

ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR LOW-POWER, NON-LICENSED TRANSMITTER

Test Report No. : OT-18O-RWD-014
AGR No. : A189A-120
Applicant : Samsung Electronics Co., Ltd.
Address : 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 17113 Republic of Korea
Manufacturer : Samsung Electronics Co., Ltd.
Address : 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 17113 Republic of Korea
Type of Equipment : ARTIK-0530
FCC ID. : A3LSIP005AFS30
IC Certification No. : 649E-SIP005AFS30
Model Name : SIP005AFS30
Multiple Model Name : N/A
Serial number : N/A
Total page of Report : 13 pages (including this page)
Date of Incoming : September 02, 2018
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SUMMARY

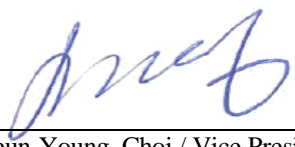
The equipment complies with the regulation; *FCC PART 15 SUBPART C Section 15.247 and SUBPART E Section 15.407, IC RSS-Gen Issue 4 Nov 2014 and RSS-247 Issue 2 February 2017*

This test report only contains the result of a single test of the sample supplied for the examination.

It is not a generally valid assessment of the features of the respective products of the mass-production.

Reviewed by: 

 Ki-Hong, Nam / Chief Engineer
 ONETECH Corp.

Approved by: 

 Keun-Young, Choi / Vice President
 ONETECH Corp.

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-18O-RWD-014	2018.10.05	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : Samsung Electronics Co., Ltd.
 Address : 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 17113 Republic of Korea
 Contact Person : Lee, Jae-Hyuk
 Telephone No. : +82-10-8848-6628
 FCC ID : A3LSIP005AFS30
 IC Certification No. : 649E-SIP005AFS30
 Model Name : SIP005AFS30
 Serial Number : N/A
 Date : October 05, 2018

EQUIPMENT CLASS	FCC: DTS – DIGITAL TRNSMISSION SYSTEM FCC : Unlicensed National Information infrastructure(UNII) IC : Low Power License-Exempt Radio-communication Device
E.U.T. DESCRIPTION	Modular Transmitter, ARTIK-0530
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247 FCC PART 15 SUBPART E Section 15.407 KDB 789033 D02 General UNII Test Procedures New Rules V02r01 RSS-Gen Issue 4 Nov 2014, RSS-247 Issue 2 February 2017
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 m, Semi Anechoic Chamber

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC&IC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

2. GENERAL INFORMATION

2.1 Product Description

The Samsung Electronics Co., Ltd., Model SIP005AFS30 (referred to as the EUT in this report) is a ARTIK-0530. Product specification information described herein was obtained from product data sheet or user’s manual.

DEVICE TYPE	ARTIK-0530		
Operating Frequency	2 402 MHz ~ 2 480 MHz (Bluetooth, Bluetooth Low Energy), 2 405 MHz ~ 2 475 MHz (Zigbee), 2 412 MHz ~ 2 462 MHz (11b/g/n_HT20), 5 745 MHz ~ 5 825 MHz (UNII 3: 11a/n_HT20), 5 755 MHz ~ 5 795 MHz (UNII 3: 11n_HT40), 5 180 MHz ~ 5 240 MHz (UNII 1: 11a/n_HT20), 5 190 MHz ~ 5 230 MHz (UNII 1: 11n_HT40), 5 260 MHz ~ 5 320 MHz (UNII 2A: 11a/n_HT20), 5 270 MHz ~ 5 310 MHz (UNII 2A: 11n_HT40), 5 500 MHz ~ 5 720 MHz (UNII 2C: 11a/n_HT20), 5 510 MHz ~ 5 710 MHz (UNII 2C: 11n_HT40),		
Modulation Type	DSSS, OFDM, GFSK, $\pi/4$ DQPSK, 8DPSK		
Number of Channels	79 channel (Bluetooth), 40 channel (Bluetooth Low Energy), 15 channel (Zigbee), 11 channel (11b/g/n_HT20), 5 channel (UNII 3: 11a/n_HT20), 2 channel (UNII 3: 11n_HT40), 4 channel (UNII 1: 11a/n_HT20), 2 channel (UNII 1: 11n_HT40), 4 channel (UNII 2A: 11a/n_HT20), 2 channel (UNII 2A: 11n_HT40), 9 channel (UNII 2C: 11a/n_HT20), 4 channel (UNII 2C: 11n_HT40)		
Antenna Type	Dipole antenna, FLEX antenna		
Antenna Gain	Dipole antenna	Bluetooth(BDR / EDR / LE), Zigbee WLAN 2.4 GHz Band	3.80 dBi
	FLEX antenna	Zigbee	3.20 dBi
	Dipole antenna	WLAN 5 GHz Band	5.50 dBi

2.2 Alternative type(s)/model(s); also covered by this test report.

-. None

3. MAXIMUM PERMISSIBLE EXPOSURE

3.1 RF Exposure Calculation

According to the FCC rule 1.1310 table 1B, the limit for the maximum permissible RF exposure for an uncontrolled environment are $f/1500$ mW/cm² for the frequency range between 300 MHz and 1 500 MHz and 1.0 mW/cm² for the frequency range between 1 500 MHz and 100 000 MHz.

The electric field generated for a 1 mW/cm² exposure is calculated as follows:

$$E = \sqrt{(30 * P * G) / d}, \text{ and } S = E^2 / Z = E^2 / 377, \text{ because } 1 \text{ mW/cm}^2 = 10 \text{ W/m}^2$$

Where

S = Power density in mW/cm², Z = Impedance of free space, 377 Ω

E = Electric field strength in V/m, G = Numeric antenna gain, and d = distance in meter

Combining equations and rearranging the terms to express the distance as a function of the remaining variable

$$d = \sqrt{(30 * P * G) / (377 * 10 S)}$$

Changing to units of mW and cm, using P (mW) = P (W) / 1 000, d (cm) = 0.01 * d (m)

$$d = 0.282 * \sqrt{(P * G) / S}$$

Where

d = distance in cm, P = Power in mW, G = Numeric antenna gain, and S = Power density in mW/cm²

3.2 Test Result for Bluetooth LE

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
		(dBm)	(dBm)	(mW)	Log	Linear			
2 402 ~ 2 480	LE	6.0 ± 0.5	6.50	4.47	3.80	2.40	0.92	0.002 1	1.00

According to above table, for 2 402 MHz ~ 2 480 MHz Band, safe distance,

$$D = 0.282 * \sqrt{(4.47 * 2.40) / 1.00} = 0.92 \text{ cm}$$

For getting power density at 20 cm separation in above table, following formula was used.

$$S = P * G / (4\pi * R^2) = 4.47 * 2.40 / (4 * 3.14 * 20^2) = 0.002 1$$

Where:

S = Power Density,

P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),

G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna



Tested by: Tae-Ho, Kim / Senior Manager

3.3 Test Result for Bluetooth

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
		(dBm)	(dBm)	(mW)	Log	Linear			
2 402 ~ 2 480	1 Mbps	7.0 ± 0.5	7.50	5.62	3.80	2.40	1.04	0.002 7	1.00
	2 Mbps	6.5 ± 0.5	7.00	5.01			0.98	0.002 4	
	3 Mbps	7.0 ± 0.5	7.50	5.62			1.04	0.002 7	

According to above table, for 2 402 MHz ~ 2 480 MHz Band, safe distance,

$$D = 0.282 * \sqrt{(5.62 * 2.40) / 1.00} = 1.04 \text{ cm}$$

For getting power density at 20 cm separation in above table, following formula was used.

$$S = P * G / (4\pi * R^2) = 5.62 * 2.40 / (4 * 3.14 * 20^2) = 0.002 7$$

Where:

S = Power Density,

P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),

G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna



Tested by: Tae-Ho, Kim / Senior Manager

3.4 Test Result for Zigbee

3.4.1 DATA For Dipole Antenna

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
		(dBm)	(dBm)	(mW)	Log	Linear			
2 402 ~ 2 480	Zigbee	16.0 ± 0.5	16.50	44.67	3.80	2.40	2.92	0.021 3	1.00

According to above table, for 2 402 MHz ~ 2 480 MHz Band, safe distance,

$$D = 0.282 * \sqrt{(44.67 * 2.40) / 1.00} = 2.92 \text{ cm}$$

For getting power density at 20 cm separation in above table, following formula was used.

$$S = P * G / (4\pi * R^2) = 44.67 * 2.40 / (4 * 3.14 * 20^2) = 0.021 3$$

Where:

S = Power Density,

P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),

G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna

3.4.2 DATA For FLEX Antenna

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
		(dBm)	(dBm)	(mW)	Log	Linear			
2 402 ~ 2 480	Zigbee	16.0 ± 0.5	16.50	44.67	3.20	2.09	2.72	0.018 6	1.00

According to above table, for 2 402 MHz ~ 2 480 MHz Band, safe distance,

$$D = 0.282 * \sqrt{(44.67 * 2.09) / 1.00} = 2.72 \text{ cm}$$

For getting power density at 20 cm separation in above table, following formula was used.

$$S = P * G / (4\pi * R^2) = 44.67 * 2.09 / (4 * 3.14 * 20^2) = 0.018 6$$

Where:

S = Power Density,

P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),

G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna



Tested by: Tae-Ho, Kim / Senior Manager

3.6 Test Result for WLAN 2.4 GHz Band

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
		(dBm)	(dBm)	(mW)	Log	Linear			
2 400 ~ 2 483.5	802.11b	14.5 ± 0.5	15.00	31.62	3.80	2.40	2.46	0.015 1	1.00
	802.11g	14.5 ± 0.5	15.00	31.62			2.46	0.015 1	1.00
	802.11n_HT20	12.5 ± 0.5	13.00	19.95			1.95	0.009 5	1.00

According to above table, for 2 400 ~ 2 483.5 MHz Band, safe distance,

$$D = 0.282 * \sqrt{(31.62 * 2.40)/1.00} = 2.46 \text{ cm}$$

For getting power density at 20 cm separation in above table, following formula was used.

$$S = P * G / (4\pi * R^2) = 31.62 * 2.40 / (4 * 3.14 * 20^2) = 0.015 1$$

Where:

S = Power Density,

P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),

G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna



Tested by: Tae-Ho, Kim / Senior Manager

3.7 Test Result for WLAN 5 GHz Band

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
		(dBm)	(dBm)	(mW)	Log	Linear			
5 150 ~ 5 250	802.11a	13.0 ± 0.5	13.50	22.39	5.50	3.55	2.51	0.015 8	1.00
	802.11n_HT20	13.0 ± 0.5	13.50	22.39			2.51	0.015 8	1.00
	802.11n_HT40	13.0 ± 0.5	13.50	22.39			2.51	0.015 8	1.00
5 250 ~ 5 350	802.11a	13.0 ± 0.5	13.50	22.39	5.50	3.55	2.51	0.015 8	1.00
	802.11n_HT20	13.0 ± 0.5	13.50	22.39			2.51	0.015 8	1.00
	802.11n_HT40	13.0 ± 0.5	13.50	22.39			2.51	0.015 8	1.00
5 470 ~ 5 725	802.11a	13.0 ± 0.5	13.50	22.39	5.50	3.55	2.51	0.015 8	1.00
	802.11n_HT20	13.0 ± 0.5	13.50	22.39			2.51	0.015 8	1.00
	802.11n_HT40	13.0 ± 0.5	13.50	22.39			2.51	0.015 8	1.00
5 725 ~ 5 850	802.11a	10.0 ± 0.5	10.50	11.22	5.50	3.55	1.78	0.007 9	1.00
	802.11n_HT20	10.0 ± 0.5	10.50	11.22			1.78	0.007 9	1.00
	802.11n_HT40	10.0 ± 0.5	10.50	11.22			1.78	0.007 9	1.00

According to above table, for 5 150 ~ 5 250 MHz Band, safe distance,

$$D = 0.282 * \sqrt{(22.39 * 3.55)/1.00} = 2.51 \text{ cm.}$$

For getting power density at 20 cm separation in above table, following formula was used.

$$S = P * G / (4\pi * R^2) = 22.39 * 3.55 / (4 * 3.14 * 20^2) = 0.015 8$$

Where:

S = Power Density,

P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),

G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna



Tested by: Tae-Ho, Kim / Senior Manager

3.8 Calculation Result Of Multiple Antenna

3.8.1 Test Data for Dipole Antenna (Zigbee)

Operating Mode	Target Power W/tolerance	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
	(dBm)	(dBm)	(mW)	Log	Linear			
Bluetooth LE + Zigbee	6.0 ± 0.5	6.50	4.47	3.80	2.40	0.92	0.002 1	1.00
	16.0 ± 0.5	16.50	44.67	3.80	2.40	2.92	0.021 3	
Bluetooth(1 Mbps) + Zigbee	7.0 ± 0.5	7.50	5.62	3.80	2.40	1.04	0.002 7	1.00
	16.0 ± 0.5	16.50	44.67	3.80	2.40	2.92	0.021 3	
WLAN 2 GHz(802.11 b) + Zigbee	14.5 ± 0.5	15.00	31.62	3.80	2.40	2.46	0.015 1	1.00
	16.0 ± 0.5	16.50	44.67	3.80	2.40	2.92	0.021 3	
WLAN 5 GHz(802.11 a _UNII 1) + Zigbee	13.0 ± 0.5	13.50	22.39	5.50	3.55	2.51	0.015 8	1.00
	16.0 ± 0.5	16.50	44.67	3.80	2.40	2.92	0.021 3	

Bluetooth LE + Zigbee = (0.002 1 / 1) + (0.021 3 / 1) = 0.023 4

Bluetooth(1 Mbps) + Zigbee = (0.002 7 / 1) + (0.021 3 / 1) = 0.024 0

WLAN 2 GHz(802.11 b) + Zigbee = (0.015 1 / 1) + (0.021 3 / 1) = 0.036 4

WLAN 5 GHz(802.11 a _UNII 1) + Zigbee = (0.015 8 / 1) + (0.021 3 / 1) = 0.037 1

- Therefore the maximum calculations of above situations are less than the “1” limit.



Tested by: Tae-Ho, Kim / Senior Manager

3.8.2 Test Data for FLEX Antenna (Zigbee)

Operating Mode	Target Power W/tolerance	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
	(dBm)	(dBm)	(mW)	Log	Linear			
Bluetooth LE + Zigbee	6.0 ± 0.5	6.50	4.47	3.80	2.40	0.92	0.002 1	1.00
	16.0 ± 0.5	16.50	44.67	3.20	2.09	2.72	0.018 6	
Bluetooth(1 Mbps) + Zigbee	7.0 ± 0.5	7.50	5.62	3.80	2.40	1.04	0.002 7	1.00
	16.0 ± 0.5	16.50	44.67	3.20	2.09	2.72	0.018 6	
WLAN 2 GHz(802.11 b) + Zigbee	14.5 ± 0.5	15.00	31.62	3.80	2.40	2.46	0.015 1	1.00
	16.0 ± 0.5	16.50	44.67	3.20	2.09	2.72	0.018 6	
WLAN 5 GHz(802.11 a _UNII 1) + Zigbee	13.0 ± 0.5	13.50	22.39	5.50	3.55	2.51	0.015 8	1.00
	16.0 ± 0.5	16.50	44.67	3.20	2.09	2.72	0.018 6	

Bluetooth LE + Zigbee = (0.002 1 / 1) + (0.018 6 / 1) = 0.020 7

Bluetooth(1 Mbps) + Zigbee = (0.002 7 / 1) + (0.018 6 / 1) = 0.021 3

WLAN 2 GHz(802.11 b) + Zigbee = (0.015 1 / 1) + (0.018 6 / 1) = 0.033 7

WLAN 5 GHz(802.11 a _UNII 1) + Zigbee = (0.015 8 / 1) + (0.018 6 / 1) = 0.034 4

- Therefore the maximum calculations of above situations are less than the “1” limit.



Tested by: Tae-Ho, Kim / Senior Manager