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RF EXPOSURE EVALUATION Maximal Permissible Exposure [MPE]

Applicant Name:

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Date of Testing:

12/27/2017 - 1/26/2018

Test Site/Location:

PCTEST Lab. Columbia, MD, USA

Test Report Serial No.:

1M1712270335-03-R2.A3L

FCC ID:

A3LSFG-D0100

APPLICANT:

Samsung Electronics Co., Ltd.

EUT Type:

Indoor Customer Premise Equipment (CPE)

FCC Classification:

Part 30 Transportable Transmitter (5GT)

FCC Rule Part:

FCC Part 1 (§1.1310) and Part 2 (§2.1091)

Test Procedure(s):

KDB 447498 D01

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in FCC KDB 447498 D01. Test results reported herein relate only to the item(s) tested.

This revised Test Report (S/N: 1M1712270335-03-R2.A3L) supersedes and replaces the previously issued test report (S/N: 1M1712270335-03-R1.A3L) on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.



Randy Ortanez
President



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1.0 RF EXPOSURE EVALUATION – MAXIMUM PERMISSIBLE EXPOSURE (MPE)

1.1 Introduction

This document is prepared to show compliance with the RF Exposure requirements as required in §1.1310 of the FCC Rules and Regulations and RSS-102 of Industry Canada.

The limit for Maximum Permissible Exposure (MPE), specified in FCC §1.1310, is listed in Table 1-1. According to FCC §1.1310 and RSS-102: the criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b).

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Average Time (Minutes)
(A) Limits For Occupational / Control Exposures (f = frequency)				
30-300	61.4	0.163	1.0	6
300-1500	...	...	f/300	6
1500-100,000	...	...	5.0	6
(B) Limits For General Population / Uncontrolled Exposure (f = frequency)				
30-300	27.5	0.073	0.2	30
300-1500	...	...	f/1500	30
1500-100,000	...	...	1.0	30

Table 1-1. Limits for Maximum Permissible Exposure (MPE)

1.2 EUT Description

The **Samsung Indoor Customer Premise Equipment (CPE) FCC ID: A3LSFG-D0100** is a device supporting mmWave (5G) and Bluetooth LE operation. The 5G mmWave operates over two cross-polarized antenna arrays where each array consists of 32 radiating elements. The 32 elements cannot be controlled individually but are rather controlled by a Beam ID. The output power of each element is 5.9dBm. When all 32 elements are simultaneously transmitting and the elements are added in-phase, the total radiated power is $5.9 + 10\log_{10}(32*32) = 36\text{dBm}$. Additionally, there is a manufacturing tolerance of $\pm 5\text{dBm}$.

Per the 5GTF specification, the 5G mmWave operates with a radio frame length of 10ms (50 subframes per 10ms frame) and this device operates using a 4:1 ratio for DL/UL, where the UL is from the CPE device. The 4:1 ratio for DL/UL operation is fixed and cannot be changed by the end user. Within each 10ms frame there are 700 symbols, of which 568 symbols are downlink (AU) and the remaining 132 symbols are uplink (CPE). Thus, $132/700 = 18.9\%$ duty cycle for the CPE.

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1.3 MPE Requirements Overview

Several different categories of transmitters are defined in FCC KDB 447498 D01 as follows:

- **Mobile Devices:** a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to be generally used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons. Transmitters designed to be used by consumers or workers that can be easily re-located, such as a wireless modem operating in a laptop computer, are considered mobile devices if they meet the 20 centimeter separation requirement. The FCC rules for evaluating mobile devices for RF compliance are found in 47 CFR §2.1091.
- **Portable Devices:** a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user. Portable device requirements are found in Section 2.1093 of the FCC's Rules (47 CFR§2.1093).

The FCC also categorizes the use of the device as based upon the user's awareness and ability to exercise control over his or her exposure. The two categories defined are Occupational/ Controlled Exposure and General Population/Uncontrolled Exposure. These two categories are defined as follows:

- **Occupational/Controlled Exposure:** In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate, warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on methods to minimize such exposure risks.
- **General Population/Uncontrolled Exposure:** The general population / uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category, and the general population/uncontrolled exposure limits apply to these devices.

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1.4 Procedure

The procedure used to determine the RF power density was based upon a calculation for determining compliance with the MPE requirements.

The power generated by the mmWave transmitter and the Bluetooth LE transmitter used in this product was measured in a radiated setup. The theoretical EIRP from each mmWave antenna array, per the Tune-Up Document, is 36dBm. Additionally, there is a ± 5 dB manufacturing tolerance on the EIRP so the maximum output power used for the power density evaluation is 41dBm for each antenna array. The maximum average Bluetooth LE power is 0dBm.

Through use of the Friis transmission formula, the maximum EIRP, and knowledge of the operational duty cycle, the power density level is calculated at a distance of 20cm.

Friis Transmission Formula

Friis transmission formula: $P_d = (P_{out} * G) / (4\pi r^2)$

Where,

P_d = Power Density (mW/cm²)

$\pi = 3.1416$

P_{out} = output power to antenna (mW)

r = distance between observation point and center of the radiator (cm)

G = gain of antenna in linear scale

Calculated MPE

The power density limit for General Population/Uncontrolled Exposure at each frequency is determined based on the information in Table 1-1.

Frequency	27925 MHz		
Limit	1.000 mW/cm ²		
Distance (cm), R =	20 cm		
EIRP (dBm), PG =	39.06 dBm	8053.78 mW	
Duty Cycle (%), DC =	18.9 %		
Average EIRP, PGavg =	31.82 dBm	1522.17 mW	
Power Density (S) =	0.3028 mW/cm ²	(at 20cm)	

Table 1-2. Calculated MPE Data for 5G mmWave (Ant A)

Frequency:	27900 MHz		
Limit:	1.000 mW/cm ²		
Distance (cm), R =	20 cm		
EIRP (dBm), PG =	39.29 dBm	8491.80 mW	
Duty Cycle (%), DC =	18.9 %		
Average EIRP, PGavg =	32.05 dBm	1604.95 mW	
Power Density (S) =	0.3193 mW/cm ²	(at 20cm)	

Table 1-3. Calculated MPE Data for 5G mmWave (Ant B)

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Frequency	2440 MHz		
Limit	1.000 mW/cm ²		
Distance (cm), R =	20 cm		
EIRP (dBm), PG =	0 dBm	1.00 mW	
TX Ant Gain (dB), G =	3.74 dBi		
Power Density (S) =	0.0005 mW/cm ²	(at 20cm)	

Table 1-4. Calculated MPE Data for 2.4GHz Band Bluetooth LE

	Power Density (mW/cm ²)	Limit (mW/cm ²)	Percent MPE Used (%)
Transmitter #1	0.3028	1.000	30.28
Transmitter #2	0.3193	1.000	31.93
Transmitter #3	0.0005	1.000	0.047
Total			62.26

Table 1-5. Co-location MPE Data for Simultaneous Transmission

Note: The power densities of all antennas are summed to demonstrate worst case RF Exposure although the output of the antennas themselves are not correlated.

1.5 Summary of Results

Frequency Band [MHz]	Corrected Maximum EIRP [dBm]	MPE @ 20cm (mW/cm ²)	Test Result
27925 (Ant A)	31.82	0.3028	PASS
27900 (Ant B)	32.05	0.3193	PASS
2440	-15.32	0.0005	PASS

Table 1-6. Maximum Permissible Exposure Summary Table

Note: This device is categorically excluded from routine environmental evaluation for RF Exposure since the maximum combined EIRP from all antennas (i.e. 31.82dBm + 32.05dBm + 3.74dBm = 34.95dBm = 3.126W) is less than the 3 Watt ERP (4.92 Watt) limit specified in §2.1091(c)(1)(ii).

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2.0 CONCLUSION

The device meets the mobile RF exposure limit at a 20cm separation distance as specified in §2.1091 of the FCC Rules and Regulations. An appropriate RF exposure compliance statement will be placed in the user's manual.

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