TEST REPORT

Part 15 Subpart C 15.247

Equipment under test HiTRONIC Logger

Model name HEBS-L-2A

FCC ID 2ATCL- HEBS-L-2A

Applicant HANWHA CORPORATION

Manufacturer HANWHA CORPORATION

Date of test(s) 2019.05.09 ~ 2019.05.10

Date of issue 2019.05.11

Issued to
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Test and report completed by :	Report approval by :
	
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Revision history

Revision	Date of issue	Test report No.	Description
-	2019.05.11	KES-RF-19T0048	Initial

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1. General information

Applicant:	HANWHA CORPORATION
Applicant address:	04541 86, Cheonggyecheon-ro, Jung-gu, Seoul, Republic of Korea
Test site:	KES Co., Ltd.
Test site address:	3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea 473-21, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
Test Facility	FCC Accreditation Designation No.: KR0100, Registration No.: 444148
FCC rule part(s):	15.247
FCC ID:	2ATCL-HEBS-L-2A
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	HiTRONIC Logger
Frequency range	2 402 ㎒ ~ 2 480 ㎒ (BLE)
Model:	HEBS-L-2A
Modulation technique	GFSK
Number of channels	2 402 ㎒ ~ 2 480 ㎒ (BLE) : 40ch
Antenna specification	MDBT50Q Chip Antenna Peck Gain : -0.65 ㏈i
Power source	DC 7.2 V

Note:

1. Certificated module is mounted in the EUT as following
   - Applicant: Raytac Corporation
   - Model : MDBT50Q
   - FCC ID : SH6MDBT50Q
   - Test lab : SGS Taiwan Ltd.
   - RF test report number: E2/2018/50091
2. This device supported only LE(1Mbps) mode and the installed module is completed identical as original except antenna change. And it does not support LE(2Mbps) and Zigbee, this mode disabled by software
3. The output power is lower as original module and confirmed that RF conducted tests of original report remain valid for this filing.

Output power

Mode	2 402 ㎒		2 442 ㎒		2 480 ㎒	
	Peak (dBm)	Average (dBm)	Peak (dBm)	Average (dBm)	Peak (dBm)	Average (dBm)
LE(1Mbps)	0.04	-0.87	0.22	-0.58	0.53	-0.34

1.2. Test configuration

The **HANWHA CORPORATION // HEBS-L-2A // FCC ID: 2ATCL-HEBS-L-2A** was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Part 15.247
KDB 558074 D01 v05
ANSI C63.10-2013

1.3. Device modifications

N/A

1.4. Accessory information

N/A

1.5. Software and Firmware description

The software and firmware installed in the EUT is ver 1.0

1.6. Measurement Uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.62 dB
Uncertainty for Radiation emission test (include Fundamental emission)	9㎑ - 30㎒	4.54 dB
	30㎒ - 1㎓	4.36 dB
	Above 1㎓ -25㎓	5.00 dB
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

1.7. Frequency/channel operations

Ch.	Frequency (㎒)	Rate(Mbps)
00	2 402	1
. .	. .	. .
20	2 442	1
. .	. .	. .
39	2 480	1

2. Summary of tests

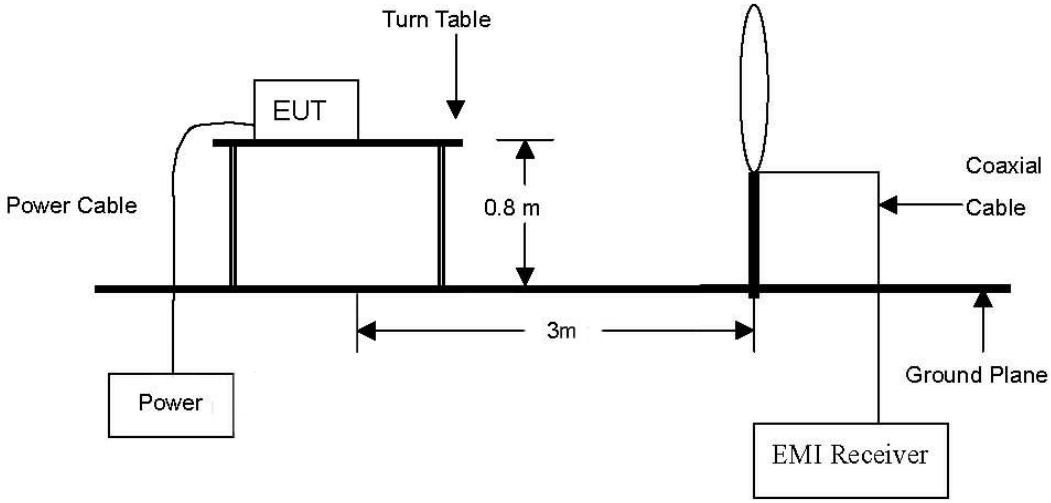
Section in FCC Part 15	Test description	Test results
15.205 15.209	Radiated restricted band and emission	Pass
15.207(a)	AC conducted emissions	Pass

3. Test results

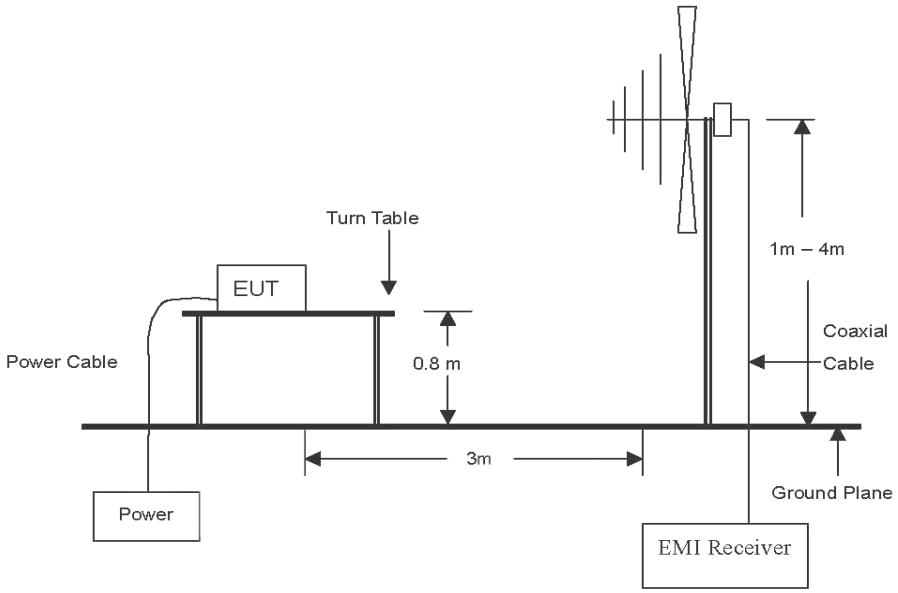
3.1. Radiated restricted band and emissions

Test setup

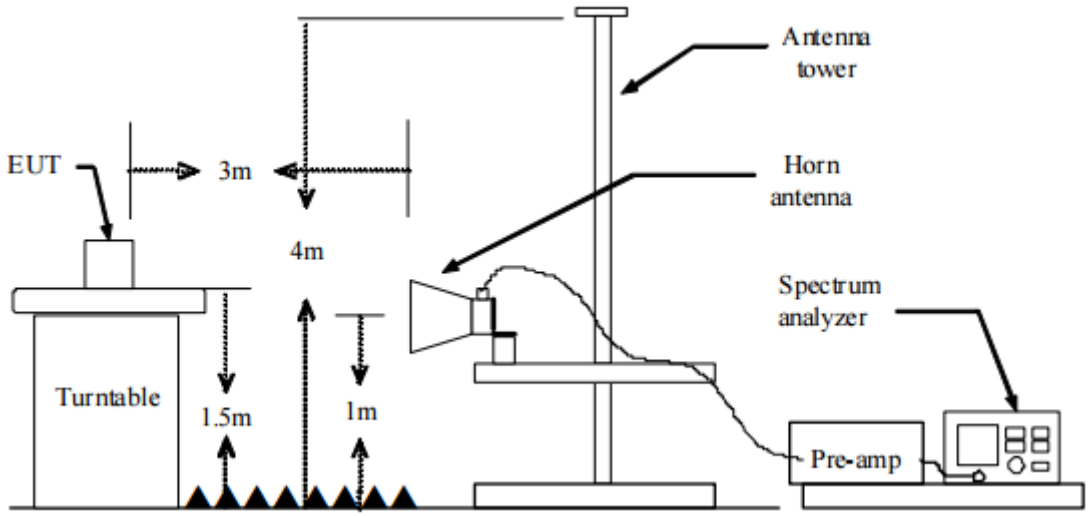
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



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.



Test procedure below 30 ㎒

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum hold mode.

Test procedure above 30 ㎒

1. Spectrum analyzer settings for $f < 1$ ㎓:
   ① Span = wide enough to fully capture the emission being measured
   ② RBW = 100 ㎑
   ③ VBW ≥ RBW
   ④ Detector = quasi peak
   ⑤ Sweep time = auto
   ⑥ Trace = max hold
2. Spectrum analyzer settings for $f \geq 1$ ㎓: Peak
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW ≥ 3 ㎒
   ④ Detector = peak
   ⑤ Sweep time = auto
   ⑥ Trace = max hold
   ⑦ Trace was allowed to stabilize

3. Spectrum analyzer settings for $f \geq 1$ ㎓: Average
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW ≥ 3 × RBW
   ④ Detector = RMS, if span/(# of points in sweep) ≤ (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
   ⑤ Averaging type = power(i.e., RMS)
      1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
      2) Some instruments require linear display mode in order to use linear voltage averaging. Log or ㏈ averaging shall not be used.
   ⑥ Sweep = auto
   ⑦ Trace = max hold
   ⑧ Perform a trace average of at least 100 traces.
   ⑨ A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:
      1) If power averaging (RMS) mode was used in step ⑤, then the applicable correction factor is 10 log(1/x), where x is the duty cycle.
      2) If linear voltage averaging mode was used in step ⑤, then the applicable correction factor is 20 log(1/x), where x is the duty cycle.
      3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

Note.

1. f <30 ㎒, extrapolation factor of 40 ㏈/decade of distance. $F_d = 40\log(D_m/Ds)$
   $f \geq 30$ ㎒, extrapolation factor of 20 ㏈/decade of distance. $F_d = 20\log(D_m/Ds)$
   Where:
   F_d = Distance factor in ㏈
   D_m = Measurement distance in meters
   D_s = Specification distance in meters
3. CF(Correction factors(㏈)) = Antenna factor(㏈/m) + Cable loss(㏈) + or Amp. gain(㏈) + or F_d(㏈)
4. Field strength(㏈㎶/m) = Level(㏈㎶) + CF (㏈) + or DCF(㏈)
5. Margin(㏈) = Limit(㏈㎶/m) - Field strength(㏈㎶/m)
6. Emissions below 18 ㎓ were measured at a 3 meter test distance while emissions above 18 ㎓ were measured at a 1 meter test distance with the application of a distance correction factor.
7. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z, it was determined that **X orientation** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **X orientation.**
8. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ of respective limits were not reported.
9. According to exploratory test no any obvious emission were detected from 9 ㎑ to 30 ㎒. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field 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 414788.

Limit

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values：

Frequency (㎒)	Distance (Meters)	Radiated (㎶/m)
0.009 ~ 0.490	300	2400/F(㎑)
0.490 ~ 1.705	30	24000/F(㎑)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**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., Sections 15.231 and 15.241.

Duty cycle

Regarding to KDB 558074 D01_v05, 6.0,Measurements of duty cycle and transmission duration shall be performed using one of the following techniques:

a) A diode detector and an oscilloscope that together have sufficiently short response time to permit accurate measurements of the on- and off-times of the transmitted signal.

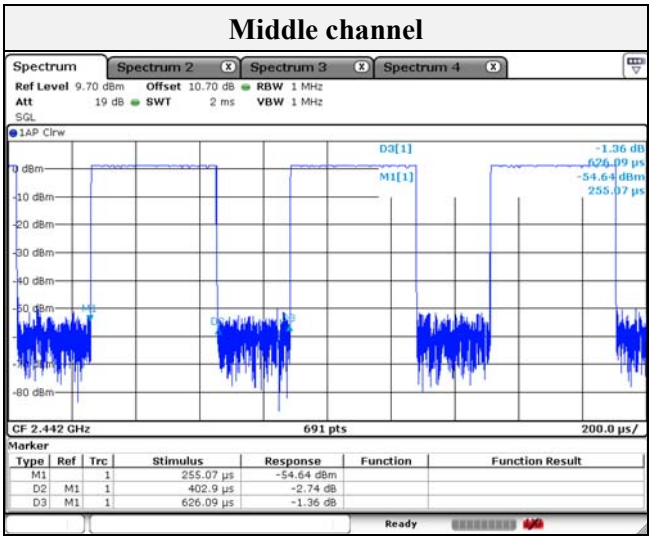
b) The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on- and off-times of the transmitted signal.

T_{on} time (㎳)	Period (㎳)	Duty cycle (Linear)	Duty cycle (%)	Duty cycle correction factor (dB)
2.0	0.403	0.64	64	-3.88

Duty cycle (Linear) = T_{on} time/Period

DCF(Duty cycle correction factor (㏈)) = 10log(1/duty cycle)

Middle channel



Test results (Below 30 ㎒)

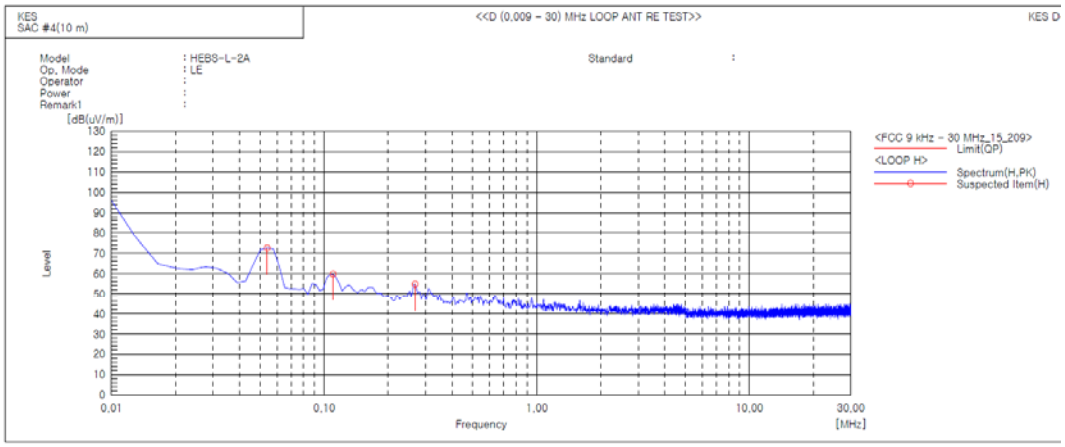
Mode: LE

Distance of measurement: 3 meter

Channel: 39 (Worst case)

Frequency (㎒)	Level (dB㎶)	Ant. Pol. (H/V)	CF (dB)	Distance factor (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
0.054	53.10	H	19.60	-80	-7.30	32.90	40.20
0.110	40.10	H	19.70	-80	-20.20	26.80	47.00
0.268	34.80	H	20.00	-80	-25.20	19.00	44.20
0.054	52.30	V	19.60	-80	-8.10	32.90	41.00
0.110	41.40	V	19.70	-80	-18.90	26.80	45.70
0.170	40.50	V	19.80	-80	-19.70	23.00	42.70
0.275	37.40	V	20.00	-80	-22.60	18.80	41.40
0.631	32.30	V	20.80	-40	13.10	31.60	18.50

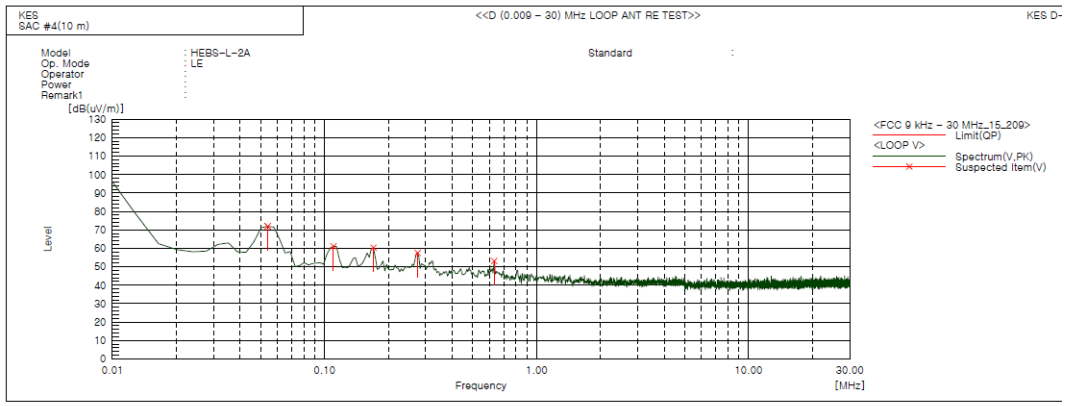
Horizontal



Spectrum Selection

No.	Frequency [MHz]	(P)	Reading [dB(uV)]	c.f [dB(1/m)]	Result PK [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	0.054	H	53.1	19.6	72.7	112.9	40.2	100.0	316.0	
2	0.110	H	40.1	19.7	59.8	106.8	47.0	100.0	198.0	
3	0.268	H	34.8	20.0	54.8	99.0	44.2	100.0	253.0	

Vertical



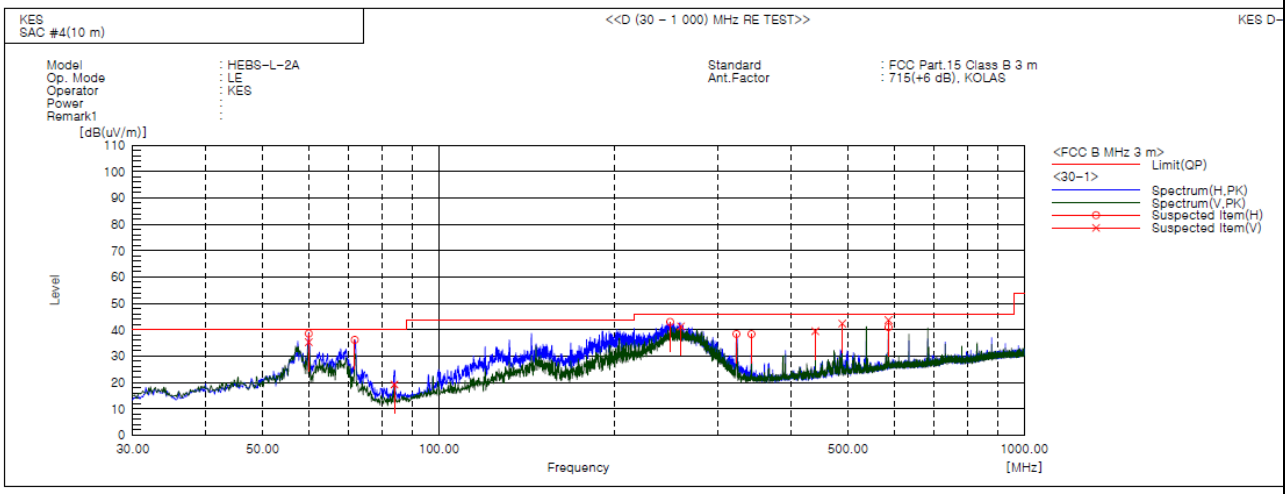
Spectrum Selection

No.	Frequency [MHz]	(P)	Reading [dB(uV)]	c.f [dB(1/m)]	Result PK [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	0.054	V	52.3	19.6	71.9	112.9	41.0	100.0	216.0	
2	0.110	V	41.4	19.7	61.1	106.8	45.7	100.0	185.0	
3	0.170	V	40.5	19.8	60.3	103.0	42.7	100.0	256.0	
4	0.275	V	37.4	20.0	57.4	98.8	41.4	100.0	263.0	
5	0.631	V	32.3	20.8	53.1	71.6	18.5	100.0	232.0	

Test results (Below 1 000 ㎒) – Worst case

Mode:	LE
Distance of measurement:	3 meter
Channel:	39 (Worst case)

Horizontal // Vertical



Spectrum Selection

No.	Frequency [MHz]	(P)	Reading [dB(uV)]	c.f [dB(1/m)]	Result PK [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	59.949	H	61.6	-23.1	38.5	40.0	1.5	400.0	349.0	
2	71.831	H	62.6	-26.4	36.2	40.0	3.8	400.0	357.0	
3	248.371	H	64.1	-21.1	43.0	46.0	3.0	100.0	232.0	
4	322.455	H	57.0	-18.6	38.4	46.0	7.6	100.0	89.0	
5	342.098	H	56.1	-17.7	38.4	46.0	7.6	100.0	284.0	
6	586.538	H	52.8	-11.8	41.0	46.0	5.0	100.0	268.0	
7	59.949	V	58.4	-23.1	35.3	40.0	4.7	100.0	217.0	
8	83.956	V	46.6	-27.4	19.2	40.0	20.8	400.0	235.0	
9	259.163	V	62.3	-21.0	41.3	46.0	4.7	100.0	201.0	
10	439.825	V	55.7	-16.2	39.5	46.0	6.5	150.0	205.0	
11	488.689	V	56.9	-14.6	42.3	46.0	3.7	100.0	221.0	
12	586.538	V	55.5	-11.8	43.7	46.0	2.3	150.0	221.0	

Test results (Above 1 000 ㎒)

Mode: LE

Distance of measurement: 3 meter

Channel: 0

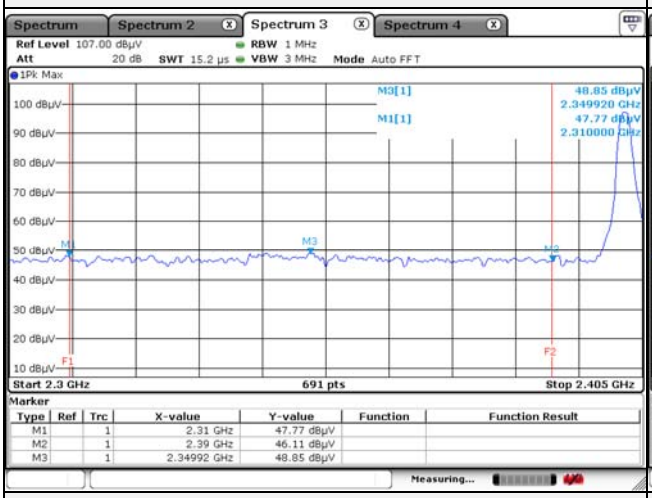
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1594.80	51.26	Peak	H	-4.81	-	46.45	74.00	27.55
1403.80	49.90	Peak	V	-6.20	-	43.70	74.00	30.30

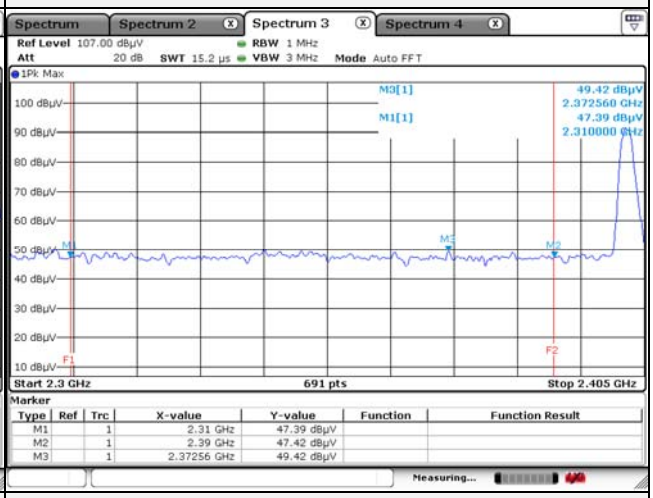
- **Band edge**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2349.92	48.85	Peak	H	-0.21	-	48.64	74.00	25.36
2372.56	49.42	Peak	V	-0.17	-	49.25	74.00	24.75

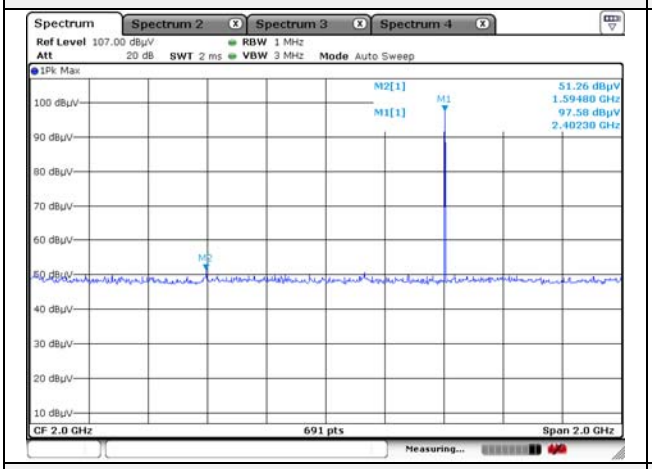
Restricted band // Horizontal // Peak



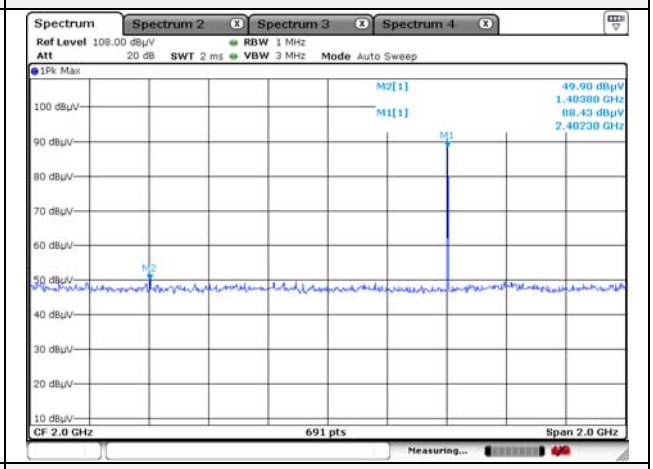
Restricted band // Vertical // Peak



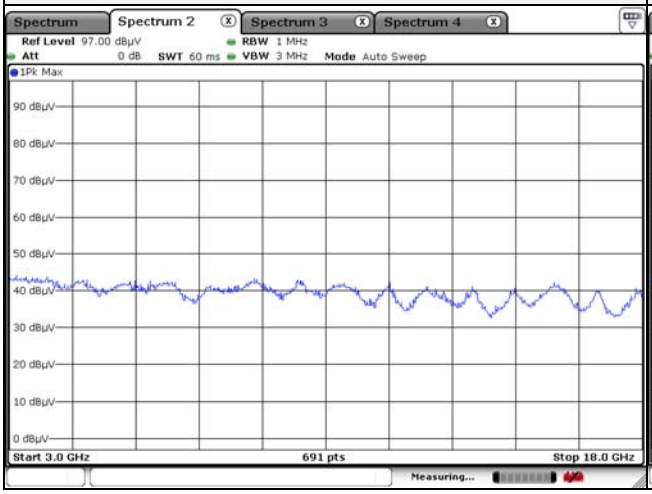
Horizontal // Peak for 1 ㎓ to 3 ㎓



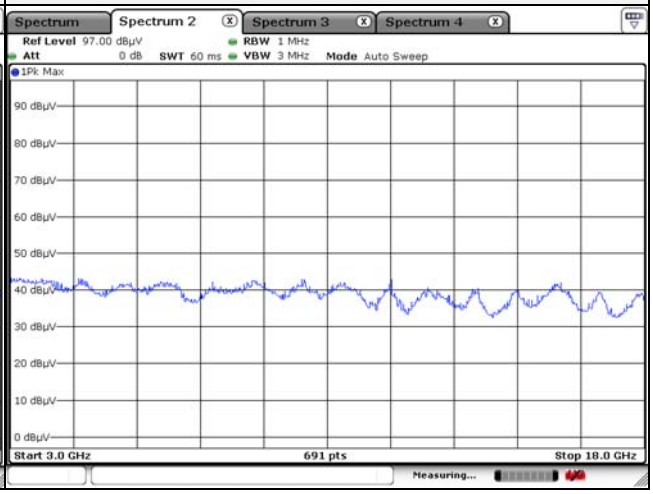
Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓



Note.

1. No spurious emission were detected above 3 ㎓

Mode: LE

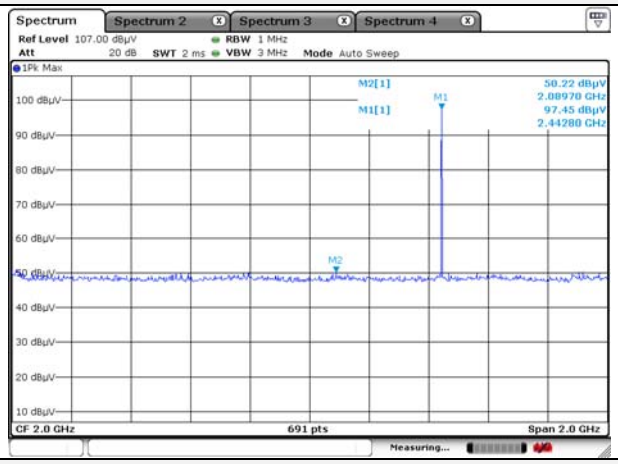
Distance of measurement: 3 meter

Channel: 20

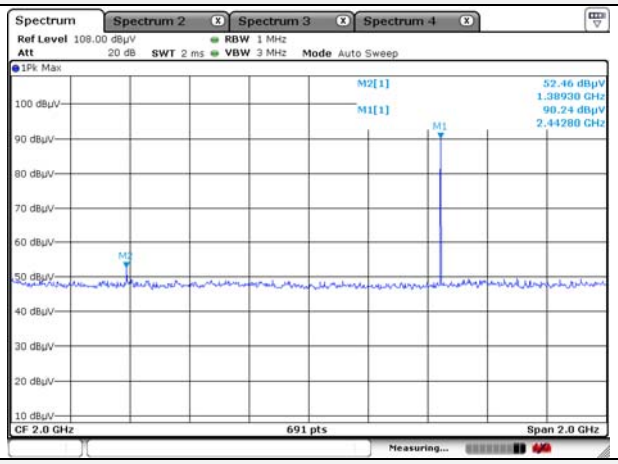
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2089.70	50.22	Peak	H	-0.75	-	49.47	74.00	24.53
1389.30	52.46	Peak	V	-6.29	-	46.17	74.00	27.83

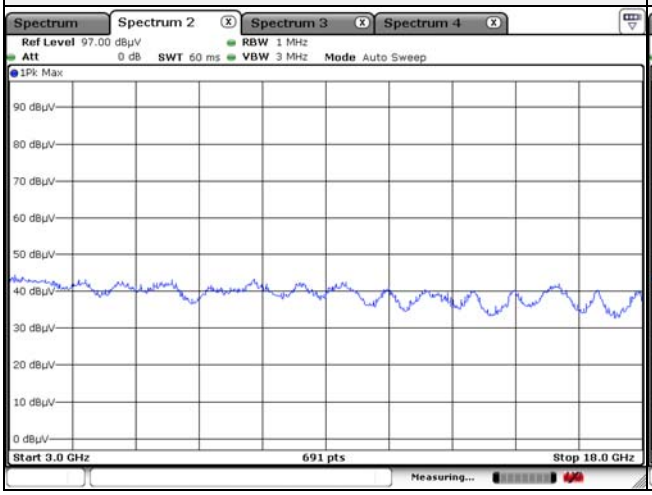
Horizontal // Peak for 1 ㎓ to 3 ㎓



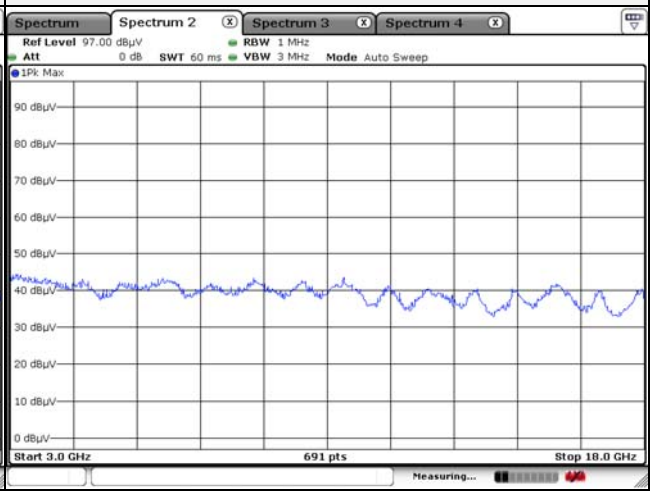
Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓



Note.

1. No spurious emission were detected above 3 ㎓

.

Mode: LE

Distance of measurement: 3 meter

Channel: 39

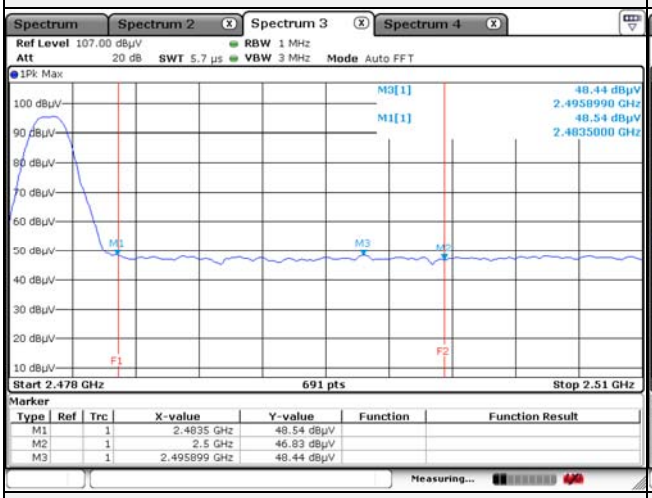
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1638.20	54.10	Peak	H	-4.39	-	49.71	74.00	24.29
2130.20	53.49	Peak	V	-0.66	-	52.83	74.00	21.17

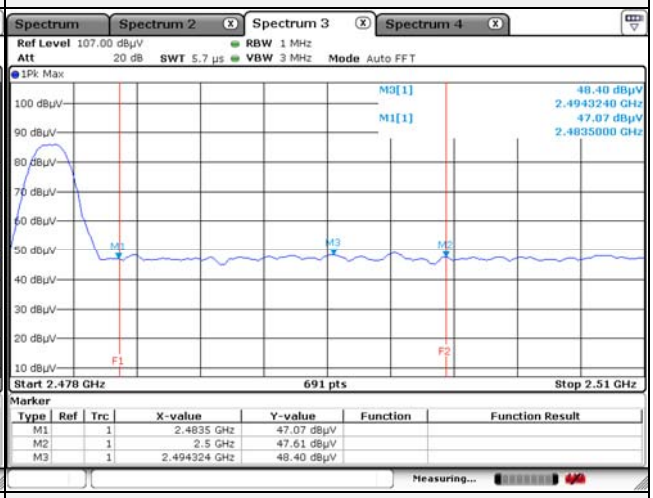
- **Band edge**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2495.90	48.44	Peak	H	0.10	-	48.54	74.00	25.46
2494.32	48.40	Peak	V	0.10	-	48.50	74.00	25.50

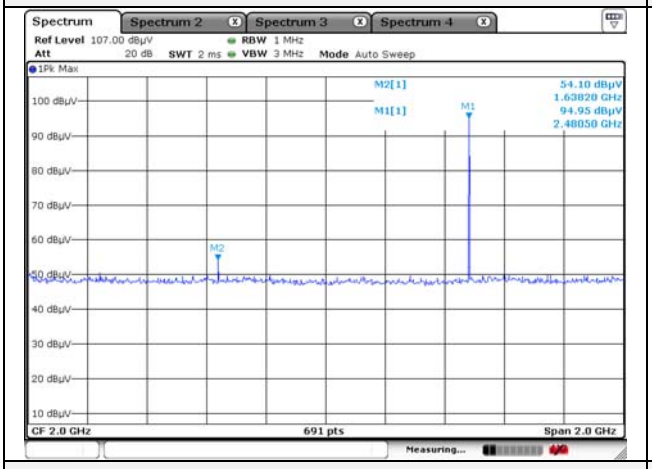
Restricted band // Horizontal // Peak



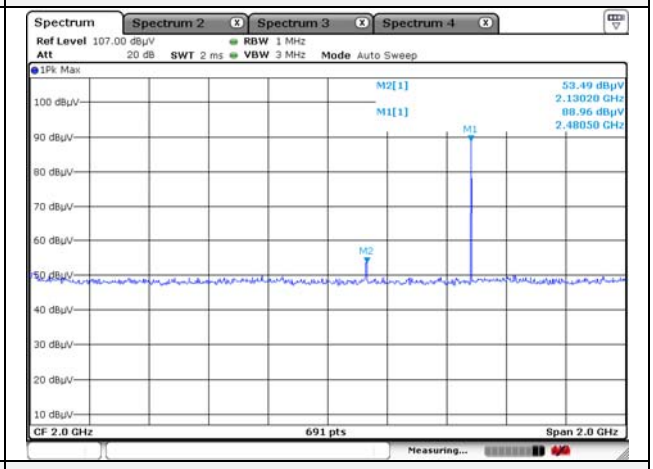
Restricted band // Vertical // Peak



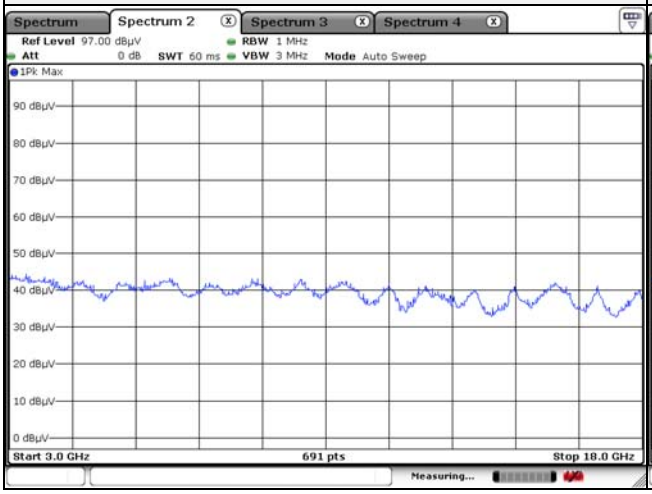
Horizontal // Peak for 1 ㎓ to 3 ㎓



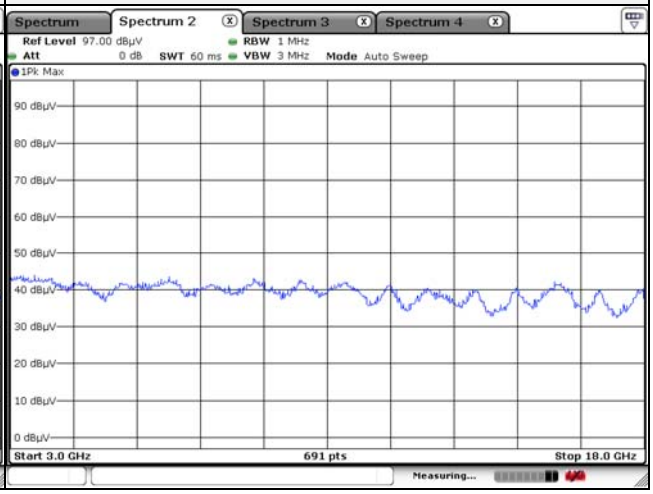
Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓

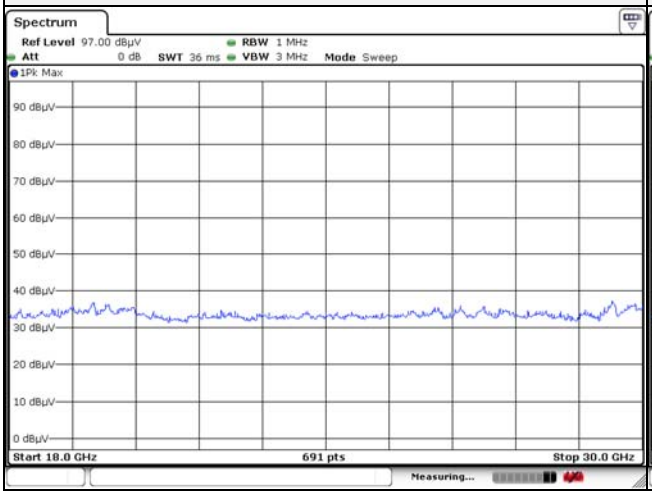
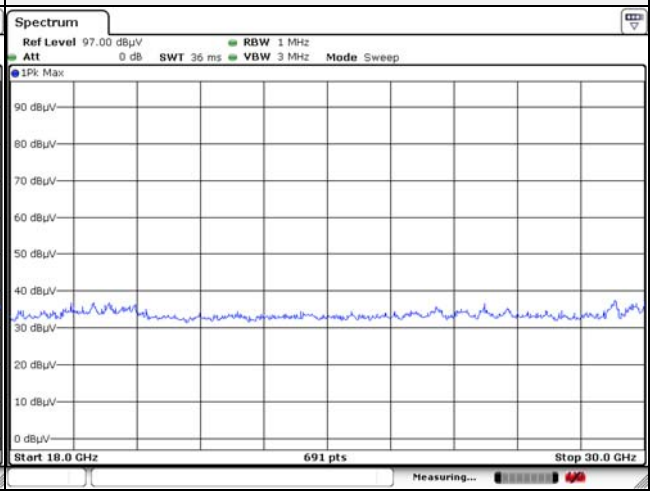


Note.

1. No spurious emission were detected above 3 ㎓

Test results (18 ㎓ to 30 ㎓) – Worst case

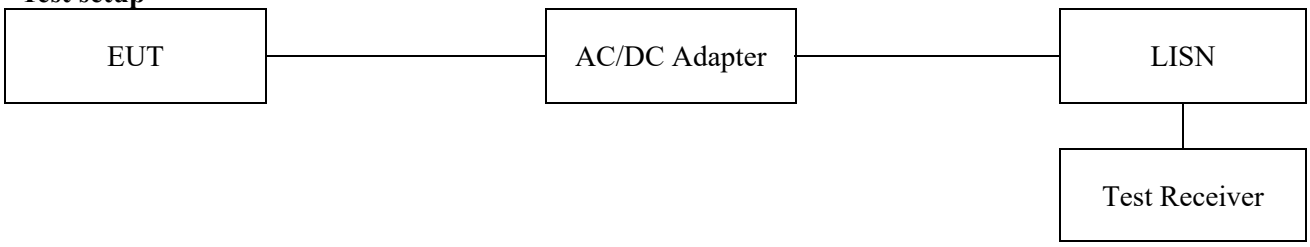
Mode:	LE
Distance of measurement:	3 meter
Channel:	39 (Worst case)

Horizontal	Vertical
	

Note.
1. No spurious emission were detected above 18 ㎓.

3.2. AC conducted emissions

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.

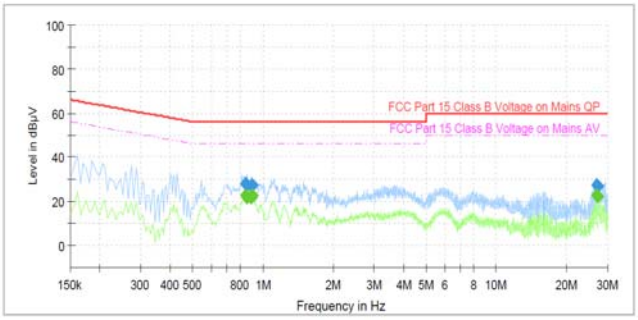
Frequency of Emission (㎒)	Conducted limit (dB㎶/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

Note:

1. All AC line conducted spurious emission are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and the appropriate frequencies. All data rates and modes were investigated for conducted spurious emission. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.
3. Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level).

Test results

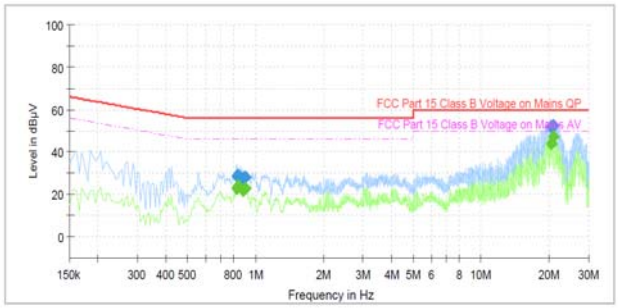
Hot Line



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.840000	---	22.71	46.00	23.29	1000.0	9.000	L1	9.9
0.840000	28.03	---	56.00	27.97	1000.0	9.000	L1	9.9
0.855000	---	21.95	46.00	24.05	1000.0	9.000	L1	9.9
0.855000	27.43	---	56.00	28.57	1000.0	9.000	L1	9.9
0.890000	---	21.52	46.00	24.48	1000.0	9.000	L1	9.9
0.890000	27.09	---	56.00	28.91	1000.0	9.000	L1	9.9
0.900000	---	22.53	46.00	23.47	1000.0	9.000	L1	9.9
0.900000	27.69	---	56.00	28.31	1000.0	9.000	L1	9.9
27.040000	---	22.69	50.00	27.31	1000.0	9.000	L1	10.1
27.040000	27.53	---	60.00	32.47	1000.0	9.000	L1	10.1
27.080000	---	22.32	50.00	27.68	1000.0	9.000	L1	10.1
27.080000	27.18	---	60.00	32.82	1000.0	9.000	L1	10.1

Neutral Line



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.825000	---	22.99	46.00	23.01	1000.0	9.000	N	9.9
0.825000	28.83	---	56.00	27.17	1000.0	9.000	N	9.9
0.835000	---	23.65	46.00	22.35	1000.0	9.000	N	9.9
0.835000	29.16	---	56.00	26.84	1000.0	9.000	N	9.9
0.885000	---	21.79	46.00	24.21	1000.0	9.000	N	9.9
0.885000	27.65	---	56.00	28.35	1000.0	9.000	N	9.9
0.900000	---	22.92	46.00	23.08	1000.0	9.000	N	9.9
0.900000	28.00	---	56.00	28.00	1000.0	9.000	N	9.9
20.425000	---	44.03	50.00	5.97	1000.0	9.000	N	10.1
20.425000	51.98	---	60.00	8.02	1000.0	9.000	N	10.1
20.845000	---	46.99	50.00	3.01	1000.0	9.000	N	10.1
20.845000	52.44	---	60.00	7.56	1000.0	9.000	N	10.1

Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV30	101389	1 year	2020.01.09
Spectrum Analyzer	R&S	FSV40	101002	1 year	2019.06.29
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2020.01.15
Power Meter	Anritsu	ML2495A	1438001	1 year	2020.01.15
Pulse Power Sensor	Anritsu	MA2411B	1339205	1 year	2020.01.15
Attenuator	HP	8494B	2630A12857	1 year	2020.01.15
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2021.02.15
Trilog-broadband antenna	SCHWARZBECK	VULB 9163	714	2 years	2020.11.26
Horn Antenna	A.H	SAS-571	414	2 years	2021.02.11
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA 9170550	2 years	2021.02.19
High Pass Filter	Wainwright Instrument Gmbh	WHJS3000-10TT	1	1 year	2019.06.29
Low Pass Filter	Wainwright Instrument Gmbh	WLK1.0/18G-10TT	1	1 year	2019.06.29
Broadband Amplifier	Schwarzbeck	BBV9721	PS9721-003	1 year	2020.01.16
Amplifier	AGILENT	8449B	3008A00538	1 year	2019.06.29
Amplifier	R&S	SCU 01	100603	1 year	2019.11.26
Attenuator	HP	8491A	32173	1 year	2020.03.11
EMI Test Receiver	R&S	ESU26	100552	1 year	2020.04.19
EMI Test Receiver	R&S	ESR3	101781	1 year	2020.04.22
DC Power supply	HP	6632B	MY43004130	1 year	2019.06.28
Pulse Limiter	R&S	ESH3-Z2	101915	1 year	2019.11.26
LISN	R&S	ENV216	101787	1 year	2020.01.04

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook computer	LG Electronics Inc.,	LGS53	306QCZP560949