

TEST REPORT

Part 15 Subpart C 15.247

Equipment under test Flat Panel Digital X-ray Detector
Model name BT-DA22W
Derivative Model BT-DB22W
FCC ID 2AVRHBT-DA22W
Applicant BONTECH Co., Ltd.
Manufacturer BONTECH Co., Ltd.
Date of test(s) 2020.02.12 ~ 2020.02.21
Date of issue 2020.02.24

Issued to
BONTECH Co., Ltd.
Digital Empire D-building #1201~#1204, 16, Deogyong-daero 1556 beon-gil,
Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea
Tel: +82-31-303-5254 / Fax: +82-31-303-5255

Issued by
KES Co., Ltd.
3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si,
Gyeonggi-do, 14057, Korea
473-21, Gayeo-ro, Yeosu-si, Gyeonggi-do, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450

Test and report completed by :	Report approval by :
	
Yeong-Jun, Cho Test engineer	Hyeon-Su, Jang Technical manager

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Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450
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Revision history

Revision	Date of issue	Test report No.	Description
-	2020.02.24	KES-RF-20T0032	Initial

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1. General information

Applicant: BONTECH Co., Ltd.
Applicant address: Digital Empire D-building #1201~#1204, 16, Deogyong-daero 1556 beon-gil,
Yeongtong-gu, Suwon-si, Gyeonggi-do, 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, Yeosu-si, Gyeonggi-do, Korea
FCC rule part(s): 15.247
FCC ID: 2AVRHBT-DA22W
Test device serial No.: ☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test Flat Panel Digital X-ray Detector
Frequency range 2 422 MHz ~ 2 452 MHz (11n_HT40)
UNII-1 5 210 MHz (11ac_VHT80)
UNII-3 5 775 MHz (11ac_VHT80)
Model: BT-DA22W
Derivative Model BT-DB22W
Modulation technique DSSS, OFDM
Number of channels 2 422 MHz ~ 2 452 MHz (11n_HT40) : 7 ch
5 210 MHz (11ac_VHT80) : 1ch
5 775 MHz (11ac_VHT80) : 1ch
Antenna specification Antenna type(2.4 GHz WIFI) : PCB antenna, Peak gain : 2.5 dBi
Antenna type(5 GHz WIFI) : PCB antenna, Peak gain : 4.5 dBi
Power source AC 120 V (Adapter DC output 12 V)
H/W version V1.0
S/W version V1.1

1.2. Test configuration

The **BONTECH Co., Ltd. // BT-DA22W // FCC ID: 2AVRHBT-DA22W** 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 r02
ANSI C63.10-2013

1.3. Device modifications

N/A

1.4. Information about derivative model

Division	Basic model	Variant model
	BT-DA22W	BT-DB22W
Dimension	(384 x 460 x 15) mm	(384 x 460 x 15) mm
Scintillator type	Csl	Gdos

1.5. Accessory information

Equipment	Manufacturer	Model	Serial No.
Control box	BONTECH Co., Ltd.	BT-CB02	-
Switching Power Supply	SINPRO	MPU51-105	-

1.6. Measurement Uncertainty

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

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1.7. Frequency/channel operations

Ch.	Frequency (MHz)	Mode
03	2422	802.11n_HT40
.	.	.
06	2437	802.11n_HT40
.	.	.
09	2452	802.11n_HT40

1.8. Worst case data rate

Worst-case data rates were: 802.11n_HT40 : MCS8

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2. Summary of tests

Section in FCC Part 15	Parameter	Test results
15.247(a)(2)	6 dB bandwidth	N/A ¹⁾
15.247(b)(3)	Output power	N/A ¹⁾
15.247(e)	Power spectral density	N/A ¹⁾
15.205 15.209	Radiated restricted band and emission	Pass
15.247(d)	Conducted spurious emission and band edge	N/A ¹⁾
15.207(a)	AC conducted emissions	Pass

Note :

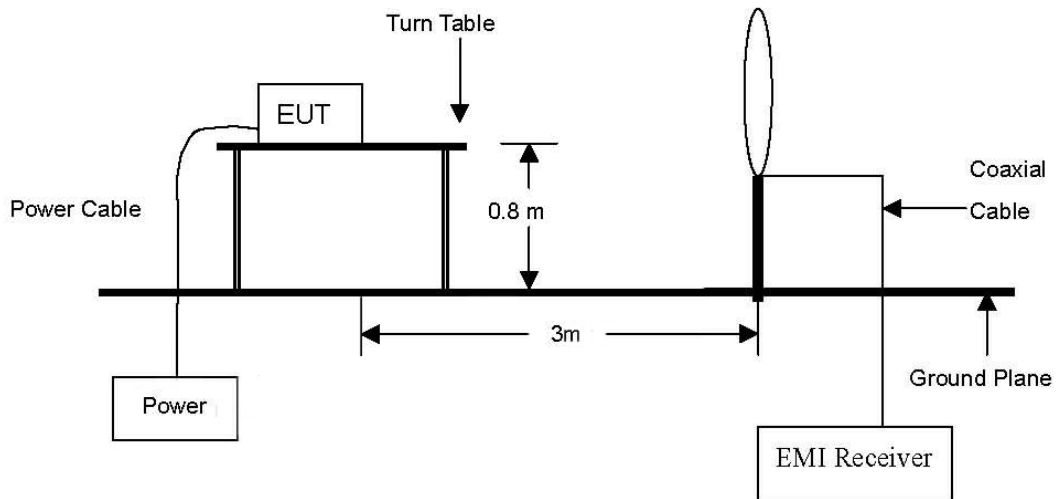
- 1) Please Refer to the approved Module Report (Report No.: 1503RSU02901) for result of existing test items.
- 2) The output power setting is same as original module and confirmed that RF conducted tests of original report remain valid for this filing.

3. Test results

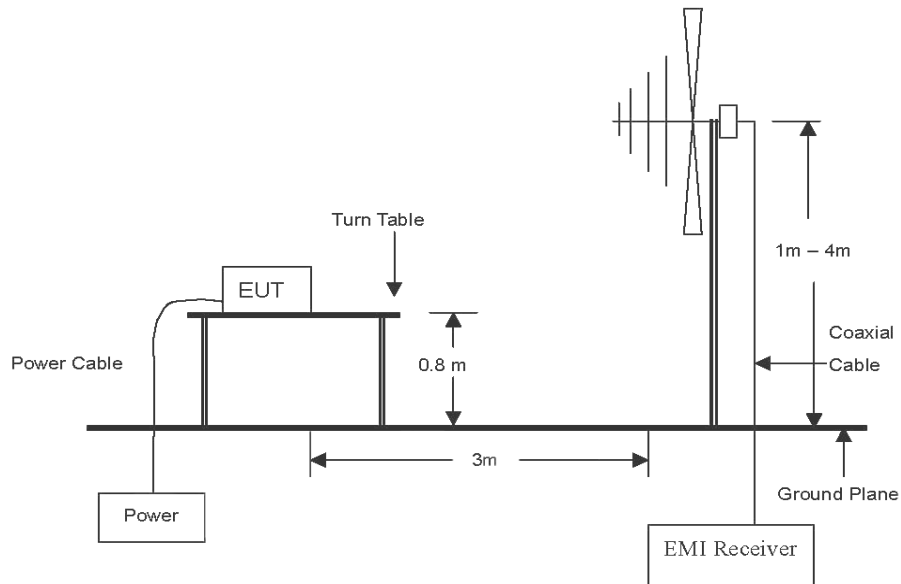
3.1. Radiated restricted band and emissions

Test setup

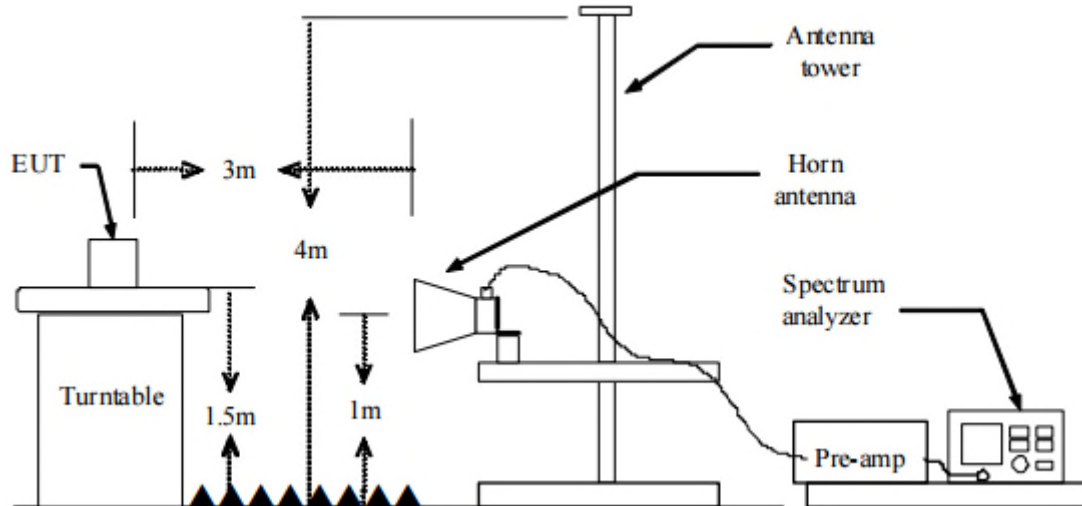
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



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



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



Test procedure

Radiated emissions from the EUT were measured according to the dictates in section 11.11 & 11.12 of ANSI C63.10-2013.

Test procedure below 30 MHz

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, ground parallel and perpendicular of the antenna are set to make the measurement. It was determined that parallel was worst-case orientation; therefore, all final radiated testing was performed with the EUT in parallel.
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 MHz

1. The EUT was placed on the top of a rotating table 1.5 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. The antenna is a bi-log antenna, a horn antenna, and its height are varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations 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 antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

5. Spectrum analyzer settings for $f < 1$ GHz:

- ① Span = wide enough to fully capture the emission being measured
- ② RBW = 100 kHz
- ③ VBW $\geq$ RBW
- ④ Detector = quasi peak
- ⑤ Sweep time = auto
- ⑥ Trace = max hold

6. Spectrum analyzer settings for $f \geq 1$ GHz: Peak

- ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
- ② RBW = 1 MHz
- ③ VBW ≥ 3 MHz
- ④ Detector = peak
- ⑤ Sweep time = auto
- ⑥ Trace = max hold
- ⑦ Trace was allowed to stabilize

7. Spectrum analyzer settings for $f \geq 1$ GHz: Average

- ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
- ② RBW = 1 MHz
- ③ VBW $\geq 3 \times$ RBW
- ④ Detector = RMS, if $\text{span}/(\# \text{ of points in sweep}) \leq (\text{RBW}/2)$. 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 dB 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. $f < 30$ MHz, extrapolation factor of 40 dB/decade of distance. $F_d = 40\log(D_m/D_s)$
 $f \geq 30$ MHz, extrapolation factor of 20 dB/decade of distance. $F_d = 20\log(D_m/D_s)$
 Where:
 F_d = Distance factor in dB
 D_m = Measurement distance in meters
 D_s = Specification distance in meters
2. Field strength(dB μ V/m) = Level(dB μ V) + CF (dB) + or DCF(dB)
3. Margin(dB) = Limit(dB μ V/m) - Field strength(dB μ V/m)
4. Emissions below 18 GHz were measured at a 3 meter test distance while emissions above 18 GHz were measured at a 1 meter test distance with the application of a distance correction factor.
5. 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**.
6. The worst-case emissions are reported however emissions whose levels were not within 20 dB of respective limits were not reported.
7. According to exploratory test no any obvious emission were detected from 9 kHz to 30 MHz. 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 (MHz)	Distance (Meters)	Radiated (μ V/m)
0.009 ~ 0.490	300	2400/F(kHz)
0.490 ~ 1.705	30	24000/F(kHz)
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 MHz, 76 ~ 88 MHz, 174 ~ 216 MHz or 470 ~ 806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

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Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
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Duty cycle

Regarding to KDB 558074 D01_v05 r02, 6. Measurements of duty cycle and transmission duration shall be performed using one of the following techniques:

- 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.
- 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.

Test mode	T _{on} time (ms)	Period (ms)	Duty cycle (Linear)	Duty cycle (%)	Duty cycle correction factor (dB)
802.11n_40	0.921	0.963	0.956	95.6	-0.195

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

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

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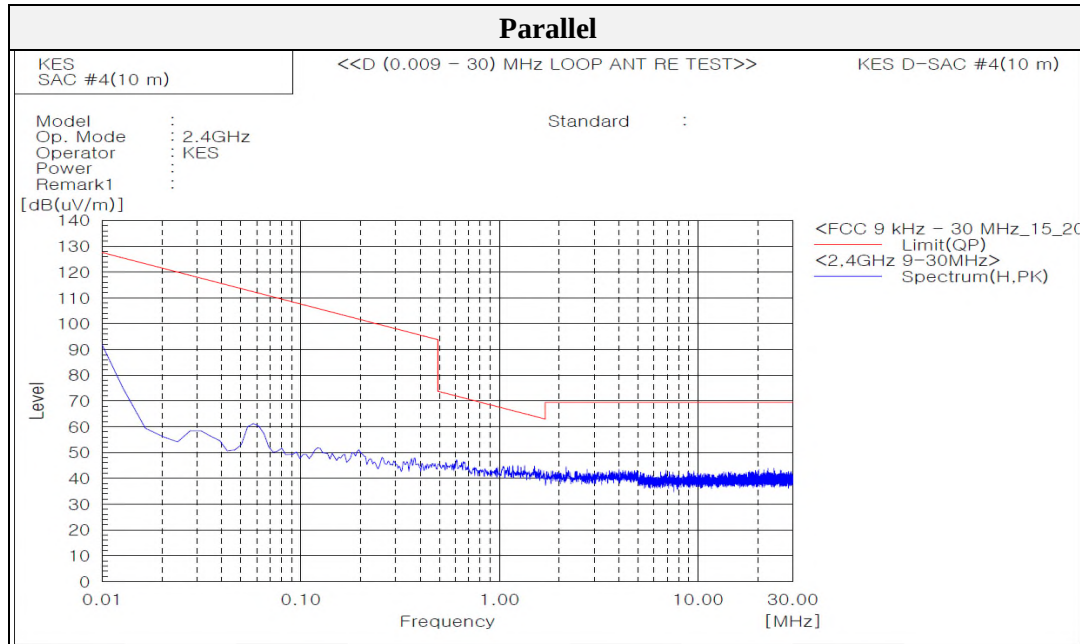
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Test results (Below 30 MHz)

Mode: 802.11n_HT40

Distance of measurement: 3 meter

Channel: 06 (Worst case)



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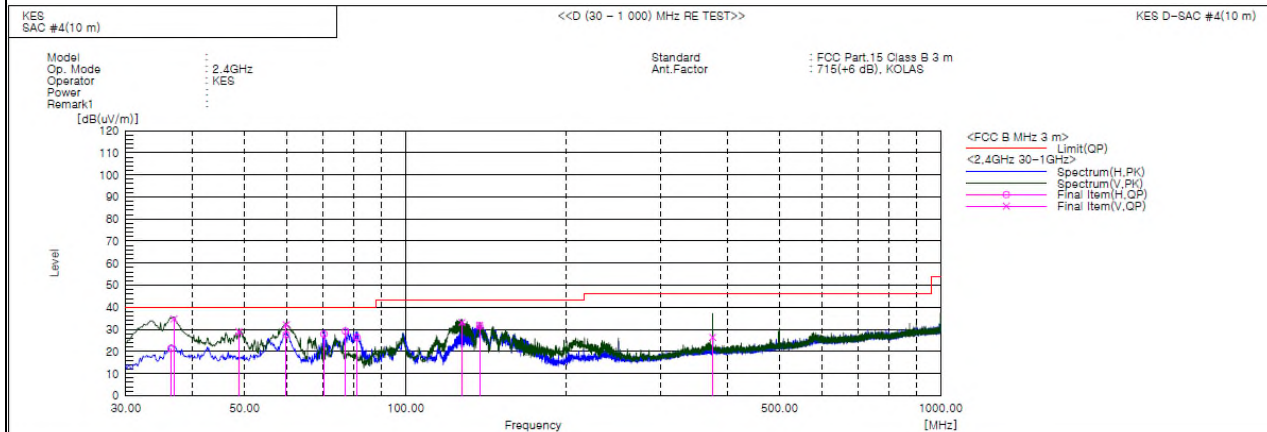
Test results (Below 1 000 MHz)

Mode: 802.11n_HT40

Distance of measurement: 3 meter

Channel: 06 (Worst case)

Horizontal // Vertical



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	36.426	H	46.5	-25.2	21.3	40.0	18.7	326.0	241.0	
2	36.911	V	59.7	-25.0	34.7	40.0	5.3	114.0	198.0	
3	48.794	V	51.0	-22.0	29.0	40.0	11.0	235.0	127.0	
4	59.828	H	50.7	-23.1	27.6	40.0	12.4	336.0	296.0	
5	59.828	V	55.2	-23.1	32.1	40.0	7.9	141.0	194.0	
6	70.376	H	53.8	-25.9	27.9	40.0	12.1	228.0	109.0	
7	77.166	H	57.3	-28.1	29.2	40.0	10.8	358.0	316.0	
8	81.168	H	54.5	-28.2	26.3	40.0	13.7	400.0	82.0	
9	127.485	V	59.1	-26.0	33.1	43.5	10.4	115.0	171.0	
10	137.549	H	58.7	-27.0	31.7	43.5	11.8	399.0	157.0	
11	137.549	V	58.9	-27.0	31.9	43.5	11.6	100.0	266.0	
12	374.956	V	43.6	-17.2	26.4	46.0	19.6	100.0	242.0	

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Test results (Above 1 000 MHz)

Mode: 802.11n_HT40
Distance of measurement: 3 meter
Channel: 03

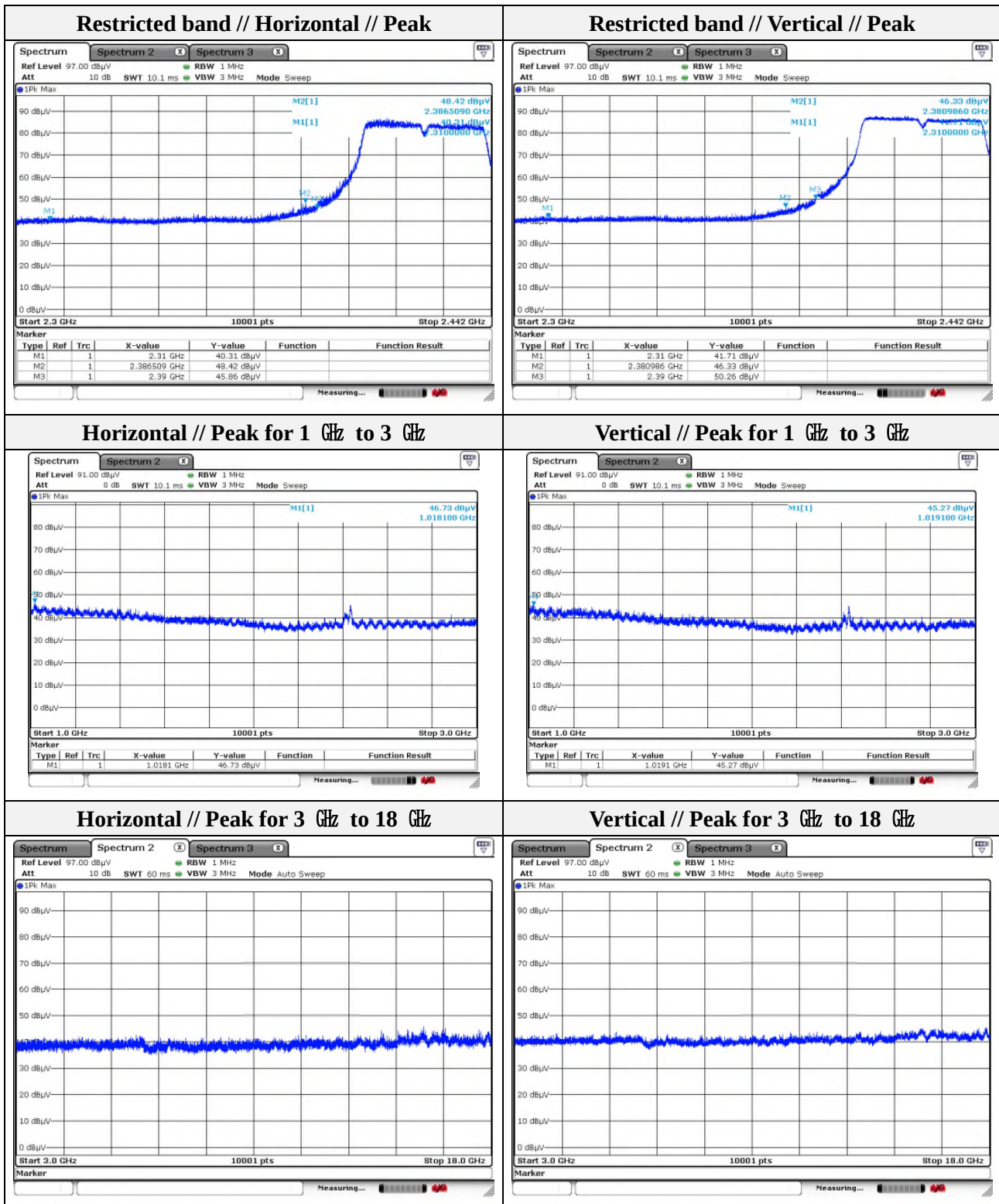
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	AF (dB)	AMP+CL (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 018.10	46.73	Peak	H	23.75	-32.12	-	38.36	74.00	35.64
1 019.10	45.27	Peak	V	23.75	-32.12	-	36.90	74.00	37.10

- Band edge

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	AF (dB)	AMP+CL (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 310.00	40.31	Peak	H	29.20	-30.39	-	39.12	74.00	34.88
2 386.51	48.42	Peak	H	29.39	-29.66	-	48.15	74.00	25.85
2 390.00	45.86	Peak	H	29.40	-29.63	-	45.63	74.00	28.37
2 310.00	41.71	Peak	V	29.20	-30.39	-	40.52	74.00	33.48
2 380.99	46.33	Peak	V	29.38	-29.72	-	45.99	74.00	28.01
2 390.00	50.26	Peak	V	29.40	-29.63	-	50.03	74.00	23.97

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Note.

1. No spurious emission were detected above 3 GHz.
2. Average test would be performed if the peak result were greater than the average limit.

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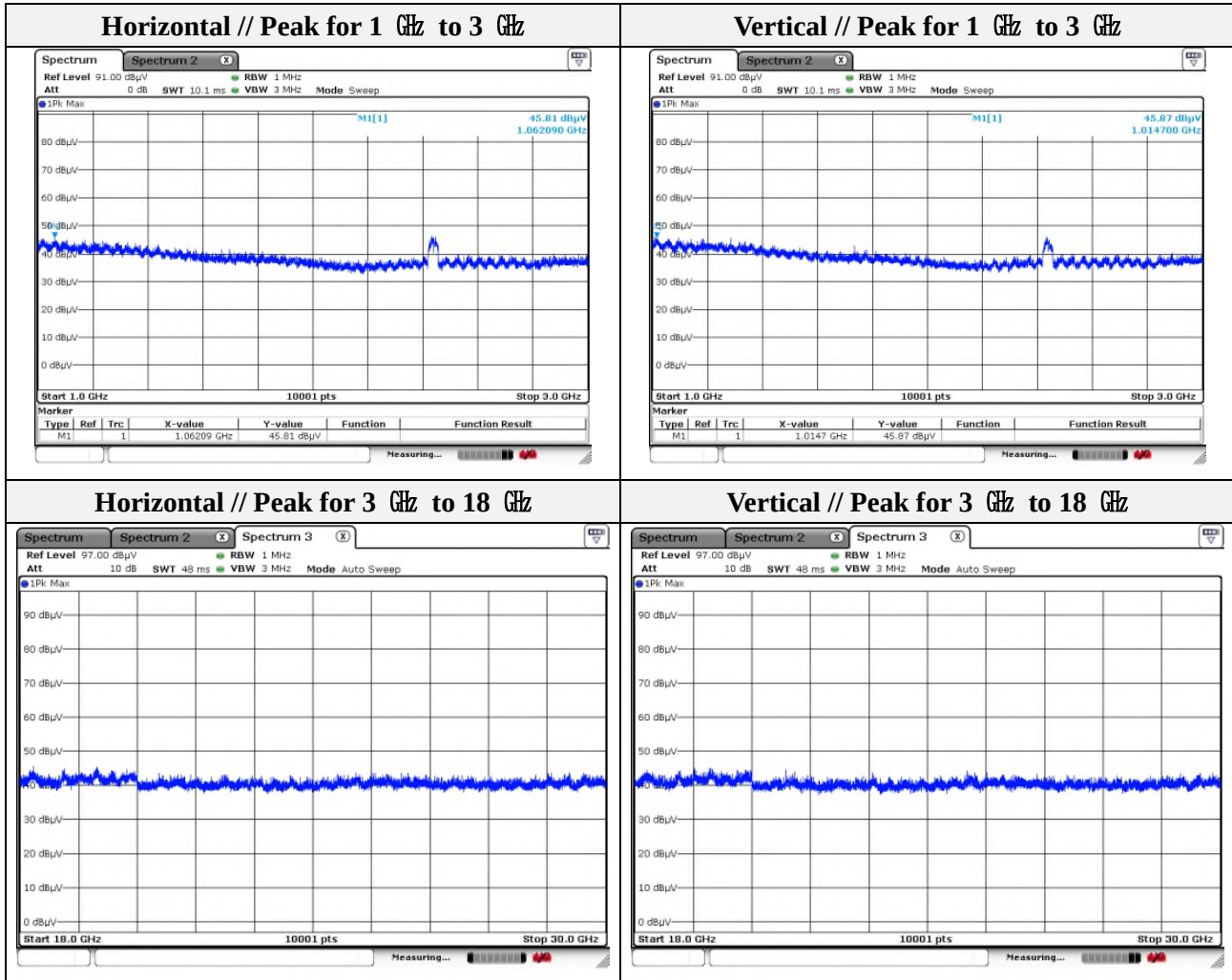
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Mode: 802.11n_HT40
Distance of measurement: 3 meter
Channel: 06

- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	AF (dB)	AMP+CL (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 062.09	45.81	Peak	H	23.87	-31.95	-	37.73	74.00	36.27
1 014.70	45.87	Peak	V	23.74	-32.14	-	37.47	74.00	36.53

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Mode: 802.11n_HT40

Distance of measurement: 3 meter

Channel: 09

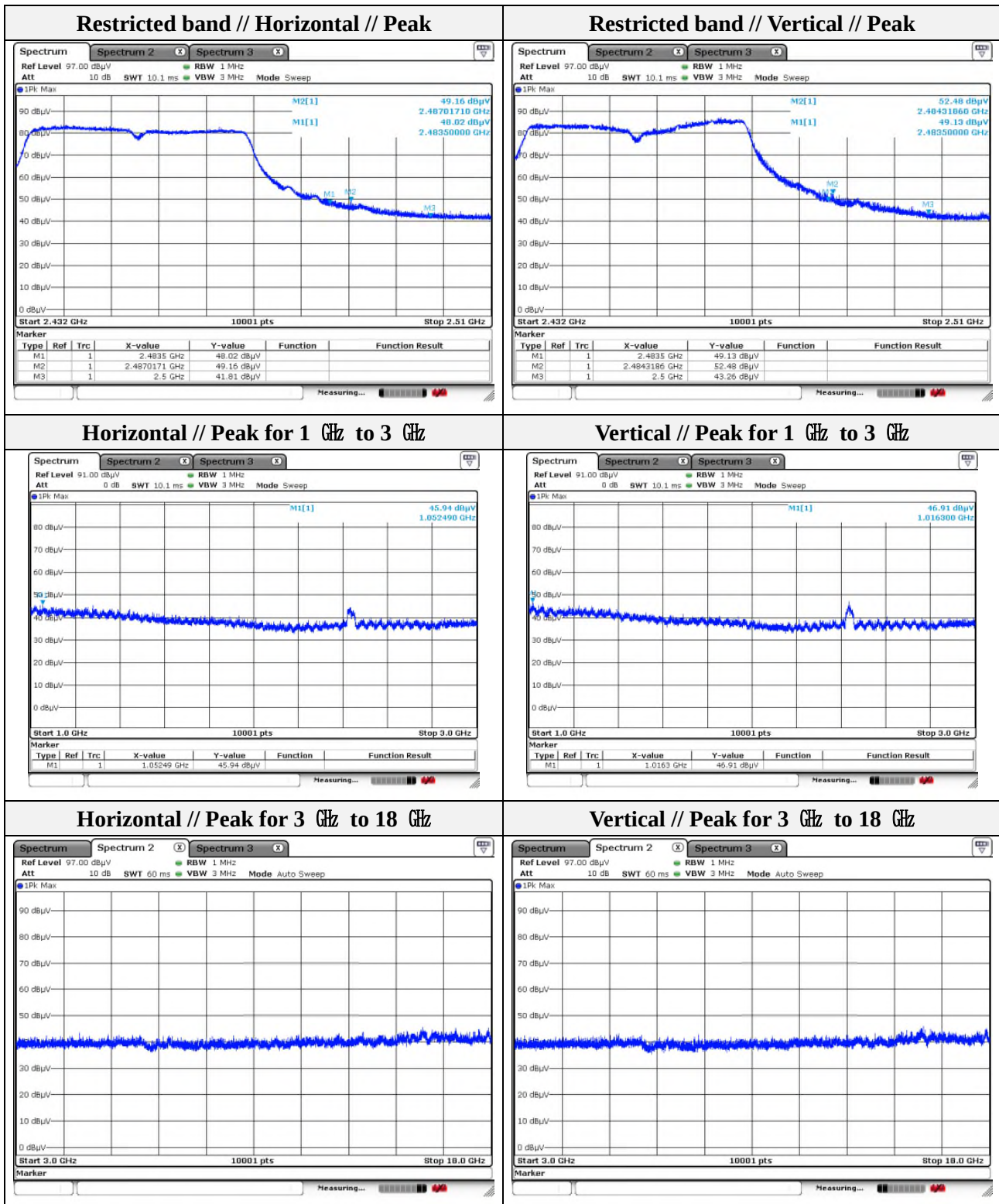
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	AF (dB)	AMP+CL (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 052.49	45.94	Peak	H	23.85	-31.98	-	37.81	74.00	36.19
1 016.30	46.91	Peak	V	23.75	-32.13	-	38.53	74.00	35.47

- Band edge

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	AF (dB)	AMP+CL (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 483.50	48.02	Peak	H	29.64	-28.72	-	48.94	74.00	25.06
2 487.02	49.16	Peak	H	29.65	-28.69	-	50.12	74.00	23.88
2 500.00	41.81	Peak	H	29.68	-28.56	-	42.93	74.00	31.07
2 483.50	49.13	Peak	V	29.64	-28.72	-	50.05	74.00	23.95
2 484.32	52.48	Peak	V	29.64	-28.71	-	53.41	74.00	20.59
2 500.00	43.26	Peak	V	29.68	-28.56	-	44.38	74.00	29.62

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Note.

1. No spurious emission were detected above 3 GHz.
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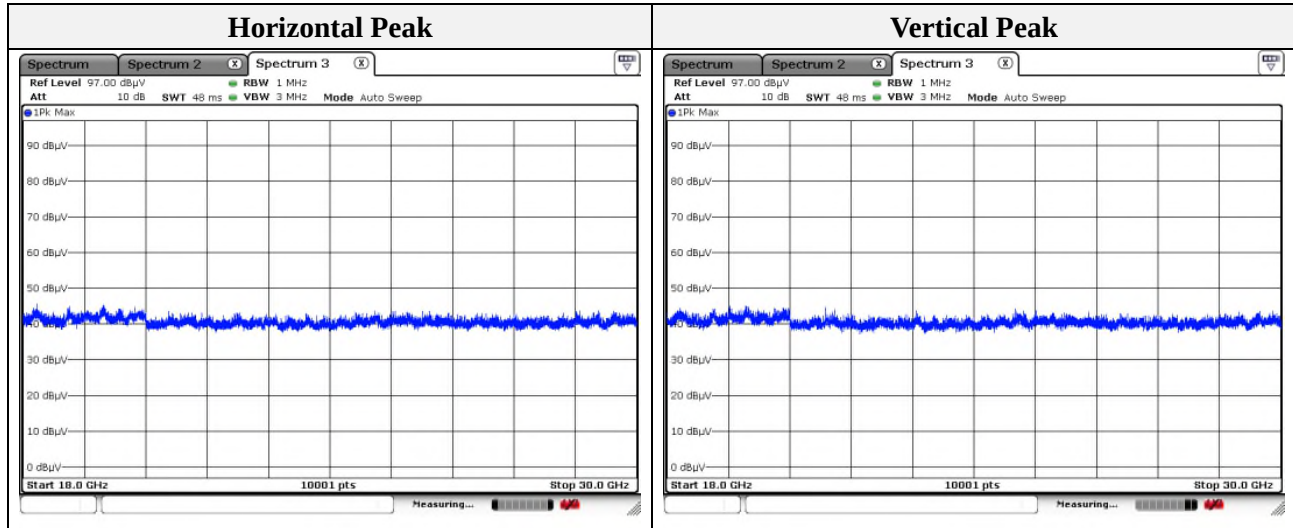
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Test results (18 GHz to 30 GHz)

Mode: 802.11n_HT40

Distance of measurement: 3 meter

Channel: 06 (Worst case)



Note.

No spurious emission were detected above 18 GHz.

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3.2. AC conducted emissions

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 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/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 (MHz)	Conducted limit (dB μ V/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.
2. Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level)



KES Co., Ltd.

3701, 40, Simin-daero 365beon-gil,
Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450
www.kes.co.kr

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KES-RF-20T0032

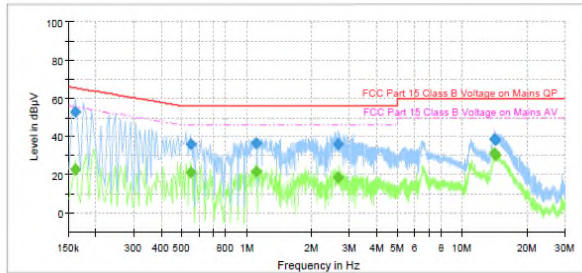
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Test results

Hot Line

Common Information

Test Description: Conducted Emission
Model No.:
Mode: 2.4GHz
Operator Name: KES



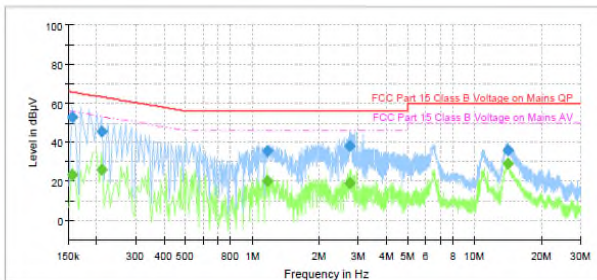
Final Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.160000	---	22.73	55.46	32.73	1000.0	9.000	L1	10.0
0.160000	52.94	---	65.46	12.52	1000.0	9.000	L1	10.0
0.550000	---	20.98	46.00	25.02	1000.0	9.000	L1	11.2
0.550000	35.92	---	56.00	20.08	1000.0	9.000	L1	11.2
1.105000	---	21.69	46.00	24.31	1000.0	9.000	L1	11.2
1.105000	36.39	---	56.00	19.61	1000.0	9.000	L1	11.2
2.640000	---	18.34	46.00	27.66	1000.0	9.000	L1	10.2
2.640000	36.23	---	56.00	19.77	1000.0	9.000	L1	10.2
14.150000	---	31.22	50.00	18.78	1000.0	9.000	L1	11.0
14.150000	38.62	---	60.00	21.38	1000.0	9.000	L1	11.0
14.230000	---	29.95	50.00	20.05	1000.0	9.000	L1	11.0
14.230000	37.99	---	60.00	22.01	1000.0	9.000	L1	11.0

Neutral Line

Common Information

Test Description: Conducted Emission
Model No.:
Mode: 2.4GHz
Operator Name: KES



Final Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.155000	---	23.20	55.73	32.53	1000.0	9.000	N	10.0
0.155000	52.98	---	65.73	12.75	1000.0	9.000	N	10.0
0.210000	---	25.85	53.21	27.36	1000.0	9.000	N	10.1
0.210000	45.46	---	63.21	17.75	1000.0	9.000	N	10.1
1.170000	---	20.27	46.00	25.73	1000.0	9.000	N	11.0
1.170000	35.46	---	56.00	20.54	1000.0	9.000	N	11.0
2.745000	---	19.23	46.00	26.77	1000.0	9.000	N	10.3
2.745000	38.37	---	56.00	17.63	1000.0	9.000	N	10.3
14.150000	---	29.05	50.00	20.95	1000.0	9.000	N	11.0
14.150000	36.06	---	60.00	23.94	1000.0	9.000	N	11.0

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3701, 40, Simin-daero 365beon-gil,
Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
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Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV30	101389	1 year	2021.01.15
Spectrum Analyzer	R&S	FSV40	101002	1 year	2020.06.24
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2021.01.15
Vector Signal Generator	R&S	SMBV100A	1407.6004K02	1 year	2020.06.25
Power Meter	Anritsu	ML2495A	1438001	1 year	2021.01.15
Pulse Power Sensor	Anritsu	MA2411B	1339205	1 year	2021.01.15
Attenuator	HP	8494B	2630A12857	1 year	2021.01.15
Attenuator	KEYSIGHT	8493C	82506	1 year	2021.01.14
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2021.02.15
Trilog-broadband antenna	SCHWARZBECK	VULB 9163	715	2 years	2020.09.20
Horn Antenna	A.H	SAS-571	414	1 year	2021.02.11
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA 9170550	1 year	2021.01.20
High Pass Filter	Wainwright Instrument Gmbh	WHJS3000-10TT	1	1 year	2020.06.25
Band Reject Filter	MICRO-TRONICS	BRM50702	G272	1 year	2021.01.15
Low Pass Filter	Wainwright Instrument Gmbh	WLK1.0/18G-10TT	1	1 year	2020.06.24
Broadband Amplifier	Schwarzbeck	BBV9721	PS9721-003	1 year	2021.01.17
Preamplifier	AGILENT	8449B	3008A01742	1 year	2021.01.02
Amplifier	R&S	SCU 01	100603	1 year	2020.11.25
EMI Test Receiver	R&S	ESU26	100551	1 year	2020.04.09
EMI Test Receiver	R&S	ESR3	101781	1 year	2020.04.22
DC Power supply	Agilent	6632B	MY43004090	1 year	2020.06.25
LISN	R&S	ENV216	101786	1 year	2021.01.20

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook Computer	HP	HP-6530B	CNU8313PMW
Test Jig Board	N/A	N/A	N/A

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