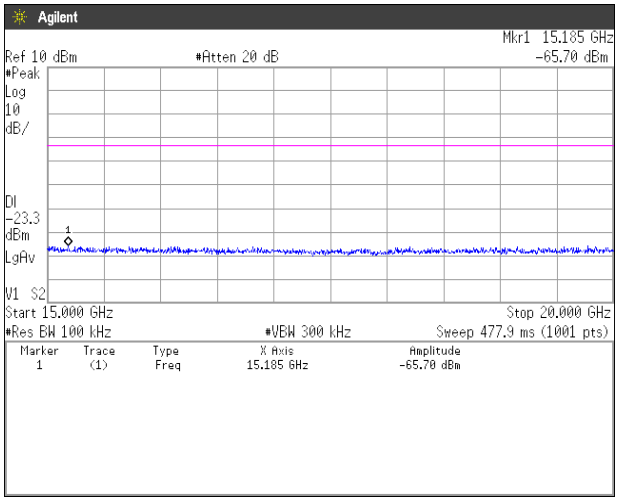
5 GHz-10 GHz



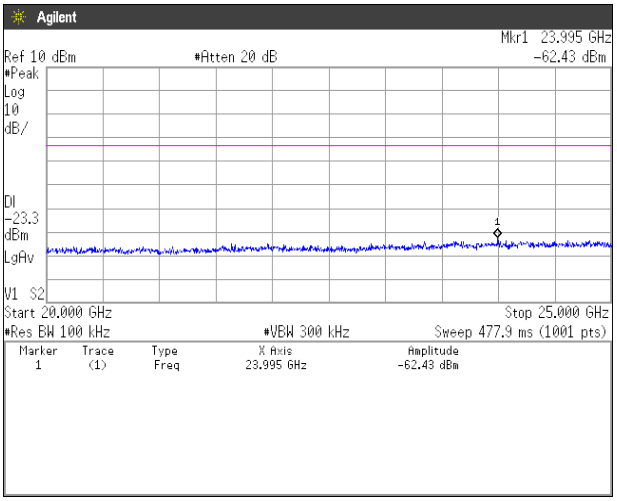
10 GHz-15 GHz



15 GHz-20 GHz

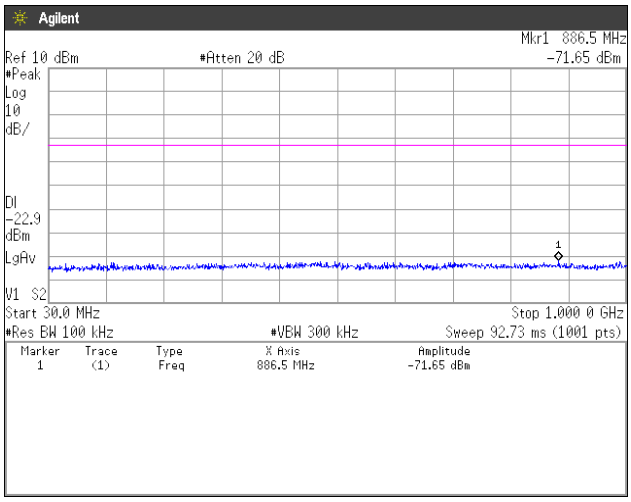


20 GHz-25 GHz

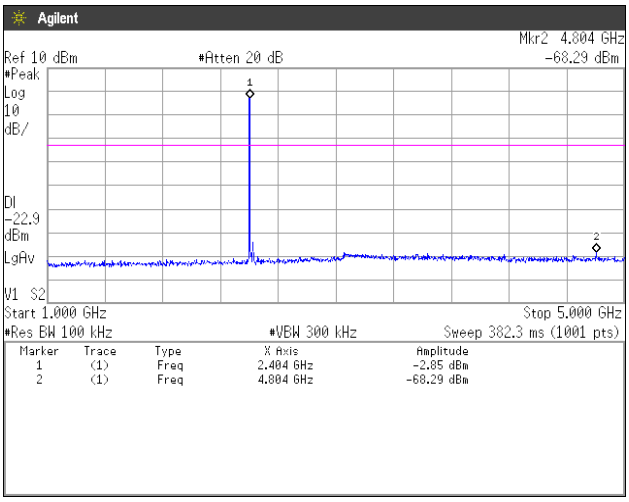


[3-DH5]
Channel Low

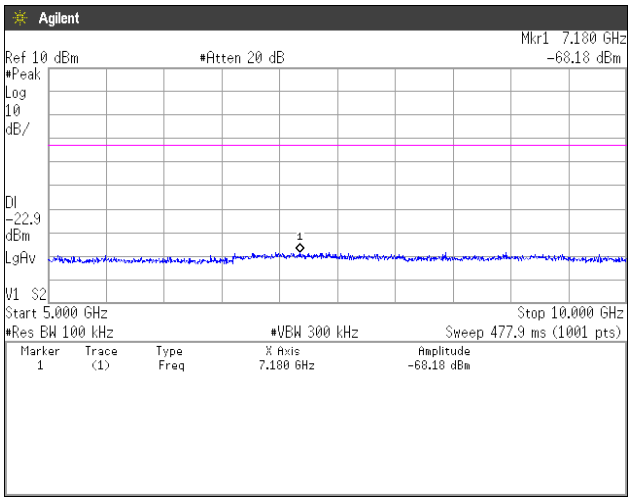
30 MHz-1 GHz



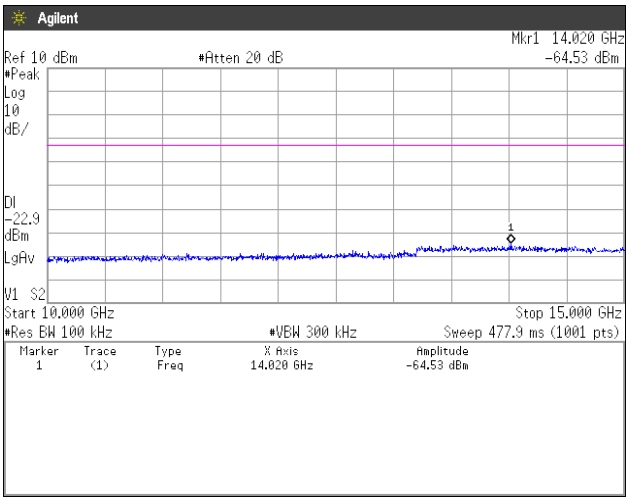
1 GHz-5 GHz



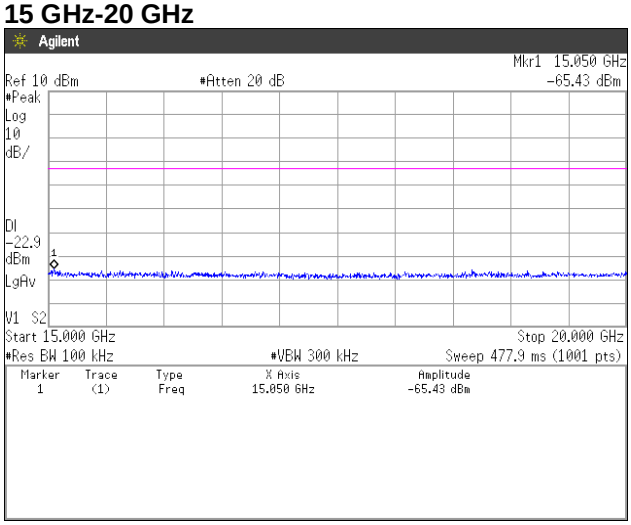
5 GHz-10 GHz



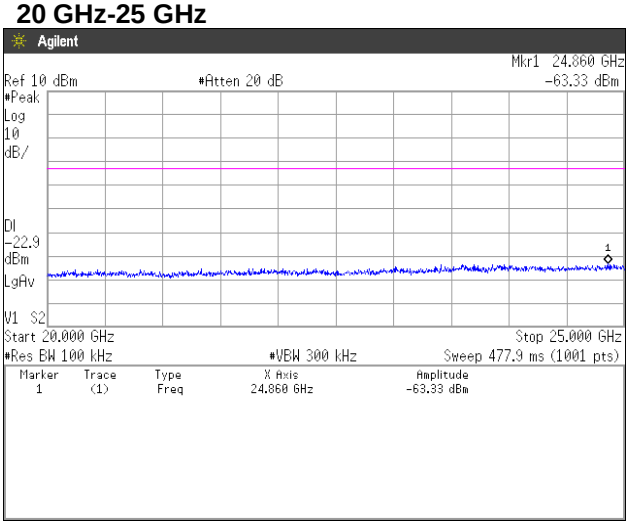
10 GHz-15 GHz



15 GHz-20 GHz

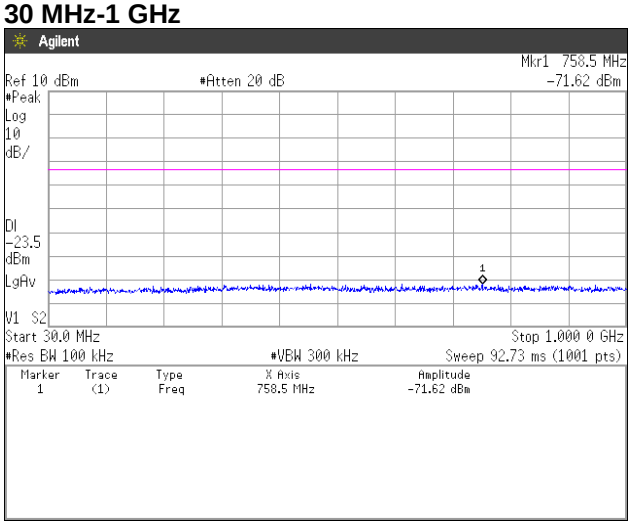


20 GHz-25 GHz

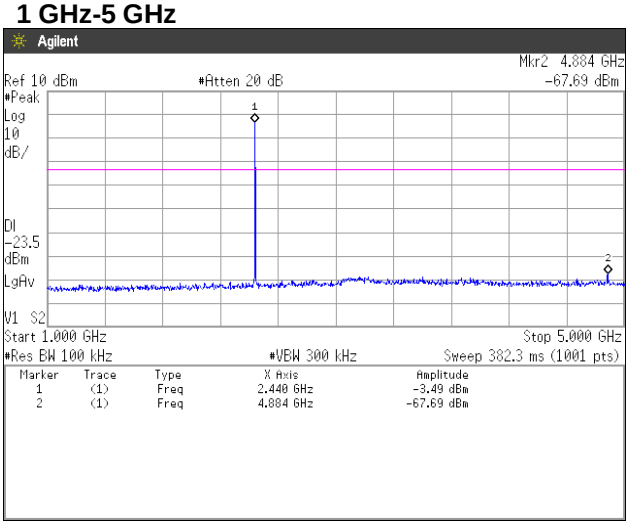


[3-DH5]
Channel Middle

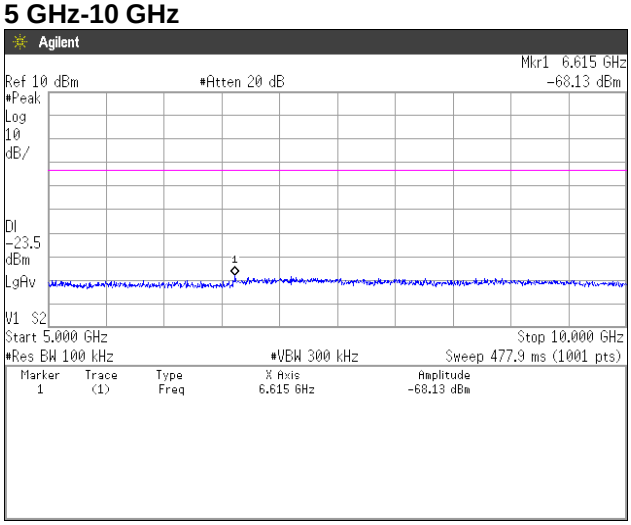
30 MHz-1 GHz



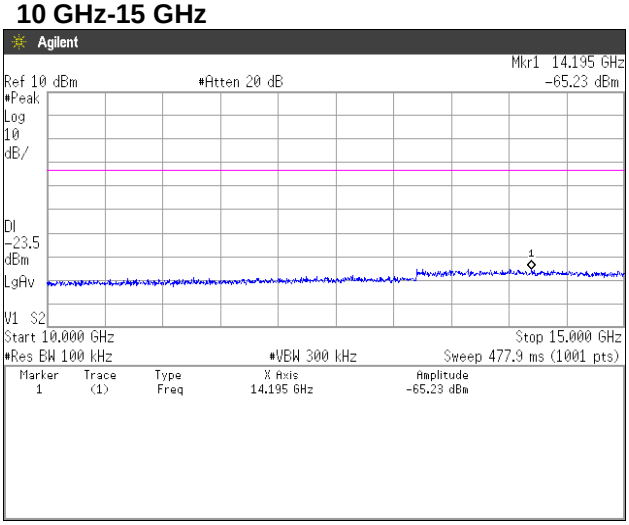
1 GHz-5 GHz



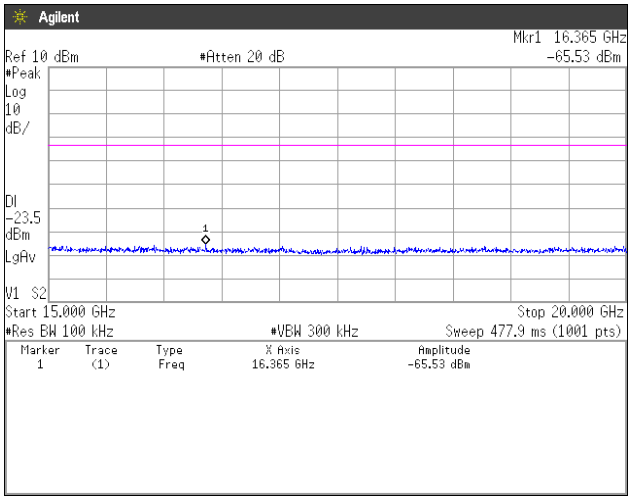
5 GHz-10 GHz



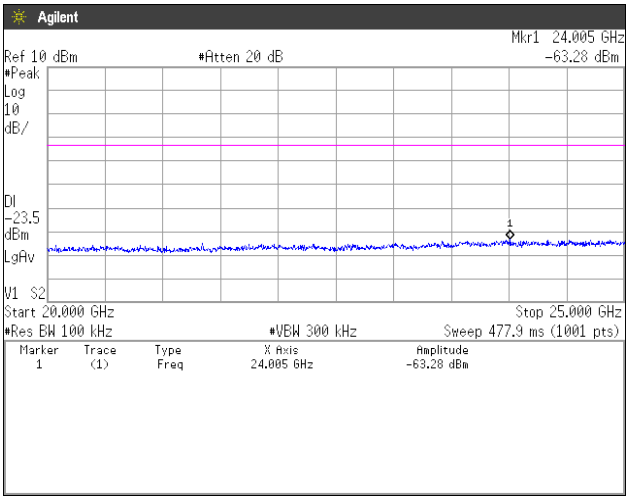
10 GHz-15 GHz



15 GHz-20 GHz

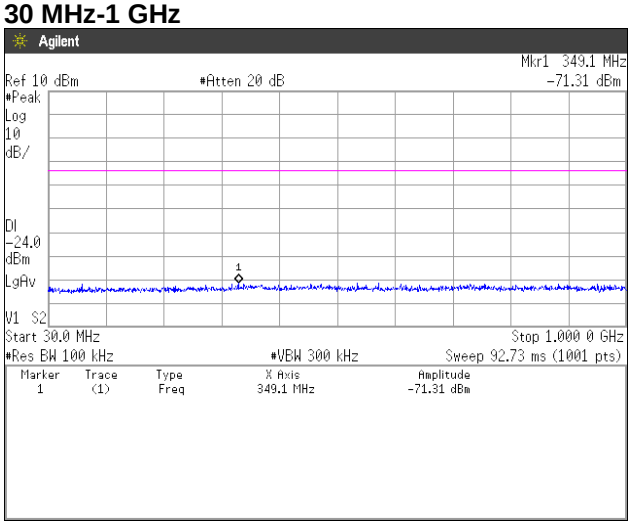


20 GHz-25 GHz

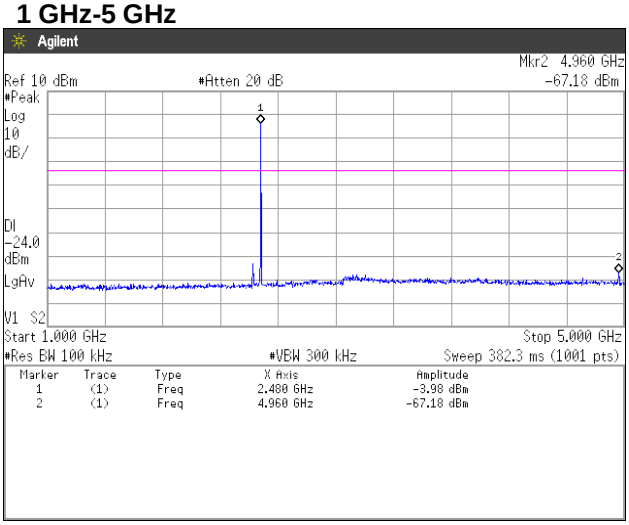


[3-DH5]
Channel High

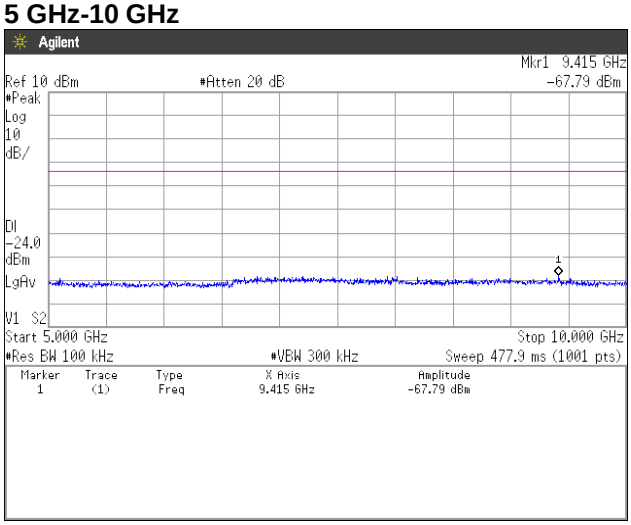
30 MHz-1 GHz



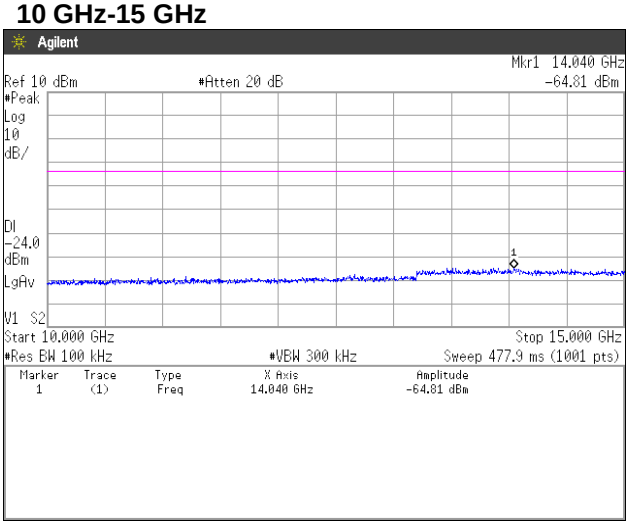
1 GHz-5 GHz



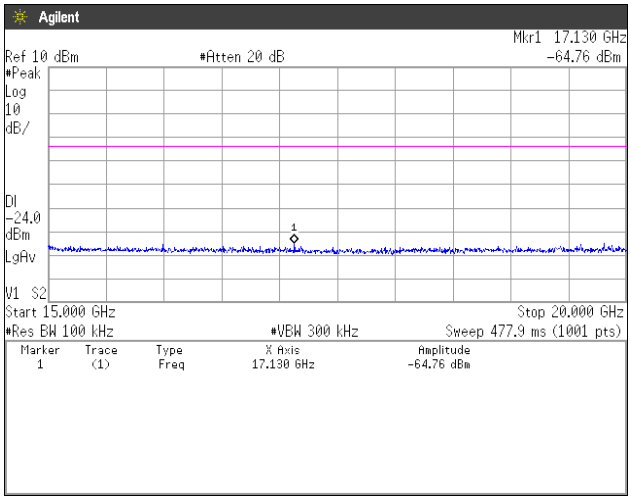
5 GHz-10 GHz



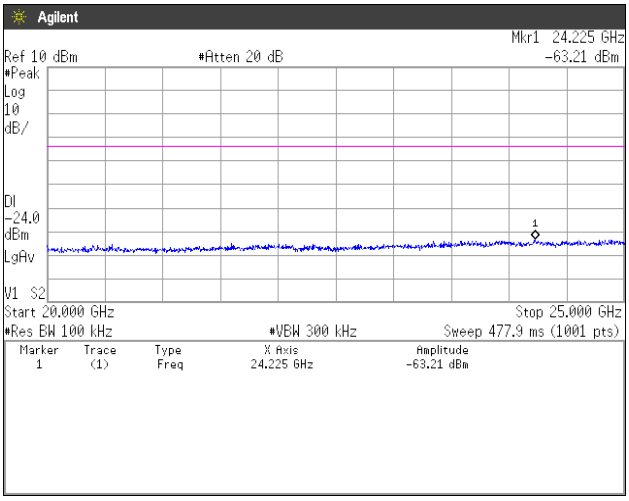
10 GHz-15 GHz



15 GHz-20 GHz



20 GHz-25 GHz



4.8 Spurious Emissions - Radiated -

4.8.1 Measurement procedure

[FCC 15.247(d), 15.205, 15.209]

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	:	Styrofoam table / (W)1.0m × (D)1.0m × (H)0.8m (below 1GHz) Styrofoam table / (W)0.6m × (D)0.6m ×(H)1.5m (above 1GHz)
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	:	RBW=1MHz, VBW=1kHz, Span=0Hz, Sweep=auto Display mode=Linear

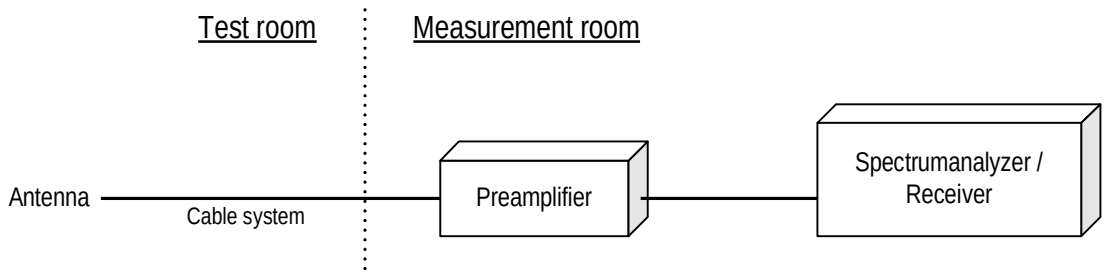
Average Measurement Setting [VBW]

Mode	Duty Cycle (%)	T_{on} (us)	T_{off} (us)	$1/T_{on}$ (kHz)	Determined VBW Setting
Bluetooth 4.2 EDR	76.93	2885	865	0.347	1kHz

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 (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/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



4.8.2 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 = 49.0dBuV Cable system loss = 8.3dB
Result = 49.0 + 8.3 = 57.3dBuV/m
Margin = 74.0 - 57.3 = 16.7dB

4.8.3 Limit

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

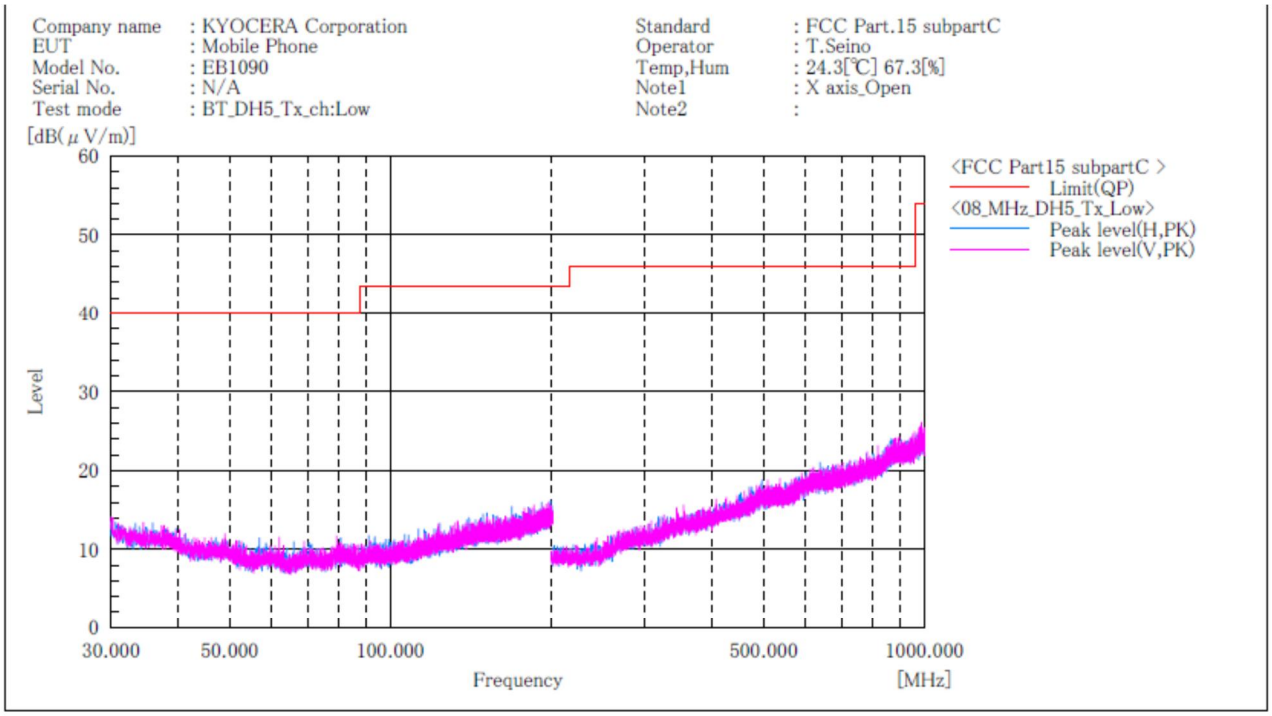
Note:
1. The lower limit shall apply at the transition frequencies.
2. Emission level [dBuV/m] = 20log Emission [uV/m]
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the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

4.8.4 Test data

Date	:	26-July-2021			
Temperature	:	24.6 [˚C]			
Humidity	:	68.8 [%]	Test engineer	:	
Test place	:	3m Semi-anechoic chamber			Tadahiro Seino

Date	:	27-July-2021			
Temperature	:	24.5 [˚C]			
Humidity	:	69.3 [%]	Test engineer	:	
Test place	:	3m Semi-anechoic chamber			Chiaki Kanno

[Transmission mode]
[DH5]
Channel: Low
BELOW 1 GHz

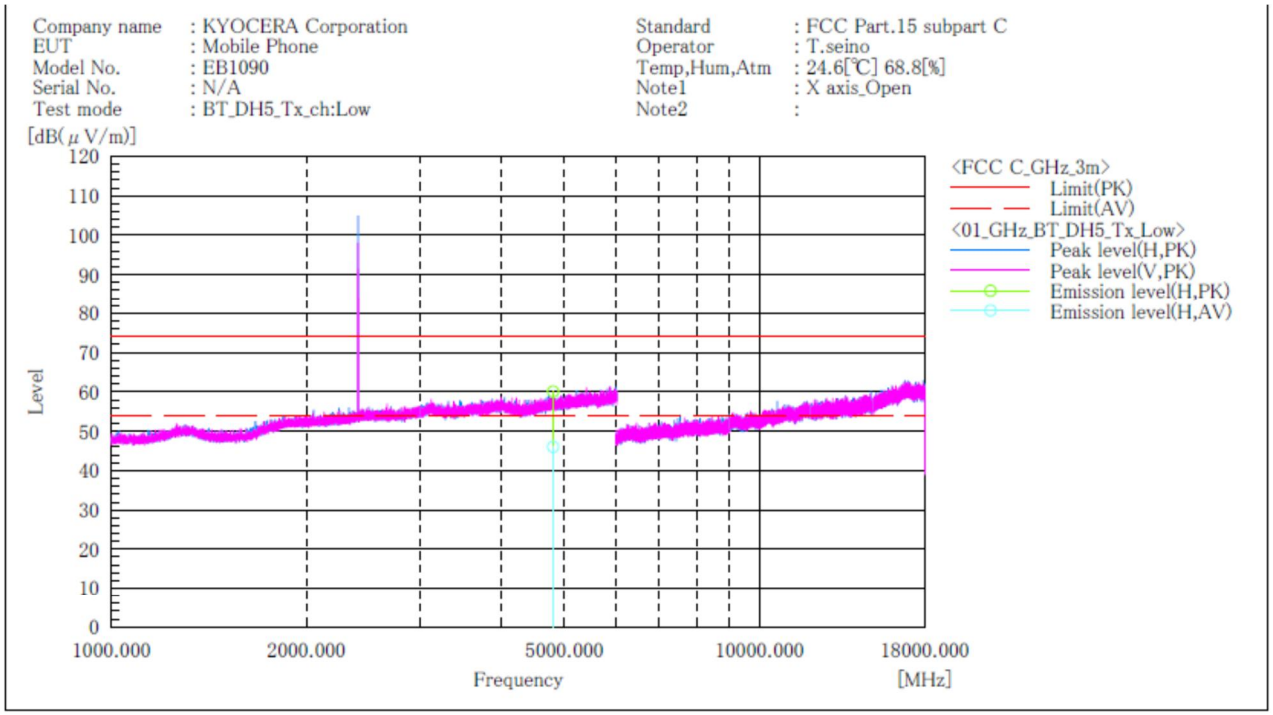


Final Result

No.	Frequency [MHz]	(P)	c.f [dB(1/m)]	Height [cm]	Angle [°]	Remark

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 9kHz to 30MHz at the 3 meters distance.

[DH5]
Channel: Low
ABOVE 1 GHz

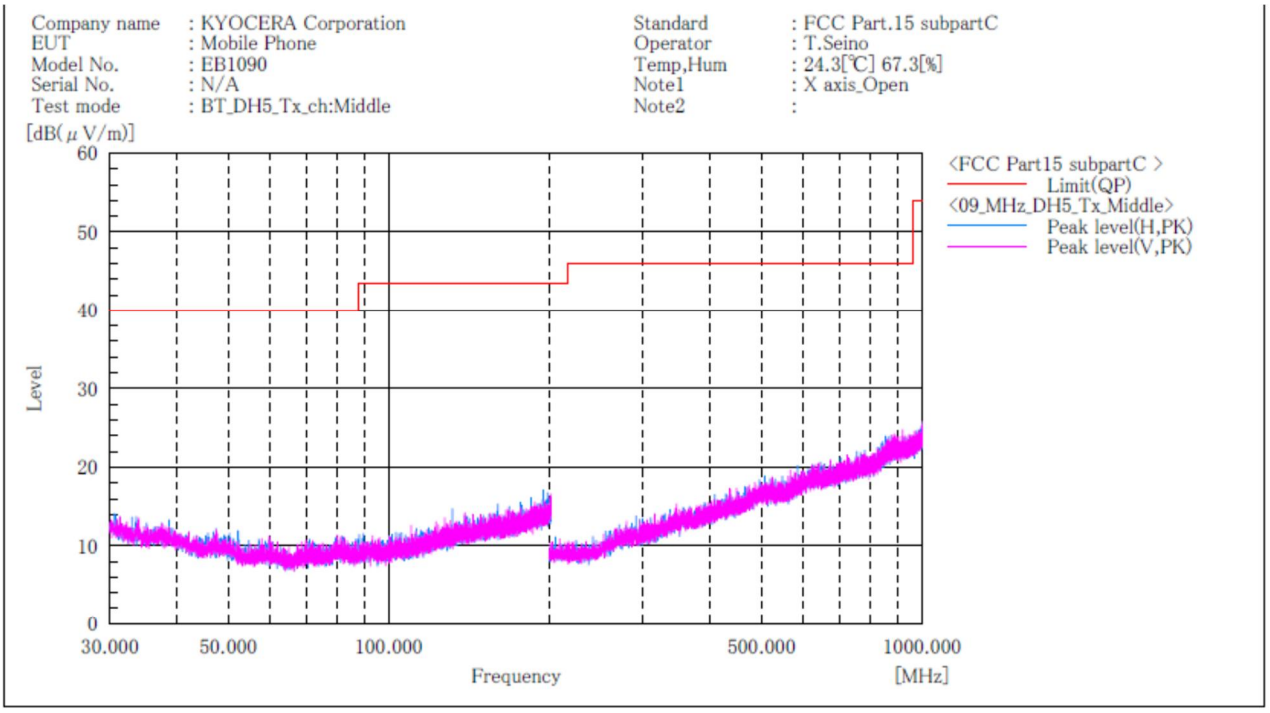


Final Result

No.	Frequency [MHz]	(P)	Reading PK [dB(μV)]	Reading AV [dB(μV)]	c.f [dB(1/m)]	Result PK [dB(μV/m)]	Result AV [dB(μV/m)]	Limit PK [dB(μV/m)]	Limit AV [dB(μV/m)]	Margin PK [dB]	Margin AV [dB]	Height [cm]	Angle [°]	Remark
1	4804.000	H	49.5	35.4	10.6	60.1	46.0	74.0	54.0	13.9	8.0	205.0	155.0	

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 18GHz to 25GHz at the 3 meters distance.

[DH5]
Channel: Middle
BELOW 1 GHz

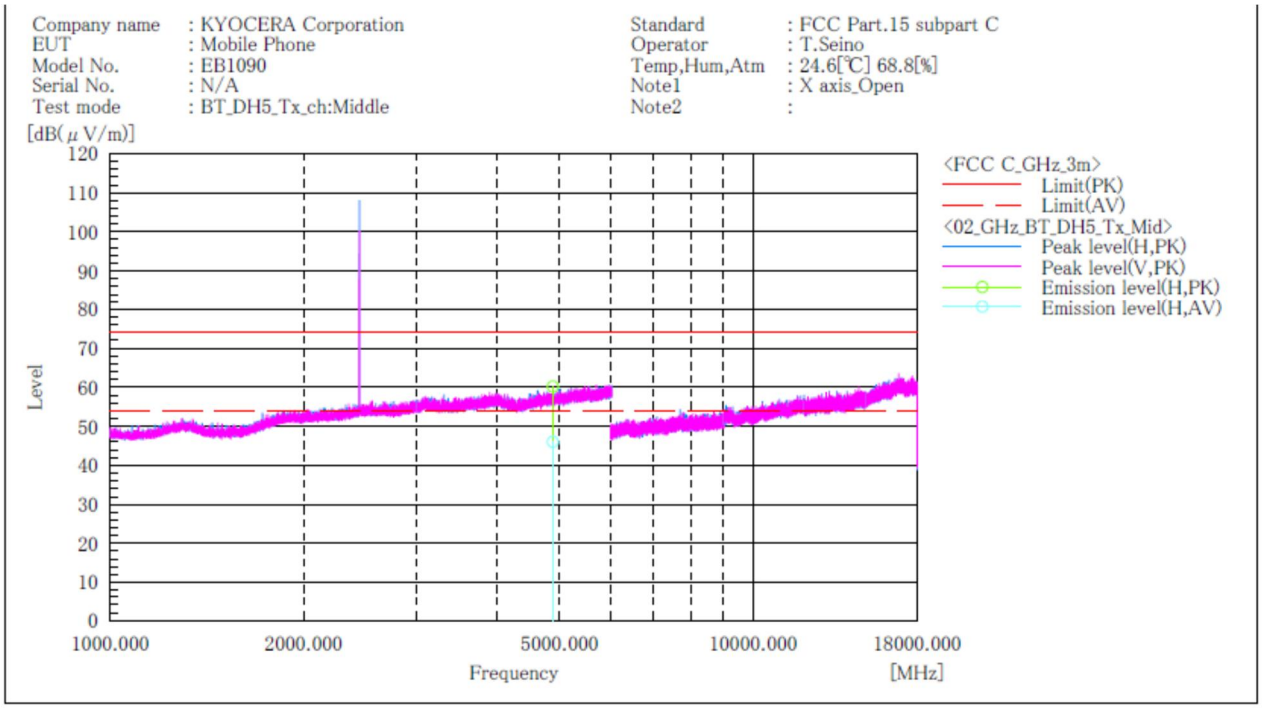


Final Result

No.	Frequency [MHz]	(P)	c.f [dB(1/m)]	Height [cm]	Angle [°]	Remark

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 9kHz to 30MHz at the 3 meters distance.

[DH5]
Channel: Middle
ABOVE 1 GHz

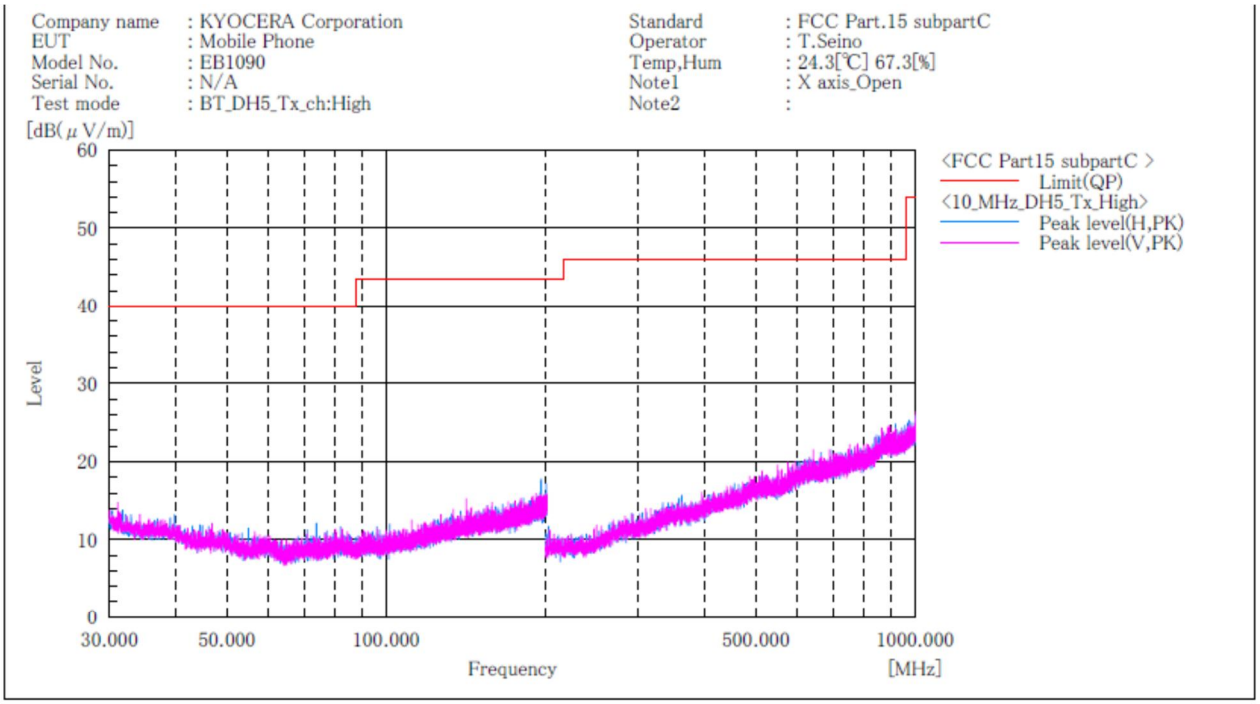


Final Result

No.	Frequency [MHz]	(P)	Reading PK [dB(μV)]	Reading AV [dB(μV)]	c.f [dB(1/m)]	Result PK [dB(μV/m)]	Result AV [dB(μV/m)]	Limit PK [dB(μV/m)]	Limit AV [dB(μV/m)]	Margin PK [dB]	Margin AV [dB]	Height [cm]	Angle [°]	Remark
1	4882.000	H	49.5	35.3	10.7	60.2	46.0	74.0	54.0	13.8	8.0	228.0	156.0	

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 18GHz to 25GHz at the 3 meters distance.

[DH5]
Channel: High
BELOW 1 GHz

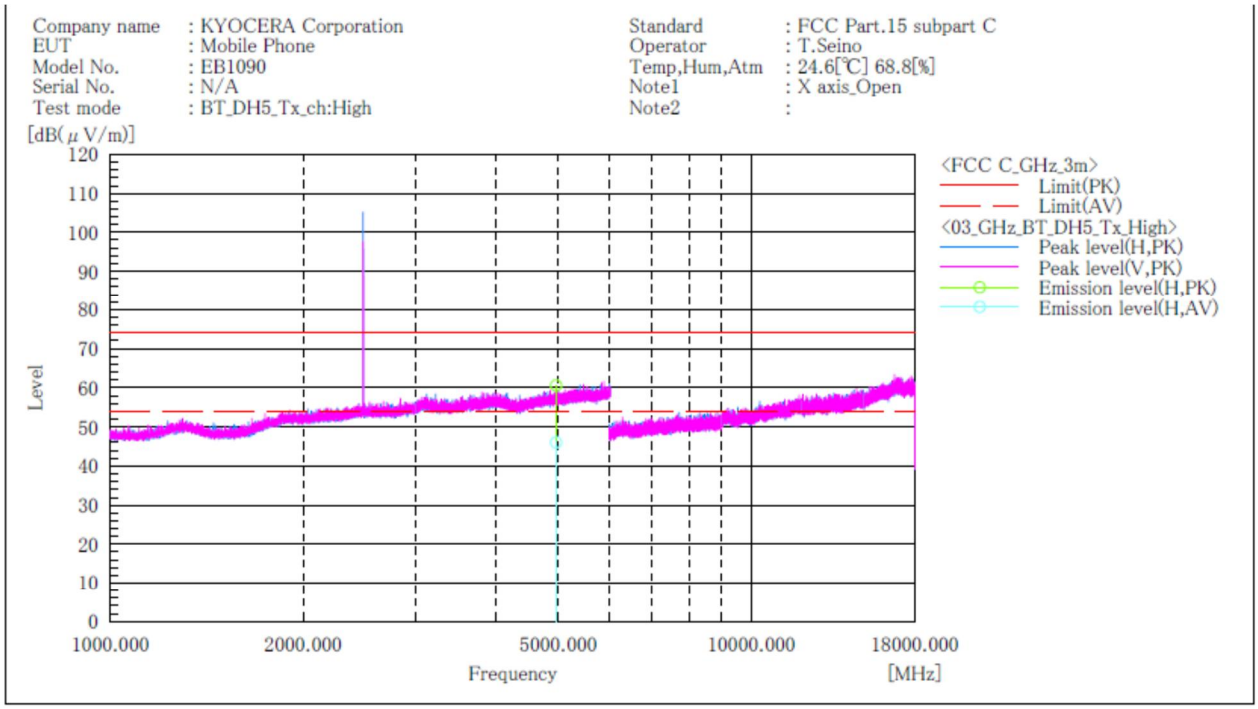


Final Result

No.	Frequency [MHz]	(P)	c.f [dB(1/m)]	Height [cm]	Angle [°]	Remark

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 9kHz to 30MHz at the 3 meters distance.

[DH5]
Channel: High
ABOVE 1 GHz

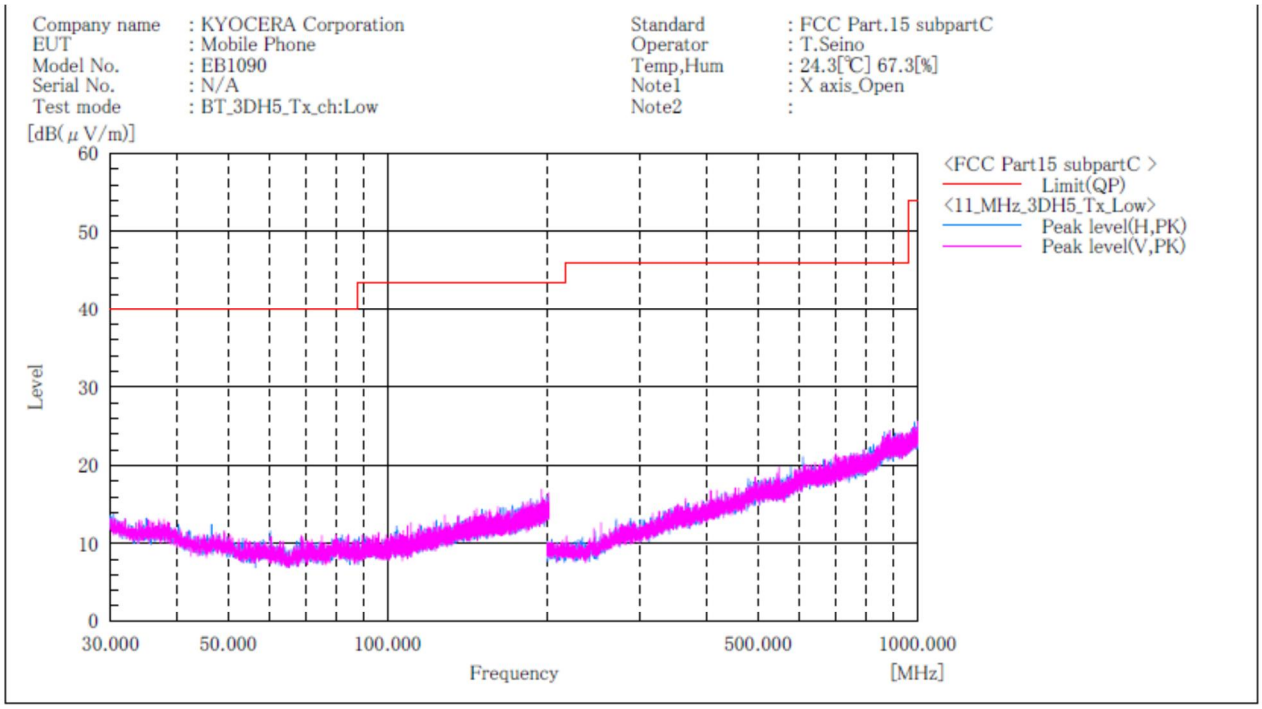


Final Result

No.	Frequency [MHz]	(P)	Reading PK [dB(μV)]	Reading AV [dB(μV)]	c.f [dB(1/m)]	Result PK [dB(μV/m)]	Result AV [dB(μV/m)]	Limit PK [dB(μV/m)]	Limit AV [dB(μV/m)]	Margin PK [dB]	Margin AV [dB]	Height [cm]	Angle [°]	Remark
1	4960.000	H	49.8	35.2	10.8	60.6	46.0	74.0	54.0	13.4	8.0	174.0	157.0	

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 18GHz to 25GHz at the 3 meters distance.

[3-DH5]
Channel: Low
BELOW 1 GHz

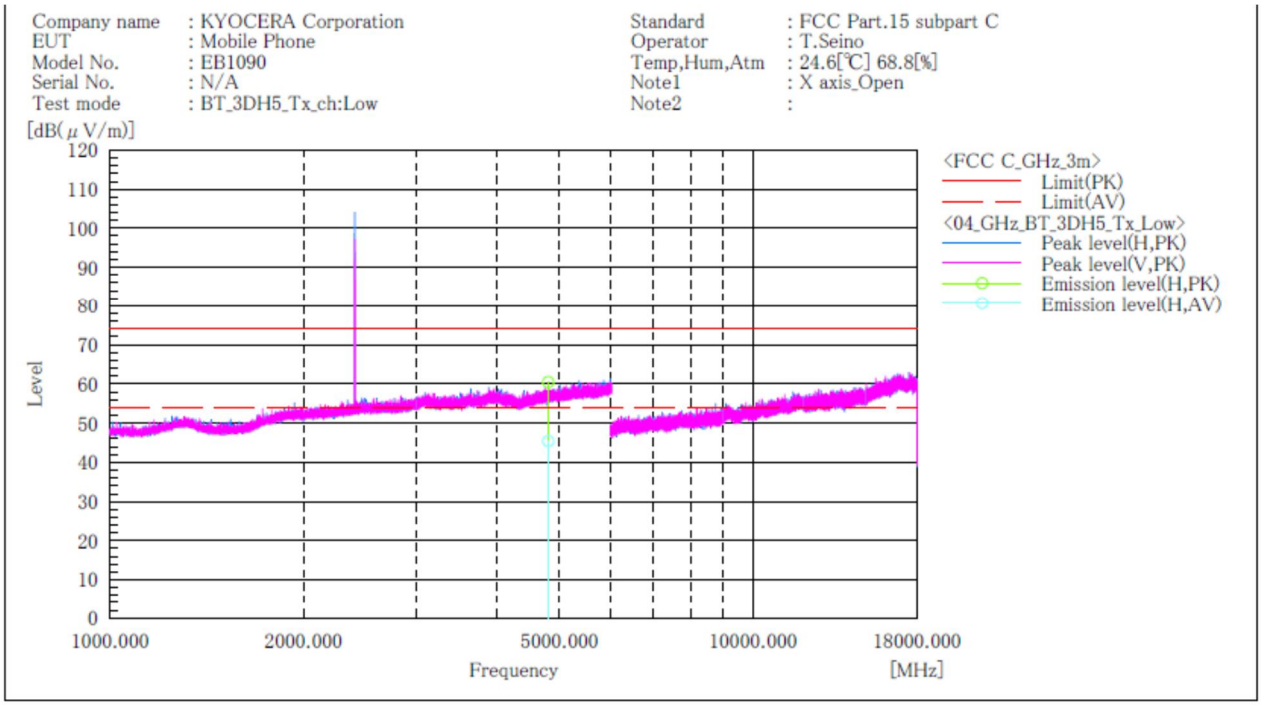


Final Result

No.	Frequency [MHz]	(P)	c.f [dB(1/m)]	Height [cm]	Angle [°]	Remark

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 9kHz to 30MHz at the 3 meters distance.

[3-DH5]
Channel: Low
ABOVE 1 GHz

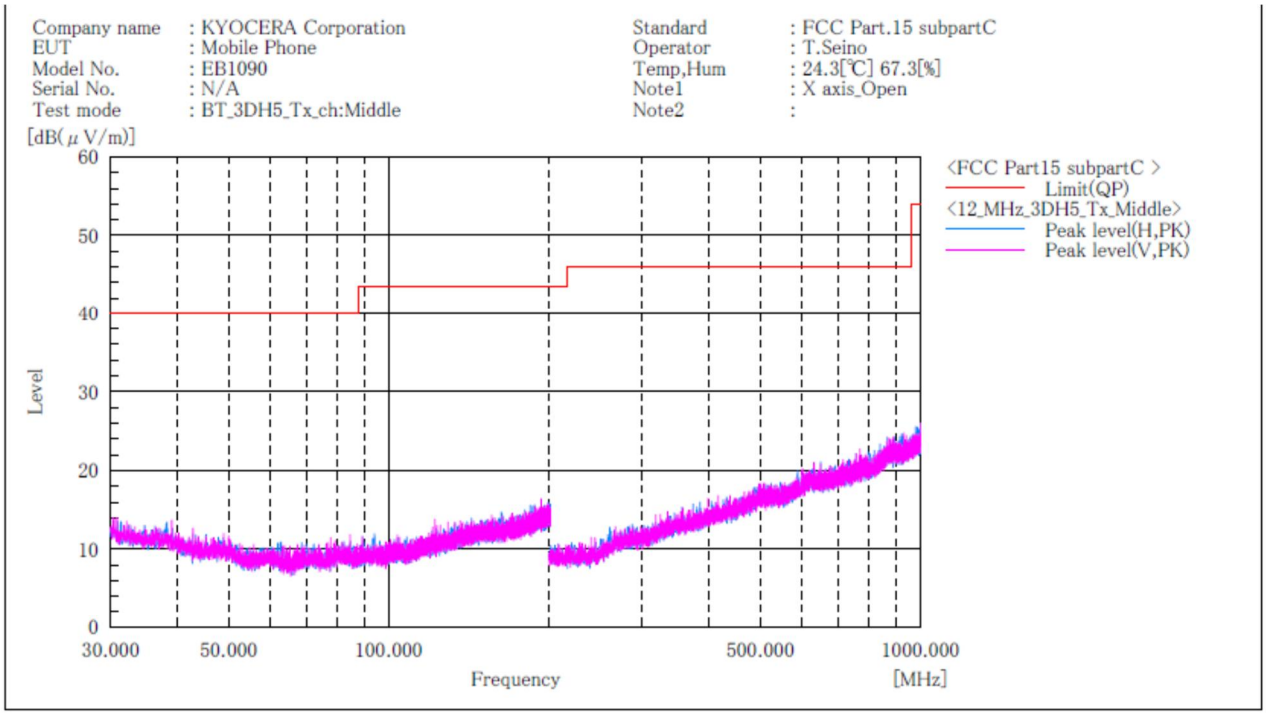


Final Result

No.	Frequency [MHz]	(P)	Reading PK [dB(μV)]	Reading AV [dB(μV)]	c.f [dB(1/m)]	Result PK [dB(μV/m)]	Result AV [dB(μV/m)]	Limit PK [dB(μV/m)]	Limit AV [dB(μV/m)]	Margin PK [dB]	Margin AV [dB]	Height [cm]	Angle [°]	Remark
1	4804.000	H	49.9	34.8	10.6	60.5	45.4	74.0	54.0	13.5	8.6	206.0	156.0	

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 18GHz to 25GHz at the 3 meters distance.

[3-DH5]
Channel: Middle
BELOW 1 GHz

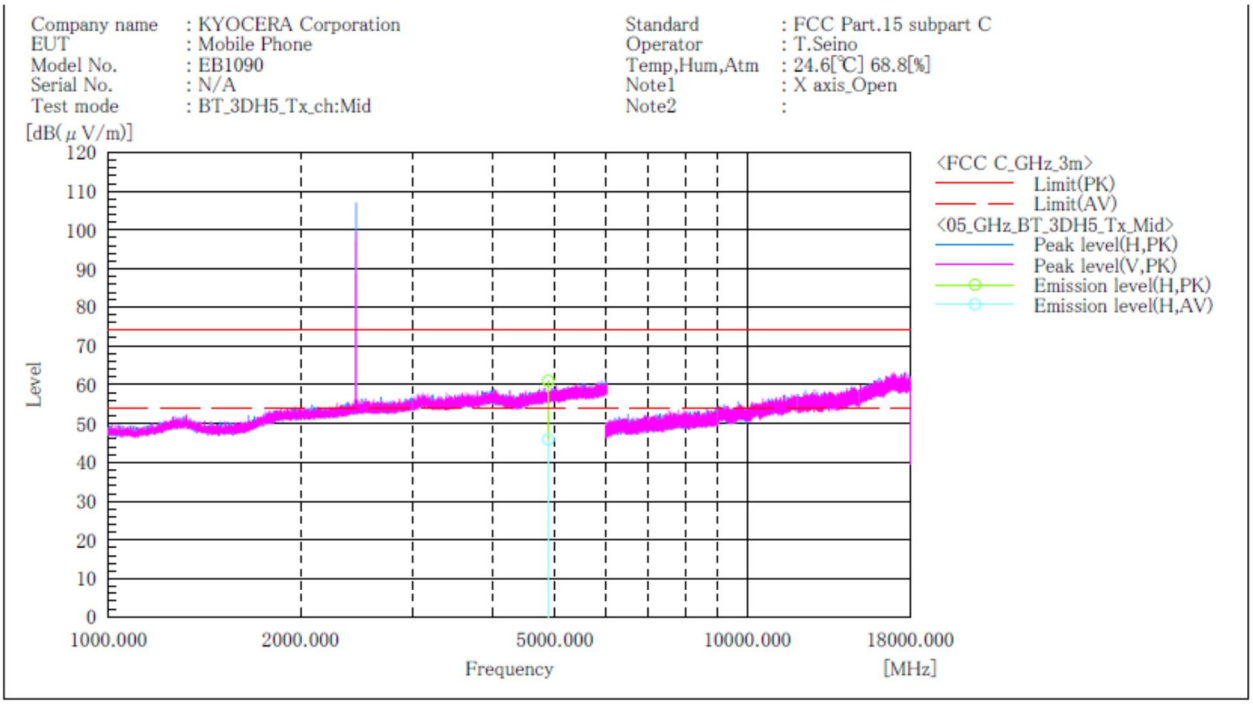


Final Result

No.	Frequency [MHz]	(P)	c.f [dB(1/m)]	Height [cm]	Angle [°]	Remark

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 9kHz to 30MHz at the 3 meters distance.

[3-DH5]
Channel: Middle
ABOVE 1 GHz

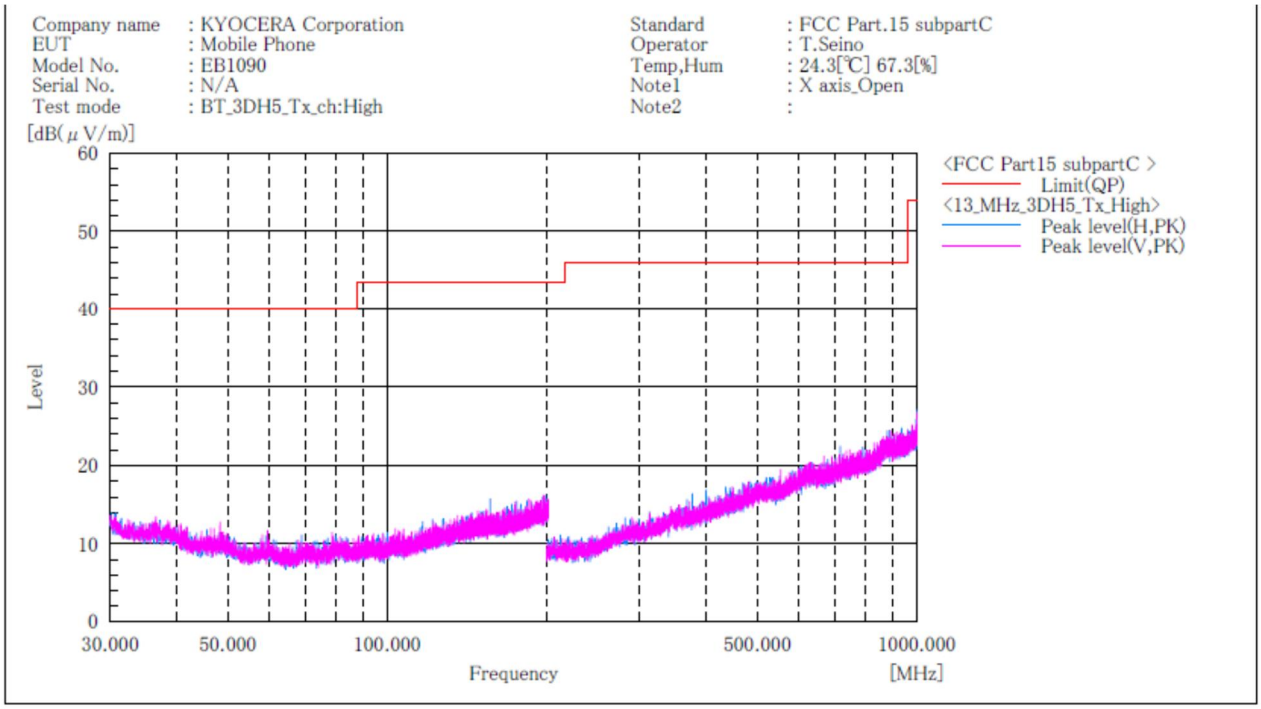


Final Result

No.	Frequency [MHz]	(P)	Reading PK [dB(μV)]	Reading AV [dB(μV)]	c.f [dB(1/m)]	Result PK [dB(μV/m)]	Result AV [dB(μV/m)]	Limit PK [dB(μV/m)]	Limit AV [dB(μV/m)]	Margin PK [dB]	Margin AV [dB]	Height [cm]	Angle [°]	Remark
1	4882.000	H	50.3	35.2	10.7	61.0	45.9	74.0	54.0	13.0	8.1	133.0	158.0	

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 18GHz to 25GHz at the 3 meters distance.

[3-DH5]
Channel: High
BELOW 1 GHz

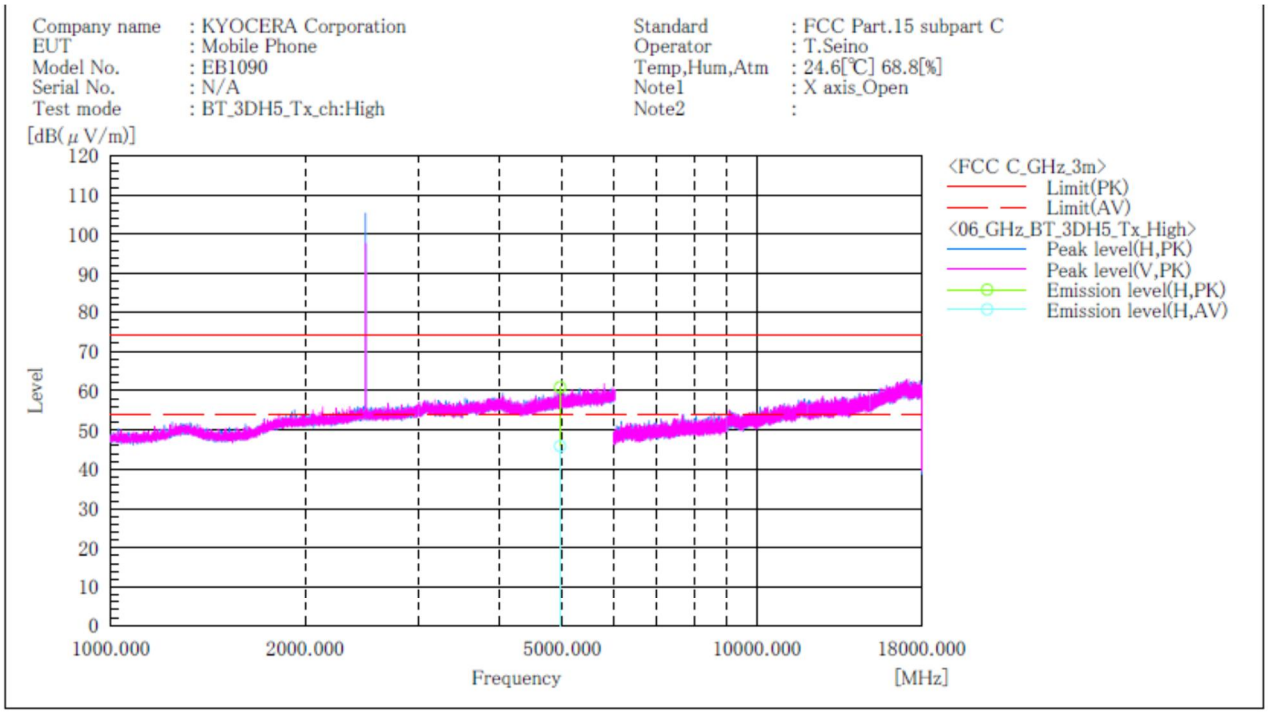


Final Result

No.	Frequency [MHz]	(P)	c.f [dB(1/m)]	Height [cm]	Angle [°]	Remark

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 9kHz to 30MHz at the 3 meters distance.

[3-DH5]
Channel: High
ABOVE 1 GHz

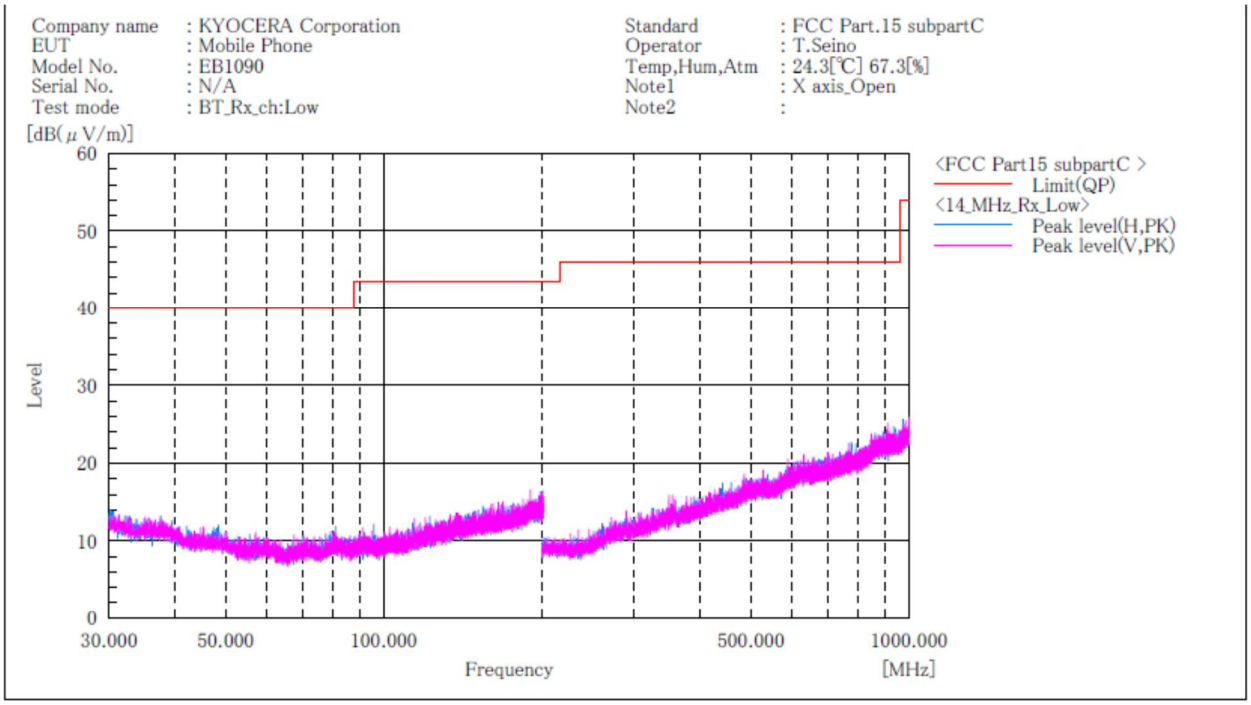


Final Result

No.	Frequency [MHz]	(P)	Reading PK [dB(μV)]	Reading AV [dB(μV)]	c.f [dB(1/m)]	Result PK [dB(μV/m)]	Result AV [dB(μV/m)]	Limit PK [dB(μV/m)]	Limit AV [dB(μV/m)]	Margin PK [dB]	Margin AV [dB]	Height [cm]	Angle [°]	Remark
1	4960.000	H	50.1	35.1	10.8	60.9	45.9	74.0	54.0	13.1	8.1	172.0	156.0	

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 18GHz to 25GHz at the 3 meters distance.

[Receive mode]
Channel: Low
BELOW 1 GHz

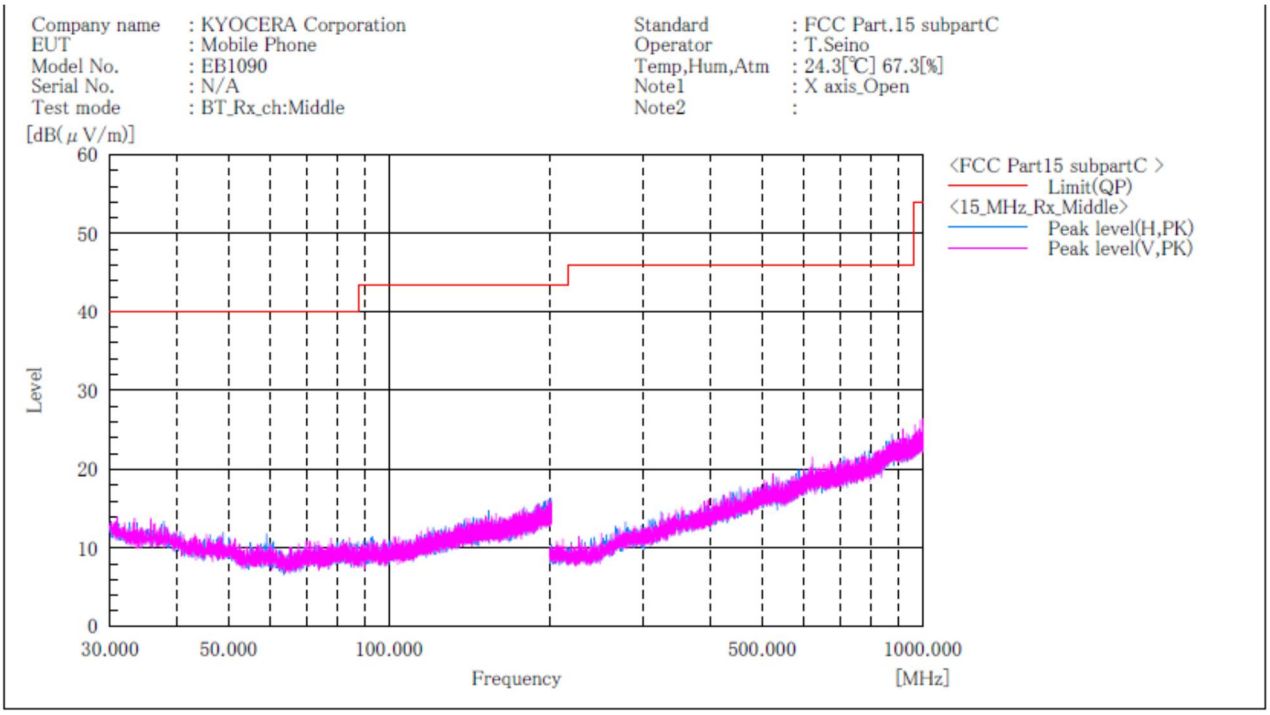


Final Result

No.	Frequency [MHz]	(P)	c.f [dB(1/m)]	Height [cm]	Angle [°]	Remark

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 9kHz to 30MHz and 1GHz to 25GHz at the 3 meters distance.

Channel: Middle
BELOW 1 GHz

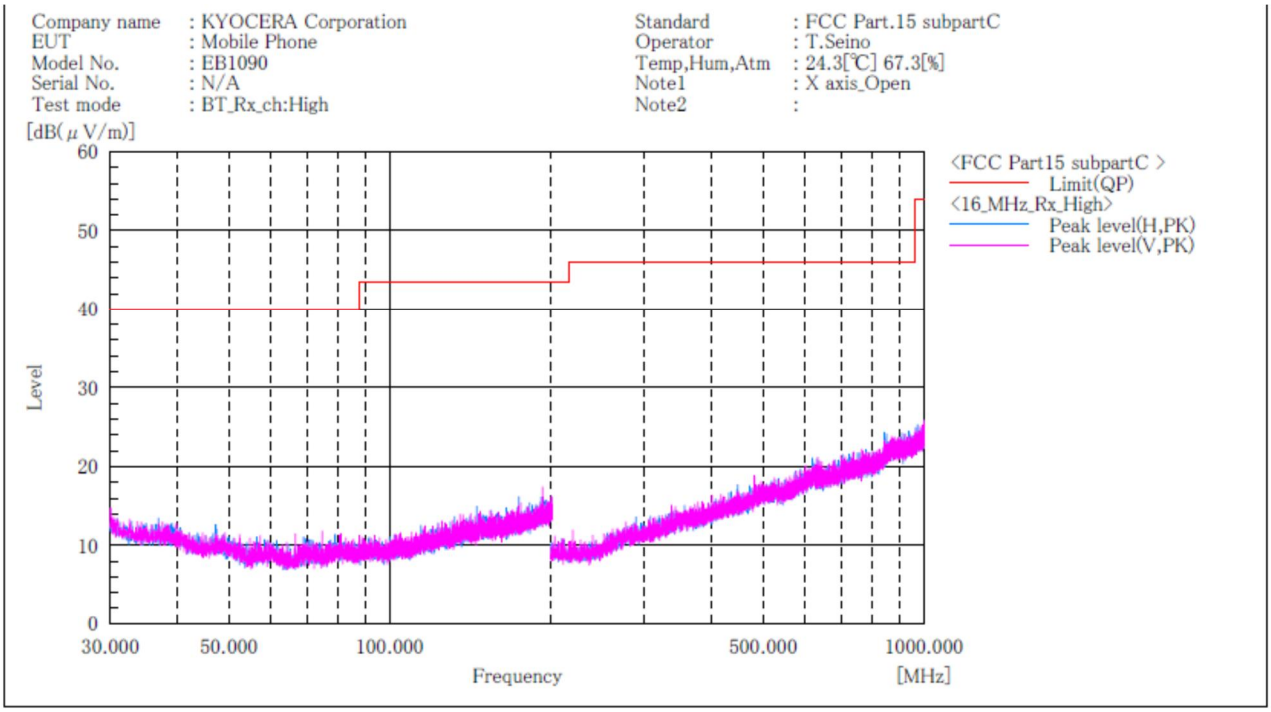


Final Result

No.	Frequency [MHz]	(P)	c.f [dB(1/m)]	Height [cm]	Angle [°]	Remark

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 9kHz to 30MHz and 1GHz to 25GHz at the 3 meters distance.

Channel: High
BELOW 1 GHz



Final Result

No.	Frequency [MHz]	(P)	c.f [dB(1/m)]	Height [cm]	Angle [°]	Remark

Note:
1. Emission Level (Margin) = Limit - [Reading + Factor (Antenna + Cable – Amp)]
2. No emission were detected in frequency range 9kHz to 30MHz and 1GHz to 25GHz at the 3 meters distance.

4.9 Restricted Band of Operation

4.9.1 Measurement procedure

[FCC 15.247(d), 15.205, 15.209]

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 × (D)1.0m × (H)0.8m (below 1GHz) Styrofoam table / (W)0.6m × (D)0.6m ×(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=1kHz, Span=Arbitrary setting, Sweep=auto Display mode=Linear

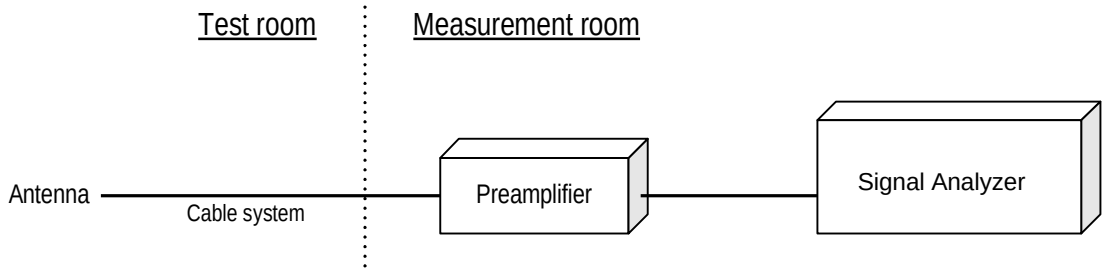
Average Measurement Setting [VBW]

Mode	Duty Cycle (%)	T_{on} (us)	T_{off} (us)	$1/T_{on}$ (kHz)	Determined VBW Setting
Bluetooth 4.2 EDR	76.93	2885	865	0.347	1kHz

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 (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/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



4.9.2 Limit

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

4.9.3 Measurement result

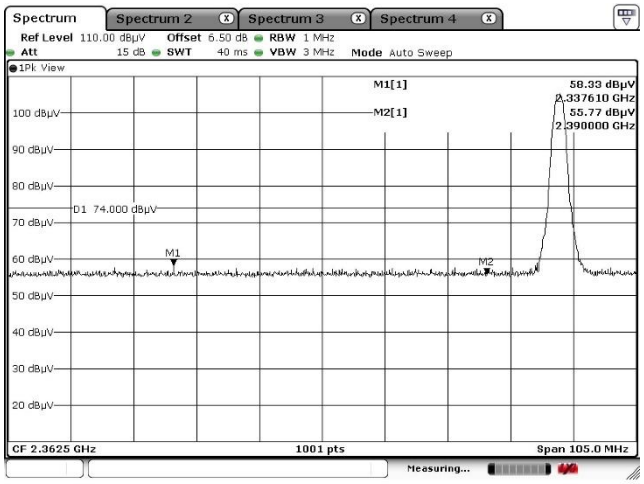
Channel	Frequency [MHz]	Results Chart	Result
Low	2402	See the Trace Data	Pass
High	2480	See the Trace Data	Pass

4.9.4 Test data

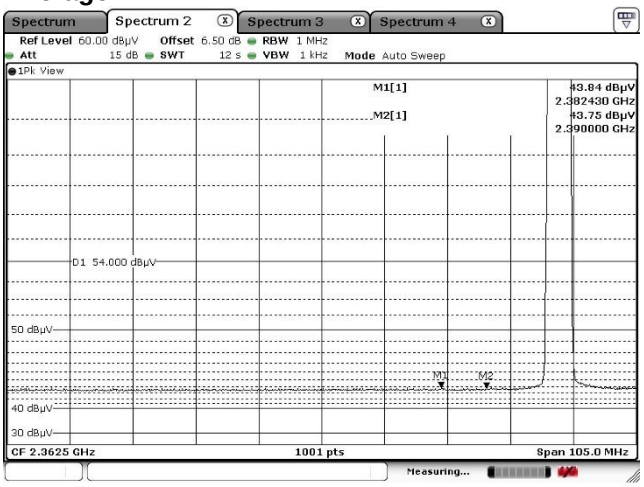
Date : 27-July-2021
Temperature : 24.5 [˚C]
Humidity : 69.3 [%]
Test place : 3m Semi-anechoic chamber

Test engineer : Chiaki Kanno

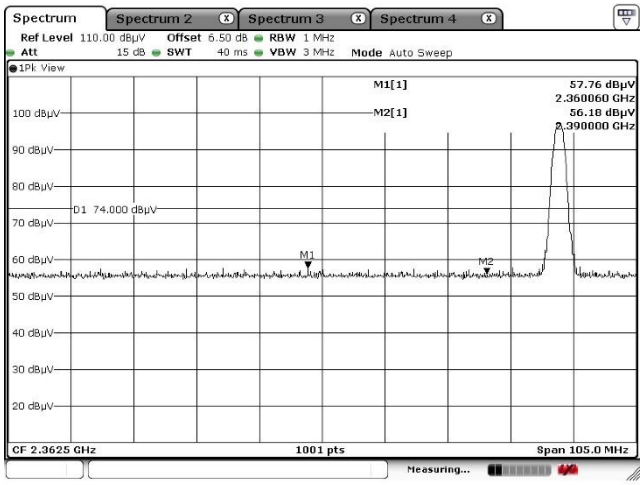
[DH5_CLOSE]
Channel: Low
Horizontal
Peak



Average



Vertical
Peak



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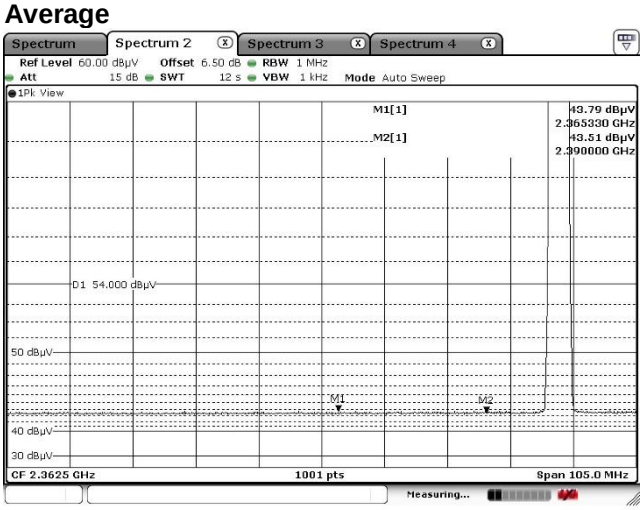
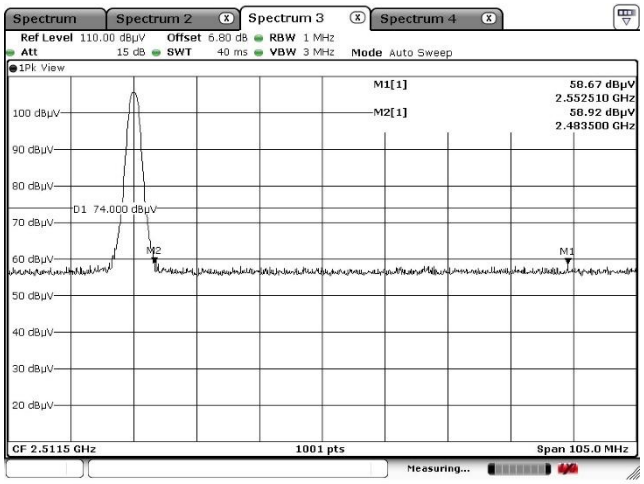
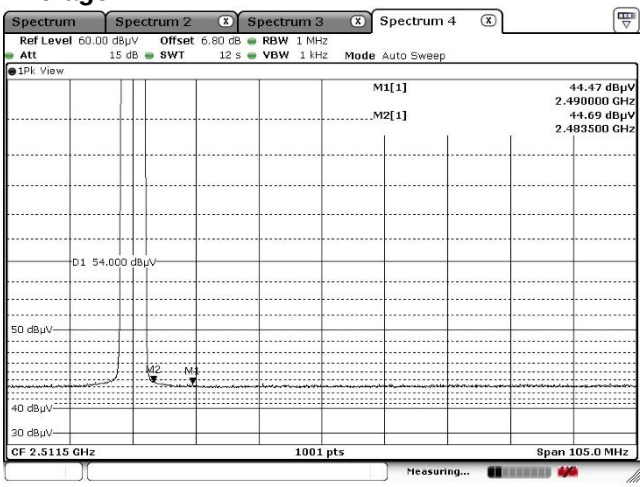


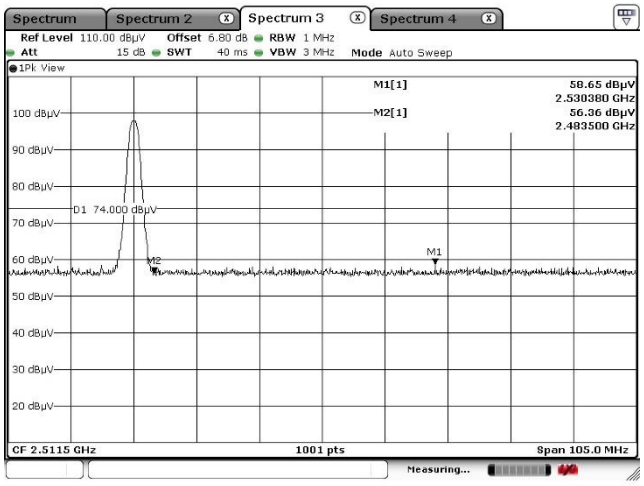
[DH5_CLOSE]
Channel: High
Horizontal
Peak



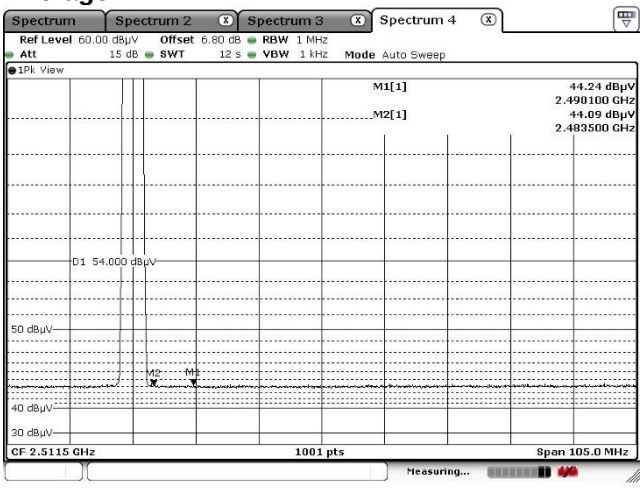
Average



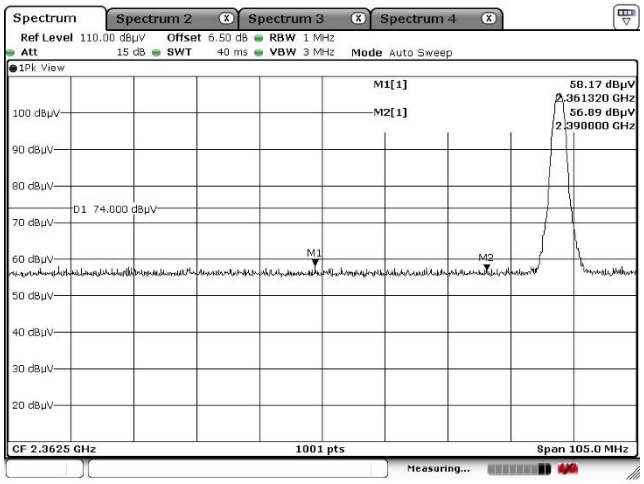
Vertical
Peak



Average



[DH5_OPEN]
Channel: Low
Horizontal
Peak



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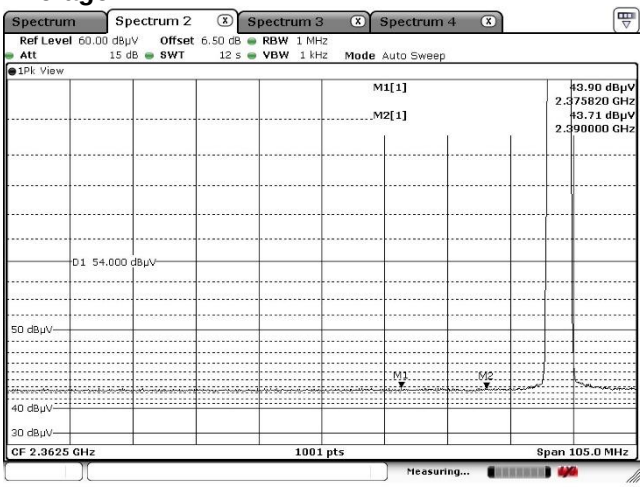
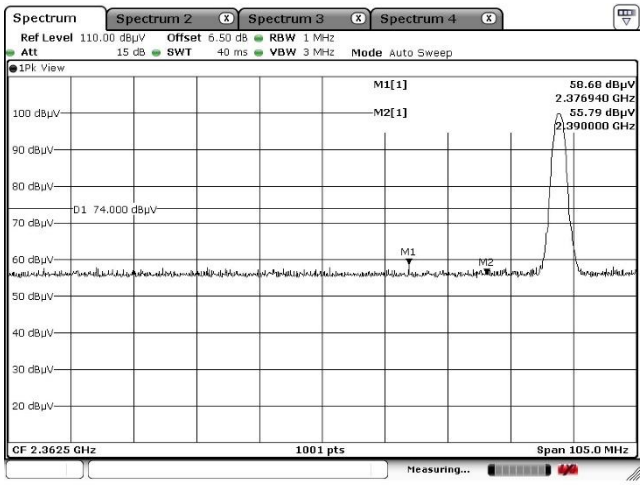
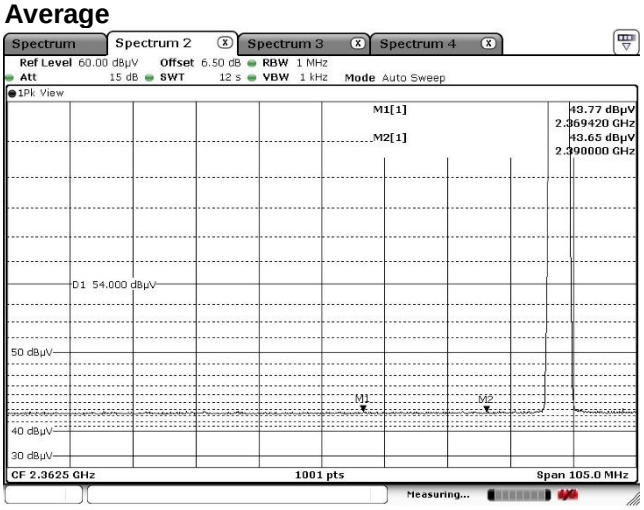


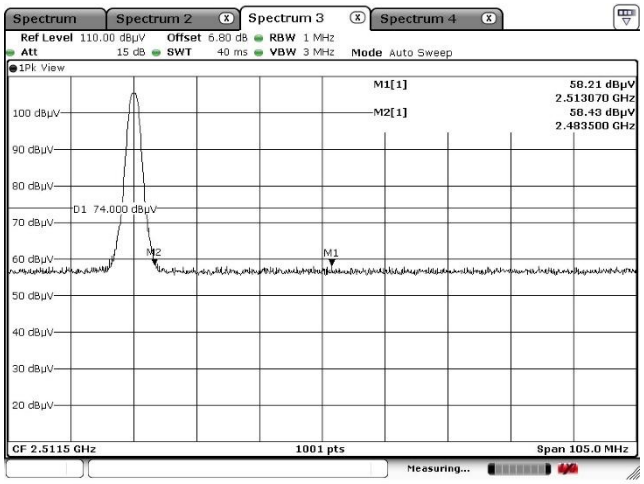
Vertical
Peak



Average



[DH5]
Channel: High
Horizontal
Peak



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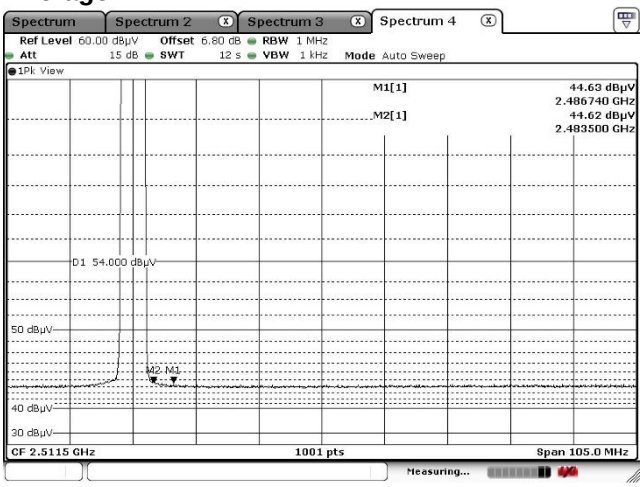
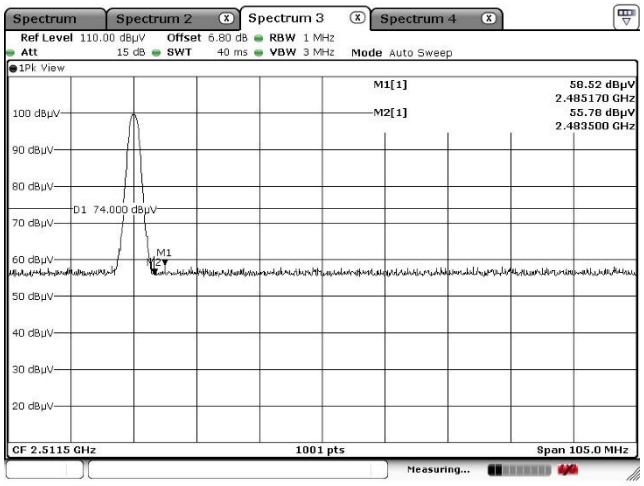


Vertical
Peak



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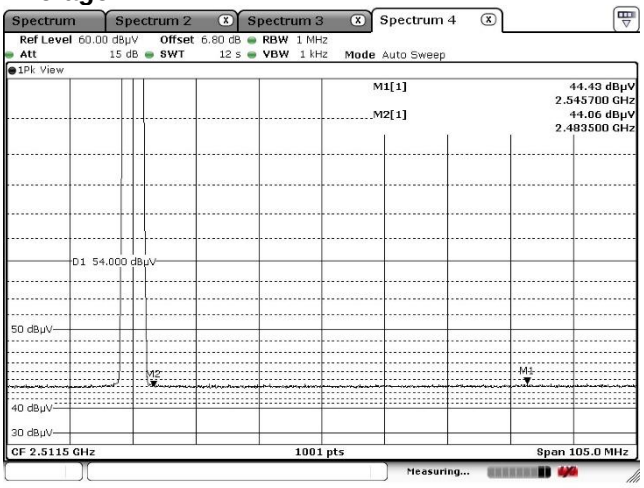
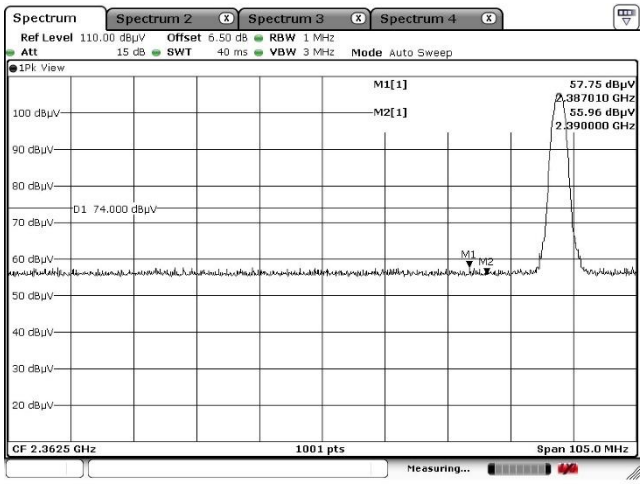


[3-DH5_CLOSE]
Channel: Low
Horizontal
Peak



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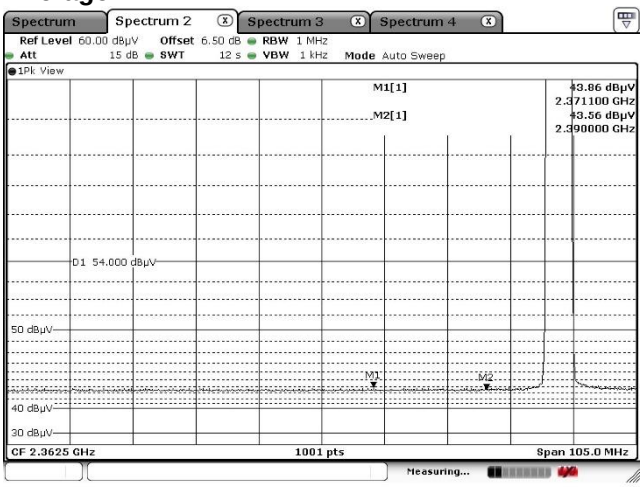
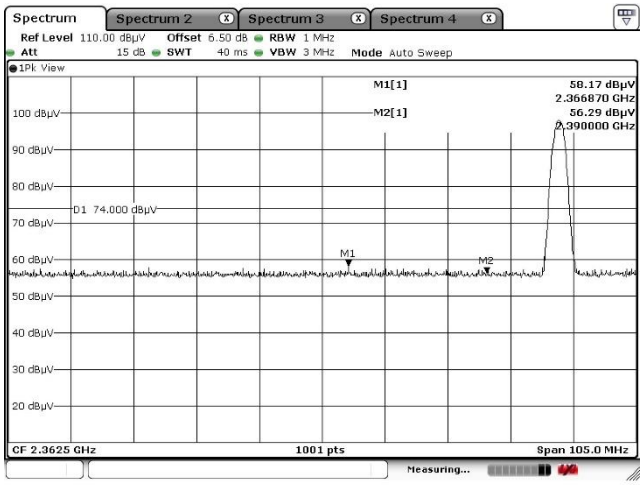


Vertical
Peak



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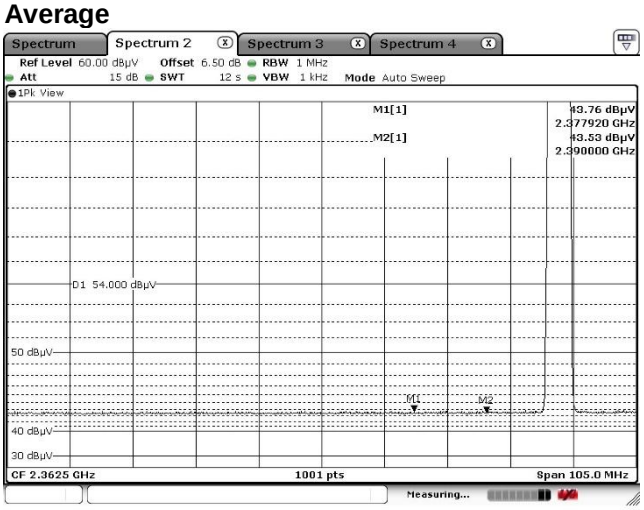
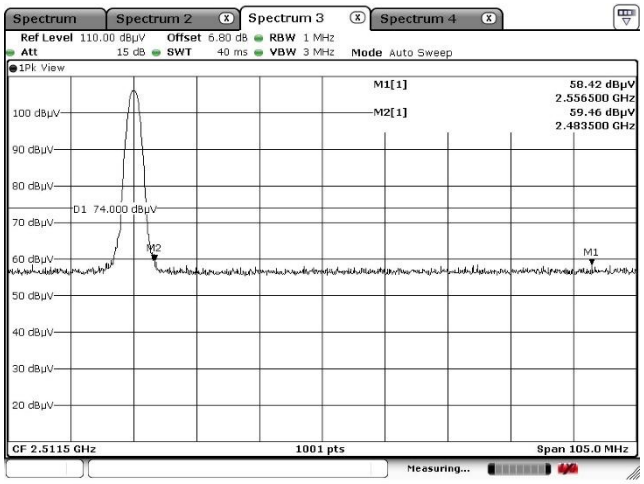


[3-DH5_CLOSE]
Channel: High
Horizontal
Peak



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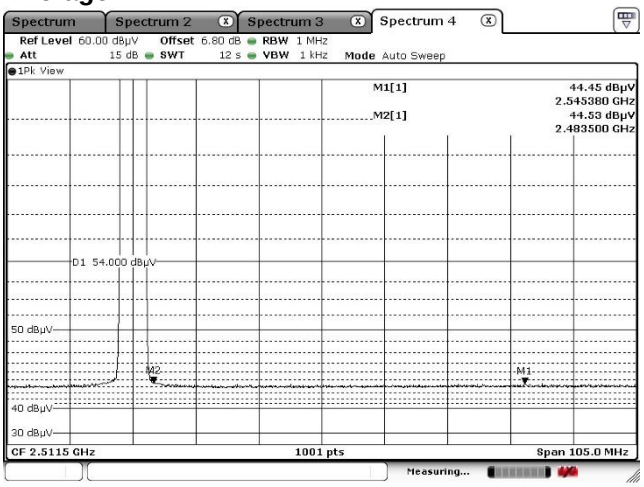
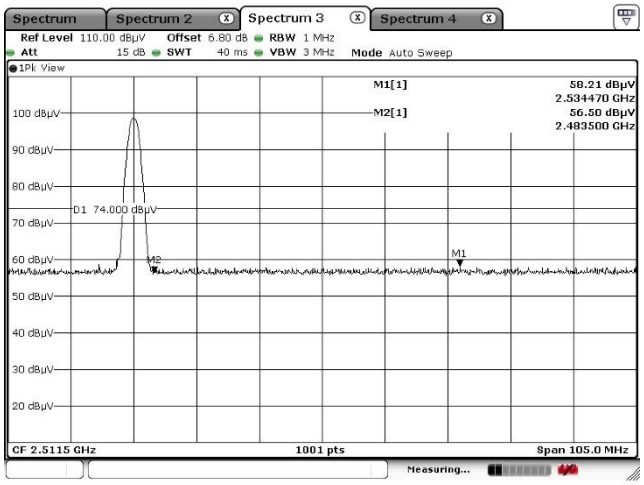


Vertical
Peak



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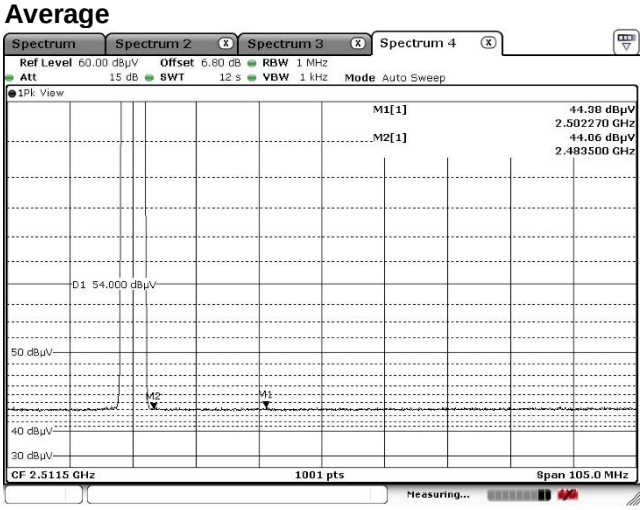
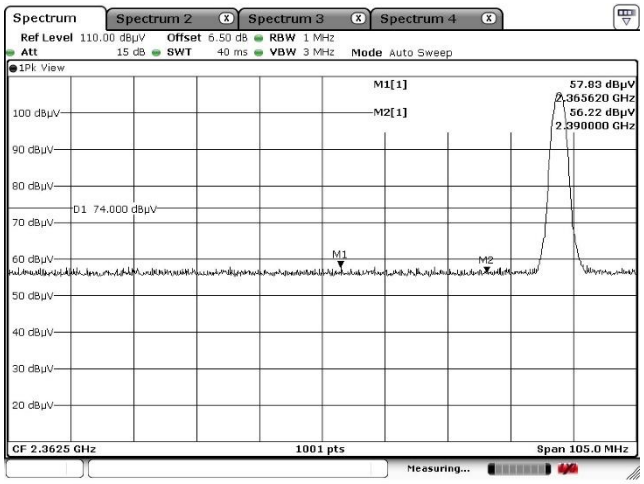


[3-DH5_OPEN]
Channel: Low
Horizontal
Peak



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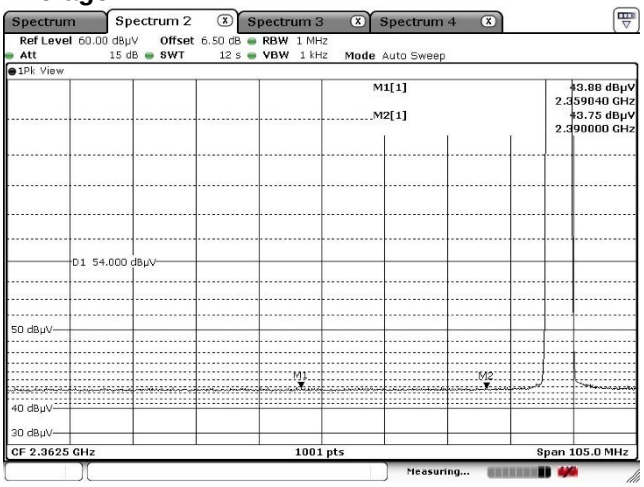
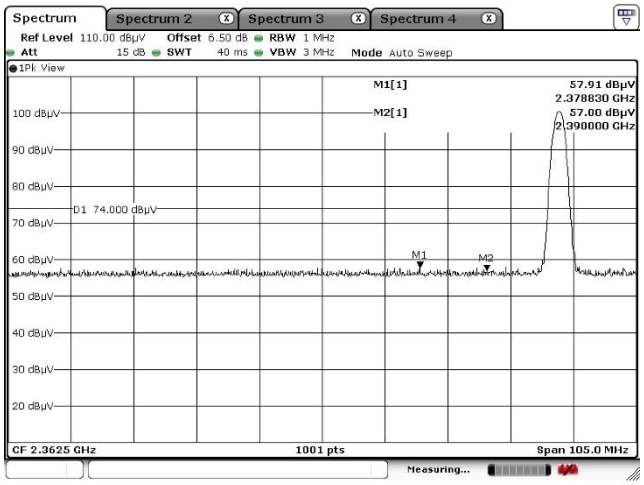
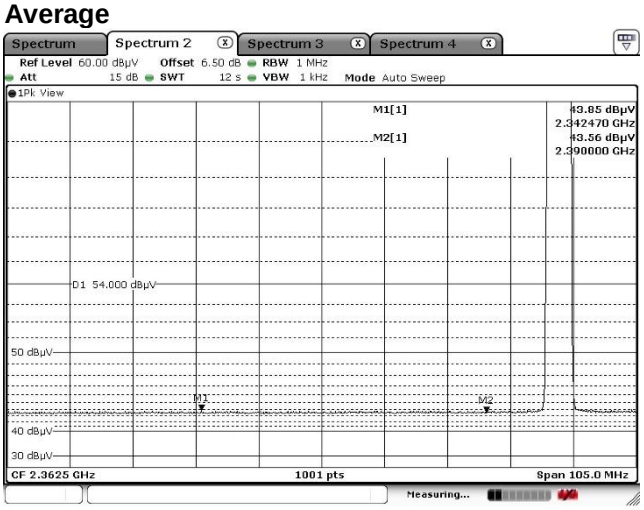


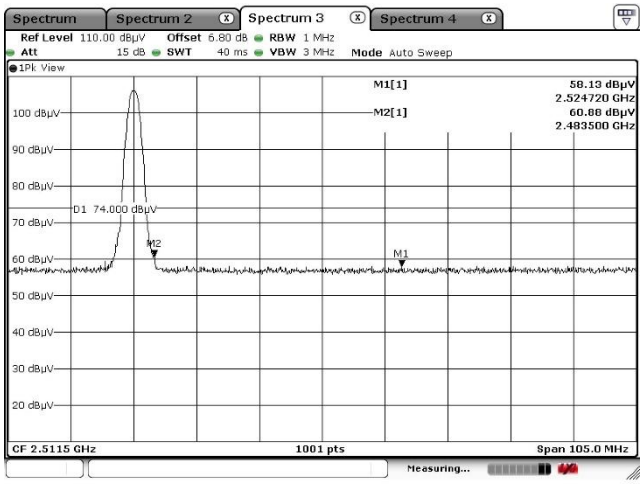
Vertical
Peak



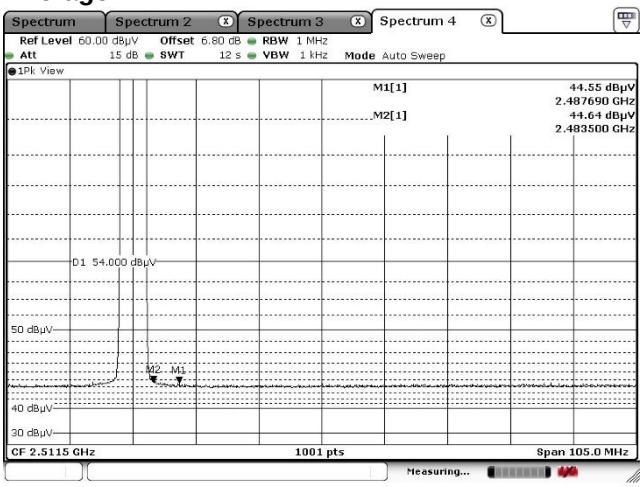
Average



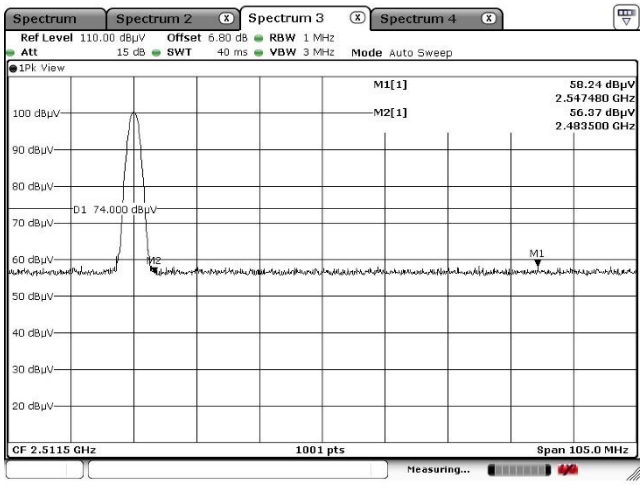
[3-DH5_OPEN]
Channel: High
Horizontal
Peak



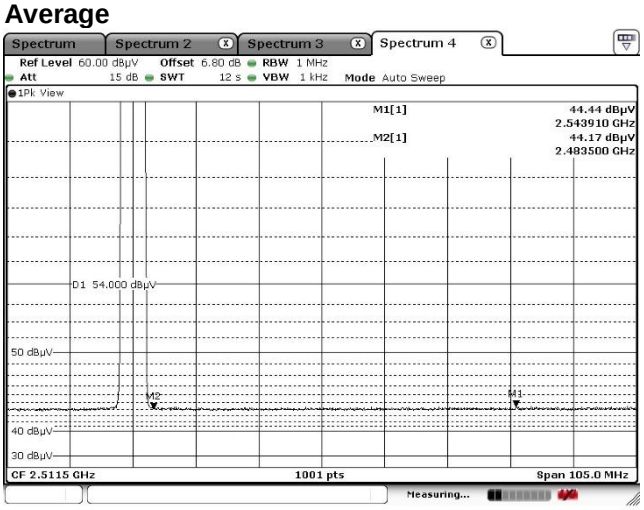
Average



Vertical
Peak



Average



4.10 AC Power Line Conducted Emissions

4.10.1 Measurement procedure

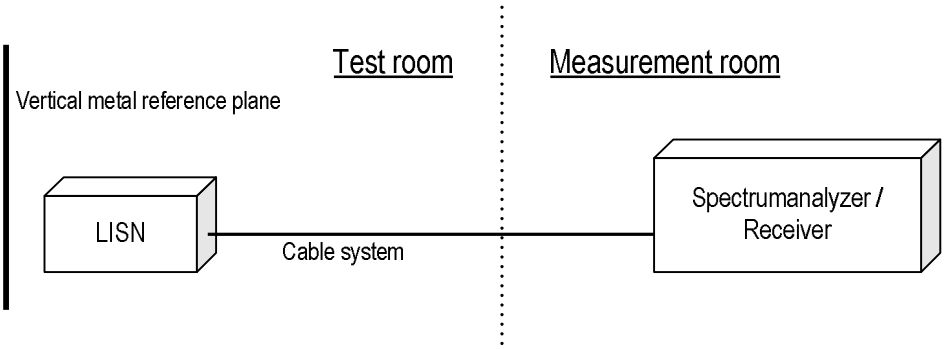
[FCC 15.207]

Test was applied by following conditions.

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

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



4.10.2 Calculation method

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

Example:
Limit @ 6.770 MHz : 60.0 dBμV(Quasi-peak)
: 50.0 dBμV(Average)
(Quasi peak) Reading = 41.2 dBμV c.f = 10.3 dB
Emission level = 41.2 + 10.3 = 51.5 dBμV
Margin = 60.0 – 51.5 = 8.5 dB
(Average) Reading = 35.0 dBμV c.f = 10.3 dB
Emission level = 35.0 + 10.3 = 45.3 dBμV
Margin = 50.0 – 45.3 = 4.7 dB

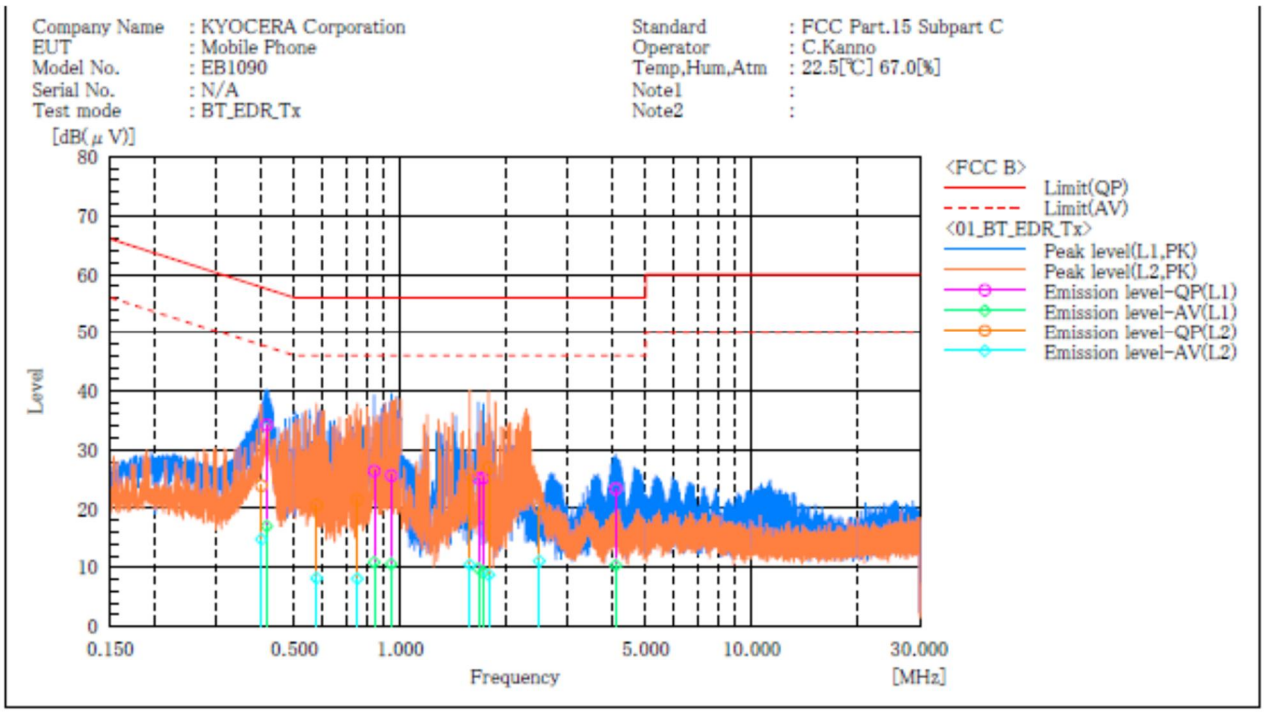
4.10.3 Limit

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.

4.10.4 Test data

Date	:	29-July-2021		
Temperature	:	22.5 [˚C]		
Humidity	:	67.0 [%]	Test engineer	:
Test place	:	3m Semi-anechoic chamber		Chiaki Kanno



Final Result

--- L1 Phase ---

No.	Frequency [MHz]	Reading QP [dB(μV)]	Reading CAV [dB(μV)]	c.f [dB]	Result QP [dB(μV)]	Result CAV [dB(μV)]	Limit QP [dB(μV)]	Limit AV [dB(μV)]	Margin QP [dB]	Margin CAV [dB]
1	0.417	23.9	6.7	10.3	34.2	17.0	57.5	47.5	23.3	30.5
2	0.843	16.1	0.6	10.3	26.4	10.9	56.0	46.0	29.6	35.1
3	0.943	15.3	0.3	10.3	25.6	10.6	56.0	46.0	30.4	35.4
4	1.668	14.7	-0.6	10.4	25.1	9.8	56.0	46.0	30.9	36.2
5	1.725	14.8	-1.2	10.4	25.2	9.2	56.0	46.0	30.8	36.8
6	4.106	12.9	-0.1	10.5	23.4	10.4	56.0	46.0	32.6	35.6

--- L2 Phase ---

No.	Frequency [MHz]	Reading QP [dB(μV)]	Reading CAV [dB(μV)]	c.f [dB]	Result QP [dB(μV)]	Result CAV [dB(μV)]	Limit QP [dB(μV)]	Limit AV [dB(μV)]	Margin QP [dB]	Margin CAV [dB]
1	0.403	13.6	4.5	10.3	23.9	14.8	57.8	47.8	33.9	33.0
2	0.578	10.3	-2.1	10.3	20.6	8.2	56.0	46.0	35.4	37.8
3	0.754	11.2	-2.2	10.3	21.5	8.1	56.0	46.0	34.5	37.9
4	1.576	15.5	0.2	10.3	25.8	10.5	56.0	46.0	30.2	35.5
5	1.784	16.7	-1.5	10.3	27.0	8.8	56.0	46.0	29.0	37.2
6	2.484	9.7	0.7	10.4	20.1	11.1	56.0	46.0	35.9	34.9

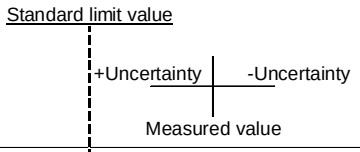
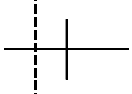
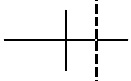
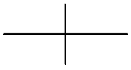
5 Antenna requirement

According to FCC section 15.203, an intentional radiator shall be designed to ensure that no antenna other than 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.

6 Measurement Uncertainty

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 Parts 1 and 2 determining compliance or non-compliance with test result.

Test item	Measurement uncertainty
Conducted emission, AMN (9 kHz – 150 kHz)	±3.7 dB
Conducted emission, AMN (150 kHz – 30 MHz)	±3.3 dB
Radiated emission (9kHz – 30 MHz)	±3.2 dB
Radiated emission (30 MHz – 1000 MHz)	±5.3 dB
Radiated emission (1 GHz – 6 GHz)	±4.8 dB
Radiated emission (6 GHz – 18 GHz)	±4.5 dB
Radiated emission (18 GHz – 40 GHz)	±6.4 dB
Radio Frequency	$\pm 1.4 * 10^{-8}$
RF power, conducted	±0.8 dB
Adjacent channel power	±2.4 dB
Temperature	±0.6 °C
Humidity	±1.2 %
Voltage (DC)	±0.4 %
Voltage (AC, <10kHz)	±0.2 %

Judge	Measured value and standard limit value	
PASS	**Case1** 	Even if it takes uncertainty into consideration, a standard limit value is fulfilled.
	Case2 	Although measured value is in a standard limit value, a limit value won't be fulfilled if uncertainty is taken into consideration.
FAIL	**Case3** 	Although measured value exceeds a standard limit value, a limit value will be fulfilled if uncertainty is taken into consideration.
	Case4 	Even if it takes uncertainty into consideration, a standard limit value isn't fulfilled.

7 Laboratory Information

Testing was performed and the report was issued at:

TÜV SÜD Japan Ltd. Yonezawa Testing Center

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

Accreditation and Registration
A2LA
Certificate #3686.03

VLAC
Accreditation No.: VLAC-013

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

Innovation, Science and Economic Development Canada
ISED#: 4224A

VCCI Council
Registration number: A-0166

Appendix A. Test Equipment

Antenna port conducted test

Equipment	Company	Model No.	Serial No.	Cal. Due	Cal. Date
Spectrum analyzer	Agilent Technologies	E4440A	US44302655	31-Aug-2021	20-Aug-2020
Attenuator	Weinschel	56-10	J4993	31-Dec-2021	14-Dec-2020
Power meter	ROHDE&SCHWARZ	NRP2	103269	31-Mar-2022	10-Mar-2021
Power sensor	ROHDE&SCHWARZ	NRP-Z81	102467	31-Mar-2022	10-Mar-2021

Radiated emission

Equipment	Company	Model No.	Serial No.	Cal. Due	Cal. Date
EMI Receiver	ROHDE&SCHWARZ	ESCI	100765	30-Sep-2021	28-Sep-2020
Spectrum analyzer	Agilent Technologies	E4447A	MY46180188	31-Mar-2022	11-Mar-2021
Spectrum analyzer	Agilent Technologies	E4440A	US40420937	31-Dec-2021	11-Dec-2020
Spectrum analyzer	ROHDE&SCHWARZ	FSV40	101731	30-Jun-2022	08-Jun-2021
Preamplifier	SONOMA	310	372170	30-Sep-2021	29-Sep-2020
Loop antenna	ROHDE&SCHWARZ	HFH2-Z2	100515	30-Apr-2022	27-Apr-2021
Biconical antenna	Schwarzbeck	VHBB9124/BBA9106	1333	31-Dec-2021	15-Dec-2020
Log periodic antenna	Schwarzbeck	VUSLP9111B	345	31-Oct-2021	19-Oct-2020
Attenuator	TOYO Connector	NA-PJ-6/6dB	N/A(S541)	30-Sep-2021	29-Sep-2020
Attenuator	TAMAGAWA.ELEC	CFA-10/3dB	N/A(S503)	31-Jul-2022	20-Jul-2021
Preamplifier	TSJ	MLA-100M18-B02-40	1929118	31-Dec-2021	15-Dec-2020
Attenuator	AEROFLEX	26A-10	081217-08	31-Dec-2021	14-Dec-2020
Double ridged guide antenna	ETS LINDGREN	3117	00052315	31-Mar-2022	30-Mar-2021
Attenuator	HUBER+SUHNER	6803.17.B	N/A(2340)	31-Dec-2021	15-Dec-2020
Double ridged guide antenna	A.H.Systems Inc.	SAS-574	469	30-Sep-2021	02-Sep-2020
Preamplifier	TSJ	MLA-1840-B03-35	1240332	30-Sep-2021	02-Sep-2020
Band rejection filter	Micro-Tronics	BRC50702	G433	30-Sep-2021	29-Sep-2020
Microwave cable	HUBER+SUHNER	SUCOFLEX104/9m	MY30037/4	31-Dec-2021	15-Dec-2020
		SUCOFLEX104/1m	my24610/4	31-Dec-2021	15-Dec-2020
		SUCOFLEX104/8m	SN MY30033/4	31-Dec-2021	15-Dec-2020
		SUCOFLEX104	MY32976/4	31-Dec-2021	15-Dec-2020
		SUCOFLEX104/1.5m	SN MY28404/4	31-Dec-2021	15-Dec-2020
		SUCOFLEX104/7m	41625/6	31-Dec-2021	15-Dec-2020
PC	DELL	DIMENSION E521	75465BX	N/A	N/A
Software	TOYO Corporation	EP5/RE-AJ	0611193/V6.0.140	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)	31-May-2022	20-May-2021
3m Semi an-echoic Chamber	TOKIN	N/A	N/A(9002-SVSWR)	31-May-2022	20-May-2021

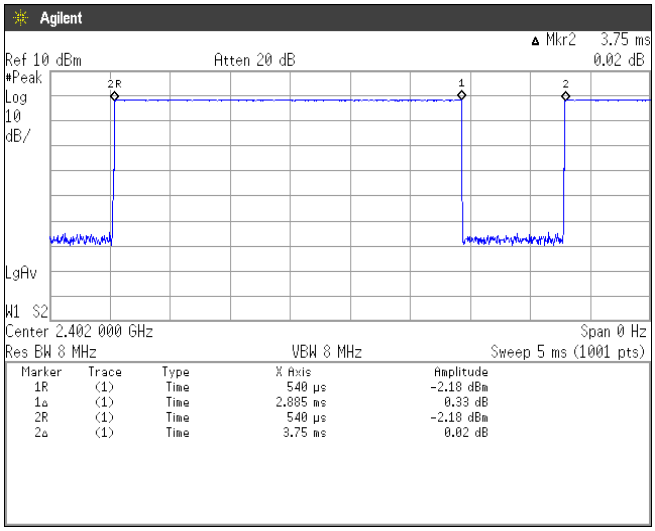
Conducted emission at mains port

Equipment	Company	Model No.	Serial No.	Cal. Due	Cal. Date
EMI Receiver	ROHDE&SCHWARZ	ESCI	100765	30-Sep-2021	28-Sep-2020
Attenuator	HUBER+SUHNER	6810.01.A	N/A (S411)	31-Dec-2021	15-Dec-2020
Line impedance stabilization network	Kyoritsu Electrical Works, Ltd.	TNW-407F2	12-17-110-2	30-Jun-2022	17-Jun-2021
Coaxial cable	FUJIKURA	5D-2W/4m	N/A (S350)	31-Dec-2021	15-Dec-2020
Coaxial cable	FUJIKURA	5D-2W/1m	N/A (S193)	31-Dec-2021	15-Dec-2020
Coaxial cable	HUBER+SUHNER	RG214/U/10m	N/A (S194)	31-Dec-2021	15-Dec-2020
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]



Duty Cycle = Ton / (Ton + Toff) = 2885[µs] / (2885[µs] + 865[µs]) = 76.93[%]