TEST REPORT

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1. Client

- Name : DREAMUS COMPANY
- Address : 5, Bangbae-ro 18gil, Seocho-gu, Seoul, Republic of Korea
- Date of Receipt : 2020-04-03

2. Use of Report : Class II Permissive change

3. Name of Product and Model : SP2000 / PPF33

4. Manufacturer and Country of Origin : DREAMUS COMPANY / Korea

5. FCC ID : QDMPPF33

6. Date of Test : 2020-04-10 to 2020-04-13

7. Test Standards : FCC Part 15 Subpart C, 15.247

8. Test Results : Refer to the test result in the test report

Affirmation	Tested by Name : Hosung Lee (Signature)	Technical Manager Name : Heesu Ahn (Signature)

2020-04-29

KCTL Inc.

Report revision history

Date	Revision	Page No
2020-04-29	Initial report	-

CONTENTS

1. General information

Client	:	DREAMUS COMPANY
Address	:	5, Bangbae-ro 18gil, Seocho-gu, Seoul, Republic of Korea
Manufacturer	:	DREAMUS COMPANY
Address	:	5, Bangbae-ro 18gil, Seocho-gu, Seoul, Republic of Korea
Laboratory	:	KCTL Inc.
Address	:	65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea
Accreditations	:	FCC Site Designation No: KR0040, FCC Site Registration No: 687132 VCCI Registration No. : R-20080, G-20078, C-20059, T-20056 Industry Canada Registration No. : 8035A KOLAS No.: KT231

2. Device information

Equipment under test	:	SP2000
Model	:	PPF33
Frequency range	:	2 402 ㎒ ~ 2 480 ㎒ (Bluetooth(BDR/EDR)) 2 412 ㎒ ~ 2 462 ㎒ (802.11b/g/n HT20) 2 422 ㎒ ~ 2 452 ㎒ (802.11n HT40) 5 180 ㎒ ~ 5 240 ㎒ (802.11a/n HT20) 5 190 ㎒ ~ 5 230 ㎒ (802.11n HT40) 5 210 ㎒ (802.11ac VHT80) 5 745 ㎒ ~ 5 825 ㎒ (802.11a/n HT20) 5 755 ㎒ ~ 5 795 ㎒ (802.11n HT40) 5 775 ㎒ (802.11ac VHT80)
Modulation technique	:	GFSK, π/4DQPSK, 8DPSK (Bluetooth(BDR/EDR)) DSSS, OFDM (WIFI(802.11a/b/g/n(HT20/40)/ac(VHT80)))
Number of channels	:	2.4 ㎓: 11 ch (802.11b/g/n HT20), 7 ch (802.11n HT40) 79 ch (Bluetooth(BDR/EDR)) 5 ㎓ (UNII 1): 4 ch (802.11a/n HT20) 2 ch (802.11n HT40) 1 ch (802.11ac VHT80) 5.8 ㎓ (UNII 3): 5 ch (802.11a/n HT20) 2 ch (802.11n HT40) 1 ch (802.11ac VHT80)
Power source	:	DC 3.8 V
Antenna specification	:	Carrier LPS Antenna
Antenna gain	:	-2.059 dBi (Bluetooth, WIFI 2.4 ㎓), 2.054 dBi (WIFI 5 ㎓) 0.004 dBi (WIFI 5.8 ㎓)
Software version	:	1.0

Hardware version : Mp
Test device serial No. : N/A
Operation temperature : 23 ℃

2.1. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
Battery	HYPERPOWER BATTERIES INC.	PR-596073G	-	DC 3.8V 3700mA/24MHz

2.2. Frequency/channel operations

This device contains the following capabilities:
WIFI(802.11a/b/g/n(HT20/HT40)/ac(VHT80) , Bluetooth(BDR, EDR)

Ch.	Frequency (㎒)
00	2 402
. .	. .
39	2 441
. .	. .
78	2 480

Table 2.2.1. Bluetooth(BDR/EDR) mode

15.247 Requirements for Bluetooth transmitter:

- This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following:
  1) This system is hopping pseudo-randomly.
  2) Each frequency is used equally on the average by each transmitter.
  3) The receiver input bandwidths that match the hopping channel bandwidths of their corresponding transmitters
  4) The receiver shifts frequencies in synchronization with the transmitted signals.
- 15.247(g): The system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this Section 15.247 should the transmitter be presented with a continuous data (or information) stream.
- 15.247(h): The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

3. Antenna requirement

Requirement of FCC part 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 use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

- The transmitter has permanently attached Carrier LPS Antenna(internal antenna) on board.

4. Summary of tests

FCC Part section(s)	Parameter	Test results
15.247(b)(1), (4)	Maximum peak output power	Pass
15.247(a)(1)	Carrier frequency separation	N/T(Note1)
15.247(a)(1)	20dB channel bandwidth	N/T(Note1)
15.247(a)(iii) 15.247(b)(1)	Number of hopping channel	N/T(Note1)
15.247(a) (iii)	Time of occupancy(dwell time)	N/T(Note1)
15.205(a), 15.209(a) 15.247(d),	Spurious emission	Pass
	Band-edge, restricted band	Pass
15.207(a)	Conducted Emissions	Pass

Notes: (N/T: Not Tested, N/A: Not Applicable)

1. These test item was performed. (FCC ID: QDMPPF33)
   Test Report No. KR19-SRF0068 issued on 30, May, 2019 by KCTL Inc.)
2. The data from that application has been verified through appropriate spot checks to demonstrate compliance for this device as shown in the test result of section 7.
3. Output power was verified to be within the expected tune up tolerances prior to performing the spot checks for radiated spurious emissions and band edge to confirm that the proposed changes to the digital circuitry had not adversely affected the previously reported values in the original filing.
4. The test scenario for spot check is based on the worst-case of original report results.

5. Measurement uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of k=2 to indicated a 95 % level of confidence. The measurement data shown herein meets of exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded uncertainty (±)	
Conducted RF power	1.76 dB	
Conducted spurious emissions	4.03 dB	
Radiated spurious emissions	9 kHz ~ 30 MHz:	2.28 dB
	30 MHz ~ 300 MHz	4.98 dB
	300 MHz ~ 1 000 MHz	5.14 dB
	1 GHz ~ 6 GHz	6.70 dB
	Above 6 GHz	6.60 dB

6. Measurement results explanation example

The offset level is set in the spectrum analyzer to compensate the RF cable loss factor between EUT conducted output port and spectrum analyzer.
With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

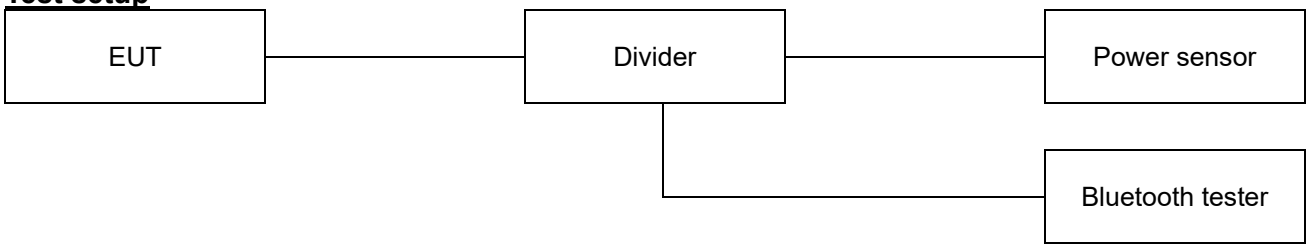
Frequency (㎒)	Factor(㏈)	Frequency (㎒)	Factor(㏈)
30	16.07	9 000	18.41
50	16.18	10 000	18.59
100	16.24	11 000	18.60
200	16.37	12 000	18.78
300	16.45	13 000	19.01
400	16.52	14 000	19.07
500	16.58	15 000	19.43
600	16.66	16 000	19.32
700	16.67	17 000	19.57
800	16.74	18 000	19.99
900	16.82	19 000	20.16
1 000	16.81	20 000	20.37
2 000	17.12	21 000	20.13
3 000	17.36	22 000	20.22
4 000	17.64	23 000	20.61
5 000	17.89	24 000	20.52
6 000	18.02	25 000	20.22
7 000	18.02	26 000	20.44
8 000	18.24	26 500	20.65

Note.
Offset(㏈) = RF cable loss(㏈) + Attenuator(㏈) + Power Divider(㏈) + EUT cable loss(㏈)

7 Test results

7.1. Maximum peak output power

Test setup



Limit

According to §15.247(a)(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2 400-2 483.5 ㎒ band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-thirds of the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

According to §15.247(b)(1), for frequency hopping systems operating in the 2 400-2 483.5 ㎒ band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725-5 850 ㎒ band: 1 watt. For all other frequency hopping systems in the 2 400-2 483.5 ㎒ band: 0.125 watts.

According to §15.247(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 ㏈i. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

Test procedure

ANSI C63.10-2013 - Section 7.8.5

Test settings

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:
Use the following spectrum analyzer settings:

1) Span: Approximately five times the 20 ㏈ bandwidth, centered on a hopping channel.
2) RBW > 20 ㏈ bandwidth of the emission being measured.
3) VBW ≥ RBW.
4) Sweep: Auto.
5) Detector function: Peak.
6) Trace: Max hold.
7) Allow trace to stabilize.

Notes:

A peak responding power sensor is used, where the power sensor system video bandwidth is greater than the occupied bandwidth of the EUT.

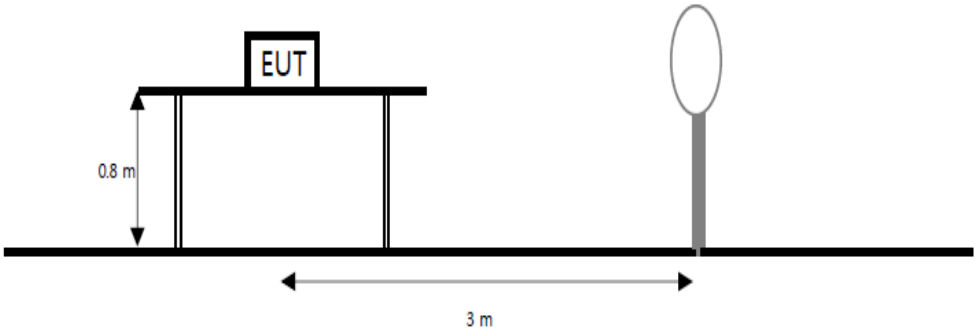
Test results

Frequency(㎒)	Data rate(Mbps)	Measured output power(㏈m)		Limit(㏈m)
		Peak	Average	
2 402	1	0.48	-0.89	20.97
2 441	1	1.86	0.53	
2 480	1	1.45	-0.01	
2 402	2	0.47	-3.44	20.97
2 441	2	1.15	-2.70	
2 480	2	0.07	-3.87	
2 402	3	0.48	-3.63	20.97
2 441	3	1.37	-2.71	
2 480	3	0.25	-3.84	

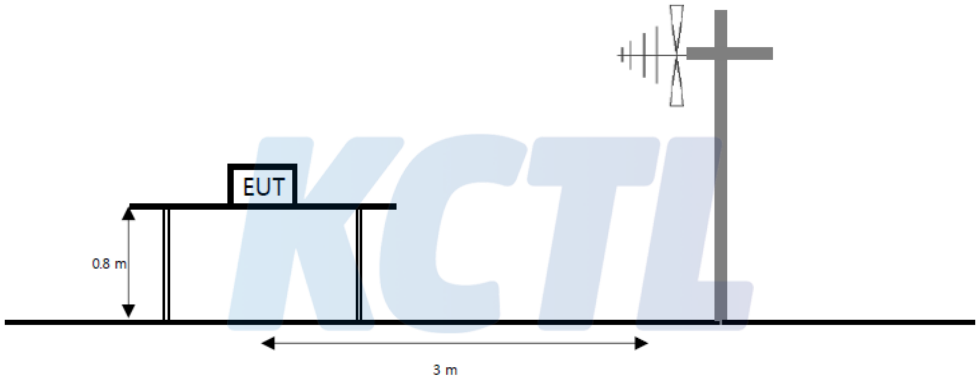
7.2. Radiated spurious emissions & band edge

Test setup

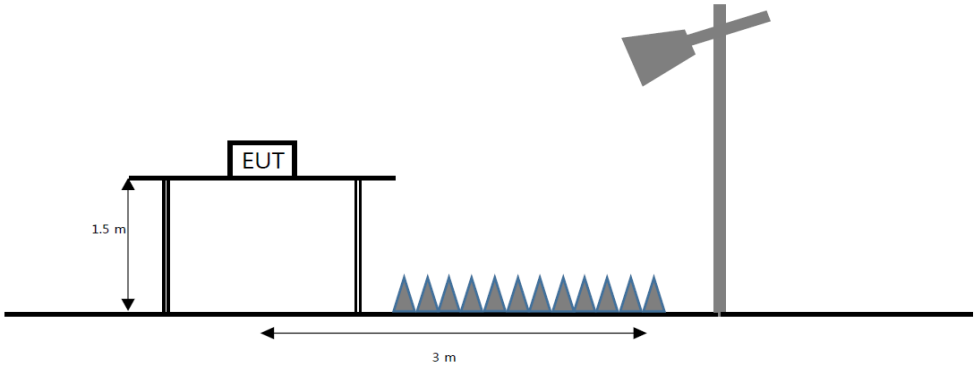
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to the tenth harmonic of the highest fundamental frequency or to 40 ㎓ emissions, whichever is lower.



Limit

According to section 15.209(a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (㎒)	Field strength (㎶/m)	Measurement distance (m)
0.009 - 0.490	2 400/F(㎑)	300
0.490 - 1.705	24 000/F(㎑)	30
1.705 - 30	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 ㎒, 76–88 ㎒, 174–216 ㎒ or 470–806 ㎒. However, operation within these frequency bands is permitted under other sections of this part, e.g., Section15.231 and 15.241.

According to section 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below:

㎒	㎒	㎒	㎓
0.009 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.694 75 - 16.695 25	608 - 614	5.35 - 5.46
2.173 5 - 2.190 5	16.804 25 - 16.804 75	960 – 1 240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1 300 – 1 427	8.025 - 8.5
4.177 25 - 4.177 75	37.5 - 38.25	1 435 – 1 626.5	9.0 - 9.2
4.207 25 - 4.207 75	73 - 74.6	1 645.5 – 1 646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1 660 – 1 710	10.6 - 12.7
6.267 75 - 6.268 25	108 - 121.94	1 718.8 – 1 722.2	13.25 - 13.4
6.311 75 - 6.312 25	123 - 138	2 200 – 2 300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2 310 – 2 390	15.35 - 16.2
8.362 - 8.366	156.524 75 - 156.525 25	2 483.5 – 2 500	17.7 - 21.4
8.376 25 - 8.386 75	156.7 - 156.9	2 690 – 2 900	22.01 - 23.12
8.414 25 - 8.414 75	162.012 5 - 167.17	3 260 – 3 267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3 332 – 3 339	31.2 - 31.8
12.519 75 - 12.520 25	240 - 285	3 345.8 – 3 358	36.43 - 36.5
12.576 75 - 12.577 25	322 - 335.4	3 600 – 4 400	Above 38.6
13.36 - 13.41			

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in section 15.209. At frequencies equal to or less than 1 000 ㎒, compliance with the limits in section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 ㎒, compliance with the emission limits in section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in section 15.35 apply to these measurements.

Test procedure
ANSI C63.10-2013

Test settings
Peak field strength measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = as specified in table
3. VBW ≥ (3×RBW)
4. Detector = peak
5. Sweep time = auto
6. Trace mode = max hold
7. Allow sweeps to continue until the trace stabilizes

Table. RBW as a function of frequency

Frequency	RBW
9 ㎑ to 150 ㎑	200 ㎐ to 300 ㎐
0.15 ㎒ to 30 ㎒	9 ㎑ to 10 ㎑
30 ㎒ to 1 000 ㎒	100 ㎑ to 120 ㎑
> 1 000 ㎒	1 ㎒

Average field strength measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1 ㎒
3. VBW = 1/T ≥ 1 ㎐
4. Averaging type was set to RMS to ensure that video filtering was applied in the power domain
5. Detector = peak
6. Sweep time = auto
7. Trace mode = max hold
8. Trace was allowed to run for at least 50 times(1/duty cycle) traces

Notes:

1. Factors(㏈) = Antenna factor(㏈/m) + Cable loss(㏈) + or Amp. gain(㏈) + or F_d(㏈)
2. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ of respective limits were not reported.
3. Average test would be performed if the peak result were greater than the average limit.
4. [1)] means restricted band.

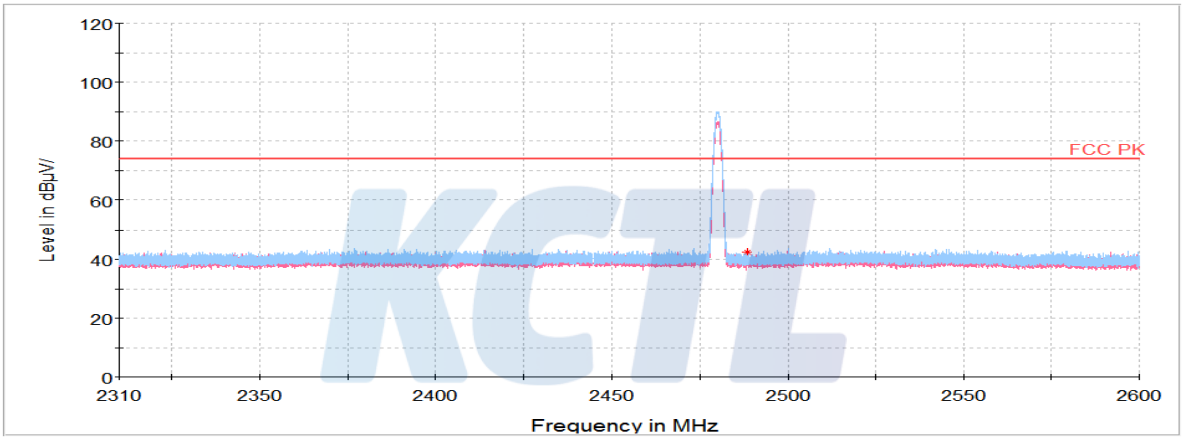
Test results

GFSK / Band-edge

Highest Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
2 488.41[1)]	H	39.55	32.08	-29.23	-	42.40	74.00	31.60
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

Horizontal/Vertical for Band-edge

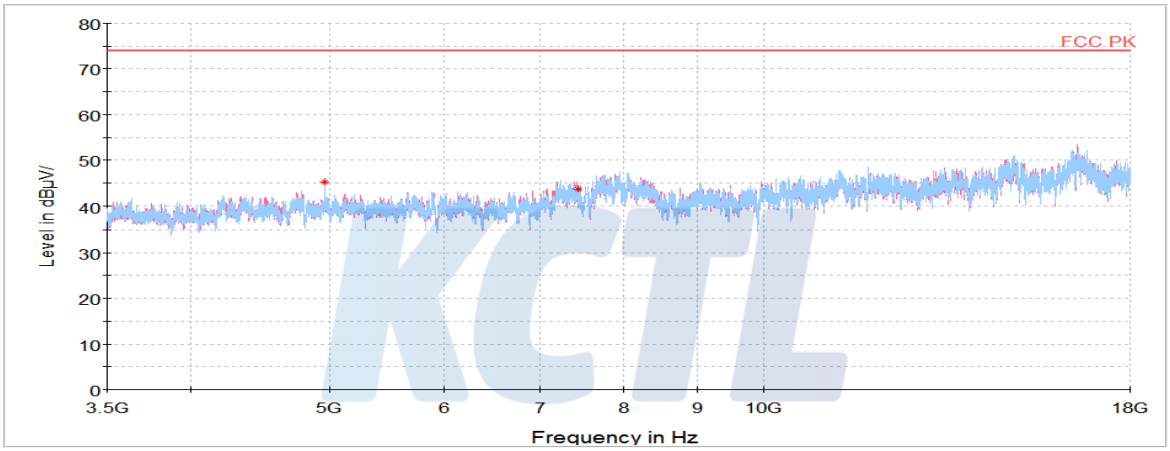


GFSK / RSE

Highest Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
4 960.42[1)]	H	66.00	33.98	-54.66	-	45.32	74.00	28.68
7 439.47[1)]	H	60.47	35.40	-52.21	-	43.66	74.00	30.34
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓

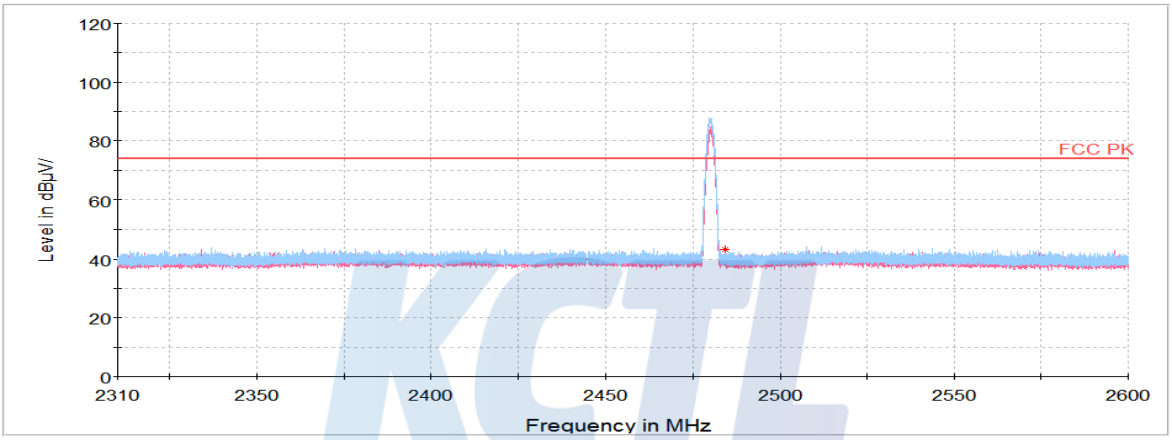


8DPSK / Band-edge

Highest Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
2 484.06[1)]	V	40.49	32.07	-29.22	-	43.34	74.00	30.66
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

Horizontal/Vertical for Band-edge

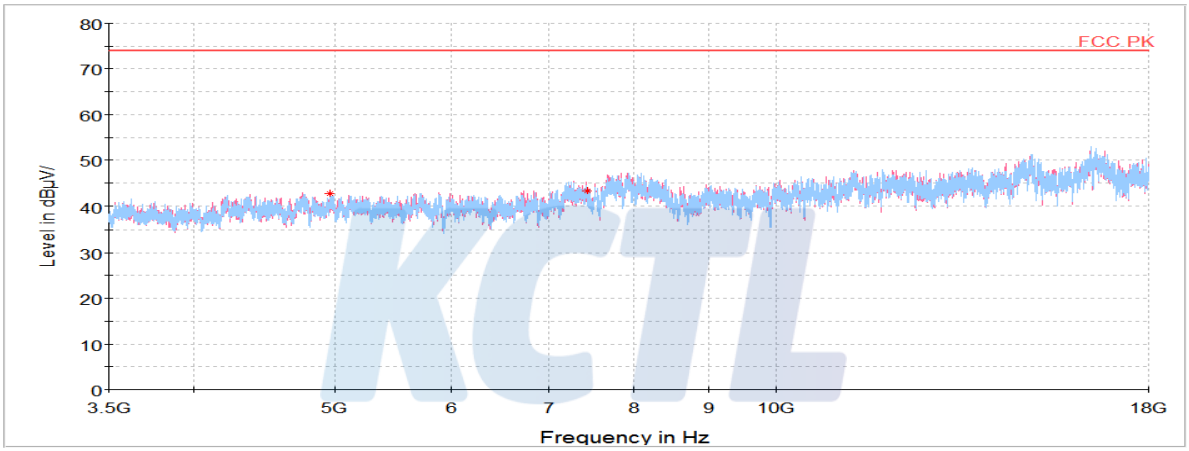


8DPSK / RSE

Highest Channel

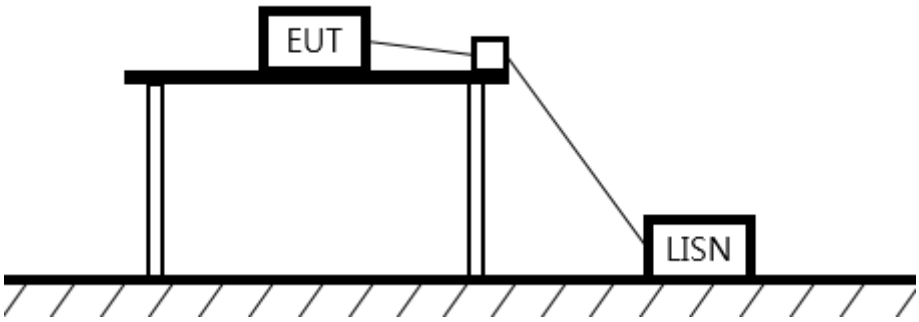
Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
4 960.88[1)]	V	63.47	33.98	-54.65	-	42.80	74.00	31.20
7 441.28[1)]	H	60.09	35.40	-52.20	-	43.29	74.00	30.71
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



7.3. AC Conducted emission

Test setup



Limit

According to 15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

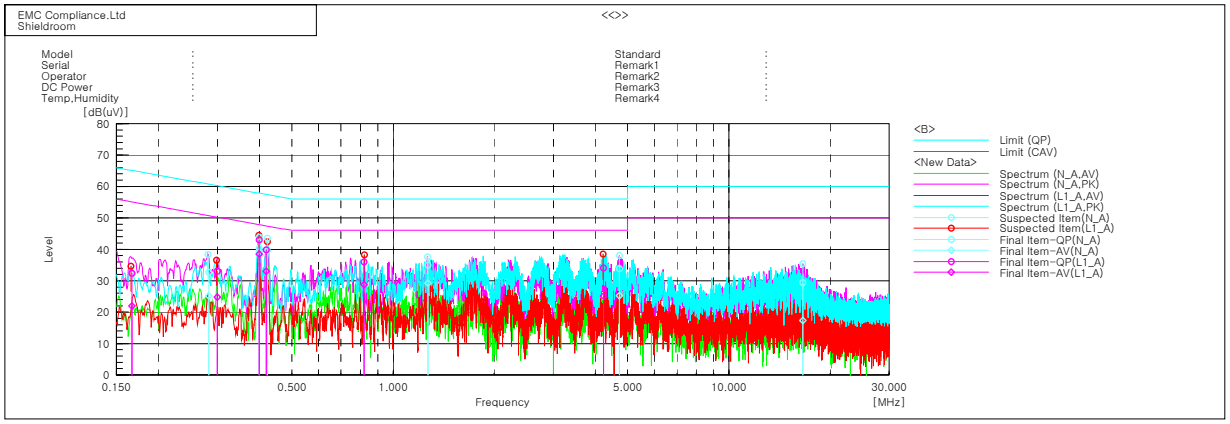
Frequency of Emission (㎒)	Conducted limit (dBμV/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

Measurement procedure

1. The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 ㎝ in which is located 40 ㎝ away from the vertical wall and 1.5m away from the side wall of the shielded room.
2. Each current-carrying conductor of the EUT power cord was individually connected through a 50Ω/50μH LISN, which is an input transducer to a spectrum analyzer or an EMI/Field Intensity Meter, to the input power source.
3. Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
4. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 ㎒ to 30 ㎒.
5. The measurements were made with the detector set to peak amplitude within a bandwidth of 10 ㎑ or to quasi-peak and average within a bandwidth of 9 ㎑. The EUT was in transmitting mode during the measurements.

Test results

Worst case: GFSK / Middle Channel



Final Result

--- L2 Phase ---

No.	Frequency [MHz]	Reading QP [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB]	Result QP [dB(uV)]	Result CAV [dB(uV)]	Limit QP [dB(uV)]	Limit AV [dB(uV)]	Margin QP [dB]	Margin CAV [dB]
1	0.28289	22.7	15.1	10.0	32.7	25.1	60.7	50.7	28.0	25.6
2	0.39944	33.8	29.1	10.1	43.9	39.2	57.9	47.9	14.0	8.7
3	0.42238	33.4	29.3	10.2	43.6	39.5	57.4	47.4	13.8	7.9
4	1.27042	25.0	19.2	10.0	35.0	29.2	56.0	46.0	21.0	16.8
5	4.72599	23.8	15.1	10.1	33.9	25.2	56.0	46.0	22.1	20.8
6	16.59689	18.7	6.6	10.7	29.4	17.3	60.0	50.0	30.6	32.7

--- L3 Phase ---

No.	Frequency [MHz]	Reading QP [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB]	Result QP [dB(uV)]	Result CAV [dB(uV)]	Limit QP [dB(uV)]	Limit AV [dB(uV)]	Margin QP [dB]	Margin CAV [dB]
1	0.16699	22.2	11.8	10.1	32.3	21.9	65.1	55.1	32.8	33.2
2	0.2996	23.3	15.0	9.8	33.1	24.8	60.3	50.3	27.2	25.5
3	0.39899	33.1	28.6	9.9	43.0	38.5	57.9	47.9	14.9	9.4
4	0.41957	30.0	23.1	9.9	39.9	33.0	57.5	47.5	17.6	14.5
5	0.81978	26.1	18.8	9.9	36.0	28.7	56.0	46.0	20.0	17.3
6	4.22937	24.1	15.2	9.9	34.0	25.1	56.0	46.0	22.0	20.9

8. Measurement equipment

Equipment Name	Manufacturer	Model No.	Serial No.	Next Cal. Date
Spectrum Analyzer	R&S	FSV40	100988	21.01.03
Directional Bridge	AGILENT	86205A	MY31400127	21.01.21
Horn antenna	ETS.lindgren	3117	155787	20.10.24
Horn antenna	ETS.lindgren	3116	00086632	21.02.17
Attenuator	API Inmet	40AH2W-10	12	20.05.15
Broadband PreAmplifier	SCHWARZBECK	BBV9718	216	20.07.30
AMPLIFIER	L-3 Narda-MITEQ	AMF-7D-01001800 -22-10P	2031196	21.02.12
AMPLIFIER	L-3 Narda-MITEQ	JS44-18004000-33-8P	2000996	21.01.22
Antenna Mast	Innco Systems	MA4640-XP-ET	-	-
Turn Table	Innco Systems	DT2000	79	-
Highpass Filter	WT	WT-A1698-HS	WT160411001	20.05.14
TWO-LINE V - NETWORK	R&S	ENV216	101358	20.10.02
EMI TEST RECEIVER	R&S	ESCI	100001	20.08.22
Vector Signal Generator	R&S	SMBV100A	257566	20.07.16
Signal Generator	R&S	SMR40	100007	20.05.13
Cable Assembly	RadiAll	2301761768000PJ	1724.659	-
Cable Assembly	gigalane	RG-400	-	-
Cable Assembly	HUER+SUHNER	SUCOFLEX 104	MY4342/4	-

End of test report