



EMC TEST REPORT

Test Report No. : KES-EM-22T0721
Date of Issue : Aug. 24, 2022
Product name : &TEAM OFFICIAL LIGHT STICK
Model/Type No. : ATNN22JOS901NN0
Variant Mode : -
Applicant : THINKWARE CORPORATION
Applicant Address : A, 9FL., Samwhan Hipex, 240, Pangyoyeok-ro, Bundang-gu, Seongnam-si, Gyeonggi-do, South Korea
Manufacturer : THINKWARE CORPORATION
Manufacturer Address : A, 9FL., Samwhan Hipex, 240, Pangyoyeok-ro, Bundang-gu, Seongnam-si, Gyeonggi-do, South Korea
FCC ID : 2ADTG-ATEAMOLS
Date of Receipt : Jul. 28, 2022
Test date : Aug. 15, 2022
Test Results : ☒ **In Compliance** ☐ **Not in Compliance**

Tested by

Dae Hyun, Kim
EMC Test Engineer

Reviewed by

Dong Hun, Jang
EMC Technical Manager

**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

Report No.:

KES-EM-22T0721

Page (2) of (29)

REPORT REVISION HISTORY

Date	Test Report No.	Revision History
Aug. 24, 2022	KES-EM-22T0721	Issued

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd. This document may be altered or revised by KES Co., Ltd. personnel only, and shall be noted in the revision section of the document. Any alteration of this document not carried out by KES Co., Ltd. will constitute fraud and shall nullify the document.

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact shchoi@kes.co.kr

TABLE OF CONTENTS

1.0	General Product Description.....	4
1.1	Test Voltage & Frequency	5
1.2	Variant Model Differences	5
1.3	Device Modifications	5
1.4	Equipment Under Test.....	5
1.5	Support Equipments	5
1.6	External I/O Cabling	6
1.7	EUT Operating Mode(s)	6
1.8	Configuration.....	7
1.9	Remarks when standards applied	8
1.10	Calibration Details of Equipment Used for Measurement	8
1.11	Test Facility	8
1.12	Measurement Procedure.....	8
1.13	Laboratory Accreditations and Listings	9
2.0	Test Regulations.....	10
2.1	Conducted Emissions at Mains Power Ports	11
2.2	Radiated Electric Field Emissions(Below 1 GHz)	13
2.3	Radiated Electric Field Emissions(Above 1 GHz)	15
APPENDIX A – TEST DATA.....		17
Conducted Emissions at Mains Power Ports.....		17
Radiated Electric Field Emissions(Below 1 GHz)		19
Radiated Electric Field Emissions(Above 1 GHz).....		21
APPENDIX B - Test Setup Photos and Configuration.....		25
Radiated Electric Field Emissions(Below 1 GHz)		26
Radiated Electric Field Emissions(Above 1 GHz).....		28



1.0 General Product Description

Main Specifications of EUT are:

Division	Characteristic
Frequency	Bluetooth 2.4 GHz Band , Zigbee 2.4 GHz Band
Power	DC 4.5 V (AAA Battery x 3 EA)
Size	(113.3 x 207.9 x 88.5) mm
Weight	142.7 g
Components	EUT x 1 EA

1.1 Test Voltage & Frequency

Unless indicated otherwise on the individual data sheet or test results, the test voltage and frequency was as indicated below.

☒ DC 4.5 V (AAA Battery x 3)

1.2 Variant Model Differences

Not applicable

1.3 Device Modifications

Not applicable

1.4 Equipment Under Test

Description	Model Number	Serial Number	Manufacturer	Remarks
&TEAM OFFICIAL LIGHT STICK	ATNN22JOS901NN0	-	THINKWARE CORPORATION	EUT
&TEAM OFFICIAL LIGHT STICK	ATNN22JOS901NN0	-	THINKWARE CORPORATION	EUT

1.5 Support Equipments

Description	Model Number	Serial Number	Manufacturer	Remarks
SmartPhone	SM-N971N	-	Samsung Electronics Co., Ltd.	-

1.6 External I/O Cabling

■ Bluetooth Mode

Start		END		Cable Spec.	
Description	I/O Port	Description	I/O Port	Length	Shield
&TEAM OFFICIAL LIGHT STICK (EUT)	Wireless	SmartPhone	Wireless	-	-

* Unshielded = U, Shielded = S

■ Zigbee Mode

Start		END		Cable Spec.	
Description	I/O Port	Description	I/O Port	Length	Shield
&TEAM OFFICIAL LIGHT STICK (EUT)	Wireless	&TEAM OFFICIAL LIGHT STICK (EUT)	Wireless	-	-

* Unshielded = U, Shielded = S

1.7 EUT Operating Mode(s)

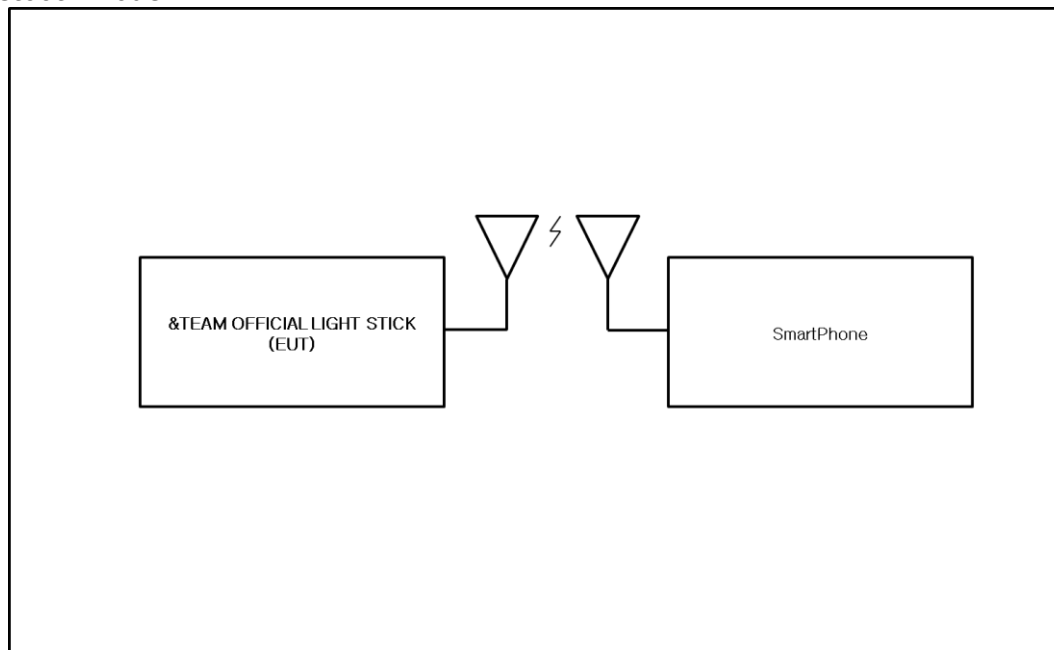
Test mode	operating
Bluetooth	Connect EUT and Smart wirelessly. The normal operation state of EUT was confirmed through the application of SmartPhone.
Zigbee	The transmission and reception status were checked through the LED of EUT.

EUT Test operating S/W		
Name	Version	Manufacture Company
-	-	-

1.8 Configuration

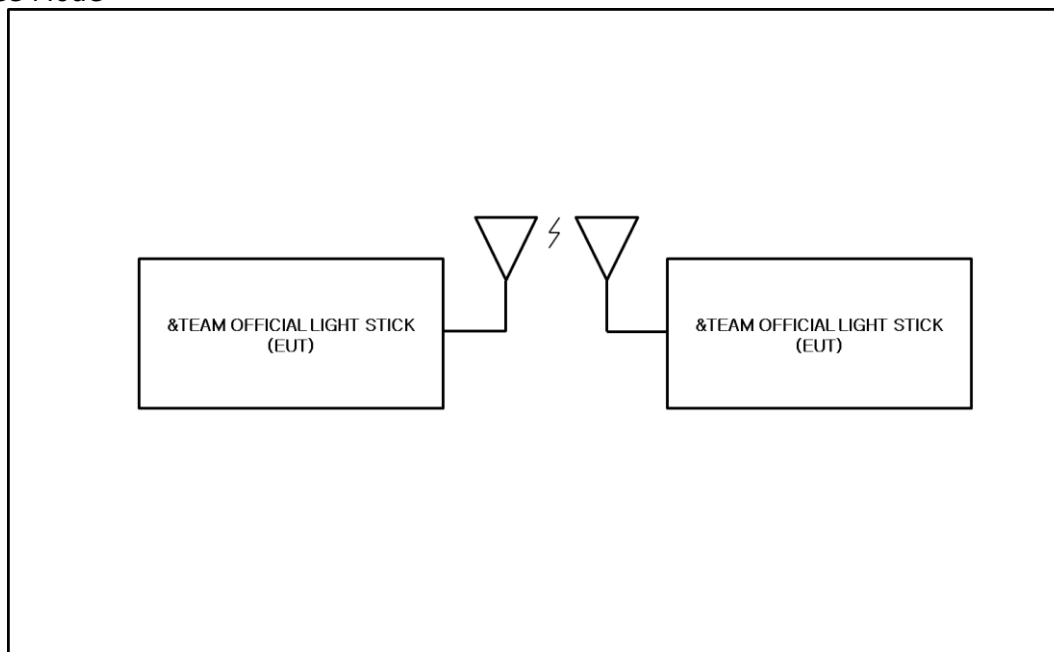
■ AC Main
 □ DC Main

■ Bluetooth Mode



EUT - SmartPhone : Bluetooth 2.4 GHz Band

■ Zigbee Mode



EUT - EUT : Zigbee 2.4 GHz Band

1.9 Remarks when standards applied

N/A

1.10 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less.

1.11 Test Facility

The measurement facility is located at 473-21 Gayeo-ro, Yeosu-si, Gyeonggi-do, 12658, Korea. The sites are constructed in conformance with the requirements of ANSI C63.4:2017a and CISPR 16-1-4:2019

1.12 Measurement Procedure

- Conducted Emissions







The conducted emission levels were measured on each current-carrying line with the spectrum analyzer operating in the CISPR quasi-peak mode (or peak mode if applicable). The initial step in collecting conducted data is a spectrum analyzer peak scan of the measurement range. If the conducted emission exceed the average limit with the instrument set to the quasi-peak mode, the measurements are made in the average mode. The emission spectrum was scanned from 150 kHz to 30 MHz. The highest emission amplitudes relative to the appropriate limits were measured and have been recorded. Quasi-peak readings are distinguished with a "QP".

- Radiated Electric Field Emissions

The test was done at a SEMI ANECHOIC CHAMBER with quasi-peak detector. The final test data was measured using a Quasi-Peak detector below 1 GHz at 10 m or 3 m distance and a Peak and Average detector above 1 GHz at 3 m distance. Test was proceeded worst case test mode and cable configuration. Measurements were made with the antenna positioned in both the horizontal and vertical planes of polarization. The antenna height was varied from 1 m to 4 m and the EUT was rotated 360° to find the maximum emitting point for each frequency.

Measurement procedures was In accordance with ANSI C63.4:2017a 7.3.3, 7.3.4, 8.3.1.1, 8.3.1.2, 8.3.2.1, 8.3.2.2

1.13 Laboratory Accreditations and Listings

Country	Agency	Scope of Accreditation	Logo
KOREA	RRA	EMI (3 m & 10 m Semi-Aechoic Chamber ,10 m Open Area and conducted test site) EMS (ESD, RS, EFT/Burst, Surge, CS, Magnetic, Dips and interruptions)	 KR0100
International	KOLAS	EMI (3 m & 10 m Semi-Aechoic Chamber , and conducted test site) EMS (ESD, RS, EFT/Burst, Surge, CS, Magnetic, Dips and interruptions)	 KT489
USA	FCC	3 m & 10 m Semi-Aechoic Chamber, 10 m Open Area and Conducted test site to perform FCC Part 15/18 measurements.	 KR0100
Canada	ISED	3 m & 10 m Semi-Aechoic Chamber and Conducted test site	 23298
JAPAN	VCCI	Mains Ports Conducted Interference Measurement, Telecommunication Ports Conducted Disturbance Measurement and Radiation 10 meter site, Facility for measuring radiated disturbance above 1 GHz	 R-20056, C-20036 T-20040, G-20057
Europe	TÜV SÜD	EMI (3 m & 10 m Semi-Aechoic Chamber , 10 m Open Area and conducted test site) EMS (ESD, RS, EFT/Burst, Surge, CS, Magnetic, Dips and interruptions)	 CARAT 001633 0004



2.0 Test Regulations

The emissions tests were performed according to following regulations:

☒ **47 CFR Part 15, Subpart B**

☐ CISPR 22:2009 +A1:2010

☐ Class A

☐ Class B

☒ ANSI C63.4-2017a

☐ Class A

☒ Class B

2.1 Conducted Emissions at Mains Power Ports

Test Date

N/A

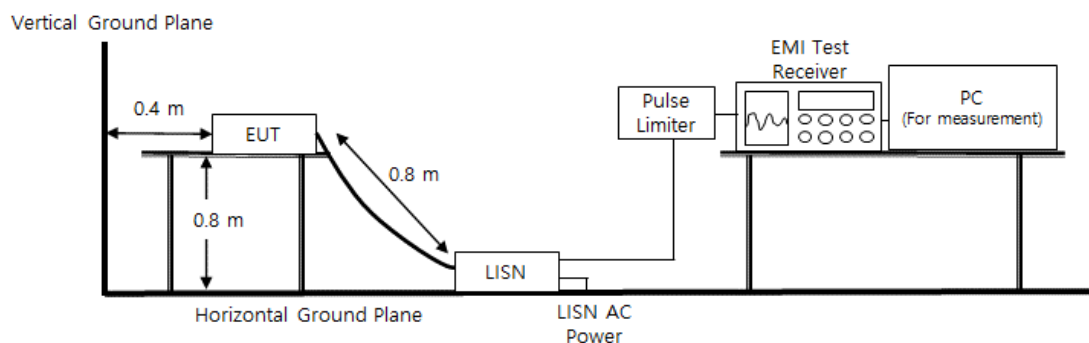
Test Location

Electro wave Shieldroom #6

Test Equipment

Used	Description	Model Number	Manufacturer	Serial Number	Cal. Due	calibration interval
<input type="checkbox"/>	EMI Test S/W	EMC32	R & S	9.12.00	-	-
<input type="checkbox"/>	EMI TEST RECEIVER	ESR3	R & S	101783	12, 28, 2022	1 Year
<input type="checkbox"/>	LISN	ENV216	R & S	101787	12, 27, 2022	1 Year
<input type="checkbox"/>	LISN	ESH2-Z5	R & S	100450	12, 27, 2022	1 Year
<input type="checkbox"/>	PULSE LIMITER	ESH3-Z2	R & S	101915	12, 27, 2022	1 Year

Diagram of test setup





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

Report No.:

KES-EM-22T0721

Page (12) of (29)

Test Conditions

Temperature: (±) °C

Relative Humidity: (±) % R.H.

Frequency Range of Measurement

150 kHz to 30 MHz

Instrument Settings

IF Band Width: 9 kHz

Test Results

The requirements are:

- ☐ PASS
- ☐ NOT PASS
- ☒ NOT APPLICABLE

Remarks

The EUT applied portable Use equipment.

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact shchoi@kes.co.kr

2.2 Radiated Electric Field Emissions(Below 1 GHz)

Test Date

Aug. 15, 2022

Test Location

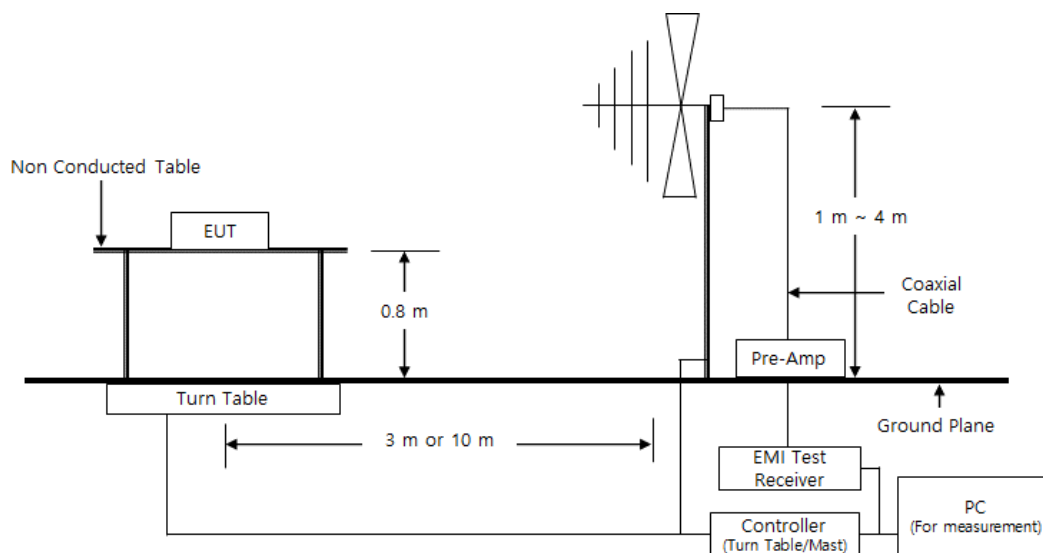
☐ OPEN AREA TEST SITE #2

☒ SEMI ANECHOIC CHAMBER #4(10 m)

Test Equipment

Used	Description	Model Number	Manufacturer	Serial Number	Cal. Due	calibration interval
<input checked="" type="checkbox"/>	EMI Test S/W	EP5/RE	TOYO Corporation	6.0.0	-	-
<input checked="" type="checkbox"/>	EMI TEST RECEIVER	ESU26	R & S	100551	03, 31, 2023	1 Year
<input checked="" type="checkbox"/>	AMPLIFIER	SCU 01	R & S	100603	11, 24, 2022	1 Year
<input checked="" type="checkbox"/>	TRILOG-BROADBAND ANTENNA	VULB9163	Schwarzbeck	715	12, 08, 2022	2 Year
<input checked="" type="checkbox"/>	ATTENUATOR	8491A	HP	32173	03, 08, 2023	1 Year

Diagram of test setup





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

Report No.:

KES-EM-22T0721

Page (14) of (29)

Test Conditions

Temperature: (24,3 ± 0,1) °C

Relative Humidity: (45,6 ± 0,2) % R.H.

Frequency Range of Measurement

30 MHz to 1 GHz

Instrument Settings

IF Band Width: 120 kHz

Test Results

The requirements are:

- ☒ PASS
- ☐ NOT PASS
- ☐ NOT APPLICABLE

Remarks

See Appendix A for test data.

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact shchoi@kes.co.kr

2.3 Radiated Electric Field Emissions(Above 1 GHz)

Test Date

Aug. 15, 2022

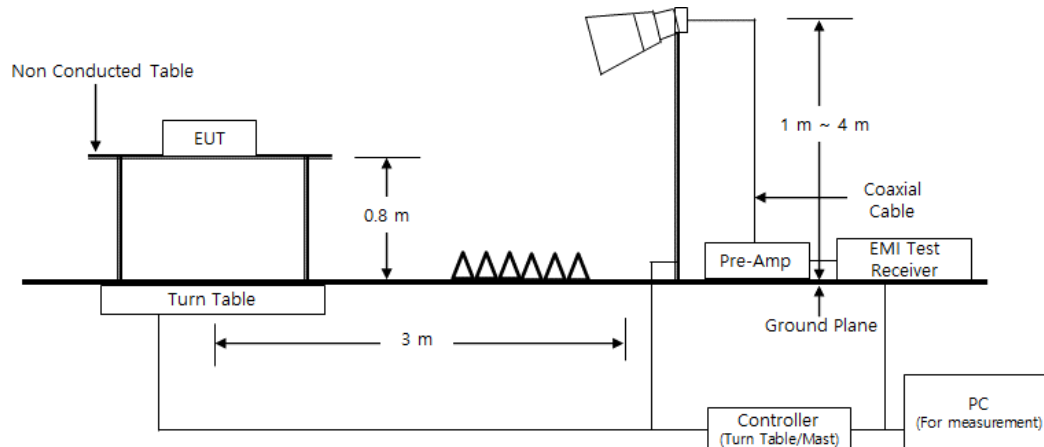
Test Location

SEMI ANECHOIC CHAMBER #4(10 m)

Test Equipment

Used	Description	Model Number	Manufacturer	Serial Number	Cal. Due	calibration interval
<input checked="" type="checkbox"/>	EMI Test S/W	EP5/RE	TOYO Corporation	6.0.0	-	-
<input checked="" type="checkbox"/>	EMI TEST RECEIVER	ESU26	R & S	100551	03, 31, 2023	1 Year
<input checked="" type="checkbox"/>	PREAMPLIFIER	8449B	AGILENT	3008A01742	12, 27, 2022	1 Year
<input checked="" type="checkbox"/>	HORN ANTENNA	BBHA 9120D	SCHWARZBECK	9120D-1802	12, 16, 2022	1 Year

Diagram of test setup





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

Report No.:

KES-EM-22T0721

Page (16) of (29)

Test Conditions

Temperature: (24,3 ± 0,1) °C

Relative Humidity: (45,6 ± 0,1) % R.H.

Frequency Range of Measurement

1 GHz to 12,5 GHz

Instrument Settings

IF Band Width: 1 MHz

Test Results

The requirements are:

- ☒ PASS
- ☐ NOT PASS
- ☐ NOT APPLICABLE

Remarks

See Appendix A for test data.

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact shchoi@kes.co.kr



APPENDIX A – TEST DATA

Conducted Emissions at Mains Power Ports

HOT LINE

N/A



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

Report No.:

KES-EM-22T0721

Page (18) of (29)

NEUTRAL LINE

N/A

◆ Calculation

QuasiPeak[dBuV] / CAverage [dBuV] = Reading Value[dBuV] + Corr. [dB]

QuasiPeak / CAverage : The Final Value

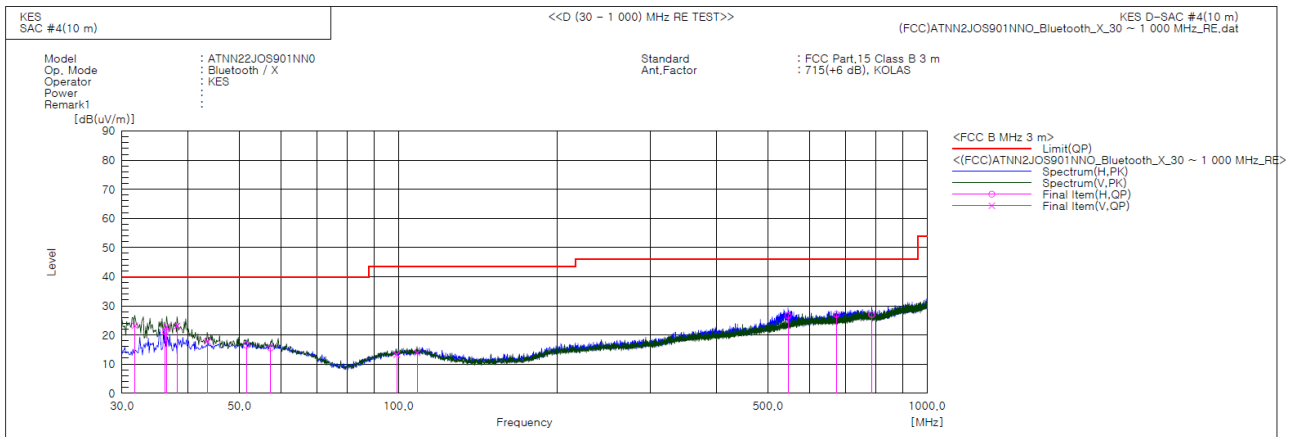
Reading Value : Not shown in the table.

Corr. : Correction values (LISN FACTOR + (Cable Loss + Pulse Limiter FACTOR))

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact shchoi@kes.co.kr

Radiated Electric Field Emissions(Below 1 GHz)

Bluetooth Mode

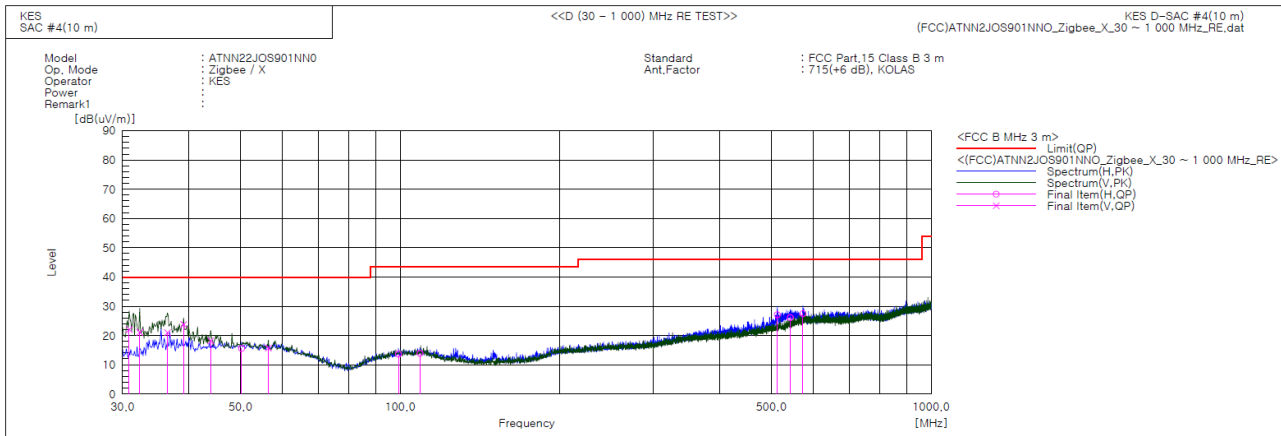


Final Result

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	31.698	V	48.6	-25.4	23.2	40.0	16.8	100.0	193.0	
2	36.184	H	46.0	-24.8	21.2	40.0	18.8	400.0	28.0	
3	36.426	V	47.5	-24.7	22.8	40.0	17.2	113.0	238.0	
4	38.124	V	47.0	-23.9	23.1	40.0	16.9	100.0	238.0	
5	43.459	V	39.8	-21.9	17.9	40.0	22.1	123.0	249.0	
6	51.583	H	37.8	-21.4	16.4	40.0	23.6	265.0	349.0	
7	57.281	H	37.5	-22.0	15.5	40.0	24.5	299.0	86.0	
8	99.234	V	36.4	-23.1	13.3	43.5	30.2	100.0	249.0	
9	108.449	V	36.8	-22.9	13.9	43.5	29.6	150.0	100.0	
10	545.676	H	38.4	-11.7	26.7	46.0	19.3	400.0	244.0	
11	673.474	H	36.5	-9.4	27.1	46.0	18.9	250.0	262.0	
12	785.873	H	35.4	-8.4	27.0	46.0	19.0	400.0	240.0	

- Orientation Worst Case : X

■ Zigbee Mode



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	30.849	V	47.5	-25.5	22.0	40.0	18.0	100.0	245.0	
2	32.304	V	46.4	-25.3	21.1	40.0	18.9	112.0	237.0	
3	36.426	V	45.7	-24.7	21.0	40.0	19.0	105.0	24.0	
4	39.094	V	47.1	-23.3	23.8	40.0	16.2	125.0	32.0	
5	43.944	V	40.1	-21.9	18.2	40.0	21.8	100.0	203.0	
6	56.433	V	37.6	-21.9	15.7	40.0	24.3	132.0	80.0	
7	50.249	H	36.9	-21.4	15.5	40.0	24.5	400.0	130.0	
8	99.234	H	36.7	-23.1	13.6	43.5	29.9	343.0	100.0	
9	108.934	H	36.8	-22.9	13.9	43.5	29.6	400.0	103.0	
10	512.939	H	39.5	-12.4	27.1	46.0	18.9	400.0	275.0	
11	543.009	H	37.9	-11.8	26.1	46.0	19.9	400.0	122.0	
12	573.200	H	38.1	-10.6	27.5	46.0	18.5	355.0	81.0	

- Orientation Worst Case : X

◆ Calculation - SAC #4(10 m)

Result(QP) [dB(μ V/m)] = (Reading(QP)[dB(μ V)] + c.f[dB(1/m)])

Margin(QP)[dB] = Limit[dB(μ V/m)] - Result(QP) [dB(μ V/m)]

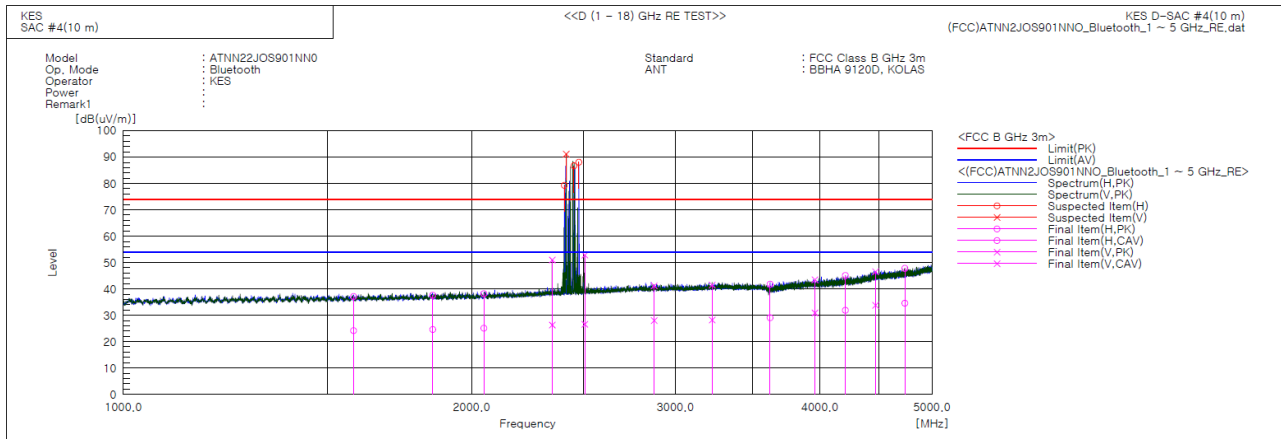
Reading(QP) : Reading value, Result(QP) : Reading value + Factor value

Limit(QP) : Limit value, c.f : (ANT Factor + Cable Loss - Preamp Factor), Margin: Margin value

Radiated Electric Field Emissions(Above 1 GHz)

Bluetooth Mode

- (1 ~ 5) GHz



Final Result

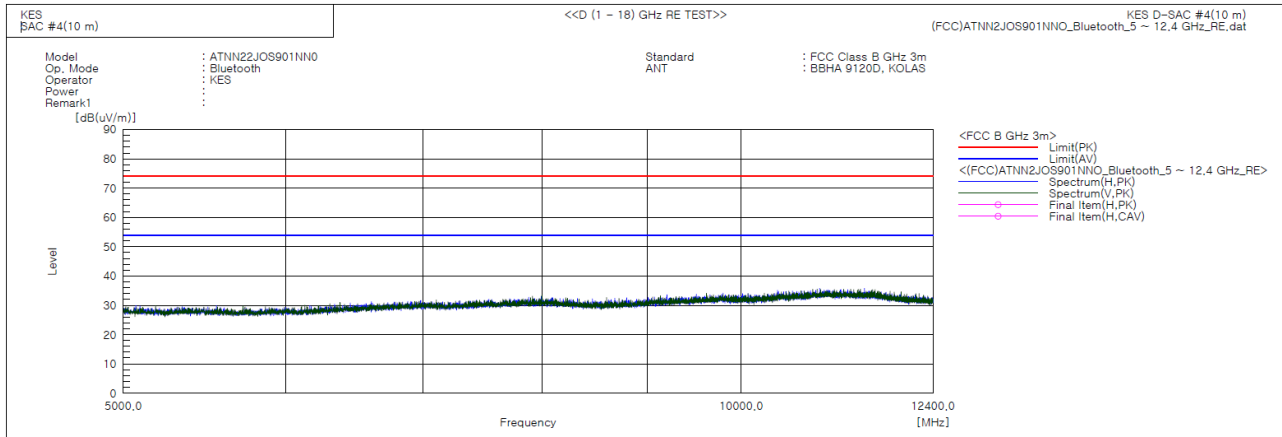
No.	Frequency [MHz]	(P)	Reading PK [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB(1/m)]	Result PK [dB(uV/m)]	Result CAV [dB(uV/m)]	Limit PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Margin PK [dB]	Margin CAV [dB]	Height [cm]	Angle [deg]	Remark
1	1581.112	H	40.1	27.2	-3.0	37.1	24.2	74.0	54.0	36.9	29.8	295.0	2.0	
2	1850.764	H	39.5	26.5	-1.9	37.6	24.6	74.0	54.0	36.4	29.4	400.0	243.0	
3	2049.329	H	39.2	26.1	-1.0	38.2	25.1	74.0	54.0	35.8	28.9	335.0	12.0	
4	2347.777	V	50.5	25.8	0.5	51.0	26.3	74.0	54.0	23.0	27.7	100.0	90.0	
5	2505.326	V	51.5	25.3	1.3	52.8	26.6	74.0	54.0	21.2	27.4	100.0	30.0	
6	2876.120	V	38.3	25.1	2.9	41.2	28.0	74.0	54.0	32.8	26.0	156.0	186.0	
7	3227.968	V	37.6	24.3	3.9	41.5	28.2	74.0	54.0	32.5	25.8	205.0	246.0	
8	3622.140	H	36.9	24.2	4.9	41.8	29.1	74.0	54.0	32.2	24.9	369.0	231.0	
9	3961.070	V	36.7	24.1	6.8	43.5	30.9	74.0	54.0	30.5	23.1	100.0	101.0	
10	4207.732	H	36.7	23.5	8.4	45.1	31.9	74.0	54.0	28.9	22.1	400.0	230.0	
11	4467.320	V	36.5	23.8	10.0	46.5	33.8	74.0	54.0	27.5	20.2	100.0	53.0	
12	4737.002	H	36.2	23.0	11.6	47.8	34.6	74.0	54.0	26.2	19.4	400.0	359.0	
13	2405.500	H	-----	-----	0.8	-----	-----	74.0	54.0	-----	-----	200.0	331.0	
14	2414.000	V	-----	-----	0.9	-----	-----	74.0	54.0	-----	-----	150.0	168.0	
15	2451.500	H	-----	-----	1.1	-----	-----	74.0	54.0	-----	-----	100.0	142.0	
16	2476.000	H	-----	-----	1.2	-----	-----	74.0	54.0	-----	-----	100.0	79.0	

* Exclusion Bands

- Fundamental Frequency: 2.4 GHz Band



- (5 ~ 12,4) GHz

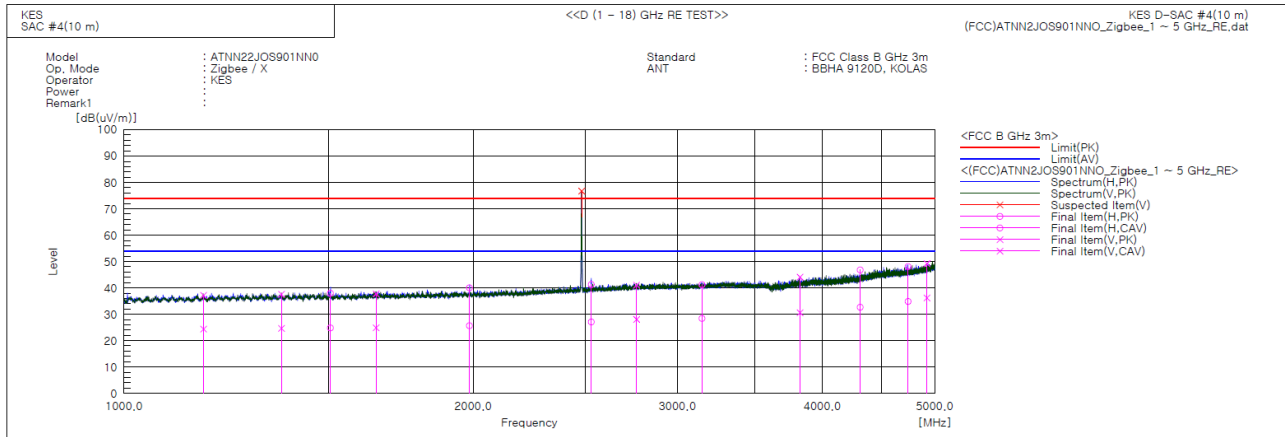


* No spurious emission were detected above 5 GHz.



■ Zigbee Mode

- (1 ~ 5) GHz



Final Result

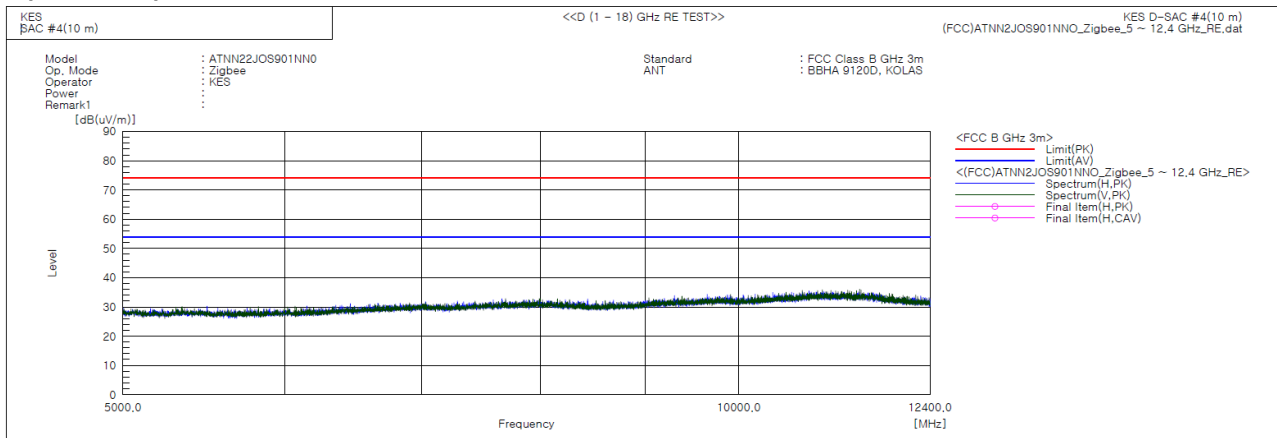
No.	Frequency [MHz]	(P)	Reading PK [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB(1/m)]	Result PK [dB(uV/m)]	Result CAV [dB(uV/m)]	Limit PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Margin PK [dB]	Margin CAV [dB]	Height [cm]	Angle [deg]	Remark
1	1170.533	V	42.3	29.5	-5.1	37.2	24.4	74.0	54.0	36.8	29.6	110.0	145.0	
2	1366.736	V	41.6	28.7	-4.0	37.6	24.7	74.0	54.0	36.4	29.3	100.0	253.0	
3	1506.139	H	41.3	28.1	-3.3	38.0	24.8	74.0	54.0	36.0	29.2	400.0	353.0	
4	1649.005	V	40.5	27.6	-2.7	37.8	24.9	74.0	54.0	36.2	29.1	125.0	216.0	
5	1985.050	H	41.3	27.0	-1.3	40.0	25.7	74.0	54.0	34.0	28.3	356.0	37.0	
6	2528.462	H	39.9	25.7	1.4	41.3	27.1	74.0	54.0	32.7	26.9	300.0	93.0	
7	2765.768	V	38.7	25.7	2.4	41.1	28.1	74.0	54.0	32.9	25.9	133.0	316.0	
8	3149.995	H	37.5	24.7	3.7	41.2	28.4	74.0	54.0	32.8	25.6	223.0	164.0	
9	3826.903	V	37.9	24.4	6.2	44.1	30.6	74.0	54.0	29.9	23.4	106.0	246.0	
10	4311.765	H	37.9	23.8	8.9	46.8	32.7	74.0	54.0	27.2	21.3	400.0	227.0	
11	4743.054	H	36.5	23.3	11.6	48.1	34.9	74.0	54.0	25.9	19.1	100.0	56.0	
12	4922.727	V	36.0	23.0	13.2	49.2	36.2	74.0	54.0	24.8	17.8	100.0	152.0	
13	2480.500	V			1.2			74.0	54.0			150.0	93.0	

* Exclusion Bands

- Fundamental Frequency: 2.4 GHz Band



- (5 ~ 12,4) GHz



* No spurious emission were detected above 5 GHz.

◆ Calculation

Result(PK/CAV) [dB(μV/m)] = (Reading(PK/CAV)[dB(μV)] + c.f[dB(1/m)])

Margin(PK/CAV)[dB] = Limit[dB(μV/m)] - Result(PK/CAV) [dB(μV/m)]

Reading(PK/CAV) : Reading value, Result(PK/CAV) : Reading value + Factor value

Limit(QP) : Limit value, c.f : (ANT Factor + Cable Loss - Preamp Factor), Margin: Marjin value